BUY SMART. BUILD BETTER.

JOB ORDER CONTRACT
TECHNICAL SPECIFICATIONS

BOOK 3 OF 5 CSI DIVISIONS 14 - 22 DECEMBER 2014

COUNTY OF LOS ANGELES
INTERNAL SERVICES DEPARTMENT

GORDIAN
JOC SOLUTIONS

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SECTION 14 01 20 00 - ELECTRIC TRACTION ELEVATORS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for electric traction elevators. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes electric traction passenger and service elevators.

C. Definitions
1. Definitions in ASME A17.1 apply to work of this Section.
2. Defective Elevator Work: Operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.
3. Service Elevator: A passenger elevator that is also used to carry freight.

D. Submittals
1. Product Data: Include capacities, sizes, performances, operations, safety features, finishes, and similar information. Include product data for the following:
   a. Car enclosures and hoistway entrances.
   b. Operation, control, and signal systems.
2. Shop Drawings: Show plans, elevations, sections, and large-scale details indicating service at each landing, machine room layout, coordination with building structure, relationships with other construction, and locations of equipment and signals. Include large-scale layout of car control station and standby power operation control panel, **as directed**. Indicate variations from specified requirements, maximum dynamic and static loads imposed on building structure at points of support, and maximum and average power demands.
3. Samples: For exposed finishes of cars, hoistway doors and frames, and signal equipment; 3-inch- (75-mm-) square Samples of sheet materials; and 4-inch (100-mm) lengths of running trim members.
4. Manufacturer Certificates: Signed by elevator manufacturer certifying that hoistway, pit, and machine room layout and dimensions, as shown on Drawings, and electrical service, as shown and specified, are adequate for elevator system being provided.
5. Qualification Data: For Installer.
6. Operation and Maintenance Data: For elevators to include in emergency, operation, and maintenance manuals.
7. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.
8. Warranty: Special warranty specified in this Section.

E. Quality Assurance
1. Installer Qualifications: Elevator manufacturer or manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
2. Source Limitations: Obtain elevators, including hydraulic passenger elevators specified in another Division 14 Section, through one source from a single manufacturer.
   a. Provide major elevator components, including driving machines, controllers, signal fixtures, door operators, car frames, cabs, and entrances, manufactured by a single manufacturer.
3. Regulatory Requirements: Comply with ASME A17.1 and elevator design requirements for earthquake loads in ASCE 7.

a. Effective peak velocity acceleration (Av) for Project's location is less than 0.10 (seismic risk zones 0 and 1) **OR** greater than or equal to 0.10, but less than 0.20 (seismic risk zone 2) **OR** greater than or equal to 0.20 (seismic risk zones 3 and 4), **as directed**.
b. Provide earthquake equipment required by ASME A17.1.
c. Design earthquake spectral response acceleration, short period (Sds) for Project is determined by Project's location and site classification.
d. Project's seismic design category is A **OR** B **OR** C **OR** D, **as directed**.
e. Elevator importance factor is 1.5 **OR** 1.0, **as directed**.

4. Accessibility Requirements: Comply with Section 4.10 in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)" **OR** 407 in ICC A117.1, **as directed**.
5. Fire-Rated Hoistway Entrance Assemblies: Door and frame assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing at as close to neutral pressure as possible according to NFPA 252 **OR** UBC Standard 7-2 **OR** UL 10B, **as directed**.

F. Delivery, Storage, And Handling
1. Deliver, store, and handle materials, components, and equipment in manufacturer's protective packaging.
2. Store materials, components, and equipment off of ground, under cover, and in a dry location. Handle according to manufacturer's written recommendations to prevent damage, deterioration, or soiling.

G. Coordination
1. Coordinate installation of sleeves, block outs, elevator equipment with integral anchors, and other items that are embedded in concrete or masonry for elevator equipment. Furnish templates, sleeves, elevator equipment with integral anchors, and installation instructions and deliver to Project site in time for installation.
2. Coordinate sequence of elevator installation with other work to avoid delaying the Work.
3. Coordinate locations and dimensions of other work relating to electric traction elevators including pit ladders, sumps, and floor drains in pits; entrance subsills; machine beams, **as directed**; and electrical service, electrical outlets, lights, and switches in pits and machine rooms **OR** hoistways, **as directed**.

H. Warranty
1. Special Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to repair, restore, or replace defective elevator work within specified warranty period.
a. Warranty Period: One year from date of Substantial Completion.

1.2 PRODUCTS

A. Non-Proprietary Systems And Components
1. General: Provide manufacturer's standard elevator systems. Where components are not otherwise indicated, provide standard components published by manufacturer as included in standard preengineered elevator systems and as required for complete system.
2. Elevator Machines: Provide variable-voltage, variable-frequency, ac-type hoisting machines **OR** At manufacturer's option, provide either variable-voltage, variable-frequency, ac-type or variable-voltage, dc-type hoisting machines, **as directed**. Provide solid-state power converters.
a. Provide regenerative **OR** nonregenerative, **as directed**, system.
b. Limit total harmonic distortion of regenerated power to 5 percent per IEEE 519.
c. Provide means for absorbing regenerated power when elevator system is operating on standby power.
d. Provide line filters or chokes to prevent electrical peaks or spikes from feeding back into building power system.

3. Fluid for Oil Buffers: If oil buffers are used, use only fire-resistant hydraulic fluid containing antioxidant, anticorrosive, antifoaming, and metal-passivating additives.
4. Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing guide rails, machinery, and other components of elevator work where installation of devices is specified in another Section.
5. Machine Beams: Provide framing to support elevator hoisting machine and deflector sheaves from the building structure. Comply with Division 5 Section "Metal Fabrications" for materials and fabrication.
6. Car Frame and Platform: Welded steel units.
7. Guides: Provide roller guides **OR** polymer-coated, nonlubricated sliding guides, **as directed**, at top and bottom of car and counterweight frames.

B. Non-Proprietary Operation Systems and Components
1. General: Provide manufacturer's standard microprocessor operation system for each elevator **OR** for each group of elevators, **as directed**, as required to provide type of operation system indicated.
2. Group Automatic Operation with Demand-Based Dispatching: Provide reprogrammable, **as directed**, group automatic system that assigns cars to hall calls based on a dispatching program designed to minimize passenger waiting time. System automatically adjusts to changes in demand for different traffic conditions including heavy incoming, heavy two-way, heavy outgoing, and light off-hours as variations of normal two-way traffic.
3. Destination-Based Group Automatic Operation: Provide reprogrammable group automatic system that assigns elevators leaving the main lobby in the up direction to a selected group of floors and directs passengers to an elevator serving their destination floor. System dispatches cars in a regulated sequence for optimum system efficiency; dispatch is based on origin and destination of calls. System automatically adjusts to changes in demand for different traffic conditions including heavy incoming, heavy two-way, heavy outgoing, and light off-hours as variations of normal two-way traffic.
4. Auxiliary **OR** Single-Car Auxiliary, **as directed**, Operations: In addition to primary operation system features, provide the following operational features for elevators where indicated:
   a. Standby Power Operation: On activation of standby power, car is returned to a designated floor and parked with doors open. Car can be manually put in service on standby power, either for return operation or for regular operation, by switches in control panel located at main lobby **OR** fire command station, **as directed**. Manual operation causes automatic operation to cease.
   b. Standby Powered Lowering: On activation of standby power, if car is at a floor, it remains at that floor, opens its doors, and shuts down. If car is between floors, it is lowered to the next floor below, opens its doors, and shuts down.
   c. Battery-Powered Lowering: If power fails and car is at a floor, it remains at that floor, opens its doors, and shuts down. If car is between floors, it is lowered to the next floor below, opens its doors, and shuts down. System includes rechargeable battery and automatic recharging system.
   d. Automatic Dispatching of Loaded Car: When car load exceeds 80 percent of rated capacity, doors will begin closing.
   e. Nuisance Call Cancel: When car calls exceed a preset number while car load is less than a predetermined weight, all car calls are canceled. Preset number of calls and predetermined weight, **as directed**, can be adjusted.
5. Group Auxiliary Operations: In addition to primary operation system features, provide the following operational features for elevators and elevator groups where indicated:
   a. Standby Power Operation: On activation of standby power, cars are returned to a designated floor and parked with doors open. One car is returned at a time, with priority given to loaded cars. If a car cannot be returned after two attempts, it is removed from the system. When all cars have been returned or removed from the system, one car is automatically placed in service. If car selected for service cannot operate within 60 seconds, the system removes car from service and places another car in service. Cars can be manually put in service on standby power, either for return operation or for regular

operation, by switches in control panel located at main lobby **OR** fire command station, **as directed**. Manual operation causes automatic operation to cease.

b. Standby Power Operation: On activation of standby power, cars are returned, one at a time, to a designated floor and parked with doors open. If a car cannot be returned, it is removed from the system. When all cars have been returned or removed from the system, one car can be put in service on standby power by a selector switch in control panel located at main lobby **OR** fire command station, **as directed**.

c. Battery-Powered Lowering: If power fails, cars that are at a floor remain at that floor, open their doors, and shut down. Cars that are between floors are lowered one at a time to the next floor below, open their doors, and shut down. System includes rechargeable battery and automatic recharging system.

d. Automatic Dispatching of Loaded Car: When car load exceeds 80 percent of rated capacity, doors will begin closing.

e. Nuisance Call Cancel: When car calls exceed a preset number while the car load is less than a predetermined weight, all car calls are canceled. Preset number of calls and predetermined weight, **as directed**, can be adjusted.

f. Emergency Hospital **OR** Priority, **as directed**, Service: Service is initiated by a keyswitch **OR** card reader **OR** remote switch, **as directed**, at designated floors. One elevator is removed from group operation and directed to the floor where service was initiated. On arriving at the floor, elevator opens its doors and parks and a lighted sign directs passengers to exit elevator, **as directed**. Car is placed in operation by selecting a floor and pressing door close button or by operating keyswitch to put car in independent service. After responding to floor selected or being removed from independent service, car is returned to group operation. If car is not placed in operation within a preset time after being called, it is returned to group operation.

g. Independent Service: Keyswitch in car control station removes car from group operation and allows it to respond only to car calls. Key cannot be removed from keyswitch when car is in independent service. When in independent service, doors close only in response to door close button.

h. Loaded-Car Bypass: When car load exceeds 80 percent of rated capacity, car will respond only to car calls, not to hall calls.

i. Distributed Parking: When cars are not required for response to calls, they are parked with doors closed, distributed in predetermined zones throughout the building. One zone shall include the main floor and adjacent floors; remaining floors shall be divided into approximately equal zones.

6. Security Features: Provide the following security features, where indicated. Security features shall not affect emergency firefighters' service.

a. Card-Reader Operation: System uses card readers at car control stations **OR** hall push-button stations, **as directed**, to authorize calls. Security system determines which landings and at what times calls require authorization by card reader. Provide required conductors in traveling cable and panel in machine room for interconnecting card readers, other security access system equipment, and elevator controllers. Allow space as indicated for card reader in car **OR** Provide stripe-swipe card reader integral with each car control station, **as directed**.

1) Security access system equipment is specified in Division 28 Section "Access Control".

OR

Security access system equipment is not in the Contract.

b. Keyswitch Operation: Push buttons are activated and deactivated by security keyswitches at car control stations **OR** hall push-button stations, **as directed**. Key is removable only in deactivated position **OR** in either position, **as directed**.

c. Keypad Operation: Allows each landing to be restricted or unrestricted. When a restricted landing button is pressed, a "Restricted Floor" lamp lights and remains lit until landing access code has been entered into a keypad or predetermined time period has elapsed.

Car calls for restricted landings do not register until landing access code is entered into keypad within predetermined time period after landing button is pressed.

1) Access codes are programmed at each car operating panel using a security keyswitch. Keypad operation can be activated and deactivated by security keyswitch at main landing.

d. Car-to-Lobby Feature: Feature, activated by keyswitch at main lobby, that causes car **OR** all cars in a group, **as directed**, to return immediately to lobby and open doors for inspection. On deactivation by keyswitch, calls registered before keyswitch activation are completed and normal operation is resumed.

C. Door Reopening Devices

1. Infrared Array: Provide door reopening devices with uniform array of 36 or more microprocessor-controlled, infrared light beams projecting across car entrance. Interruption of one or more of the light beams shall cause doors to stop and reopen.
2. Nudging Feature: After car doors are prevented from closing for predetermined adjustable time, through activating door reopening device, a loud buzzer shall sound and doors shall begin to close at reduced kinetic energy.

D. Finish Materials

1. General: Provide the following materials for exposed parts of elevator car enclosures, car doors, hoistway entrance doors and frames, and signal equipment as indicated.
2. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, commercial steel, Type B, exposed, matte finish.
3. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, commercial steel, Type B, pickled.
4. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304.
   a. Textured Stainless-Steel Sheet: Product with coined **OR** embossed, **as directed**, texture rolled into exposed surface.
      1) Metal surface is satin polished **OR** satin relieved **OR** titanium nitride colored **OR** oxide colored **OR** satin polished and titanium nitride colored **OR** satin relieved and titanium nitride colored **OR** satin polished and oxide colored **OR** satin relieved and oxide colored **OR** color coated and satin relieved **OR** color coated and bright relieved, **as directed**, after rolling.
5. Stainless-Steel Bars: ASTM A 276, Type 304.
6. Stainless-Steel Tubing: ASTM A 554, Grade MT 304.
7. Bronze Plate and Sheet: ASTM B 36/B 36M, Alloy UNS No. C28000 (muntz metal).
8. Bronze Extrusions: ASTM B 455, Alloy UNS No. C38500 (architectural bronze).
9. Bronze Tubing: ASTM B 135 (ASTM B 135M), Alloy UNS No. C23000 (red brass, 85 percent copper).
10. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063.
11. Nickel Silver Extrusions: ASTM B 151/B 151M, Alloy UNS No. C74500 or No. C77600.
12. Plastic Laminate: High-pressure type complying with NEMA LD 3, Type HGS for flat applications **OR** Type HGL for flat applications, **as directed**, Type HGP for postformed applications and Type BKV for panel backing.

E. Car Enclosures

1. General: Provide enameled-steel car enclosures to receive removable **OR** steel-framed car enclosures with nonremovable, **as directed**, wall panels, with car **OR** removable car, **as directed**, roof, access doors, power door operators, and ventilation.
   a. Provide standard railings complying with ASME A17.1 on car tops where required by ASME A17.1.
   b. Provide finished car including materials and finishes specified below.
2. Materials and Finishes: Provide manufacturer's standards, but not less than the following:
   a. Subfloor: Underlayment grade, exterior plywood, 5/8-inch (16-mm) nominal thickness.
   b. Floor Finish: Specified in a Division 9 Section **OR** Elevator manufacturer's standard level-loop nylon carpet; color as selected from manufacturer's full range, **as directed**.

c. Enameled-Steel Wall Panels: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel finish; colors as selected from manufacturer's full range.
d. Stainless-Steel Wall Panels: Flush, hollow-metal construction; fabricated from stainless-steel sheet.
e. Bronze Wall Panels: Flush, hollow-metal construction; fabricated from bronze sheet.
f. Plastic-Laminate Wall Panels: Plastic laminate adhesively applied to 1/2-inch (13-mm) fire-retardant-treated particleboard **OR** manufacturer's standard honeycomb core, **as directed**, with plastic-laminate panel backing and, **as directed**, manufacturer's standard protective edge trim. Panels have a flame-spread index of 25 **OR** 75, **as directed**, or less, when tested according to ASTM E 84. Plastic-laminate color, texture, and pattern as selected from plastic-laminate **OR** elevator, **as directed**, manufacturer's full range.
g. Fabricate car with recesses and cutouts for signal equipment.
h. Fabricate car door frame integrally with front wall of car.
i. Enameled-Steel Doors: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel finish; colors as selected from manufacturer's full range.
j. Stainless-Steel Doors: Flush, hollow-metal construction; fabricated from stainless-steel sheet **OR** by laminating stainless-steel sheet to exposed faces and edges of enameled cold-rolled steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning, **as directed**.
k. Bronze Doors: Flush, hollow-metal construction; fabricated by laminating bronze sheet to exposed faces and edges of enameled cold-rolled steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning.
l. Plastic-Laminate Doors: Flush, hollow-metal construction; fabricated by laminating plastic laminate to exposed faces of enameled cold-rolled steel doors and covering edges with protective edge trim matching return panels, **as directed**. Plastic-laminate color, texture, and pattern as selected from plastic-laminate **OR** elevator, **as directed**, manufacturer's full range.
m. Sight Guards: Provide sight guards on car doors.
n. Sills: Extruded metal, with grooved surface, 1/4 inch (6.4 mm) thick.
o. Luminous Ceiling: Fluorescent light fixtures and ceiling panels of translucent acrylic or other permanent rigid plastic.
p. Metal **OR** Metallic-Finish, Plastic-Laminate, **as directed**, Ceiling: Flush panels, with incandescent downlights in the center of **OR** four low-voltage downlights in, **as directed**, each panel. Align ceiling panel joints with joints between wall panels, **as directed**.
q. Handrails: Manufacturer's standard handrails, of shape, metal, and finish indicated.

F. Hoistway Entrances
1. General: Provide manufacturer's standard horizontal-sliding, door-and-frame hoistway entrances complete with track systems, hardware, sills, and accessories. Provide frame size and profile to coordinate with hoistway wall construction.
   a. Where gypsum board wall construction is indicated, provide self-supporting frames with reinforced head sections.
2. Materials and Fabrication: Provide manufacturer's standards, but not less than the following:
   a. Enameled-Steel Frames: Formed from cold-rolled or hot-rolled steel sheet. Provide with factory-applied enamel finish; colors as selected from manufacturer's full range.
   b. Steel Subframes: Formed from cold-rolled or hot-rolled steel sheet with factory-applied enamel finish or corrosion-inhibiting primer. Fabricate to receive applied finish as indicated.
   c. Stainless-Steel Frames: Formed from stainless-steel sheet.
   d. Bronze Frames: Formed from cold-rolled or hot-rolled steel sheet, with enamel finish, and with formed-bronze sheet laminated to steel frames using adhesive that fully bonds metal to metal without telegraphing or oil-canning.

e. Enameled-Steel Doors and Transoms: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel finish; colors as selected from manufacturer's full range.
f. Stainless-Steel Doors and Transoms: Flush, hollow-metal construction; fabricated from stainless-steel sheet **OR** by laminating stainless-steel sheet to exposed faces and edges of enameled cold-rolled steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning, **as directed**.
g. Bronze Doors and Transoms: Flush, hollow-metal construction; fabricated by laminating bronze sheet to exposed faces and edges of enameled cold-rolled steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning.
h. Plastic-Laminate Doors and Transoms: Flush, hollow-metal construction; fabricated by laminating plastic laminate to exposed faces of enameled cold-rolled steel doors and covering edges with protective edge trim matching door frames, **as directed**. Plastic-laminate color, texture, and pattern as selected from plastic-laminate **OR** elevator, **as directed**, manufacturer's full range.
i. Sight Guards: Provide sight guards on doors matching door edges.
j. Sills: Extruded metal, with grooved surface, 1/4 inch (6.4 mm) thick.
k. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107.

G. Signal Equipment
1. General: Provide hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled. Fabricate lighted elements with long-life incandescent lamps and acrylic or other permanent, nonyellowing translucent plastic diffusers **OR** LEDs, **as directed**.
OR
General: Provide signal equipment designed for destination-based system. Fabricate lighted elements with long-life incandescent lamps and acrylic or other permanent, nonyellowing translucent plastic diffusers **OR** LEDs, **as directed**.
2. Car Control Stations: Provide manufacturer's standard recessed **OR** semirecessed, **as directed**, car control stations. Mount in return panel adjacent to car door, unless otherwise indicated.
OR
Swing-Return Car Control Stations: Provide car control stations mounted on rear of hinged return panel adjacent to car door and with buttons, switches, controls, and indicator lights projecting through return panel but substantially flush with face of return panel.
a. Mark buttons and switches with standard identification for required use or function that complies with ASME A17.1. Use both tactile symbols and Braille.
b. Provide "No Smoking" sign matching car control station, either integral with car control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.
3. Emergency Communication System: Provide system that complies with ASME A17.1 and the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)." On activation, system dials preprogrammed number of monitoring station and identifies elevator location to monitoring station. System provides two-way voice communication without using a handset and provides visible signals that indicate when system has been activated and when monitoring station has responded. System is contained in flush-mounted cabinet, with identification, instructions for use, and battery backup power supply.
4. Firefighters' Two-Way Telephone Communication Service: Provide flush-mounted cabinet **OR** telephone jack, **as directed**, in each car and required conductors in traveling cable for firefighters' two-way telephone communication service specified in Division 28 Section(s) "Digital, Addressable Fire-alarm System" OR "Zoned (dc Loop) Fire-alarm System".
5. Car Position Indicator: Provide illuminated, **as directed**, digital-type car position indicator, located above car door or above car control station. Also provide audible signal to indicate to passengers that car is either stopping at or passing each of the floors served.
a. Include travel direction arrows if not provided in car control station.

6. Hall Push-Button Stations: Provide one hall push-button station at each landing for each single elevator or group of elevators, but not less than one station for each four elevators in a group, **as directed**.
   OR
   Hall Push-Button Stations: Provide hall push-button stations at each landing as indicated.
   a. Provide manufacturer's standard wall-mounted units.
      OR
      Provide units with flat faceplate for mounting with body of unit recessed in wall.
   b. Equip units with buttons for calling elevator and for indicating desired direction of travel.
      OR
      Equip units with buttons **OR** touch screen, **as directed**, for calling elevator and for indicating direction of travel or destination as required by system. Provide a signaling system to verify floor selection, where destination registration is required, and to direct passengers to appropriate car.
      1) Provide a means for passengers to indicate that they have disabilities so control system can allow extra room in assigned car.
      2) Provide for connecting units that require destination registration to building security access system so a card reader can be used to register calls.
   c. Provide telephone jack in each unit for firefighters' two-way telephone communication service specified in Division 28 Section(s) "Digital, Addressable Fire-alarm System" OR "Zoned (dc Loop) Fire-alarm System".
7. Hall Lanterns: Units with illuminated arrows; but provide single arrow at terminal landings. Provide one of the following:
   a. Manufacturer's standard wall-mounted units, for mounting above entrance frames.
   b. Units with flat faceplate for mounting with body of unit recessed in wall and with illuminated elements projecting from faceplate for ease of angular viewing.
   c. Units mounted in both jambs of entrance frame for each elevator, **as directed**.
   d. Units mounted in both car door jambs; may be used only for single elevators or for two-car groups, **as directed**.
8. Hall Annunciator: With each hall lantern, provide audible signals indicating car arrival and direction of travel. Signals sound once for up and twice for down.
   a. At manufacturer's option, audible signals may be placed on car **OR** each car, **as directed**.
9. Hall Position Indicators: Provide illuminated, **as directed**, digital-display-type position indicators, located above each, **as directed**, hoistway entrance at ground floor. Provide units with flat faceplate for mounting with body of unit recessed in wall.
   a. Integrate ground-floor hall lanterns with hall position indicators.
10. Standby Power Elevator Selector Switches: Provide switches, as required by ASME A17.1, where indicated. Adjacent to switches, provide illuminated signal that indicates when normal power supply has failed. For each elevator, provide illuminated signals that indicate when they are operational and when they are at the designated emergency return level with doors open.
    OR
    Fire Command Center Annunciator Panel: Provide panel containing illuminated position indicators for each elevator, clearly labeled with elevator designation; include illuminated signal that indicates when elevator is operational and when it is at the designated emergency return level with doors open. Provide standby power elevator selector switch(es), as required by ASME A17.1, adjacent to position indicators. Provide illuminated signal that indicates when normal power supply has failed.
11. Corridor Call Station Pictograph Signs: Provide signs matching hall push-button stations, with text and graphics as required by authorities having jurisdiction, indicating that in case of fire elevators are out of service and exits should be used instead. Provide one sign at each hall push-button station, unless otherwise indicated.

H. Elevators
   1. Elevator Description:

a. Group Number: <**Insert a different number for each group of elevators that share a group operation system.**>
b. Elevator Number(s): <**Insert elevator number(s) as shown on Drawings.**>
c. Service Elevator Number(s): <**Insert elevator number(s) as shown on Drawings.**>
d. Type: Geared **OR** Gearless, **as directed**, traction.
e. Machine Location: Machine room above hoistway **OR** Hoistway; no machine room is provided, **as directed**.
f. Rated Load: 2000 lb (908 kg) **OR** 2100 lb (953 kg) **OR** 2500 lb (1135 kg) **OR** 3000 lb (1362 kg) **OR** 3500 lb (1589 kg) **OR** 4000 lb (1816 kg) **OR** 4500 lb (2043 kg) **OR** 5000 lb (2270 kg), **as directed**.
g. Freight Loading Class for Service Elevator(s): Class A.
h. Rated Speed: 200 fpm (1.0 m/s) **OR** 350 fpm (1.8 m/s) **OR** 400 fpm (2.0 m/s) **OR** 450 fpm (2.3 m/s) **OR** 500 fpm (2.5 m/s) **OR** 700 fpm (3.6 m/s) **OR** 800 fpm (4.1 m/s) **OR** 1000 fpm (5.1 m/s) **OR** 1200 fpm (6.1 m/s) **OR** 1400 fpm (7.1 m/s), **as directed**.
i. Operation System: Selective collective automatic operation **OR** Group automatic operation **OR** Group automatic operation with demand-based dispatching **OR** Destination-based group automatic operation, **as directed**.
j. Auxiliary Operations:
   1) Standby power operation.
   2) Standby powered lowering.
   3) Battery-powered lowering.
   4) Earthquake Emergency Operation: Comply with requirements in ASME A17.1.
   5) Automatic dispatching of loaded car.
   6) Nuisance call cancel.
   7) Emergency hospital **OR** Priority, **as directed**, service at designated floors **OR** all floors, **as directed**.
   8) Independent service for service elevator **OR** all cars in group, **as directed**.
   9) Loaded-car bypass.
   10) Distributed parking.
k. Security Features: Card-reader operation **OR** Keyswitch operation **OR** Keypad operation **OR** Car-to-lobby feature, **as directed**.
l. Dual Car Control Stations: Provide two car control stations in each elevator, **aas directed**; equip only one with required keyswitches if any.
m. Car Enclosures:
   1) Inside Width: 64 inches (1626 mm) **OR** 68 inches (1727 mm) **OR** 80 inches (2032 mm) **OR** 92 inches (2337 mm), **as directed**, from side wall to side wall.
   2) Inside Depth: 51 inches (1295 mm) **OR** 53 inches (1346 mm) **OR** 57 inches (1448 mm) **OR** 65 inches (1651 mm) **OR** 87-1/2 inches (2222 mm) **OR** 90 inches (2286 mm) **OR** 93 inches (2362 mm) **OR** 93-1/2 inches (2375 mm) **OR** 96 inches (2438 mm) **OR** 101 inches (2565 mm) **OR** 102 inches (2591 mm), **as directed**, from back wall to front wall (return panels).
   3) Inside Height: 88 inches (2235 mm) **OR** 92 inches (2337 mm) **OR** 94 inches (2388 mm) **OR** 100 inches (2540 mm) **OR** 104 inches (2642 mm) **OR** 108 inches (2743 mm) **OR** 112 inches (2845 mm), **as directed**, to underside of ceiling.
   4) Front Walls (Return Panels): Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered, **as directed**.
   5) Car Fixtures: Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered, **as directed**.
   6) Side and Rear Wall Panels: Enameled steel **OR** Plastic laminate **OR** Satin stainless steel, No. 4 finish **OR** Textured stainless steel, **as directed**.
   7) Reveals: Enameled steel **OR** Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered, **as directed**.

8) Door Faces (Interior): Enameled steel **OR** Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Textured stainless steel **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered **OR** Plastic laminate, **as directed**.
9) Door Sills: Aluminum, mill finish **OR** Bronze, polished **OR** Nickel silver, polished, **as directed**.
10) Ceiling: Luminous ceiling **OR** Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Polished bronze, lacquered **OR** Reflective metallic-finish, plastic-laminate, stainless steel **OR** Reflective metallic-finish, plastic-laminate, bronze, **as directed**.
11) Handrails: 1-1/2 inches (38 mm) round, **as directed**, mirror-polished stainless steel, No. 8 finish **OR** satin stainless steel, No. 4 finish **OR** mirror-polished bronze, lacquered **OR** satin bronze, lacquered, **as directed**, at sides **OR** rear **OR** sides and rear, **as directed**, of car.
12) Lighting:
    a) Two **OR** Three, **as directed**, 48-inch (1219-mm), suspended, **OR** surface-mounted, **as directed**, 2-tube fluorescent light fixture(s) with white reflectors, **as directed**, and wire lamp guards, **as directed**.
    OR
    b) Not Less Than Two, **as directed**, 48-inch (1219-mm), recessed, 2 **OR** 3, **as directed**,-tube fluorescent light fixture(s) with UV stabilized acrylic diffusers not less than 0.125 inch (3.2 mm) thick.
    c) Illumination at car threshold, with doors closed, shall not be less than 50LX (5 FC) for freight elevators.
13) Floor: Manufacturer's standard carpet.
    OR
    Floor prepared to receive carpet (specified in Division 09 Section "Sheet Carpeting").
    OR
    Floor prepared to receive resilient tile (specified in Division 09 Section "Resilient Tile Flooring").
    OR
    Floor prepared to receive sheet vinyl (specified in Division 09 Section "Resilient Sheet Flooring").
    OR
    Floor recessed and prepared to receive dimension stone tile (specified in Division 09 Section "Stone Tiling") **OR** ceramic tile (specified in Division 09 Section "Tiling"), **as directed**.
14) Floor Thickness, Including Setting Materials: <**Insert thickness**> above plywood subfloor.

n. Hoistway Entrances: As follows:
1) Width: 36 inches (914 mm) **OR** 42 inches (1067 mm) **OR** 48 inches (1219 mm) **OR** 54 inches (1372 mm), **as directed**.
2) Height: 84 inches (2134 mm) **OR** 96 inches (2438 mm), **as directed**.
3) Type: Single-speed side sliding **OR** Two-speed side sliding **OR** Single-speed center opening **OR** Two-speed center opening, **as directed**.
4) Fire-Protection Rating: 1 hour **OR** 1-1/2 hours, **as directed**, with 30-minute temperature rise of 450 deg F (250 deg C), **as directed**.
5) Frames at First Floor **OR** at Basement Floors, **as directed**: Enameled steel **OR** Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered, **as directed**.
6) Frames at Other Floors: Enameled steel **OR** Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered, **as directed**.
7) Doors and Transoms at First Floor **OR** at Basement Floors, **as directed**: Enameled steel **OR** Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish

OR Textured stainless steel **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered **OR** Plastic laminate, **as directed**.

8) Doors and Transoms at Other Floors: Enameled steel **OR** Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Textured stainless steel **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered **OR** Plastic laminate, **as directed**.

9) Sills at First Floor **OR** at Basement Floors, **as directed**: Aluminum, mill finish **OR** Bronze, polished **OR** Nickel silver, polished, **as directed**.

10) Sills at Other Floors: Aluminum, mill finish **OR** Bronze, polished **OR** Nickel silver, polished, **as directed**.

o. Hall Fixtures at First Floor **OR** at Basement Floors, **as directed**: Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered **OR** Recessed type with no exposed-metal surfaces, **as directed**.

p. Hall Fixtures at Other Floors: Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered **OR** Recessed type with no exposed-metal surfaces, **as directed**.

q. Additional Requirements:

1) Provide inspection certificate in each car, mounted under acrylic cover with frame made from polished stainless steel, No. 8 finish **OR** satin stainless steel, No. 4 finish **OR** polished bronze, lacquered **OR** satin bronze, lacquered, **as directed**.

2) Provide blanket hooks in all cars, **as directed**, and one **OR** two, **as directed**, complete set(s) of full-height protective blankets.

1.3 EXECUTION

A. Examination

1. Examine elevator areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance. Examine hoistways, hoistway openings, pits, and machine rooms as constructed; verify critical dimensions; and examine supporting structure and other conditions under which elevator work is to be installed.
   a. For the record, prepare a written report, endorsed by Installer, listing dimensional discrepancies and conditions detrimental to performance or indicating that dimensions and conditions were found to be satisfactory.
   b. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Installation

1. Comply with manufacturer's written instructions.
2. Welded Construction: Provide welded connections for installing elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance, and replacement of worn parts. Comply with AWS standards for workmanship and for qualifications of welding operators.
3. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts designed to minimize transmission of vibrations to structure and thereby minimize structure-borne noise from elevator system.
4. Lubricate operating parts of systems, including ropes, as recommended by manufacturers.
5. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with car. Where possible, delay final adjustment of sills and doors until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.
6. Leveling Tolerance: 1/8 inch (3 mm), up or down, regardless of load and direction of travel.
7. Set sills flush with finished floor surface at landing. Fill space under sill solidly with nonshrink, nonmetallic grout.
8. Locate hall signal equipment for elevators as follows, unless otherwise indicated:
   a. For groups of elevators, locate hall push-button stations between two elevators at center of group or at location most convenient for approaching passengers.

b. Place hall lanterns either above or beside each hoistway entrance.
c. Mount hall lanterns at a minimum of 72 inches (1829 mm) above finished floor.

C. Field Quality Control
1. Acceptance Testing: On completion of elevator installation and before permitting use (either temporary or permanent) of elevators, perform acceptance tests as required and recommended by ASME A17.1 and by governing regulations and agencies.
2. Operating Test: Load elevator **OR** each elevator **OR** one elevator of each type, capacity, speed, and travel distance, **as directed**, to rated capacity and operate continuously for 30 minutes over full travel distance, stopping at each level and proceeding immediately to the next. Record temperature rise of elevator machine during 30-minute test period. Record failure to perform as required.
3. Advise Owner and authorities having jurisdiction in advance of dates and times tests are to be performed on elevators.

D. Protection
1. Temporary Use: Limit temporary use for construction purposes to one elevator **as directed**. Comply with the following requirements for each, **as directed**, elevator used for construction purposes:
a. Provide car with temporary enclosure, either within finished car or in place of finished car, to protect finishes from damage.
b. Provide strippable protective film on entrance and car doors and frames.
c. Provide padded wood bumpers on entrance door frames covering jambs and frame faces.
d. Provide other protective coverings, barriers, devices, signs, and procedures as needed to protect elevator and elevator equipment.
e. Do not load elevators beyond their rated weight capacity.
f. Engage elevator Installer to provide full maintenance service. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as necessary for proper elevator operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.
g. Engage elevator Installer to restore damaged work, if any, so no evidence remains of correction. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

E. Demonstration
1. Train Owner's maintenance personnel to operate, adjust, and maintain elevator(s).
2. Check operation of each elevator with Owner's personnel present and before date of Substantial Completion. Determine that operation systems and devices are functioning properly.
3. Check operation of each elevator with Owner's personnel present not more than one month before end of warranty period. Determine that operation systems and devices are functioning properly.

END OF SECTION 14 01 20 00

SECTION 14 01 20 00a - HYDRAULIC ELEVATORS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for hydraulic elevators. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes hydraulic passenger and service elevators.

C. Definitions
1. Definitions in ASME A17.1 apply to work of this Section.
2. Defective Elevator Work: Operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.
3. Service Elevator: A passenger elevator that is also used to carry freight.

D. Submittals
1. Product Data: Include capacities, sizes, performances, operations, safety features, finishes, and similar information. Include product data for the following:
   a. Car enclosures and hoistway entrances.
   b. Operation, control, and signal systems.
2. Shop Drawings: Show plans, elevations, sections, and large-scale details indicating service at each landing, machine room layout, coordination with building structure, relationships with other construction, and locations of equipment and signals. Include large-scale layout of car control station and standby power operation control panel, **as directed**. Indicate variations from specified requirements, maximum dynamic and static loads imposed on building structure at points of support, and maximum and average power demands.
3. Samples: For exposed finishes of cars, hoistway doors and frames, and signal equipment; 3-inch- (75-mm-) square Samples of sheet materials; and 4-inch (100-mm) lengths of running trim members.
4. Manufacturer Certificates: Signed by elevator manufacturer certifying that hoistway, pit, and machine room layout and dimensions, as shown on Drawings, and electrical service, as shown and specified, are adequate for elevator system being provided.
5. Qualification Data: For Installer.
6. Operation and Maintenance Data: For elevators to include in emergency, operation, and maintenance manuals.
7. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.
8. Warranty: Special warranty specified in this Section.

E. Quality Assurance
1. Installer Qualifications: Elevator manufacturer or manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
2. Source Limitations: Obtain elevators, including electric traction passenger elevators specified in another Division 14 Section, through one source from a single manufacturer.
   a. Provide major elevator components, including pump-and-tank units, plunger-cylinder assemblies, controllers, signal fixtures, door operators, car frames, cabs, and entrances, manufactured by a single manufacturer.

3. Regulatory Requirements: Comply with ASME A17.1 and elevator design requirements for earthquake loads in ASCE 7.
   a. Effective peak velocity acceleration (Av) for Project's location is less than 0.10 (seismic risk zones 0 and 1) **OR** greater than or equal to 0.10, but less than 0.20 (seismic risk zone 2) **OR** greater than or equal to 0.20 (seismic risk zones 3 and 4), **as directed**.
   b. Design earthquake spectral response acceleration, short period (Sds) for Project is determined by Project's location and site classification.
   c. Project's seismic design category is A **OR** B **OR** C **OR** D, **as directed**.
   d. Elevator importance factor is 1.5 **OR** 1.0, **as directed**.
4. Accessibility Requirements: Comply with Section 4.10 in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)" **OR** 407 in ICC A117.1, **as directed**.
5. Fire-Rated Hoistway Entrance Assemblies: Door and frame assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing at as close to neutral pressure as possible according to NFPA 252 **OR** UBC Standard 7-2 **OR** UL 10B, **as directed**.

F. Delivery, Storage, And Handling
1. Deliver, store, and handle materials, components and equipment in manufacturer's protective packaging.
2. Store materials, components, and equipment off of ground, under cover, and in a dry location. Handle according to manufacturer's written recommendations to prevent damage, deterioration, or soiling.

G. Coordination
1. Coordinate installation of sleeves, block outs, and items that are embedded in concrete or masonry for elevator equipment. Furnish templates and installation instructions and deliver to Project site in time for installation.
2. Furnish well casing and coordinate delivery with related excavation work.
3. Coordinate sequence of elevator installation with other work to avoid delaying the Work.
4. Coordinate locations and dimensions of other work relating to hydraulic elevators including pit ladders, sumps, and floor drains in pits; entrance subsills; and electrical service, electrical outlets, lights, and switches in pits and machine rooms.

H. Warranty
1. Special Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to repair, restore, or replace defective elevator work within specified warranty period.
   a. Warranty Period: One year from date of Substantial Completion.

1.2 PRODUCTS

A. Non-Proprietary Operating Systems And Components
1. General: Provide manufacturer's standard elevator systems. Where components are not otherwise indicated, provide standard components published by manufacturer as included in standard preengineered elevator systems and as required for complete system.
2. Pump Units: Positive-displacement type with a maximum of 10 percent variation between no load and full load and with minimum pulsations. Provide the following, **as directed**:
   a. Pump, with fan-cooled squirrel-cage induction motor, mounted on oil tank with vibration isolation mounts. Enclose pump in prime-painted steel enclosure lined with 1-inch- (25-mm-) thick, glass-fiber insulation board.
   b. Submersible pump, with submersible squirrel-cage induction motor, suspended inside oil tank from vibration isolation mounts.
   c. Provide motor with wye-delta **OR** solid-state, **as directed**, starting.
   d. Provide variable-voltage variable-frequency motor control.

3. Hydraulic Silencers: Provide hydraulic silencer containing pulsation-absorbing material in a blowout-proof housing at pump unit.
4. Piping: Provide size, type, and weight piping recommended by manufacturer, and provide flexible connectors to minimize sound and vibration transmissions from power unit.
   a. Provide dielectric couplings at cylinder units.
   b. Casing for Underground Piping: PVC pipe complying with ASTM D 1785, joined with PVC fittings complying with ASTM D 2466 and solvent cement complying with ASTM D 2564.
5. Hydraulic Fluid: Elevator manufacturer's standard fire-resistant, **as directed**, fluid with additives as needed to prevent oxidation of fluid, corrosion of cylinder and other components, and other adverse effects.
   OR
   Hydraulic Fluid: Nontoxic, readily biodegradable, fire-resistant, **as directed**, fluid made from vegetable oil with antioxidant, anticorrosive, antifoaming, and metal-passivating additives. Hydraulic fluid is approved by elevator manufacturer for use with elevator equipment.
6. Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing guide rails, machinery, and other components of elevator work where installation of devices is specified in another Section.
7. Inspection of existing cylinders:
   a. Any cylinder that does not conform to ASME A17.1 Rule 3.18.3 & 3.18.3.4 must be replaced. All cylinders must be inspected and any cylinders that do not have the conforming safety bulkhead or a double-bottom cylinder shall be replaced with a conforming cylinder.
8. All cylinders buried in the ground shall be provided with a safety bulkhead conforming to ASME A17.1 **OR** a double bottom cylinder is used and liner and outer cylinders conform.
9. Protective Cylinder Casing: PVC or HDPE pipe casing complying with ASME A17.1, of sufficient size to provide not less than 1-inch (25-mm) clearance from cylinder and extending above pit floor. Provide means to monitor casing effectiveness to comply with ASME A17.1.
10. Corrosion Protective Filler: A nontoxic, petroleum-based gel formulated for filling the space between hydraulic cylinder and protective casing. Filler is electrically nonconductive, displaces or absorbs water, and gels or solidifies at temperatures below 60 deg F (16 deg C).
11. Car Frame and Platform: Welded steel units.
12. Guides: Provide either roller guides or sliding guides at top and bottom of car and counterweight frames. If sliding guides are used, provide guide-rail lubricators or polymer-coated, nonlubricated guides.

B. Non-Proprietary Operation Systems
1. General: Provide manufacturer's standard microprocessor operation system for each elevator **OR** for each group of elevators, **as directed**, as required to provide type of operation system indicated.
2. Auxiliary **OR** Single-Car Auxiliary, **as directed**, Operations: In addition to primary operation system features, provide the following operational features for elevators where indicated:
   a. Standby Power Operation: On activation of standby power, car is returned to a designated floor and parked with doors open. Car can be manually put in service on standby power, either for return operation or for regular operation, by switches in control panel located at main lobby **OR** fire command station, **as directed**. Manual operation causes automatic operation to cease.
      OR
      Standby-Powered Lowering: On activation of standby power, if car is at a floor it remains at that floor, opens its doors, and shuts down. If car is between floors, it is lowered to a preselected floor, opens its doors, and shuts down. If car is below the preselected floor, it is lowered to the next lower floor, opens its doors, and shuts down.
      OR
      Standby-Powered Lowering: On activation of standby power, car is lowered to the lowest floor, opens its doors, and shuts down.
      OR

Battery-Powered Lowering: If power fails and car is at a floor, it remains at that floor, opens its doors, and shuts down. If car is between floors, it is lowered to a preselected floor, opens its doors, and shuts down. If car is below the preselected floor, it is lowered to the next lower floor, opens its doors, and shuts down. System includes rechargeable battery and automatic recharging system.

OR

Battery-Powered Lowering: When power fails, car is lowered to the lowest floor, opens its doors, and shuts down. System includes rechargeable battery and automatic recharging system.

b. Automatic Dispatching of Loaded Car: When car load exceeds 80 percent of rated capacity, doors will begin closing.

c. Nuisance Call Cancel: When car calls exceed a preset number while car load is less than a predetermined weight, all car calls are canceled. Preset number of calls and predetermined weight, **as directed**, can be adjusted.

3. Group Auxiliary Operations: In addition to primary operation system features, provide the following operational features for elevators and elevator groups where indicated:

a. Standby Power Operation: On activation of standby power, cars are returned to a designated floor and parked with doors open. Only one car is moved upward at a time, with priority given to loaded cars. If a car cannot be returned after two attempts, it is removed from the system. When all cars have been returned or removed from the system, one car is automatically placed in service. If car selected for service cannot operate within 60 seconds, the system removes car from service and places another car in service. Cars can be manually put in service on standby power, either for return operation or for regular operation, by switches in control panel located at main lobby **OR** fire command station, **as directed**. Manual operation causes automatic operation to cease.

OR

Standby Power Operation: On activation of standby power, cars are returned to lowest floor and parked with doors open. If a car cannot be returned, it is removed from the system. One car is selected for service on standby power by a switch located at main lobby **OR** fire command station, **as directed**.

OR

Standby-Powered Lowering: On activation of standby power, cars that are at a floor remain at that floor, open their doors, and shut down. Cars that are between floors are lowered to a preselected floor, open their doors, and shut down. Cars that are below the preselected floor are lowered to the next lower floor, open their doors, and shut down.

OR

Standby-Powered Lowering: On activation of standby power, cars are lowered to the lowest floor, open their doors, and shut down.

OR

Battery-Powered Lowering: If power fails, cars that are at a floor remain at that floor, open their doors, and shut down. Cars that are between floors are lowered to a preselected floor, open their doors, and shut down. Cars that are below the preselected floor are lowered to the next lower floor, open their doors, and shut down. System includes rechargeable battery and automatic recharging system.

OR

Battery-Powered Lowering: When power fails, cars are lowered to the lowest floor, open their doors, and shut down. System includes rechargeable battery and automatic recharging system.

b. Automatic Dispatching of Loaded Car: When car load exceeds 80 percent of rated capacity, doors will begin closing.

c. Nuisance Call Cancel: When car calls exceed a preset number while car load is less than a predetermined weight, all car calls are canceled. Preset number of calls and predetermined weight, **as directed**, can be adjusted.

d. Emergency Hospital **OR** Priority, **as directed**, Service: Service is initiated by a keyswitch **OR** card reader **OR** remote switch, **as directed**, at designated floors. One elevator is

removed from group operation and directed to the floor where service was initiated. On arriving at the floor, elevator opens its doors and parks and a lighted sign directs passengers to exit elevator, **as directed**. Car is placed in operation by selecting a floor and pressing door close button or by operating keyswitch to put car in independent service. After responding to floor selected or being removed from independent service, car is returned to group operation. If car is not placed in operation within a preset time after being called, it is returned to group operation.

e. Independent Service: Keyswitch in car control station removes car from group operation and allows it to respond only to car calls. Key cannot be removed from keyswitch when car is in independent service. When in independent service, doors close only in response to door close button.

f. Loaded-Car Bypass: When car load exceeds 80 percent of rated capacity, car will respond only to car calls, not to hall calls.

4. Security Features: Provide the following security features, where indicated. Security features shall not affect emergency firefighters' service.

a. Card-Reader Operation: System uses card readers at car control stations **OR** hall push-button stations, **as directed**, to authorize calls. Security system determines which landings and at what times calls require authorization by card reader. Provide required conductors in traveling cable and panel in machine room for interconnecting card readers, other security access system equipment, and elevator controllers. Allow space as indicated for card reader in car **OR** Provide stripe-swipe card reader integral with each car control station, **as directed**.

1) Security access system equipment is specified in Division 28 Section "Access Control".

OR

Security access system equipment is not in the Contract.

b. Keyswitch Operation: Push buttons are activated and deactivated by security keyswitches at car control stations **OR** hall push-button stations, **as directed**. Key is removable only in deactivated position **OR** in either position, **as directed**.

c. Keypad Operation: Allows each landing to be restricted or unrestricted. When a restricted landing button is pressed, a "Restricted Floor" lamp lights and remains lit until landing access code has been entered into a keypad or predetermined time period has elapsed. Car calls for restricted landings do not register until landing access code is entered into keypad within predetermined time period after landing button is pressed.

1) Access codes are programmed at each car operating panel using a security keyswitch. Keypad operation can be activated and deactivated by security keyswitch at main landing.

d. Car-to-Lobby Feature: Feature, activated by keyswitch at main lobby, that causes car **OR** all cars in a group, **as directed**, to return immediately to lobby and open doors for inspection. On deactivation by keyswitch, calls registered before keyswitch activation are completed and normal operation is resumed.

C. Door Reopening Devices

1. Infrared Array: Provide door reopening devices with uniform array of 36 or more microprocessor-controlled, infrared light beams projecting across car entrance. Interruption of one or more of the light beams shall cause doors to stop and reopen.

2. Nudging Feature: After car doors are prevented from closing for predetermined adjustable time, through activating door reopening device, a loud buzzer shall sound and doors shall begin to close at reduced kinetic energy.

D. Finish Materials

1. General: Provide the following materials for exposed parts of elevator car enclosures, car doors, hoistway entrance doors and frames, and signal equipment as indicated.

2. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, commercial steel, Type B, exposed, matte finish.

3. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, commercial steel, Type B, pickled.

4. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304.
   a. Textured Stainless-Steel Sheet: Product with coined **OR** embossed, **as directed**, texture rolled into exposed surface.
      1) Metal surface is satin polished **OR** satin relieved **OR** titanium nitride colored **OR** oxide colored **OR** satin polished and titanium nitride colored **OR** satin relieved and titanium nitride colored **OR** satin polished and oxide colored **OR** satin relieved and oxide colored **OR** color coated and satin relieved **OR** color coated and bright relieved, **as directed**, after rolling.
5. Stainless-Steel Bars: ASTM A 276, Type 304.
6. Stainless-Steel Tubing: ASTM A 554, Grade MT 304.
7. Bronze Plate and Sheet: ASTM B 36/B 36M, Alloy UNS No. C28000 (muntz metal).
8. Bronze Extrusions: ASTM B 455, Alloy UNS No. C38500 (architectural bronze).
9. Bronze Tubing: ASTM B 135 (ASTM B 135M), Alloy UNS No. C23000 (red brass, 85 percent copper).
10. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063.
11. Nickel Silver Extrusions: ASTM B 151/B 151M, Alloy UNS No. C74500 or No. C77600.
12. Plastic Laminate: High-pressure type complying with NEMA LD 3, Type HGS for flat applications **OR** Type HGL for flat applications, **as directed**, Type HGP for postformed applications and Type BKV for panel backing.

E. Car Enclosures
1. General: Provide enameled-steel car enclosures to receive removable **OR** steel-framed car enclosures with nonremovable, **as directed**, wall panels, with car **OR** removable car, **as directed**, roof, access doors, power door operators, and ventilation.
   a. Provide standard railings complying with ASME A17.1 on car tops where required by ASME A17.1.
   b. Provide finished car including materials and finishes specified below.
2. Materials and Finishes: Provide manufacturer's standards, but not less than the following:
   a. Subfloor: Underlayment grade, exterior plywood, 5/8-inch (16-mm) nominal thickness.
   b. Floor Finish: Specified in a Division 07 **OR** Elevator manufacturer's standard level-loop nylon carpet; color as selected from manufacturer's full range, **as directed**.
   c. Enameled-Steel Wall Panels: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel finish; colors as selected from manufacturer's full range.
   d. Stainless-Steel Wall Panels: Flush, hollow-metal construction; fabricated from stainless-steel sheet.
   e. Bronze Wall Panels: Flush, hollow-metal construction; fabricated from bronze sheet.
   f. Plastic-Laminate Wall Panels: Plastic laminate adhesively applied to 1/2-inch (13-mm) fire-retardant-treated particleboard **OR** manufacturer's standard honeycomb core, **as directed**, with plastic-laminate panel backing and, **as directed**, manufacturer's standard protective edge trim. Panels have a flame-spread index of 25 **OR** 75, **as directed**, or less, when tested according to ASTM E 84. Plastic-laminate color, texture, and pattern as selected from plastic-laminate **OR** elevator, **as directed**, manufacturer's full range.
   g. Fabricate car with recesses and cutouts for signal equipment.
   h. Fabricate car door frame integrally with front wall of car.
   i. Enameled-Steel Doors: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel finish; colors as selected from manufacturer's full range.
   j. Stainless-Steel Doors: Flush, hollow-metal construction; fabricated from stainless-steel sheet **OR** by laminating stainless-steel sheet to exposed faces and edges of enameled cold-rolled steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning, **as directed**.
   k. Bronze Doors: Flush, hollow-metal construction; fabricated by laminating bronze sheet to exposed faces and edges of enameled cold-rolled steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning.

l. Plastic-Laminate Doors: Flush, hollow-metal construction; fabricated by laminating plastic laminate to exposed faces of enameled cold-rolled steel doors and covering edges with protective edge trim matching return panels, **as directed**. Plastic-laminate color, texture, and pattern as selected from plastic-laminate **OR** elevator, **as directed**, manufacturer's full range.

m. Sight Guards: Provide sight guards on car doors.

n. Sills: Extruded metal, with grooved surface, 1/4 inch (6.4 mm) thick.

o. Luminous Ceiling: Fluorescent light fixtures and ceiling panels of translucent acrylic or other permanent rigid plastic.

p. Lighting:

1) Two **OR** Three, **as directed**, 48-inch (1219-mm), suspended, **OR** surface-mounted, **as directed**, 2-tube fluorescent light fixture(s) with white reflectors, **as directed**, and wire lamp guards, **as directed**.

OR

2) Not Less Than Two, **as directed**, 48-inch (1219-mm), recessed, 2 **OR** 3, **as directed**,-tube fluorescent light fixture(s) with UV stabilized acrylic diffusers not less than 0.125 inch (3.2 mm) thick.

3) Illumination at car threshold, with doors closed, shall not be less than 50LX (5 FC) for passenger elevators.

q.

r. Metal **OR** Metallic-Finish, Plastic-Laminate, **as directed**, Ceiling: Flush panels, with incandescent downlights in the center of **OR** four low-voltage downlights in, **as directed**, each panel. Align ceiling panel joints with joints between wall panels, **as directed**.

s. Handrails: Manufacturer's standard handrails, of shape, metal, and finish indicated.

F. Hoistway Entrances

1. General: Provide manufacturer's standard horizontal-sliding, door-and-frame hoistway entrances complete with track systems, hardware, sills, and accessories. Provide frame size and profile to coordinate with hoistway wall construction.

a. Where gypsum board wall construction is indicated, provide self-supporting frames with reinforced head sections.

2. Materials and Fabrication: Provide manufacturer's standards, but not less than the following:

a. Enameled-Steel Frames: Formed from cold-rolled or hot-rolled steel sheet. Provide with factory-applied enamel finish; colors as selected from manufacturer's full range.

b. Steel Subframes: Formed from cold-rolled or hot-rolled steel sheet with factory-applied enamel finish or corrosion-inhibiting primer. Fabricate to receive applied finish as indicated.

c. Stainless-Steel Frames: Formed from stainless-steel sheet.

d. Bronze Frames: Formed from cold-rolled or hot-rolled steel sheet, with enamel finish, and with formed-bronze sheet laminated to steel frames using adhesive that fully bonds metal to metal without telegraphing or oil-canning.

e. Enameled-Steel Doors and Transoms: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel finish; colors as selected from manufacturer's full range.

f. Stainless-Steel Doors and Transoms: Flush, hollow-metal construction; fabricated from stainless-steel sheet **OR** by laminating stainless-steel sheet to exposed faces and edges of enameled cold-rolled steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning, **as directed**.

g. Bronze Doors and Transoms: Flush, hollow-metal construction; fabricated by laminating bronze sheet to exposed faces and edges of enameled cold-rolled steel doors using adhesive that fully bonds metal to metal without telegraphing or oil-canning.

h. Plastic-Laminate Doors and Transoms: Flush, hollow-metal construction; fabricated by laminating plastic laminate to exposed faces of enameled cold-rolled steel doors and covering edges with protective edge trim matching door frames, **as directed**. Plastic-laminate color, texture, and pattern as selected from plastic-laminate **OR** elevator, **as directed**, manufacturer's full range.

i. Sight Guards: Provide sight guards on doors matching door edges.
j. Sills: Extruded metal, with grooved surface, 1/4 inch (6.4 mm) thick.
k. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107.

G. Signal Equipment
1. General: Provide hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled. Fabricate lighted elements with long-life incandescent lamps and acrylic or other permanent, nonyellowing translucent plastic diffusers **OR** LEDs, **as directed**.
2. Car Control Stations: Provide manufacturer's standard recessed **OR** semirecessed, **as directed**, car control stations. Mount in return panel adjacent to car door, unless otherwise indicated.
OR
Swing-Return Car Control Stations: Provide car control stations mounted on rear of hinged return panel adjacent to car door and with buttons, switches, controls, and indicator lights projecting through return panel but substantially flush with face of return panel.
a. Mark buttons and switches with standard identification for required use or function that complies with ASME A17.1. Use both tactile symbols and Braille.
b. Provide "No Smoking" sign matching car control station, either integral with car control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.
3. Emergency Communication System: Provide system that complies with ASME A17.1 and the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)." On activation, system dials preprogrammed number of monitoring station and identifies elevator location to monitoring station. System provides two-way voice communication without using a handset and provides visible signals that indicate when system has been activated and when monitoring station has responded. System is contained in flush-mounted cabinet, with identification, instructions for use, and battery backup power supply.
4. Firefighters' Two-Way Telephone Communication Service: Provide flush-mounted cabinet **OR** telephone jack, **as directed**, in each car and required conductors in traveling cable for firefighters' two-way telephone communication service specified in Division 28 Section(s) "Digital, Addressable Fire-alarm System" OR "Zoned (dc Loop) Fire-alarm System"
5. Car Position Indicator: Provide illuminated, **as directed**, digital-type car position indicator, located above car door or above car control station. Also provide audible signal to indicate to passengers that car is either stopping at or passing each of the floors served.
a. Include travel direction arrows if not provided in car control station.
6. Hall Push-Button Stations: Provide one hall push-button station at each landing for each single elevator or group of elevators, but not less than one station for each four elevators in a group, **as directed**.
OR
Hall Push-Button Stations: Provide hall push-button stations at each landing as indicated.
a. Provide manufacturer's standard wall-mounted units.
b. Provide units with flat faceplate for mounting with body of unit recessed in wall.
c. Equip units with buttons for calling elevator and for indicating desired direction of travel.
d. Provide telephone jack in each unit for firefighters' two-way telephone communication service specified in Division 28 Section(s) "Digital, Addressable Fire-alarm System" OR "Zoned (dc Loop) Fire-alarm System".
7. Hall Lanterns: Units with illuminated arrows; but provide single arrow at terminal landings. Provide one of the following, **as directed**:
a. Manufacturer's standard wall-mounted units, for mounting above entrance frames.
b. Units with flat faceplate for mounting with body of unit recessed in wall and with illuminated elements projecting from faceplate for ease of angular viewing.
c. Units mounted in both jambs of entrance frame for each elevator, **as directed**.
d. Units mounted in both car door jambs; may be used only for single elevators or for two-car groups, **as directed**.

8. Hall Annunciator: With each hall lantern, provide audible signals indicating car arrival and direction of travel. Signals sound once for up and twice for down.
   a. At manufacturer's option, audible signals may be placed on car **OR** each car, **as directed**.
9. Hall Position Indicators: Provide illuminated, **as directed**, digital-display-type position indicators, located above each, **as directed**, hoistway entrance at ground floor. Provide units with flat faceplate for mounting and with body of unit recessed in wall.
   a. Integrate ground-floor hall lanterns with hall position indicators.
10. Standby Power Elevator Selector Switches: Provide switches, as required by ASME A17.1, where indicated. Adjacent to switches, provide illuminated signal that indicates when normal power supply has failed. For each elevator, provide illuminated signals that indicate when they are operational and when they are at the designated emergency return level with doors open, **as directed**.
    OR
    Fire Command Center Annunciator Panel: Provide panel containing illuminated position indicators for each elevator, clearly labeled with elevator designation; include illuminated signal that indicates when elevator is operational and when it is at the designated emergency return level with doors open. Provide standby power elevator selector switch(es), as required by ASME A17.1, adjacent to position indicators. Provide illuminated signal that indicates when normal power supply has failed.
11. Corridor Call Station Pictograph Signs: Provide signs matching hall push-button stations, with text and graphics as required by authorities having jurisdiction, indicating that in case of fire elevators are out of service and exits should be used instead. Provide one sign at each hall push-button station, unless otherwise indicated.

H. Elevators
1. Elevator Description:
   a. Group Number: <**Insert a different number for each group of elevators that share a group operation system.**>
   b. Elevator Number(s): <**Insert elevator number(s) as shown on Drawings.**>
   c. Service Elevator Number(s): <**Insert elevator number(s) as shown on Drawings.**>
   d. Type: Under-the-car single cylinder.
      OR
      Type: Holeless, beside-the-car, single-acting, single **OR** dual, **as directed**, cylinder.
      OR
      Type: Holeless, beside-the-car, telescoping, single **OR** dual, **as directed**, cylinder.
      OR
      Type: Holeless, beside-the-car, roped hydraulic, single **OR** dual, **as directed**, cylinder.
   e. Rated Load: 2000 lb (908 kg) **OR** 2100 lb (953 kg) **OR** 2500 lb (1135 kg) **OR** 3000 lb (1362 kg) **OR** 3500 lb (1589 kg) **OR** 4000 lb (1816 kg) **OR** 4500 lb (2043 kg) **OR** 5000 lb (2270 kg), **as directed**.
   f. Freight Loading Class for Service Elevators: Class A.
   g. Rated Speed: 75 or 80 fpm (0.38 or 0.41 m/s) **OR** 100 fpm (0.51 m/s) **OR** 125 fpm (0.64 m/s) **OR** 150 fpm (0.76 m/s) **OR** 175 fpm (0.89 m/s) **OR** 200 fpm (1.0 m/s), **as directed**.
   h. Operation System: Single automatic **OR** Selective collective automatic **OR** Group automatic, **as directed**, operation.
   i. Auxiliary Operations:
      1) Standby power operation.
      2) Standby-powered lowering.
      3) Battery-powered lowering.
      4) Automatic dispatching of loaded car.
      5) Nuisance call cancel.
      6) Emergency hospital **OR** Priority, **as directed**, service at designated floors **OR** all floors, **as directed**.
      7) Independent service for service elevator **OR** all cars in group, **as directed**.
      8) Loaded-car bypass.

j. Security Features: Card-reader operation **OR** Keyswitch operation **OR** Keypad operation **OR** Car-to-lobby feature, **as directed**.

k. Dual Car Control Stations: Provide two car control stations in each elevator, **as directed**; equip only one with required keyswitches, if any.

l. Car Enclosures:

1) Inside Width: 64 inches (1626 mm) **OR** 68 inches (1727 mm) **OR** 80 inches (2032 mm) **OR** 92 inches (2337 mm), **as directed**, from side wall to side wall.

2) Inside Depth: 51 inches (1295 mm) **OR** 53 inches (1346 mm) **OR** 57 inches (1448 mm) **OR** 65 inches (1651 mm) **OR** 87-1/2 inches (2222 mm) **OR** 90 inches (2286 mm) **OR** 93 inches (2362 mm) **OR** 93-1/2 inches (2375 mm) **OR** 96 inches (2438 mm) **OR** 101 inches (2565 mm) **OR** 102 inches (2591 mm), **as directed**, from back wall to front wall (return panels).

3) Inside Height: 88 inches (2235 mm) **OR** 92 inches (2337 mm) **OR** 94 inches (2388 mm) **OR** 100 inches (2540 mm) **OR** 104 inches (2642 mm) **OR** 108 inches (2743 mm) **OR** 112 inches (2845 mm), **as directed**, to underside of ceiling.

4) Front Walls (Return Panels): Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered, **as directed**, with integral car door frames.

5) Car Fixtures: Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered, **as directed**.

6) Side and Rear Wall Panels: Enameled steel **OR** Plastic laminate **OR** Satin stainless steel, No. 4 finish **OR** Textured stainless steel, **as directed**.

7) Reveals: Enameled steel **OR** Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered, **as directed**.

8) Door Faces (Interior): Enameled steel **OR** Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Textured stainless steel **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered **OR** Plastic laminate, **as directed**.

9) Door Sills: Aluminum, mill finish **OR** Bronze, polished **OR** Nickel silver, polished, **as directed**.

10) Ceiling: Luminous ceiling **OR** Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Polished bronze, lacquered **OR** Reflective metallic-finish, plastic-laminate, stainless steel **OR** Reflective metallic-finish, plastic-laminate, bronze, **as directed**.

11) Handrails: 1-1/2 inches (38 mm) round, **as directed**, mirror-polished stainless steel, No. 8 finish **OR** satin stainless steel, No. 4 finish **OR** mirror-polished bronze, lacquered **OR** satin bronze, lacquered, **as directed**, at sides **OR** sides and rear, **as directed**, of car.

12) Floor: Manufacturer's standard carpet.

OR

Floor prepared to receive carpet (specified in Division 09 Section "Sheet Carpeting").

OR

Floor prepared to receive resilient tile (specified in Division 09 Section "Resilient Tile Flooring").

OR

Floor prepared to receive sheet vinyl (specified in Division 09 Section "Resilient Sheet Flooring").

OR

Floor recessed and prepared to receive dimension stone tile (specified in Division 09 Section "Stone Tiling") **OR** ceramic tile (specified in Division 09 Section "Tiling"), **as directed**.

OR

Floor Thickness, Including Setting Materials: <**Insert thickness**> above plywood subfloor.

m. Hoistway Entrances:
   1) Width: 36 inches (914 mm) **OR** 42 inches (1067 mm) **OR** 48 inches (1219 mm) **OR** 54 inches (1372 mm), **as directed**.
   2) Height: 84 inches (2134 mm) **OR** 96 inches (2438 mm), **as directed**.
   3) Type: Single-speed side sliding **OR** Two-speed side sliding **OR** Single-speed center opening **OR** Two-speed center opening, **as directed**.
   4) Fire-Protection Rating: 1 hour **OR** 1-1/2 hours, **as directed**, with 30-minute temperature rise of 450 deg F (250 deg C), **as directeed**.
   5) Frames at First Floor **OR** at Basement Floors, **as directed**: Enameled steel **OR** Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered, **as directed**.
   6) Frames at Other Floors: Enameled steel **OR** Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered, **as directed**.
   7) Doors and Transoms at First Floor **OR** at Basement Floors, **as directed**: Enameled steel **OR** Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Textured stainless steel **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered **OR** Plastic laminate, **as directed**.
   8) Doors and Transoms at Other Floors: Enameled steel **OR** Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Textured stainless steel **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered **OR** Plastic laminate, **as directed**.
   9) Sills at First Floor **OR** at Basement Floors, **as directed**: Aluminum, mill finish **OR** Bronze, polished **OR** Nickel silver, polished, **as directed**.
   10) Sills at Other Floors: Aluminum, mill finish **OR** Bronze, polished **OR** Nickel silver, polished, **as directed**.

n. Hall Fixtures at First Floor **OR** at Basement Floors, **as directed**: Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered **OR** Recessed type with no exposed-metal surfaces, **as directed**.

o. Hall Fixtures at Other Floors: Polished stainless steel, No. 8 finish **OR** Satin stainless steel, No. 4 finish **OR** Polished bronze, lacquered **OR** Satin bronze, lacquered **OR** Recessed type with no exposed-metal surfaces, **as directed**.

p. Additional Requirements:
   1) Provide inspection certificate in each car, mounted under acrylic cover with frame made from polished stainless steel, No. 8 finish **OR** satin stainless steel, No. 4 finish **OR** polished bronze, lacquered **OR** satin bronze, lacquered, **as directed**.
   2) Provide blanket hooks in all cars, **as directed**, and one **OR** two, **as directed**, complete set(s) of full-height protective blankets.

1.3 EXECUTION

A. Examination
   1. Examine elevator areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance. Verify critical dimensions and examine supporting structure and other conditions under which elevator work is to be installed.
      a. For the record, prepare a written report, endorsed by Installer, listing dimensional discrepancies and conditions detrimental to performance or indicating that dimensions and conditions were found to be satisfactory.
      b. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Installation
   1. Excavation for Cylinder: Drill well hole in each, **as directed**, elevator pit to accommodate installation of cylinder; comply with applicable requirements in Division 31 Section "Earth Moving".
   2. Provide waterproof well casing as necessary to retain walls of well hole.

3. Install double-bottom cylinder inside PVC field casing within well hole. Before installing protective casing, remove water and debris from well hole and provide permanent waterproof seal at bottom of well casing, **as directed**.
   a. Fill void space between protective casing and cylinder with corrosion protective filler.
   b. Align cylinders and fill space around protective casing with fine sand.
4. Install cylinder plumb and accurately centered for elevator car position and travel. Anchor securely in place, supported at pit floor. Seal between well **OR** protective, **as directed**, casing and pit floor with 4 inches (100 mm) of nonshrink, nonmetallic grout.
5. Install cylinder plumb and accurately centered for elevator car position and travel. Anchor securely in place, supported at pit floor and braced at intervals as needed to maintain alignment. Anchor cylinder guides at spacing needed to maintain alignment and avoid overstressing guides.
6. Welded Construction: Provide welded connections for installing elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance, and replacement of worn parts. Comply with AWS standards for workmanship and for qualifications of welding operators.
7. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts designed to effectively prevent transmission of vibrations to structure and thereby eliminate sources of structure-borne noise from elevator system.
8. Install piping above the floor, where possible. Where not possible, install underground piping in Schedule 40 PVC pipe casing assembled with solvent-cemented fittings.
   OR
   Install piping above the floor, where possible. Where not possible, cover underground piping with permanent protective wrapping before backfilling.
9. Lubricate operating parts of systems as recommended by manufacturers.
10. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with car. Where possible, delay installation of sills and frames until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.
11. Leveling Tolerance: 1/4 inch (6 mm), up or down, regardless of load and direction of travel.
12. Set sills flush with finished floor surface at landing. Fill space under sill solidly with nonshrink, nonmetallic grout.
13. Locate hall signal equipment for elevators as follows, unless otherwise indicated:
    a. For groups of elevators, locate hall push-button stations between two elevators at center of group or at location most convenient for approaching passengers.
    b. Place hall lanterns either above or beside each hoistway entrance.
    c. Mount hall lanterns at a minimum of 72 inches (1829 mm) above finished floor.

C. Field Quality Control
1. Acceptance Testing: On completion of elevator installation and before permitting use (either temporary or permanent) of elevators, perform acceptance tests as required and recommended by ASME A17.1 and by governing regulations and agencies.
2. Advise Owner and authorities having jurisdiction in advance of dates and times tests are to be performed on elevators.

D. Protection
1. Temporary Use: Limit temporary use for construction purposes to one elevator, **as directed**. Comply with the following requirements for each, **as directed**, elevator used for construction purposes:
   a. Provide car with temporary enclosure, either within finished car or in place of finished car, to protect finishes from damage.
   b. Provide strippable protective film on entrance and car doors and frames.
   c. Provide padded wood bumpers on entrance door frames covering jambs and frame faces.
   d. Provide other protective coverings, barriers, devices, signs, and procedures as needed to protect elevator and elevator equipment.
   e. Do not load elevators beyond their rated weight capacity.

f. Engage elevator Installer to provide full maintenance service. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as necessary for proper elevator operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

g. Engage elevator Installer to restore damaged work, if any, so no evidence remains of correction. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

E. Demonstration

1. Train Owner's maintenance personnel to operate, adjust, and maintain elevator(s).
2. Check operation of each, **as directed**, elevator with Owner's personnel present and before date of Substantial Completion. Determine that operation systems and devices are functioning properly.
3. Check operation of each, **as directed**, elevator with Owner's personnel present not more than one month before end of warranty period. Determine that operation systems and devices are functioning properly.

END OF SECTION 14 01 20 00a

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Task	Specification	Specification Description
14 01 30 00	14 01 20 00	Electric Traction Elevators
14 01 30 00	14 01 20 00a	Hydraulic Elevators
14 01 30 00	14 31 00 00	Escalators

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SECTION 14 21 13 00 - ELECTRIC TRACTION FREIGHT ELEVATORS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for electric traction freight elevators. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes electric traction freight elevators.

C. Definitions
1. Definitions in ASME A17.1 apply to work of this Section.
2. Defective Elevator Work: Operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.

D. Submittals
1. Product Data: Include capacities, sizes, performances, operations, safety features, finishes, and similar information.
2. Shop Drawings: Show plans, elevations, sections, and large-scale details indicating service at each landing, machine room layout, coordination with building structure, relationships with other construction, and locations of equipment and signals. Indicate variations from specified requirements, maximum dynamic and static loads imposed on building structure at points of support, and maximum and average power demands.
3. Samples: For finishes involving color selection.
4. Manufacturer Certificates: Signed by elevator manufacturer certifying that hoistway, pit, and machine room layout and dimensions, as shown on Drawings, and electrical service, as shown and specified, are adequate for elevator system being provided.
5. Qualification Data: For Installer.
6. Operation and Maintenance Data: For elevators to include in emergency, operation, and maintenance manuals.
7. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.
8. Warranty: Special warranty specified in this Section.

E. Quality Assurance
1. Installer Qualifications: Elevator manufacturer or manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
2. Source Limitations: Obtain freight elevators, including hydraulic freight elevators specified in another Division 14 Section, through one source from a single manufacturer.
   a. Provide major elevator components, including driving machines, controllers, signal fixtures, door operators, car frames, cabs, and entrances, manufactured by a single manufacturer.
3. Regulatory Requirements: Comply with ASME A17.1 and elevator design requirements for earthquake loads in ASCE 7.
   a. Effective peak velocity acceleration (Av) for Project's location is less than 0.10 (seismic risk zones 0 and 1) **OR** greater than or equal to 0.10, but less than 0.20 (seismic risk zone 2) **OR** greater than or equal to 0.20 (seismic risk zones 3 and 4), **as directed**.
   b. Provide earthquake equipment required by ASME A17.1.
   c. Design earthquake spectral response acceleration, short period (Sds) for Project is determined by Project's location and site classification.

d. Project's seismic design category is A **OR** B **OR** C **OR** D, **as directed**.
e. Elevator importance factor is 1.5 **OR** 1.0, **as directed**.

4. Accessibility Requirements: Comply with Section 4.10 in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)" **OR** 407 in ICC A117.1, **as directed**.
5. Fire-Rated Hoistway Entrance Assemblies: Door and frame assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing at as close to neutral pressure as possible according to NFPA 252 **OR** UBC Standard 7-2 **OR** UL 10B, **as directed**.

F. Delivery, Storage, And Handling
1. Deliver, store, and handle materials, components, and equipment in manufacturer's protective packaging.
2. Store materials, components, and equipment off of ground, under cover, and in a dry location. Handle according to manufacturer's written recommendations to prevent damage, deterioration, or soiling.

G. Coordination
1. Coordinate installation of sleeves, block outs, elevator equipment with integral anchors, and other items that are embedded in concrete or masonry for elevator equipment. Furnish templates, sleeves, elevator equipment with integral anchors, and installation instructions and deliver to Project site in time for installation.
2. Coordinate sequence of freight elevator installation with other work to avoid delaying the Work.
3. Coordinate locations and dimensions of other work relating to electric traction freight elevators including pit ladders, sumps, and floor drains in pits; entrance subsills; machine beams, **as directed**; and electrical service, electrical outlets, lights, and switches in pits and machine rooms **OR** hoistways, **as directed**.

H. Warranty
1. Special Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to repair, restore, or replace defective elevator work within specified warranty period.
a. Warranty Period: One year from date of Substantial Completion.

1.2 PRODUCTS

A. Systems And Components – Non Proprietary
1. General: Provide manufacturer's standard freight elevator systems. Where components are not otherwise indicated, provide standard components published by manufacturer as included in standard preengineered freight elevator systems and as required for complete system.
2. Elevator Machines: At manufacturer's option, provide either variable-voltage, variable-frequency, ac-type or variable-voltage, dc-type hoisting machines. Provide solid-state power converters.
a. Limit total harmonic distortion of regenerated power to 5 percent per IEEE 519.
b. Provide line filters or chokes to prevent electrical peaks or spikes from feeding back into building power system from solid-state converters.
3. Fluid for Oil Buffers: If oil buffers are used, use only fire-resistant hydraulic fluid containing antioxidant, anticorrosive, antifoaming, and metal-passivating additives.
4. Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing guide rails, machinery, and other components of elevator work where installation of devices is specified in another Section.
5. Machine Beams: Provide framing to support elevator hoisting machine and deflector sheaves from the building structure. Comply with Division 05 Section "Metal Fabrications" for materials and fabrication.
6. Car Frame and Platform: Welded steel units.

a. Provide special heavy-duty units where indicated for power truck loading, designed to withstand impacts and wheel loadings indicated.

7. Guides: Provide roller guides or polymer-coated, nonlubricated sliding guides, **as directed**, at top and bottom of car and counterweight frames.

B. Operation Systems – Non Proprietary

1. General: Provide manufacturer's standard microprocessor operation system for each elevator **OR** for each group of elevators, **as directed**, as required to provide type of operation system indicated.
2. Load-Weighing Device: When car load exceeds 80 percent of rated capacity, a signal light is lit in the car control station; when car load exceeds rated capacity, car will not respond to car or hall calls.
3. Security Features: Provide the following security features, where indicated. Security features shall not affect emergency firefighters' service.
   a. Card-Reader Operation: System uses card readers at car control stations **OR** hall push-button stations, **as directed**, to authorize calls. Security system determines which landings and at what times calls require authorization by card reader. Provide required conductors in traveling cable and panel in machine room for interconnecting card readers, other security access system equipment, and elevator controllers. Allow space as indicated for card reader in car **OR** Provide stripe-swipe card reader integral with each car control station, **as directed**.
      1) Security access system equipment is specified in Division 28 Section "Access Control".
         OR
         Security access system equipment is not in the Contract.
   b. Keyswitch Operation: Push buttons are activated and deactivated by security keyswitches at car control stations **OR** hall push-button stations, **as directed**. Key is removable only in deactivated position **OR** in either position, **as directed**.

C. Door Reopening Devices

1. Infrared Array: Provide door reopening devices with a uniform array of 36 or more microprocessor-controlled, infrared light beams projecting across car entrance. Interruption of one or more of the light beams shall cause doors to stop and reopen.

D. Finish Materials

1. General: Provide the following materials for exposed parts of elevator car enclosures, car doors, hoistway entrance doors and frames, and signal equipment as indicated.
2. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, commercial steel, Type B, exposed, matte finish.
3. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, commercial steel, Type B, pickled.
4. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, commercial steel, with G60 (Z180) zinc coating (galvanized) or A60 (ZF180) zinc-iron-alloy coating (galvannealed).
5. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304.
   a. Textured Stainless-Steel Sheet: Product with coined **OR** embossed, **as directed**, texture rolled into exposed surface.
6. Stainless-Steel Bars: ASTM A 276, Type 304.
7. Stainless-Steel Tubing: ASTM A 554, Grade MT 304.
8. Rolled Steel Floor Plate: ASTM A 786/A 786M.
9. Rolled Stainless-Steel Floor Plate: ASTM A 793.
10. Aluminum-Alloy Rolled Tread Plate: ASTM B 632/B 632M, Pattern 1, Alloy 6061-T6.

E. Car Enclosures

1. General: Provide car enclosures as indicated including ventilation, lighting, finishes, access doors, thresholds, trim, and accessories. Fabricate with recesses and cutouts for signal equipment.
   a. Provide power door operators with linkages for hoistway door operation.

b. Provide standard railings complying with ASME A17.1 on car tops where required by ASME A17.1.

2. Materials and Fabrication: Provide manufacturer's standard, flush panel, welded construction made from metal sheet, of metal indicated, not less than 0.067 inch (1.7 mm) and reinforced at 16-inch (406-mm) maximum spacing.
   a. Provide perforated panels for ceiling and for walls above 72 inches (1829 mm) from car floor, unless required to be solid by ASME A17.1.

F. Hoistway Entrances
1. General: Structural-steel frames and sills for hoistway entrances are specified in Division 05 Section(s) "Structural Steel Framing" OR "Metal Fabrications", **as directed**. Unless otherwise indicated, provide hoistway entrance doors of type indicated below, with truckable sill bars and resilient safety meeting-rail gaskets.
   a. Equip for power operation by coordinated linkage with power-operated car door.
   b. Where gypsum board wall construction is indicated, provide fire-resistance-rated, hollow-metal, door-and-frame hoistway entrances. Provide self-supporting frames with reinforced head sections.
2. Materials and Fabrication: Provide manufacturer's standards, but not less than the following:
   a. Metal Door Panels: Constructed of metal sheets, flush on room side, welded and reinforced in steel framing with vertical reinforcing spaced not more than 24 inches (610 mm) o.c. Fabricate panel faces from metal sheet, of metal indicated, not less than 0.097 inch (2.5 mm) thick.

G. Signal Equipment
1. General: Provide hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled. Fabricate lighted elements of acrylic or other permanent, nonyellowing translucent plastic.
2. Car Control Stations: Provide manufacturer's standard car control station. Mount adjacent to car door, unless otherwise indicated.
   a. Mark buttons and switches with manufacturer's standard identification for required use or function that complies with ASME A17.1. Use both tactile symbols and Braille.
   b. Mount controls at heights complying with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)" **OR** ICC A117.1, **as directed**.
3. Emergency Communication System: Provide system that complies with ASME A17.1 and the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)." On activation, system dials preprogrammed number of monitoring station and identifies elevator location to monitoring station. System provides two-way voice communication without using a handset and provides visible signals that indicate when system has been activated and when monitoring station has responded. System is contained in flush-mounted cabinet, with identification, instructions for use, and battery backup power supply.
4. Firefighters' Two-Way Telephone Communication Service: Provide flush-mounted cabinet **OR** telephone jack, **as directed**, in each car and required conductors in traveling cable for firefighters' two-way telephone communication service specified in Division 28 Section(s) "Digital, Addressable Fire-alarm System" OR "Zoned (dc Loop) Fire-alarm System".
5. Car Position Indicator: Provide illuminated, digital-type car position indicator, located above car door or above car control station.
6. Hall Push-Button Stations: Provide hall push-button stations at each landing as indicated.
   a. Provide single-button stations with position **OR** "In-Use", **as directed**, indicator.

H. Elevators
1. Elevator No(s).: <**Insert elevator number(s) as shown on Drawings.**>
   a. Type: Geared **OR** Gearless, **as directed**, traction.

b. Machine Location: Machine room above hoistway **OR** Hoistway; no machine room is provided, **as directed**.
c. Rated Load: 2000 lb (908 kg) **OR** 2500 lb (1135 kg) **OR** 3000 lb (1362 kg) **OR** 4000 lb (1816 kg) **OR** 5000 lb (2270 kg) **OR** 6000 lb (2720 kg) **OR** 8000 lb (3632 kg) **OR** 10 000 lb (4540 kg), **as directed**.
d. Freight Loading Class: Class A **OR** B **OR** C1 **OR** C2 **OR** C3, **as directed**.
e. Rated Speed: 75 fpm (0.38 m/s) **OR** 100 fpm (0.51 m/s) **OR** 150 fpm (0.76 m/s) **OR** 200 fpm (1.0 m/s) **OR** 350 fpm (1.8 m/s), **as directed**.
f. Operation System: Single automatic **OR** Car-switch automatic floor-stop **OR** Selective collective automatic, **as directed**, operation.
g. Auxiliary Operations: Card-reader operation **OR** Keyswitch operation **OR** Load-weighing device **OR** Earthquake emergency operation, **as directed**.
h. Auxiliary Car Control Station: Provide additional car control station mounted on side of car at height to facilitate operation by forklift-truck operator without leaving truck.
i. Car Enclosures:
   1) Platform Width: 64 inches (1626 mm) **OR** 76 inches (1930 mm) **OR** 88 inches (2235 mm) **OR** 100 inches (2540 mm), **as directed**.
   2) Platform Depth: 84 inches (2134 mm) **OR** 96 inches (2438 mm) **OR** 120 inches (3048 mm) **OR** 144 inches (3658 mm) **OR** 168 inches (4267 mm), **as directed**.
   3) Ceiling Height: 84 inches (2134 mm) **OR** 96 inches (2438 mm) **OR** 108 inches (2743 mm), **as directed**.
   4) Walls and Ceiling: Prime-painted steel **OR** Prime-painted, metallic-coated steel **OR** Satin stainless steel, No. 4 finish **OR** Textured stainless steel, **as directed**.
   5) Car Fixtures: Satin stainless steel, No. 4 finish.
   6) Floor: Rolled steel floor plate **OR** Aluminum-alloy rolled tread plate **OR** Rolled stainless-steel floor plate, **as directed**.
   7) Car Gate Type: Vertical biparting **OR** Single-speed vertical lift **OR** Two-speed vertical lift, **as directed**.
   8) Car Gate Operation: Manual **OR** Power operated, **as directed**.
   9) Car Gate Material: Prime-painted steel **OR** Satin stainless steel, No. 4 finish, **as directed**.
   10) Car Sill: Steel angle.
   11) Lighting:
      a) Two **OR** Three, **as directed**, 48-inch (1219-mm), suspended, **OR** surface-mounted, **as directed**, 2-tube fluorescent light fixture(s) with white reflectors, **as directed**, and wire lamp guards, **as directed**.
      OR
      b) Not Less Than Two, **as directed**, 48-inch (1219-mm), recessed, 2 **OR** 3, **as directed**,-tube fluorescent light fixture(s) with UV stabilized acrylic diffusers not less than 0.125 inch (3.2 mm) thick.
      c) Illumination at car threshold, with doors closed, shall not be less than 25LX (2.5 FC) for freight elevators.
j. Hoistway Entrances:
   1) Width: 60 inches (1524 mm) **OR** 72 inches (1829 mm) **OR** 96 inches (2438 mm), **as directed**.
   2) Height: 84 inches (2134 mm) **OR** 96 inches (2438 mm), **as directed**.
   3) Door Type: Vertical biparting **OR** Single-speed vertical lift **OR** Two-speed vertical lift, **as directed**.
   4) Fire-Protection Rating: 1 hour **OR** 1-1/2 hours, **as directed**, with 30-minute temperature rise of 450 deg F (250 deg C), **as directed**.
   5) Door Operation: Manual **OR** Power operated, **as directed**.
   6) Door Material: Prime-painted steel **OR** Satin stainless steel, No. 4 finish, **as directed**.
   7) Door Frame Material: Prime-painted steel **OR** Satin stainless steel, No. 4 finish, **as directed**.

8) Door frames and sills are specified in Division 05 Section(s) "Structural Steel Framing" OR "Metal Fabrications", **as directed**.

k. Hall Fixtures: Satin stainless steel, No. 4 finish.

l. Auxiliary Hall Stations: Provide additional pendant-mounted, hall push-button stations where indicated, mounted at height to facilitate operation by forklift-truck operator without leaving truck.

m. Additional Requirements:

1) Door reopening device.

1.3 EXECUTION

A. Examination

1. Examine elevator areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance. Examine hoistways, hoistway openings, pits, and machine rooms as constructed; verify critical dimensions; and examine supporting structure and other conditions under which elevator work is to be installed.

a. For the record, prepare a written report, endorsed by Installer, listing dimensional discrepancies and conditions detrimental to performance or indicating that dimensions and conditions were found to be satisfactory.

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

B. Installation

1. Comply with manufacturer's written instructions.
2. Welded Construction: Provide welded connections for installing elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance, and replacement of worn parts. Comply with AWS standards for workmanship and for qualifications of welding operators.
3. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts designed to minimize transmission of vibrations to structure and thereby minimize structure-borne noise from elevator system.
4. Lubricate operating parts of systems, including ropes, as recommended by manufacturers.
5. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with car. Where possible, delay final adjustment of sills and doors until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.

C. Field Quality Control

1. Acceptance Testing: On completion of elevator installation and before permitting use (either temporary or permanent) of elevators, perform acceptance tests as required and recommended by ASME A17.1 and by governing regulations and agencies.
2. Operating Test: Load elevator **OR** each elevator **OR** one elevator of each type, capacity, speed, and travel distance, **as directed**, to rated capacity and operate continuously for 30 minutes over full travel distance, stopping at each level and proceeding immediately to the next. Record temperature rise of elevator machine during 30-minute test period. Record failure to perform as required.
3. Advise Owner and authorities having jurisdiction in advance of dates and times tests are to be performed on elevators.

D. Protection

1. Temporary Use: Limit temporary use for construction purposes to one elevator, **as directed**. Comply with the following requirements for each, **as directed**, elevator used for construction purposes:

a. Provide protective coverings, barriers, devices, signs, and procedures as needed to protect elevator and elevator equipment.

b. Do not load elevators beyond their rated weight capacity.

c. Engage elevator Installer to provide full maintenance service. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as necessary for proper elevator operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

d. Engage elevator Installer to restore damaged work, if any, so no evidence remains of correction. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

E. Demonstration

1. Train Owner's maintenance personnel to operate, adjust, and maintain elevator(s).
2. Check operation of each, **as directed**, elevator with Owner's personnel present and before date of Substantial Completion. Determine that operation systems and devices are functioning properly.
3. Check operation of each, **as directed**, elevator with Owner's personnel present not more than one month before end of warranty period. Determine that operation systems and devices are functioning properly.

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SECTION 14 24 13 00 - HYDRAULIC FREIGHT ELEVATORS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for hydraulic freight elevators. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes hydraulic freight elevators.

C. Definitions
1. Definitions in ASME A17.1 apply to work of this Section.
2. Defective Elevator Work: Operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.

D. Submittals
1. Product Data: Include capacities, sizes, performances, operations, safety features, finishes, and similar information.
2. Shop Drawings: Show plans, elevations, sections, and large-scale details indicating service at each landing, machine room layout, coordination with building structure, relationships with other construction, and locations of equipment and signals. Indicate variations from specified requirements, maximum dynamic and static loads imposed on building structure at points of support, and maximum and average power demands.
3. Samples for Initial Selection: For finishes involving color selection.
4. Manufacturer Certificates: Signed by elevator manufacturer certifying that hoistway, pit, and machine room layout and dimensions, as shown on Drawings, and electrical service, as shown and specified, are adequate for elevator system being provided.
5. Qualification Data: For Installer.
6. Operation and Maintenance Data: For elevators to include in emergency, operation, and maintenance manuals.
7. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.
8. Warranty: Special warranty specified in this Section.

E. Quality Assurance
1. Installer Qualifications: Elevator manufacturer or manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
2. Source Limitations: Obtain freight elevators, including electric traction freight elevators specified in another Division 14 Section, through one source from a single manufacturer.
   a. Provide major elevator components, including pump-and-tank units, plunger-cylinder assemblies, controllers, signal fixtures, door operators, car frames, cabs, and entrances, manufactured by a single manufacturer.
3. Regulatory Requirements: Comply with ASME A17.1 and elevator design requirements for earthquake loads in ASCE 7.
   a. Effective peak velocity acceleration (Av) for Project's location is less than 0.10 (seismic risk zones 0 and 1) **OR** greater than or equal to 0.10, but less than 0.20 (seismic risk zone 2) **OR** greater than or equal to 0.20 (seismic risk zones 3 and 4), **as directed**.
   b. Design earthquake spectral response acceleration, short period (Sds) for Project is determined by Project's location and site classification.

c. Project's seismic design category is A **OR** B **OR** C **OR** D, **as directed**.
d. Elevator importance factor is 1.5 **OR** 1.0, **as directed**.

4. Accessibility Requirements: Comply with Section 4.10 in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)" **OR** 407 in ICC A117.1, **as directed**.
5. Fire-Rated Hoistway Entrance Assemblies: Door and frame assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing at as close to neutral pressure as possible according to NFPA 252 **OR** UBC Standard 7-2 **OR** UL 10B, **as directed**.

F. Delivery, Storage, And Handling
1. Deliver, store, and handle materials, components and equipment in manufacturer's protective packaging.
2. Store materials, components, and equipment off of ground, under cover, and in a dry location. Handle according to manufacturer's written recommendations to prevent damage, deterioration, or soiling.

G. Coordination
1. Coordinate installation of sleeves, block outs, and items that are embedded in concrete or masonry for elevator equipment. Furnish templates and installation instructions and deliver to Project site in time for installation.
2. Furnish well casing and coordinate delivery with related excavation work.
3. Coordinate sequence of freight elevator installation with other work to avoid delaying the Work.
4. Coordinate locations and dimensions of other work relating to hydraulic freight elevators including pit ladders, sumps, and floor drains in pits; entrance subsills; and electrical service, electrical outlets, lights, and switches in pits and machine rooms.

H. Warranty
1. Special Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to repair, restore, or replace defective elevator work within specified warranty period.
a. Warranty Period: One year from date of Substantial Completion.

1.2 PRODUCTS

A. Systems And Components
1. General: Provide manufacturer's standard freight elevator systems. Where components are not otherwise indicated, provide standard components published by manufacturer as included in standard preengineered freight elevator systems and as required for complete system.
2. Pump Units: Positive-displacement type with a maximum of 10 percent variation between no load and full load and with minimum pulsations. Provide either of the following:
a. Pump, with fan-cooled squirrel-cage induction motor, mounted on oil tank with vibration isolation mounts. Enclose pump in prime-painted steel enclosure lined with 1-inch- (25-mm-) thick, glass-fiber insulation board.
b. Submersible pump, with submersible squirrel-cage induction motor, suspended inside oil tank from vibration isolation mounts.
c. Provide motor with wye-delta or solid-state starting.
3. Hydraulic Silencers: Provide hydraulic silencer containing pulsation-absorbing material in a blowout-proof housing at pump unit.
4. Piping: Provide size, type, and weight piping recommended by manufacturer, and provide flexible connectors to minimize sound and vibration transmissions from power unit.
a. Provide dielectric couplings at cylinder units.
b. Casing for Underground Piping: PVC pipe complying with ASTM D 1785, joined with PVC fittings complying with ASTM D 2466 and solvent cement complying with ASTM D 2564.

5. Hydraulic Fluid: Elevator manufacturer's standard fluid **OR** fire-resistant fluid, **as directed**, with additives as needed to prevent oxidation of fluid, corrosion of cylinder and other components, and other adverse effects.
   OR
   Hydraulic Fluid: Nontoxic, readily biodegradable, fluid **OR** fire-resistant fluid, **as directed**, made from vegetable oil with antioxidant, anticorrosive, antifoaming, and metal-passivating additives. Hydraulic fluid is approved by elevator manufacturer for use with elevator equipment.
6. Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing guide rails, machinery, and other components of elevator work where installation of devices is specified in another Section.
7. Inspection of existing cylinders:
   a. Any cylinder that does not conform to ASME A17.1 Rule 3.18.3 & 3.18.3.4 must be replaced. All cylinders must be inspected and any cylinders that do not have the conforming safety bulkhead or a double-bottom cylinder shall be replaced with a conforming cylinder.
8. All cylinders buried in the ground shall be provided with a safety bulkhead conforming to ASME A17.1 **OR** a double bottom cylinder is used and liner and outer cylinders conform.
9. Protective Cylinder Casing: PVC or HDPE pipe casing complying with ASME A17.1, of sufficient size to provide not less than 1-inch (25-mm) clearance from cylinder and extending above pit floor. Provide means to monitor casing effectiveness to comply with ASME A17.1.
10. Corrosion Protective Filler: A nontoxic, petroleum-based gel formulated for filling the space between hydraulic cylinder and protective casing. Filler is electrically nonconductive, displaces or absorbs water, and gels or solidifies at temperatures below 60 deg F (16 deg C).
11. Car Frame and Platform: Welded steel units.
    a. Provide special heavy-duty units where indicated for power truck loading, designed to withstand impacts and wheel loadings indicated.
12. Guides: Provide either roller guides or sliding guides at top and bottom of car and counterweight frames. If sliding guides are used, provide guide-rail lubricators or polymer-coated, nonlubricated guides.

B. Non-Proprietary Operation Systems and Components
1. General: Provide manufacturer's standard microprocessor operation system for each elevator **OR** for each group of elevators, **as directed**, as required to provide type of operation system indicated.
2. Battery-Powered Lowering: When power fails, car is lowered to the lowest floor, opens its doors, and shuts down. System includes rechargeable battery and automatic recharging system.
3. Load-Weighing Device: When car load exceeds 80 percent of rated capacity, a signal light is lit in the car control station; when car load exceeds rated capacity, car will not respond to car or hall calls.
4. Security Features: Provide the following security features, where indicated. Security features shall not affect emergency firefighters' service.
   a. Card-Reader Operation: System uses card readers at car control stations **OR** hall push-button stations, **as directed**, to authorize calls. Security system determines which landings and at what times calls require authorization by card reader. Provide required conductors in traveling cable and panel in machine room for interconnecting card readers, other security access system equipment, and elevator controllers. Allow space as indicated for card reader in car **OR** Provide stripe-swipe card reader integral with each car control station, **as directed**.
      1) Security access system equipment is specified in Division 28 Section "Access Control".
         OR
         Security access system equipment is not in the Contract.

      OR
      Keyswitch Operation: Push buttons are activated and deactivated by security keyswitches at car control stations **OR** hall push-button stations, **as directed**. Key is removable only in deactivated position **OR** in either position, **as directed**.

C. Door Reopening Devices
   1. Infrared Array: Provide door reopening devices with uniform array of 36 or more microprocessor-controlled, infrared light beams projecting across car entrance. Interruption of one or more of the light beams shall cause doors to stop and reopen.

D. Finish Materials
   1. General: Provide the following materials for exposed parts of elevator car enclosures, car doors, hoistway entrance doors and frames, and signal equipment as indicated.
   2. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, commercial steel, Type B, exposed, matte finish.
   3. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, commercial steel, Type B, pickled.
   4. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, commercial steel, with G60 (Z180) zinc coating (galvanized) or A60 (ZF180) zinc-iron-alloy coating (galvannealed).
   5. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304.
      a. Textured Stainless-Steel Sheet: Product with coined **OR** embossed, **as directed**, texture rolled into exposed surface.
   6. Stainless-Steel Bars: ASTM A 276, Type 304.
   7. Stainless-Steel Tubing: ASTM A 554, Grade MT 304.
   8. Rolled Steel Floor Plate: ASTM A 786/A 786M.
   9. Rolled Stainless-Steel Floor Plate: ASTM A 793.
   10. Aluminum-Alloy Rolled Tread Plate: ASTM B 632/B 632M, Pattern 1, Alloy 6061-T6.

E. Car Enclosures
   1. General: Provide car enclosures as indicated, including ventilation, lighting, finishes, access doors, thresholds, trim, and accessories. Fabricate with recesses and cutouts for signal equipment.
      a. Provide power door operators with linkages for hoistway door operation.
      b. Provide standard railings complying with ASME A17.1 on car tops where required by ASME A17.1.
   2. Materials and Fabrication: Provide manufacturer's standard, flush panel, welded construction made from metal sheet, of metal indicated, not less than 0.067 inch (1.7 mm) and reinforced at 16-inch (406-mm) maximum spacing.
      a. Provide perforated panels for ceiling and for walls above 72 inches (1829 mm) from car floor unless required to be solid by ASME A17.1.

F. Hoistway Entrances
   1. General: Structural-steel frames and sills for hoistway entrances are specified in Division 05 Section(s) "Structural Steel Framing" OR "Metal Fabrications", **as directed**. Unless otherwise indicated, provide hoistway entrance doors of type indicated below, with truckable sill bars and resilient safety meeting-rail gaskets.
      a. Equip for power operation by means of coordinated linkage with power-operated car door.
      b. Where gypsum board wall construction is indicated, provide fire-resistance-rated, hollow-metal, door-and-frame hoistway entrances. Provide self-supporting frames with reinforced head sections.
   2. Materials and Fabrication: Provide manufacturer's standards, but not less than the following:
      a. Metal Door Panels: Constructed of metal sheets, flush on room side, welded and reinforced in steel framing with vertical reinforcing spaced not more than 24 inches (610 mm) o.c. Fabricate panel faces from metal sheet, of metal indicated, not less than 0.097 inch (2.5 mm) thick.

G. Signal Equipment
   1. General: Provide hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled. Fabricate lighted elements of acrylic or other permanent, nonyellowing translucent plastic.

2. Car Control Stations: Provide manufacturer's standard car control station. Mount adjacent to car door, unless otherwise indicated.
   a. Mark buttons and switches with manufacturer's standard identification for required use or function that complies with ASME A17.1. Use both tactile symbols and Braille.
   b. Mount controls at heights complying with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)" **OR** ICC A117.1, **as directed**.
3. Emergency Communication System: Provide system that complies with ASME A17.1 and the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Building and Facilities (ADAAG)." On activation, system dials preprogrammed number of monitoring station and identifies elevator location to monitoring station. System provides two-way voice communication without using a handset and provides visible signals that indicate when system has been activated and when monitoring station has responded. System is contained in flush-mounted cabinet, with identification, instructions for use, and battery backup power supply.
4. Firefighters' Two-Way Telephone Communication Service: Provide flush-mounted cabinet **OR** telephone jack, **as directed**, in each car and required conductors in traveling cable for firefighters' two-way telephone communication service specified in Division 28 Section(s) "Digital, Addressable Fire-alarm System" OR "Zoned (dc Loop) Fire-alarm System".
5. Car Position Indicator: Provide illuminated digital-type car position indicator, located above car door or above car control station.
6. Hall Push-Button Stations: Provide hall push-button stations at each landing as indicated.
   a. Provide single-button stations with position **OR** "In-Use", **as directed**, indicator.

H. Elevators
1. Elevator No(s).: <**Insert elevator number(s) as shown on Drawings.**>
   a. Type: Under-the-car single or dual cylinder.
      OR
      Type: Holeless, beside-the-car, single-acting, single **OR** dual, **as directed**, cylinder.
      OR
      Type: Holeless, beside-the-car, telescoping, single **OR** dual, **as directed**, cylinder.
      OR
      Type: Holeless, beside-the-car, roped hydraulic, single **OR** dual, **as directed**, cylinder.
   b. Rated Load: 2000 lb (908 kg) **OR** 2500 lb (1135 kg) **OR** 3000 lb (1362 kg) **OR** 4000 lb (1816 kg) **OR** 5000 lb (2270 kg) **OR** 6000 lb (2720 kg) **OR** 8000 lb (3632 kg) **OR** 10 000 lb (4540 kg), **as directed**.
   c. Freight Loading Class: Class A **OR** B **OR** C1 **OR** C2 **OR** C3, **as directed**.
   d. Rated Speed (Up): 50 fpm (0.25 m/s) **OR** 75 or 80 fpm (0.38 or 0.41 m/s) **OR** 100 fpm (0.51 m/s), **as directed**.
   e. Operational Speed (Down): Approximately 30 percent more than **OR** Same as, **as drected**, rated speed (up).
   f. Operation System: Single automatic **OR** Car-switch automatic floor-stop **OR** Selective collective automatic, **as directed**, operation.
   g. Auxiliary Operations: Battery-powered lowering **OR** Card-reader operation **OR** Keyswitch operation **OR** Load-weighing device, **as directed**.
   h. Auxiliary Car Control Station: Provide additional car control station mounted on side of car at height to facilitate operation by forklift-truck operator without leaving truck.
   i. Car Enclosures:
      1) Platform Width: 60 inches (1524 mm) **OR** 64 inches (1626 mm) **OR** 66 inches (1676 mm) **OR** 76 inches (1930 mm) **OR** 78 inches (1981 mm) **OR** 88 inches (2235 mm) **OR** 100 inches (2540 mm) **OR** 102 inches (2591 mm) **OR** 124 inches (3150 mm) **OR** 126 inches (3200 mm), **as directed**.
      2) Platform Depth: 72 inches (1829 mm) **OR** 84 inches (2134 mm) **OR** 96 inches (2438 mm) **OR** 120 inches (3048 mm) **OR** 144 inches (3658 mm) **OR** 168 inches (4267 mm), **as directed**.

3) Ceiling Height: 84 inches (2134 mm) **OR** 96 inches (2438 mm) **OR** 108 inches (2743 mm), **as directed**.
4) Walls and Ceiling: Prime-painted steel **OR** Prime-painted, metallic-coated steel **OR** Satin stainless steel, No. 4 finish **OR** Textured stainless steel, **as directed**.
5) Car Fixtures: Satin stainless steel, No. 4 finish.
6) Floor: Rolled steel floor plate **OR** Aluminum-alloy rolled tread plate **OR** Rolled stainless-steel floor plate, **as directed**.
7) Car Gate Type: Vertical biparting **OR** Single-speed vertical lift **OR** Two-speed vertical lift, **as directed**.
8) Car Gate Operation: Manual **OR** Power operated, **as directed**.
9) Car Gate Material: Prime-painted steel **OR** Satin stainless steel, No. 4 finish, **as directed**.
10) Car Sill: Steel angle.
11) Lighting:
    a) Two **OR** Three, **as directed**, 48-inch (1219-mm), suspended, **OR** surface-mounted, **as directed**, 2-tube fluorescent light fixture(s) with white reflectors, **as directed**, and wire lamp guards, **as directed**.
    OR
    b) Not Less Than Two, **as directed**, 48-inch (1219-mm), recessed, 2 **OR** 3, **as directed**,-tube fluorescent light fixture(s) with UV stabilized acrylic diffusers not less than 0.125 inch (3.2 mm) thick.
    c) Illumination at car threshold, with doors closed, shall not be less than 25LX (2.5 FC) for freight elevators.

j. Hoistway Entrances:
1) Width: 56 inches (1422 mm) **OR** 60 inches (1524 mm) **OR** 62 inches (1575 mm) **OR** 72 inches (1829 mm) **OR** 96 inches (2438 mm) **OR** 98 inches (2489 mm) **OR** 120 inches (3048 mm) **OR** 122 inches (3099 mm), **as directed**.
2) Height: 84 inches (2134 mm) **OR** 96 inches (2438 mm), **as directed**.
3) Door Type: Vertical biparting **OR** Single-speed vertical lift **OR** Two-speed vertical lift, **as directed**.
4) Fire-Protection Rating: 1 hour **OR** 1-1/2 hours, **as directed**, with 30-minute temperature rise of 450 deg F (250 deg C), **as directed**.
5) Door Operation: Manual **OR** Power operated, **as directed**.
6) Door Material: Prime-painted steel **OR** Satin stainless steel, No. 4 finish, **as directed**.
7) Door Frame Material: Prime-painted steel **OR** Satin stainless steel, No. 4 finish, **as directed**.
8) Door frames and sills are specified in Division 05 Section(s) "Structural Steel Framing" OR "Metal Fabrications", **as directed**.

k. Hall Fixtures: Satin stainless steel, No. 4 finish.

l. Auxiliary Hall Stations: Provide additional pendant-mounted, hall push-button stations where indicated mounted at height to facilitate operation by forklift-truck operator without leaving truck.

m. Additional Requirements:
1) Provide door reopening device.

1.3 EXECUTION

A. Examination
1. Examine elevator areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance. Verify critical dimensions and examine supporting structure and other conditions under which elevator work is to be installed.

a. For the record, prepare a written report, endorsed by Installer, listing dimensional discrepancies and conditions detrimental to performance or indicating that dimensions and conditions were found to be satisfactory.
b. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Installation
1. Excavation for Cylinder: Drill well hole in each elevator pit to accommodate installation of cylinder; comply with applicable requirements in Division 31 Section "Earth Moving".
2. Provide waterproof well casing as necessary to retain walls of well hole.
3. Install cylinder in protective casing within well hole. Before installing protective casing, remove water and debris from well hole and provide permanent waterproof seal at bottom of well casing.
   a. Fill void space between protective casing and cylinder with corrosion-protective filler.
   b. Align cylinders and fill space around protective casing with fine sand.
4. Install cylinder plumb and accurately centered for elevator car position and travel. Anchor securely in place, supported at pit floor. Seal between well **OR** protective, **as directed**, casing and pit floor with 4 inches (100 mm) of nonshrink, nonmetallic grout.
5. Install cylinder plumb and accurately centered for elevator car position and travel. Anchor securely in place, supported at pit floor and braced at intervals as needed to maintain alignment. Anchor cylinder guides at spacing needed to maintain alignment and avoid overstressing guides.
6. Welded Construction: Provide welded connections for installing elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance, and replacement of worn parts. Comply with AWS standards for workmanship and for qualifications of welding operators.
7. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts designed to effectively prevent transmission of vibrations to structure and thereby eliminate sources of structure-borne noise from elevator system.
8. Install piping above the floor, where possible. Where not possible, install underground piping in Schedule 40 PVC pipe casing assembled with solvent-cemented fittings.
   OR
   Install piping above the floor, where possible. Where not possible, cover underground piping with permanent protective wrapping before backfilling.
9. Lubricate operating parts of systems as recommended by manufacturers.
10. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with car. Where possible, delay installation of sills and frames until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.

C. Field Quality Control
1. Acceptance Testing: On completion of elevator installation and before permitting use (either temporary or permanent) of elevators, perform acceptance tests as required and recommended by ASME A17.1 and by governing regulations and agencies.
2. Advise Owner and authorities having jurisdiction in advance of dates and times tests are to be performed on elevators.

D. Protection
1. Temporary Use: Limit temporary use for construction purposes to one elevator, **as directed**. Comply with the following requirements for each, **as directed**, elevator used for construction purposes:
   a. Provide protective coverings, barriers, devices, signs, and procedures as needed to protect elevator and elevator equipment.
   b. Do not load elevators beyond their rated weight capacity.
   c. Engage elevator Installer to provide full maintenance service. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as necessary for proper elevator operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

d. Engage elevator Installer to restore damaged work, if any, so no evidence remains of correction. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

E. Demonstration
1. Train Owner's maintenance personnel to operate, adjust, and maintain elevator(s).
2. Check operation of each elevator with Owner's personnel present and before date of Substantial Completion. Determine that operation systems and devices are functioning properly.
3. Check operation of each elevator with Owner's personnel present not more than one month before end of warranty period. Determine that operation systems and devices are functioning properly.

END OF SECTION 14 24 13 00

Task	Specification	Specification Description
14 24 13 00	14 01 20 00a	Hydraulic Elevators
14 24 23 00	14 01 20 00a	Hydraulic Elevators

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SECTION 14 31 00 00 - ESCALATORS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for escalators. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes high-traffic, interior and exterior escalators.

C. Definitions
1. High-Traffic Escalators: Escalators designed specifically for use where high-traffic volumes produce dense occupancy resulting in structural, machinery, and brake loads much higher than normal.
2. Defective Escalator Work: Operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; the need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.

D. Performance Requirements
1. Rated Speed: 90 fpm (0.46 m/s) or 100 fpm (0.5 m/s).
2. Braking Performance: Provide brakes that stop escalator in up-running mode at a rate no greater than 3 ft./s^2 (0.91 m/s^2).
OR
Braking Performance: Provide brakes that produce a stopping force on escalator in up-running mode that is one-third that used in down-running mode.
3. Step/Skirt Performance Index: Not more than 0.15.
4. Structural and Mechanical Performance for High-Traffic Escalators: For the purpose of structural design, driving machine and power transmission calculations, and brake calculations, design high-traffic escalators for loads not less than 2 times the design loads required by ASME A17.1.
5. Structural Performance of Balustrades, Deck Barricades, and Handrails: Provide components and assemblies capable of withstanding the effects of loads indicated in ASCE 7 for handrail assemblies and guardrail systems.

E. Submittals
1. Product Data: Include capacities, sizes, performances, safety features, finishes, and similar information.
2. Shop Drawings: Show plans, elevations, sections, and details indicating coordination with building structure and relationships with other construction. Indicate variations from specified requirements, maximum loads imposed on building structure at points of support, and power requirements. Indicate access and ventilation for escalator machine space.
3. Samples: For exposed finishes, 3-inch- (75-mm-) square Samples of sheet materials, and 4-inch (100-mm) lengths of running trim members.
4. Manufacturer Certificates: Signed by manufacturer certifying that escalator layout and dimensions, as shown on Drawings, and electrical service, as shown and specified, are adequate for escalator system being provided.
5. Qualification Data: For Installer.
6. Operation and Maintenance Data: For escalators to include in emergency, operation, and maintenance manuals.
7. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted escalator use.

8. Warranty: Special warranty specified in this Section.

F. Quality Assurance
1. Installer Qualifications: Escalator manufacturer or manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
2. Source Limitations: Obtain escalators and moving walks, specified in another Division 14 Section, through one source from a single manufacturer.
3. Regulatory Requirements: Comply with ASME A17.1.

G. Delivery, Storage, And Handling
1. Deliver, store, and handle materials, components, and equipment in manufacturer's protective packaging.
2. Store materials, components, and equipment off of ground, under cover, and in a dry location. Handle according to manufacturer's recommendations to prevent damage, deterioration, or soiling.

H. Coordination
1. Coordinate installation of sleeves, block outs, escalator equipment with integral anchors, and other items that are embedded in concrete or masonry for escalator equipment. Furnish templates, sleeves, escalator equipment with integral anchors, and installation instructions and deliver to Project site in time for installation.
2. Coordinate sequence of escalator installation with other work to avoid delaying the Work.
3. Coordinate locations and dimensions of other work relating to escalators including sumps and floor drains in pits, electrical service, and electrical outlets, lights, and switches in pits.

I. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair, restore, or replace defective escalator work within specified warranty period.
   a. Warranty Period: One year from date of Substantial Completion.

1.2 PRODUCTS

A. Materials
1. Stainless Steel: ASTM A 240/A 240M, Type 304 **OR** 316 **OR** 304, except use Type 316 for exterior escalators, **as directed**.
   a. Satin Finish: No. 4 directional satin.
   b. Polished Finish: No. 8 mirror polish.
   c. Gold-Colored Satin Finish: No. 4 directional satin with gold-colored oxide or titanium nitride finish.
   d. Gold-Colored Mirror Finish: No. 8 mirror polish with gold-colored oxide or titanium nitride finish.
2. Satin Bronze Sheet: ASTM B 36/B 36M, Alloy UNS No. C28000 (muntz metal), fine satin finish, lacquered.
3. Satin Bronze Extrusions: ASTM B 455, Alloy UNS No. C38500 (architectural bronze), fine satin finish, lacquered.
4. Steel Sheet: Cold-rolled steel sheet, ASTM A 1008/A 1008M, commercial steel, Type B, exposed, matte finish.
5. Clear Tempered Glass: ASTM C 1048, Condition A (uncoated surfaces), Type 1 (transparent glass, flat), Class 1 (clear), Quality q3 (glazing, select), Kind FT (fully tempered), [**10.0**] [**12.0**] mm thick.
6. Tinted Tempered Glass: ASTM C 1048, Condition A (uncoated surfaces), Type 1 (transparent glass, flat), Class 2 (tinted), Quality q3 (glazing, select), Kind FT (fully tempered), [**10.0**] [**12.0**] mm thick.
   a. Color: Bronze **OR** Gray **OR** Green, **as directed**.

B. Components
1. General: Provide preengineered escalators complying with requirements. Unless otherwise indicated, provide standard components as indicated in manufacturers' publications and as required for a complete escalator.
2. General: Provide high-traffic escalators complying with requirements. Unless otherwise indicated, provide heavy-duty components as indicated in manufacturers' publications and as required for a complete escalator.
   a. Provide escalators with two **OR** three **OR** four, **as directed**, flat steps at top and bottom landings.
   b. Fabricate exposed metalwork, including deck covers, balustrade panels, and trim to provide surface flatness equivalent to stretcher-leveled standard of flatness and sufficient strength for indicated use; increase metal thickness or reinforce with concealed stiffeners, backing materials, or both, as necessary. Support joints with concealed stiffeners as needed to hold exposed faces of adjoining sheets in flush alignment.
3. Opaque Balustrades: Manufacturer's standard profile or arrangement of moving handrails on fully paneled guide rail with interior balustrade panels, deck covers, skirts, trim, and accessories. Prepare for exterior finish below the deck covers, specified in another Section.
4. Transparent Balustrades: Manufacturer's standard profile or arrangement of moving handrails on guide rail that is supported by tempered glass panels, with deck covers, skirts, trim, and accessories. Prepare for exterior finish below the deck covers, specified in another Section.
5. Guards at Ceiling Intersection: Clear plastic.
6. Handrails: Smooth, jointless, reinforced neoprene.
   a. Color: Black **OR** As selected from manufacturer's full range, **as directed**.
7. Deck Covers and Trim: Satin stainless steel **OR** Polished stainless steel **OR** Gold-colored satin stainless steel **OR** Gold-colored polished stainless steel **OR** Satin bronze, **as directed**.
8. Step chain roller shall be made of steel; aluminum is unacceptable.
9. Antislide Devices: Satin stainless steel **OR** Polished stainless steel **OR** Gold-colored satin stainless steel **OR** Gold-colored polished stainless steel **OR** Satin bronze, **as directed**.
10. Balustrade Interior Panels: Satin stainless steel **OR** Polished stainless steel **OR** Gold-colored satin stainless steel **OR** Gold-colored polished stainless steel **OR** Satin bronze, **as directed**.
11. Balustrade Exterior Panels and Escalator Soffits: Satin stainless steel **OR** Polished stainless steel **OR** Gold-colored satin stainless steel **OR** Gold-colored polished stainless steel **OR** Satin bronze, **as directed**.
12. Skirt Panels, if Applicable: Satin stainless steel **OR** Polished stainless steel **OR** Satin stainless steel with exposed surface coated with clear PTFE **OR** Steel panels with exposed surface coated with PTFE **OR** Manufacturer's standard low-friction material, **as directed**.
13. Steps: One-piece, die-cast aluminum with demarcation grooves at front and rear of tread surface.
   a. Finish: Powder-coated, gray **OR** black, **as directed**.
   b. Step Demarcation: Yellow inserts at sides and back of step treads.
   c. Nosing Demarcation: 2-inch- (50-mm-) wide yellow stripe at nosings of step treads.
14. Combs: Integrally colored structural plastic **OR** Cast aluminum **OR** Cast aluminum with powder-coated finish, **as directed**.
   a. Comb Color: Yellow.
15. Floor Plates: Cast or extruded aluminum with grooved or patterned surface and mill finish.
16. Abrasive-Surface Floor Plates: Cast or extruded aluminum **OR** Stainless steel, **as directed**, with grooved or patterned surface and with abrasive material embedded in or metallically bonded to floor-plate surface and having a coefficient of friction of 0.6 or higher when tested according to ASTM C 1028.
17. Operational Control: Provide escalators designed and equipped to run equally in either direction. Provide key-operated switches for directional control and key-operated starter switches located on exterior deck above newel base at both upper and lower landings of escalators.

C. Features

1. Fault Indicator: Provide escalators with a microprocessor unit that monitors safety devices, motor temperature, and escalator speed and records in nonvolatile memory date, time, and device identification if a safety device is activated or escalator malfunctions.
   a. Provide built-in or plug-in unit to display recorded information.
2. Reduced-Current Starting: Provide escalator motors with solid-state starting.
3. Energy-Saving Feature: Provide escalator motors and controls designed for motors to run on partial windings (at reduced power) when not under full load.
4. Provide motors complying with NEMA MG 1, Insulation Class B.
5. Brake-Saving Feature: Provide stopping mechanism that allows escalator to coast to a stop before applying brakes, unless stopping is initiated by a safety device.
6. Equip step drive mechanism with automatic step-chain lubricators.
7. Oil Drip Pan: Provide metal pan under full width and length of escalator to collect and hold oil and grease drippings from lubricated components. Design and fabricate drip pan to sustain a load of 250 lbf (1.1 kN) on a 1.0-sq. ft. (0.9-sq. m) area at any location without permanent deflection.
8. Direction Indicator Lights: Provide red and green indicator lights at least 2 inches (50 mm) in diameter in right-hand **OR** both, **as directed**, balustrade newels at both upper and lower landings. Green light indicates entrance end, and red light indicates exit end. When escalator is stopped, red lights are illuminated at both ends.
9. Combplate Lights: Provide recessed light fixtures with flush lenses mounted in skirt panels at each side of combplates designed to illuminate steps at combplate.
10. Overspeed Governor: Provide units with overspeed governor that is activated if speed of steps exceeds rated speed by more than 20 percent.
11. Upper-Landing, Step Upthrust Device: Activated if a step is displaced against upthrust track at upper curve in passenger-carrying line of track system.
12. Comb-Step Impact Device: Activated if a horizontal force in direction of travel is applied exceeding 112 lbf (500 N) at either side or exceeding 225 lbf (1000 N) at center of front edge of combplate, or a resultant force in upward direction is applied exceeding 150 lbf (688 N) at center of front edge of combplate.

D. Exterior Escalators
1. Fabricate exposed components from stainless steel **OR** bronze, **as directed**, unless otherwise indicated.
2. Hot-dip galvanize escalator trusses and other structural components to comply with ASTM A 123/A 123M. Use only stainless-steel or zinc-plated fasteners for assembly of escalator components.
3. Fabricate oil drip pan from galvanized steel sheet. Provide drain and oil/water separator in oil drip pan.
4. Provide drains, weeps, and drips to prevent water accumulation on horizontal surfaces and to direct water away from electrical equipment and moving parts.
5. Provide enclosures complying with NEMA 250, Type 4 for electrical connections, switches, and equipment.
6. Provide totally enclosed motors complying with NEMA MG 1, Insulation Class B.
7. Equip step drive mechanism with automatic step-chain lubricators.

1.3 EXECUTION

A. Examination
1. Examine escalator areas, with Installer present, for compliance with requirements, installation tolerances, and other conditions affecting performance. Examine supporting structure, machine spaces, and pits; verify critical dimensions; and examine conditions under which escalators are to be installed.
   a. Proceed with installation only after unsatisfactory conditions have been corrected.

b. For the record, prepare written report, endorsed by Installer, listing dimensional discrepancies and conditions detrimental to performance or indicating that dimensions and conditions were found to be satisfactory.

B. Installation
1. Comply with manufacturer's written instructions.
2. Set escalators true to line and level, properly supported, and anchored to building structure. Use established benchmarks, lines, and levels to ensure dimensional coordination of the Work.
3. Adjust installed components for smooth, efficient operation, complying with required tolerances and free of hazardous conditions. Lubricate operating parts, including bearings, tracks, chains, guides, and hardware. Test operating devices, equipment, signals, controls, and safety devices. Install oil drip pans and verify that no oil drips outside of pans.
4. Repair damaged finishes so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

C. Field Quality Control
1. Acceptance Testing: On completion of escalator installation and before permitting use of escalators, perform acceptance tests as required and recommended by ASME A17.1 and by authorities having jurisdiction.
   a. For escalators specified to comply with requirements more stringent than those of ASME A17.1, perform tests for compliance with specified requirements. Test optional safety devices.
2. Advise Owner and authorities having jurisdiction in advance of dates and times tests are to be performed.

D. Demonstration
1. Train Owner's maintenance personnel to operate, adjust, and maintain escalators.
2. Check operation of escalators with Owner's personnel present and before date of Substantial Completion. Determine that operation systems and devices are functioning properly.
3. Check operation of escalators with Owner's personnel present not more than one month before end of warranty period. Determine that operation systems and devices are functioning properly.

END OF SECTION 14 31 00 00

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SECTION 14 32 00 00 - MOVING WALKS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for moving walks. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes interior and exterior moving walks.

C. Definition
1. Defective Moving Walk Work: Operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; the need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.

D. Performance Requirements
1. Rated Speed: 90 fpm (0.45 m/s) **OR** 100 fpm (0.5 m/s) **OR** 120 fpm (0.6 m/s) **OR** 130 fpm (0.66 m/s) **OR** 150 fpm (0.76 m/s), **as directed**.
2. Structural Performance of Balustrades, Deck Barricades, and Handrails: Provide components and assemblies capable of withstanding the effects of loads indicated in ASCE 7 for handrail assemblies and guardrail systems.

E. Submittals
1. Product Data: Include capacities, sizes, performances, safety features, finishes, and similar information.
2. Shop Drawings: Show plans, elevations, sections, and details indicating coordination with building structure and relationships with other construction. Indicate variations from specified requirements, maximum loads imposed on building structure at points of support, and power requirements. Indicate access and ventilation for moving walk machine space.
3. Samples: For exposed finishes, 3-inch- (75-mm-) square Samples of sheet materials, and 4-inch (100-mm) lengths of running trim members.
4. Manufacturer Certificates: Signed by manufacturer certifying that moving walk layout and dimensions, as shown on Drawings, and electrical service, as shown and specified, are adequate for moving walks being provided.
5. Operation and Maintenance Data: For moving walks to include in emergency, operation, and maintenance manuals.
6. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted use of moving walks.

F. Quality Assurance
1. Regulatory Requirements: Comply with ASME A17.1.

G. Delivery, Storage, And Handling
1. Deliver, store, and handle materials, components, and equipment in manufacturer's protective packaging.
2. Store materials, components, and equipment off of ground, under cover, and in a dry location. Handle according to manufacturer's recommendations to prevent damage, deterioration, or soiling.

H. Warranty

1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair, restore, or replace defective moving walk work within one year from date of Substantial Completion.

I. Maintenance Service
1. Initial Maintenance Service: Beginning at Substantial Completion, provide one years' full maintenance service by skilled employees of moving walk Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper moving walk operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

1.2 PRODUCTS

A. General
1. Provide preengineered pallet- or belt-type moving walks complying with requirements.

B. Materials
1. Stainless Steel: ASTM A 240/A 240M, Type 304 **OR** 316 **OR** 304, except use Type 316 for exterior moving walks, **as directed**.
   a. Satin Finish: No. 4 directional satin.
   b. Polished Finish: No. 8 mirror polish.
   c. Gold-Colored Satin Finish: No. 4 directional satin with gold-colored oxide or titanium nitride finish.
   d. Gold-Colored Mirror Finish: No. 8 mirror polish with gold-colored oxide or titanium nitride finish.
2. Satin Bronze Sheet: ASTM B 36/B 36M, Alloy UNS No. C28000 (muntz metal), fine satin finish, lacquered.
3. Satin Bronze Extrusions: ASTM B 455, Alloy UNS No. C38500 (architectural bronze), fine satin finish, lacquered.
4. Steel Sheet: Cold-rolled steel sheet, ASTM A 1008/A 1008M, commercial steel, Type B, exposed, matte finish.
5. Clear Tempered Glass: ASTM C 1048, Condition A (uncoated surfaces), Type 1 (transparent glass, flat), Class 1 (clear), Quality q3 (glazing, select), Kind FT (fully tempered), 10.0 **OR** 12.0, **as directed**, mm thick.
6. Tinted Tempered Glass: ASTM C 1048, Condition A (uncoated surfaces), Type 1 (transparent glass, flat), Class 2 (tinted), Quality q3 (glazing, select), Kind FT (fully tempered), 10.0 **OR** 12.0, **as directed**, mm thick.
   a. Color: Bronze **OR** Gray **OR** Green, **as directed**.

C. Components
1. General: Unless otherwise indicated, provide standard components as indicated in manufacturers' publications and as required for a complete moving walk.
   a. Fabricate exposed metalwork, including deck covers, balustrade panels, and trim to provide surface flatness equivalent to stretcher-leveled standard of flatness and sufficient strength for indicated use; increase metal thickness or reinforce with concealed stiffeners, backing materials, or both, as necessary. Support joints with concealed stiffeners as needed to hold exposed faces of adjoining sheets in flush alignment.
2. Step chain roller shall be made of steel; aluminum is unacceptable.
3. Opaque Balustrades: Manufacturer's standard profile or arrangement of moving handrails on fully paneled guide rail with interior balustrade panels, deck covers, skirts, trim, and accessories. Prepare for exterior finish below the deck covers, specified in another Section.
4. Transparent Balustrades: Manufacturer's standard profile or arrangement of moving handrails on guide rail that is supported by clear **OR** tinted, **as directed**, tempered glass panels, with deck covers, skirts, trim, and accessories. Prepare for exterior finish below the deck covers, specified in another Section.

5. Handrails: Smooth, jointless, reinforced neoprene.
   a. Color: Black **OR** As selected from manufacturer's full range, **as directed**.
6. Deck Covers and Trim: Satin stainless steel **OR** Polished stainless steel **OR** Gold-colored satin stainless steel **OR** Gold-colored polished stainless steel **OR** Satin bronze, **as directed**.
7. Balustrade Interior Panels: Satin stainless steel **OR** Polished stainless steel **OR** Gold-colored satin stainless steel **OR** Gold-colored polished stainless steel **OR** Satin bronze, **as directed**.
8. Balustrade Exterior Panels: Satin stainless steel **OR** Polished stainless steel **OR** Gold-colored satin stainless steel **OR** Gold-colored polished stainless steel **OR** Satin bronze, **as directed**.
9. Skirt Panels, if Applicable: Polished stainless steel **OR** Satin stainless steel with exposed surface coated with clear PTFE **OR** Steel panels with exposed surface coated with PTFE, **as directed**.
   a. Clearance between skirt panels or overhanging balustrade panels and treadway shall not exceed 1/16 inch (1.6 mm).
10. Combs: Integrally colored structural plastic **OR** Cast aluminum **OR** Cast aluminum with powder-coated finish, **as directed**.
    a. Comb Color: Yellow **OR** Black **OR** Gray **OR** Red, **as directed**.
11. Floor Plates: Cast or extruded aluminum **OR** Stainless steel, **as directed**, with grooved or patterned surface and mill finish.
12. Abrasive-Surface Floor Plates: Cast or extruded aluminum **OR** Stainless steel, **as directed**, with grooved or patterned surface and with abrasive material embedded in or metallically bonded to floor-plate surface and having a coefficient of friction of 0.6 or higher when tested according to ASTM C 1028.
13. Operational Control: Provide moving walks designed and equipped to run equally in either direction. Provide key-operated switches for directional control and key-operated starter switches located on exterior deck above newel base at both ends of moving walks.

D. Features
1. Fault Indicator: Provide moving walks with a microprocessor unit that monitors safety devices, motor temperature, and moving walk speed and records in nonvolatile memory date, time, and device identification if a safety device is activated or moving walk malfunctions.
   a. Provide built-in or plug-in unit to display recorded information.
2. Reduced-Current Starting: Provide moving walk motors with solid-state starting.
3. Energy-Saving Feature: Provide moving walk motors and controls designed for motors to run on partial windings (at reduced power) when not under full load.
4. Brake-Saving Feature: Provide stopping mechanism that allows moving walks to coast to a stop before applying brakes, unless stopping is initiated by a safety device.
5. Equip pallet drive mechanism with automatic pallet drive-chain lubricators.
6. Oil Drip Pan: Provide metal pan under full width and length of moving walks to collect and hold oil and grease drippings from lubricated components. Design and fabricate drip pan to sustain a load of 250 lbf (1.1 kN) on a 1.0-sq. ft. (0.09-sq. m) area at any location without permanent deflection.
7. Direction Indicator Lights: Provide red and green indicator lights at least 2 inches (50 mm) in diameter in right-hand **OR** both, **as directed**, balustrade newels at both landings. Green light indicates entrance end, and red light indicates exit end. When moving walk is stopped, red lights are illuminated at both ends.
8. Combplate Lights: Provide recessed light fixtures with flush lenses mounted in interior balustrade panels at each side of combplates designed to illuminate treadway at combplate.
9. Comb-Step Impact Device: Activated if a horizontal force in direction of travel is applied exceeding 112 lbf (500 N) at either side or exceeding 225 lbf (1000 N) at center of front edge of combplate, or a resultant force in upward direction is applied exceeding 150 lbf (688 N) at center of front edge of combplate.

E. Exterior Moving Walks
1. Fabricate exposed components from stainless steel **OR** bronze, **as directed**, unless otherwise indicated.

2. Hot-dip galvanize moving walk trusses and other structural components to comply with ASTM A 123/A 123M. Use only stainless-steel or zinc-plated fasteners for assembly of moving walk components.
3. Fabricate oil drip pan from galvanized steel sheet. Provide drain and oil/water separator in oil drip pan.
4. Provide drains, weeps, and drips to prevent water accumulation on horizontal surfaces and to direct water away from electrical equipment and moving parts.
5. Provide enclosures complying with NEMA 250, Type 4 for electrical connections, switches, and equipment.
6. Provide totally enclosed fan-cooled motors complying with NEMA MG 1, Insulation Class B.
7. Equip pallet drive mechanism with automatic pallet drive-chain lubricators.
8. Provide electric heaters with integral thermostats in moving walk truss space to maintain temperature above 40 deg F (4.4 deg C).
9. Equip combplates with 400-W electric heaters to prevent ice and snow accumulation.

1.3 EXECUTION

A. Installation
1. Comply with manufacturer's written instructions.
2. Set moving walks true to line and level, or to indicated slope, properly supported, and anchored to building structure. Use established benchmarks, lines, and levels to ensure dimensional coordination of the Work.
3. Adjust installed components for smooth, efficient operation, complying with required tolerances and free of hazardous conditions. Lubricate operating parts, including bearings, tracks, chains, guides, and hardware. Test operating devices, equipment, signals, controls, and safety devices. Install oil drip pans and verify that no oil drips outside of pans.
4. Repair damaged finishes so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

B. Field Quality Control
1. Acceptance Testing: On completion of moving walk installation and before permitting use of moving walks, perform acceptance tests as required and recommended by ASME A17.1 and by authorities having jurisdiction.
2. Advise Owner, Architect, and authorities having jurisdiction in advance of dates and times tests are to be performed.

C. Demonstration
1. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate, adjust, and maintain moving walks.

END OF SECTION 14 32 00 00

SECTION 14 42 13 00 - WHEELCHAIR LIFTS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for wheelchair lifts. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Vertical and Private-residence, vertical platform lifts.
b. Inclined and Private-residence, inclined platform lifts.
c. Inclined and Private-residence, inclined stairway chairlifts.

C. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: For each lift. Include plans, elevations, sections, details, and attachments to other work.
a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
b. Wiring Diagrams: For power, signal, and control wiring.
3. Samples: For each type of exposed finish required.
4. Manufacturer Certificates: Signed by lift manufacturer certifying that runway, ramp or pit, and dimensions as shown on Drawings and that electrical service as shown and specified are adequate for lift being provided.
5. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted use of lifts.
6. Operation and Maintenance Data: For each type of lift to include in operation and maintenance manuals.
7. Warranty: Sample of special warranty.
8. Continuing maintenance proposal.

D. Quality Assurance
1. Regulatory Requirements: In addition to requirements of authorities having jurisdiction, comply with ASME A18.1, "Safety Standard for Platform Lifts and Stairway Chairlifts."
2. Fire-Rated, Runway-Enclosure Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at as close to neutral pressure as possible according to NFPA 252 **OR** UBC Standard 7-2 **OR** UL 10B, **as directed**.
a. Temperature-Rise Limit: Provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.

E. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lifts that fail in materials or workmanship within two **OR** Four **OR** Five, **as directed**, years from date of Substantial Completion.

F. Maintenance Service
1. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of lift Installer. Include quarterly preventive maintenance and repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as

required for proper lift operation at rated speed and capacity. Provide parts and supplies the same as those used in the manufacture and installation of original equipment.

2. Continuing Maintenance Proposal: From Installer to Owner, in the form of a standard yearly **OR** two-year **OR** five-year, **as directed**, maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

1.2 PRODUCTS

A. Materials

1. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
2. Steel Tubing: ASTM A 500.
3. Steel Pipe: ASTM A 53/A 53M; standard weight (Schedule 40) unless otherwise indicated or required by structural loads.
4. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, commercial steel (CS), Type B, exposed, matte finish.
5. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, commercial steel (CS), Type B, pickled.
6. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 (Z275) zinc coating,
7. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:
   a. ASTM A 123/A 123M, for galvanizing steel and iron products.
   b. ASTM A 153/A 153M, for galvanizing steel and iron hardware.
8. Aluminum: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required:
   a. Extruded Aluminum: ASTM B 221 (ASTM B 221M), Alloy 6063-T6.
   b. Aluminum Sheet: ASTM B 209 (ASTM B 209M), Alloy 5005-H15.
9. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.
10. Stainless-Steel Tubing: ASTM A 554, Grade MT-304.
11. Stainless-Steel Sheet, Strip, and Plate: ASTM A 240/A 240M or ASTM A 666, Type 304.
12. Stainless-Steel Floor Plate: ASTM A 793.
13. Wood and Wood Panel Products: Comply with requirements in Division 06 Section "Interior Architectural Woodwork".
14. Wood and Wood Panel Products:
    a. Wood: Clear, vertical-grain, straight, kiln-dried wood, AWPA C20-02, Interior Type A, fire-retardant treated, **as directed**; of manufacturer's standard species.
    b. Wood Panels: Provide wood panels consisting of wood veneer and wood panel as follows:
       1) Wood Veneer: Laminated to core with moisture-resistant adhesive.
       2) Plywood: DOC PS 1.
       3) Particleboard: ANSI A208.1, made with binder containing no urea formaldehyde, **as directed**.
       4) Medium-Density Fiberboard: ANSI A208.2, made with binder containing no urea formaldehyde, **as directed**.
    c. Fire-Retardant-Treated Wood Panels: Provide wood panels consisting of wood veneer and AWPA C27-02 fire-retardant-treated wood panels. Panels shall have flame-spread index of 75 **OR** 25, **as directed**, or less and smoke-developed index of 450 or less per ASTM E 84.
       1) Wood Veneer: Laminated to core with moisture-resistant adhesive.
       2) Plywood: DOC PS 1.
       3) Particleboard: ANSI A208.1, made with binder containing no urea formaldehyde, **as directed**.
       4) Medium-Density Fiberboard: ANSI A208.2, made with binder containing no urea formaldehyde, **as directed**.

15. Fiberglass: Multiple laminations of glass-fiber-reinforced polyester resin with UV-light-stable, colorfast, nonfading, weather- and stain-resistant, colored polyester gel coat, and manufacturer's standard finish.
16. Glass:
    a. Comply with requirements in Division 08 Section "Glazing".
       OR
       As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**, and complying with ASME A18.1.
       1) Safety Glazing Products: Comply with testing requirements in 16 CFR 1201, Category II.
       2) Safety Glass Marking: Glass permanently marked with certification label of SGCC or another certification agency or manufacturer acceptable to authorities having jurisdiction.
17. Acrylic Glazing: ASTM D 4802, Category A-1 (cell-cast) or Category A-2 (continuous cast), Finish 1 (smooth or polished), clear or tinted as indicated.
18. Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing structural members, guide rails, machines, and other lift components where installation of devices is specified in another Section.
19. Expansion Anchors: Anchor-bolt-and-sleeve assembly of material indicated below with capability to sustain a load equal to 10 times the load imposed as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.
    a. Material:
       1) Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.
          OR
          Group 1, Alloy 304 or Alloy 316, stainless-steel bolts and nuts complying with ASTM F 593 (ASTM F 738M) and ASTM F 594 (ASTM F 836M).
20. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107.

B. Vertical Platform Lifts
1. Private-Residence, **as directed**, Vertical Platform Lifts: Manufacturer's standard preengineered lift systems as indicated.
2. Platform Size: 34 by 54 inches (864 by 1372 mm) **OR** 35 by 48 inches (889 by 1220 mm) **OR** 35 by 51 inches (889 by 1295 mm) **OR** 36 by 56 inches (914 by 1422 mm) **OR** 36 by 60 inches (914 by 1524 mm), **as directed**.
3. Door Operation and Clear Opening Width: Low-energy, power-operated doors that remain open for 20 seconds minimum; end door with minimum 32-inch (815-mm) and side door with minimum 42-inch (1065-mm) clear opening width.
4. Rated Speed: 8 fpm (0.04 m/s)\ **OR** 10 fpm (0.05 m/s) **OR** 12 fpm (0.06 m/s) **OR** 15 fpm (0.08 m/s) **OR** 20 fpm (0.10 m/s) **OR** 22 fpm (0.11 m/s) **OR** 30 fpm (0.15 m/s), **as directed**.
5. Power Supply: 208 V, 60 Hz, 3 phase **OR** 240 V, 60 Hz, 1 phase **OR** 120 V, 60 Hz, 1 phase, **as directed**.
6. Emergency Operation: Provide emergency manual operation and emergency battery power system **OR** connection to indicated standby (emergency) power, **as directed**, to raise or lower units in case of malfunction or power loss.
7. Attendant Operation: Provide attendant operation at location shown.
8. Self-Supporting Units: Support vertical loads of units only at base, with lateral support only at landing levels.
9. Partial, **as directed**, Runway Enclosure: Manufacturer's standard weather-resistant, **as directed**, enclosure assembly.
   a. Runway Enclosure: One of the following, **as directed.**
      1) Rectangular steel-tube frame with flush steel-sheet panels.
      2) Rectangular hot-dip-galvanized steel-tube frame with flush galvanized-steel-sheet panels.
      3) Extruded-aluminum frame with flush galvanized-steel-sheet panels.

4) Extruded-aluminum frame with flush aluminum-sheet panels; with hot-dip-galvanized steel-tube frame for structural framing that cannot be aluminum.
5) Rectangular steel-tube frame with wood panels and trim.
6) Rectangular wood frame with wood panels and trim.
7) Rectangular steel-tube frame with fiberglass panels.

b. Glazed Runway Enclosure: Rectangular structure of glazed extruded-aluminum framing with a tinted, acrylic dome roof.
1) Glazing:
a) Bronze-tinted acrylic glazing, 6.0 mm thick.
OR
Bronze-tinted, float glass **OR** tempered safety **OR** laminated safety, **as directed**, glass, 6.0 mm thick, where indicated.

c. Runway-Enclosure Doors: One of the following, **as directed**:
1) Rectangular steel-tube frames with flush steel-sheet panels.
2) Rectangular steel-tube frames glazed with 6.0-mm-thick, clear acrylic glazing and with 12-inch- (300-mm-) high, steel kick panels.
3) Wide-stile aluminum entrance doors glazed with bronze-tinted tempered safety glass, 6.0 mm thick.
4) Enclosure doors matching appearance of adjacent glass-supported railings, complying with Division 05 Section "Decorative Metal Railings".

d. Fire-Rated Runway-Enclosure Door: Provide fire-rated runway-enclosure door where shown **OR** at upper landing **OR** at lower landing, **as directed**.
1) Fire-Protection Rating: 1-1/2 hours.
2) Equip door with wired glass vision panel, delay-action door closer, dead latch, dummy trim door handle, and electric strike.

10. Platform: One of the following, **as directed:**
a. Galvanized-steel sheet with black rubber flooring.
b. Stainless-steel floor plate with checkered texture.
c. Aluminum floor plate with nonskid surface texture.

11. Platform Low-Profile Carriage: Fabricate platform floor assembly to total thickness not exceeding 1-1/2 inches (38 mm).

12. Platform Enclosure and Door: One of the following, **as directed:**
a. Rectangular steel-tube frame with flush steel-sheet panels.
b. Rectangular hot-dip-galvanized steel-tube frame with flush galvanized-steel-sheet panels.
c. Extruded-aluminum frame with flush galvanized-steel-sheet panels.
d. Extruded-aluminum frame with flush aluminum-sheet panels; with hot-dip-galvanized steel-tube frame for structural framing that cannot be aluminum.
e. Rectangular steel-tube frame with wood panels and trim.
f. Rectangular steel-tube frame with fiberglass panels.
g. Enclosure walls and doors matching appearance of adjacent glass-supported railings, complying with Division 05 Section "Decorative Metal Railings".

13. Platform Top: Provide a non-load-bearing top, matching construction of enclosure walls. Permanently mark top to indicate that it cannot sustain a load.

14. Fixed Ramp: Provide fixed ramp matching platform to provide transition from floor to lift platform at bottom landing.

15. Retractable Ramp: Provide ramp matching platform to provide transition from lower floor to lift platform. Ramp lowers to floor automatically when lifts reach lower landing and door opens. Ramp rises automatically when lift control is activated for lift to leave lower landing.
a. Ramp Size: End ramps a minimum of 32 inches (815 mm) and side ramps a minimum of 42 inches (1065 mm) wide; length as required for slope.
b. Ramp Slope: As indicated **OR** Maximum 1:12, **as directed**.
c. Ramp Finish: Finish ramps to match lift platform **OR** Ramp finish is specified elsewhere as indicated, **as directed**.

16. Accessories: Provide units with the following accessories:
a. Fold-down seat with armrests and safety belt.

b. Forced Ventilation System: Minimum 1 air change per minute, continuously operating **OR** thermostatically controlled to activate at 90 deg F (32.22 deg C) , **as directed**, and with auxiliary power source to operate ventilation for 1 hour in case of power failure.
c. Lighting system within lift enclosures as indicated on Drawings **OR** selected from manufacturer's available products, **as directed**.
d. Proper posting of signage at upper and lower landings will be required.

C. Inclined Platform Lifts
1. Private-Residence, **as directed**, Inclined Platform Lifts: Manufacturer's standard preengineered lift systems as indicated.
2. Platform Size: 29 by 33 inches (737 by 838 mm) **OR** 28 by 35 inches (711 by 889 mm) **OR** 30 by 35 inches (760 by 889 mm) **OR** 30 by 36 inches (760 by 914 mm) **OR** 31 by 39 inches (787 by 991 mm) **OR** 30 by 41 inches (760 by 1041 mm) **OR** 30 by 42 inches (760 by 1067 mm) **OR** 31 by 43 inches (787 by 1092 mm) **OR** 30 by 48 inches (760 by 1220 mm), **as directed**.
3. Door Operation and Clear Opening Width: Low-energy, power-operated doors that remain open for 20 seconds minimum; end door with minimum 32-inch (815-mm) and side door with minimum 42-inch (1065-mm) clear opening width.
4. Rated Speed: 20 fpm (0.10 m/s) **OR** 22 fpm (0.11 m/s) **OR** 25 fpm (0.13 m/s) **OR** 30 fpm (0.15 m/s), **as directed**.
5. Minimum Headroom Clearance during Travel: Minimum of 80 inches (2032 mm) above any point on platform floor.
6. Power Supply: 208 V, 60 Hz, 3 phase **OR** 240 V, 60 Hz, 1 phase **OR** 120 V, 60 Hz, 1 phase, **as directed**.
7. Emergency Operation: Provide emergency manual operation and emergency battery power system **OR** connection to indicated standby (emergency) power, **as directed**, to raise or lower units in case of malfunction or power loss.
8. Attendant Operation: Provide attendant operation at location shown.
9. Platform: One of the following, **as directed:**
   a. Galvanized-steel sheet with black rubber flooring.
   b. Stainless-steel floor plate with checkered texture.
   c. Aluminum floor plate with nonskid surface texture.
10. Automatic Folding Platforms: When not in use, platforms automatically fold up against wall to minimize projection into stairway.
11. Manual Folding Platforms: When not in use, platforms can be folded up against wall to minimize projection into stairway.
12. Platform Guarding: Guard platform with passenger restraining arms **OR** enclosure, **as directed**.
    a. Passenger Restraining Arms: Steel **OR** Galvanized-steel **OR** Stainless-steel, **as directed**, tubing, manually **OR** power, **as directed**, operated.
    b. Platform Enclosure (Side Walls and Self-Closing Door): One of the following, **as directed**:
       1) Rectangular steel-tube frame with flush steel-sheet panels.
       2) Enclosure walls and doors matching appearance of adjacent glass-supported railings, complying with Division 05 Section "Decorative Metal Railings".
13. Platform Guarding: Guard platform with automatically **OR** manually, **as directed**, actuated, retractable metal guard on lower access end of platform.
14. Fixed Ramp: Provide fixed ramp matching platform to provide transition from floor to lift platform at bottom landing.
15. Retractable Ramp: Provide ramp matching platform to provide transition from floor to lift platform. Ramp lowers to floor automatically when lifts reach landing and enclosure door opens. Ramp rises automatically when lift control is activated for lift to leave landing.
    a. Ramp Size: End ramps a minimum of 32 inches (815 mm) and side ramps a minimum of 42 inches (1065 mm) wide; length as required for slope.
    b. Ramp Slope: As indicated **OR** Maximum 1:12, **as directed**.
    c. Ramp Finish: Finish ramps to match lift platform **OR** Ramp finish is specified elsewhere as indicated, **as directed**.

16. Supporting Structure: Provide framing to support vertical loads from floor or stair treads and only lateral loads from walls. Fabricate framing from steel **OR** stainless-steel, **as directed**, rectangular tubing, plates, shapes, and bars.
17. Guide Rails: Fabricate from steel **OR** stainless-steel, **as directed**, tubing.
18. Accessories: Provide units with the following accessories:
    a. Fold-down seat with armrests and safety belt.
    b. Caution sign as required by ASME A18.1. Proper posting of signage at upper and lower landings will be required.

D. Inclined Stairway Chairlifts
1. Private-Residence, **as directed**, Inclined Stairway Chairlifts: Manufacturer's standard preengineered lift systems as indicated.
2. Systems and Machinery: Manufacturer's standard preengineered lift systems as indicated in published product literature and as follows:
    a. Rated Capacity: Minimum 250 lb (113 kg) **OR** 400 lb (181 kg), **as directed**.
    b. Rated Speed: 18 fpm (0.09 m/s) **OR** 20 fpm (0.10 m/s) **OR** 22 fpm (0.11 m/s) **OR** 25 fpm (0.13 m/s), **as directed**.
3. Power Supply: 120 V, 60 Hz, 1 phase.
4. Battery Operation: Provide battery-operated drive with automatic charging system.
5. Manual Lowering: Provide means to manually lower units in case of malfunction or power loss.
6. Folding Units: Provide units that can be folded up against wall when not in use, to minimize projection into stairway.
7. Supporting Structure: Provide brackets to support vertical loads from floor or stair treads and to support lateral loads from walls. Fabricate brackets from steel plates, shapes, or bars.
8. Accessories: Provide units with the following accessories:
    a. Tubular-steel, manually operated safety arms designed to restrain and provide grab bar for occupant.
    b. Retractable seat belt.
    c. Seat with back and two handgrips or arms.
    d. Proper posting of signage at upper and lower landings will be required.

E. General Finish Requirements
1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
3. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

F. Finishes
1. Steel and Galvanized-Steel Factory Finish:
    a. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard 2-coat, baked-on finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil (0.025 mm) for topcoat.
    b. Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard, thermosetting polyester or acrylic urethane powder coating with a cured film thickness not less than 1.5 mils (0.04 mm).
    c. Color and Gloss: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range, **as directed**.
2. Stainless-Steel Finishes:
    a. Floor Plate Finish: Mill **OR** Abrasive blasted, **as directed**.
    b. Grab Rail Finish: As selected from manufacturer's full range **OR** Directional satin finish No. 4, **as directed**.
3. Aluminum Finishes:

a. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm **OR** AA-M12C22A31, Class II, 0.010 mm, **as directed**, or thicker.
b. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm **OR** AA-M12C22A32/A34, Class II, 0.010 mm, **as directed**, or thicker.
1) Color: As selected from full range of industry colors and color densities.
c. Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard, thermosetting polyester or acrylic urethane powder coating with a cured film thickness not less than 1.5 mils (0.04 mm).
1) Color and Gloss: As selected from manufacturer's full range.
4. Wood Finish:
a. As specified in Division 09 Section "Staining And Transparent Finishing".
OR
As selected from manufacturer's full range, as follows:
1) Type: Transparent finish **OR** Transparent finish over stain, **as directed**, over wood variety indicated.
5. Fiberglass Color and Gloss: As selected from manufacturer's full range.

1.3 EXECUTION

A. Installation
1. Wiring Method: Conceal conductors and cables within housings of units or building construction. Do not install conduit exposed to view in finished spaces. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
2. Coordinate runway doors with platform travel and positioning, for accurate alignment and minimum clearance between platforms, runway doors, sills, and door frames.
3. Position sills accurately and fill space under sills solidly with nonshrink, nonmetallic grout.
4. Coordinate platform doors with platform travel and positioning.
5. Adjust stops for accurate stopping and leveling at each landing, within required tolerances.
a. Leveling Tolerance: 1/4 inch (6 mm) up or down, regardless of load and direction of travel.
6. Adjust retractable ramps to meet maximum allowable slope and change-in-elevation requirements, and to lie fully against landing surfaces.
7. Lubricate operating parts of lift, including drive mechanism, guide rails, hinges, safety devices, and hardware.
8. Test safety devices and verify smoothness of required protective enclosures and fascias

B. Field Quality Control
1. Acceptance Testing: On completion of lift installation and before permitting use of lifts, perform acceptance tests as required and recommended by ASME A18.1 and authorities having jurisdiction.
2. Operating Test: In addition to above testing, load lifts to rated capacity and operate continuously for 30 minutes between lowest and highest landings served. Readjust stops, signal equipment, and other devices for accurate stopping and operation of system.
3. Advise Owner, Architect, and authorities having jurisdiction in advance of dates and times tests are to be performed on lifts.

C. Demonstration
1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lifts. Include a review of emergency systems and emergency procedures to be followed at time of operational failure and other building emergencies.

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Task	Specification	Specification Description
14 42 16 00	14 42 13 00	Wheelchair Lifts

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SECTION 21 05 19 00 - WATER DISTRIBUTION

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for water distribution. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes water-distribution piping and related components outside the building for water service **OR** fire-service mains **OR** combined water service and fire-service mains, **as directed**.
2. Utility-furnished products include water meters that will be furnished to the site, ready for installation.

C. Definitions
1. EPDM: Ethylene propylene diene terpolymer rubber.
2. LLDPE: Linear, low-density polyethylene plastic.
3. PA: Polyamide (nylon) plastic.
4. PE: Polyethylene plastic.
5. PP: Polypropylene plastic.
6. PVC: Polyvinyl chloride plastic.
7. RTRF: Reinforced thermosetting resin (fiberglass) fittings.
8. RTRP: Reinforced thermosetting resin (fiberglass) pipe.

D. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.
   a. Wiring Diagrams: Power, signal, and control wiring for alarms.
3. Field quality-control test reports.
4. Operation and Maintenance Data.

E. Quality Assurance
1. Regulatory Requirements:
   a. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
   b. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
   c. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.
2. Piping materials shall bear label, stamp, or other markings of specified testing agency.
3. 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.
4. Comply with ASTM F 645 for selection, design, and installation of thermoplastic water piping.
5. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.
6. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.
7. NSF Compliance:

a. Comply with NSF 14 for plastic potable-water-service piping. Include marking "NSF-pw" on piping.
b. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

F. Delivery, Storage, And Handling
1. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:
a. Ensure that valves are dry and internally protected against rust and corrosion.
b. Protect valves against damage to threaded ends and flange faces.
c. Set valves in best position for handling. Set valves closed to prevent rattling.
2. During Storage: Use precautions for valves, including fire hydrants, according to the following:
a. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
b. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.
3. Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.
4. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.
5. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.
6. Protect flanges, fittings, and specialties from moisture and dirt.
7. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

G. Project Conditions
1. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:
a. Notify the Owner no fewer than two days in advance of proposed interruption of service.
b. Do not proceed with interruption of water-distribution service without the Owner's written permission.

H. Coordination
1. Coordinate connection to water main with utility company.

1.2 PRODUCTS

A. Copper Tube And Fittings
1. Soft Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) **OR** ASTM B 88, Type L (ASTM B 88M, Type B), **as directed,** water tube, annealed temper.
a. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
b. Copper, Pressure-Seal Fittings:
1) NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
2) NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.
2. Hard Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) **OR** ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**, water tube, drawn temper.
a. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
b. Copper, Pressure-Seal Fittings:

1) NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
2) NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.

3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.
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.

B. Ductile-Iron Pipe And Fittings
1. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   a. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
   b. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
2. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   a. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
   b. Gaskets: AWWA C111, rubber.
3. Grooved-Joint, Ductile-Iron Pipe: AWWA C151, with cut, rounded-grooved ends.
   a. Grooved-End, Ductile-Iron Pipe Appurtenances:
      1) Grooved-End, Ductile-Iron Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.
      2) Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.
4. Flanges: ASME 16.1, Class 125, cast iron.

C. PE Pipe And Fittings
1. PE, ASTM Pipe: ASTM D 2239, SIDR No. 5.3, 7, or 9; with PE compound number required to give pressure rating not less than 160 psig (1100 kPa) **OE** 200 psig (1380 kPa), **as directed**.
   a. Insert Fittings for PE Pipe: ASTM D 2609, made of PA, PP, or PVC with serrated male insert ends matching inside of pipe. Include bands or crimp rings.
   b. Molded PE Fittings: ASTM D 3350, PE resin, socket- or butt-fusion type, made to match PE pipe dimensions and class.
2. PE, AWWA Pipe: AWWA C906, DR No. 7.3, 9, or 9.3; with PE compound number required to give pressure rating not less than 160 psig (1100 kPa) **OR** 200 psig (1380 kPa), **as directed**.
   a. PE, AWWA Fittings: AWWA C906, socket- or butt-fusion type, with DR number matching pipe and PE compound number required to give pressure rating not less than 160 psig (1100 kPa) **OR** 200 psig (1380 kPa), **as directed**.
3. PE, Fire-Service Pipe: ASTM F 714, AWWA C906, or equivalent for PE water pipe; FMG approved, with minimum thickness equivalent to FMG Class 150 and Class 200.
   a. Molded PE Fittings: ASTM D 3350, PE resin, socket- or butt-fusion type, made to match PE pipe dimensions and class.

D. PVC Pipe And Fittings
1. PVC, Schedule 40 Pipe: ASTM D 1785.
   a. PVC, Schedule 40 Socket Fittings: ASTM D 2466.
2. PVC, Schedule 80 Pipe: ASTM D 1785.
   a. PVC, Schedule 80 Socket Fittings: ASTM D 2467.
   b. PVC, Schedule 80 Threaded Fittings: ASTM D 2464.
3. PVC, AWWA Pipe: AWWA C900, Class 150 **OR** Class 200, **as directed**, with bell end with gasket, and with spigot end.
   a. Comply with UL 1285 for fire-service mains if indicated.

b. PVC Fabricated Fittings: AWWA C900, Class 150 **OR** Class 200, **as directed**, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
c. PVC Molded Fittings: AWWA C907, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
d. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
   1) Gaskets: AWWA C111, rubber.
e. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
   1) Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

E. Fiberglass Pipe And Fittings
1. AWWA RTRP: AWWA C950, Class 150 **OR** Class 200 **OR** Class 250, **as directed**, Type I **OR** II, **as directed**, Grade 1, epoxy **OR** Grade 2, polyester, **as directed**, with bell-and-spigot ends for bonded **OR** with gasket or seal for gasketed, **as directed**, joints. Liner is optional, unless otherwise indicated. Include FMG approval if used for fire-service mains.
   a. RTRF: AWWA C950, similar to pipe in material, pressure class, and joining method.
2. UL RTRP: UL 1713, Class 150 **OR** Class 200 **OR** Class 250, **as directed**, with bell-and-spigot ends with gasket or seal for gasketed joints. Liner is optional, unless otherwise indicated.
   a. RTRF: Similar to pipe in material, pressure class, and joining method.

F. Special Pipe Fittings
1. Ductile-Iron Rigid Expansion Joints:
   a. Description: Three-piece, ductile-iron assembly consisting of telescoping sleeve with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
      1) Pressure Rating: 250 psig (1725 kPa) minimum.
      2) Expansion Required: As directed by the manufacturer or as directed by the Owner.
2. Ductile-Iron Flexible Expansion Joints:
   a. Description: Compound, ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections. Assemble components for offset and expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
      1) Pressure Rating: 250 psig (1725 kPa) minimum.
      2) Offset: As directed by the manufacturer or as directed by the Owner.
      3) Expansion Required: As directed by the manufacturer or as directed by the Owner.
3. Ductile-Iron Deflection Fittings:
   a. Description: Compound, ductile-iron coupling fitting with sleeve and 1 or 2 flexing sections for up to 15-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
      1) Pressure Rating: 250 psig (1725 kPa) minimum.

G. Joining Materials
1. Refer to Division 33 Section "Common Work Results For Utilities" for commonly used joining materials.
2. Brazing Filler Metals: AWS A5.8, BCuP Series.
3. Bonding Adhesive for Fiberglass Piping: As recommended by fiberglass piping manufacturer.
4. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

H. Piping Specialties

1. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
2. Tubular-Sleeve Pipe Couplings:
   a. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners and with ends of same sizes as piping to be joined.
      1) Standard: AWWA C219.
      2) Center-Sleeve Material: Manufacturer's standard **OR** Carbon steel **OR** Stainless steel **OR** Ductile iron **OR** Malleable iron, **as directed**.
      3) Gasket Material: Natural or synthetic rubber.
      4) Pressure Rating: 150 psig (1035 kPa) **OR** 200 psig (1380 kPa), **as directed**, minimum.
      5) Metal Component Finish: Corrosion-resistant coating or material.
3. Split-Sleeve Pipe Couplings:
   a. Description: Metal, bolted, split-sleeve-type, reducing or transition coupling with sealing pad and closure plates, O-ring gaskets, and bolt fasteners.
      1) Standard: AWWA C219.
      2) Sleeve Material: Manufacturer's standard **OR** Carbon steel **OR** Stainless steel, **as directed**.
      3) Sleeve Dimensions: Of thickness and width required to provide pressure rating.
      4) Gasket Material: O-rings made of EPDM rubber, unless otherwise indicated.
      5) Pressure Rating: 150 psig (1035 kPa) **OR** 200 psig (1380 kPa), **as directed**, minimum.
      6) Metal Component Finish: Corrosion-resistant coating or material.
4. Flexible Connectors:
   a. Nonferrous-Metal Piping: Bronze hose covered with bronze wire braid; with copper-tube, pressure-type, solder-joint ends or bronze flanged ends brazed to hose.
   b. Ferrous-Metal Piping: Stainless-steel hose covered with stainless-steel wire braid; with ASME B1.20.1, threaded steel pipe nipples or ASME B16.5, steel pipe flanges welded to hose.
5. Dielectric Fittings: Combination of copper alloy and ferrous; threaded, solder, or plain end types; and matching piping system materials.
   a. Dielectric Unions: Factory-fabricated union assembly, designed for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C). Include insulating material that isolates dissimilar metals and ends with inside threads according to ASME B1.20.1.
   b. Dielectric Flanges: Factory-fabricated companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure to suit system pressures.
   c. Dielectric-Flange Insulation Kits: Field-assembled companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
      1) Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure to suit system pressures.
   d. Dielectric Couplings: Galvanized-steel couplings with inert and noncorrosive thermoplastic lining, with threaded ends and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
   e. Dielectric Nipples: Electroplated steel nipples with inert and noncorrosive thermoplastic lining, with combination of plain, threaded, or grooved end types, and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

I. Corrosion-Protection Piping Encasement
   1. Encasement for Underground Metal Piping:
      a. Standards: ASTM A 674 or AWWA C105.
      b. Form: Sheet **OR** Tube, **as directed**.
      c. Material: LLDPE film of 0.008-inch (0.20-mm) minimum thickness.
      d. Material: LLDPE film of 0.008-inch (0.20-mm) minimum thickness, or high-density, crosslaminated PE film of 0.004-inch (0.10-mm) minimum thickness.

e. Material: High-density, crosslaminated PE film of 0.004-inch (0.10-mm) minimum thickness.
f. Color: Black **OR** Natural, **as directed**.

J. Gate Valves
1. AWWA, Cast-Iron Gate Valves:
a. Nonrising-Stem, Metal-Seated Gate Valves:
1) Description: Gray- or ductile-iron body and bonnet; with cast-iron or bronze double-disc gate, bronze gate rings, bronze stem, and stem nut.
a) Standard: AWWA C500.
b) Minimum Pressure Rating: 200 psig (1380 kPa).
c) End Connections: Mechanical joint.
d) Interior Coating: Complying with AWWA C550.
b. Nonrising-Stem, Resilient-Seated Gate Valves:
1) Description: Gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.
a) Standard: AWWA C509.
b) Minimum Pressure Rating: 200 psig (1380 kPa).
c) End Connections: Mechanical joint.
d) Interior Coating: Complying with AWWA C550.
c. Nonrising-Stem, High-Pressure, Resilient-Seated Gate Valves:
1) Description: Ductile-iron body and bonnet; with bronze or ductile-iron gate, resilient seats, bronze stem, and stem nut.
a) Standard: AWWA C509.
b) Minimum Pressure Rating: 250 psig (1725 kPa).
c) End Connections: Push on or mechanical joint.
d) Interior Coating: Complying with AWWA C550.
d. OS&Y, Rising-Stem, Metal-Seated Gate Valves:
1) Description: Cast- or ductile-iron body and bonnet, with cast-iron double disc, bronze disc and seat rings, and bronze stem.
a) Standard: AWWA C500.
b) Minimum Pressure Rating: 200 psig (1380 kPa).
c) End Connections: Flanged.
e. OS&Y, Rising-Stem, Resilient-Seated Gate Valves:
1) Description: Cast- or ductile-iron body and bonnet, with bronze or gray- or ductile-iron gate, resilient seats, and bronze stem.
a) Standard: AWWA C509.
b) Minimum Pressure Rating: 200 psig (1380 kPa).
c) End Connections: Flanged.
2. UL/FMG, Cast-Iron Gate Valves:
a. UL/FMG, Nonrising-Stem Gate Valves:
1) Description: Iron body and bonnet with flange for indicator post, bronze seating material, and inside screw.
a) Standards: UL 262 and FMG approved.
b) Minimum Pressure Rating: 175 psig (1207 kPa).
c) End Connections: Flanged.
b. OS&Y, Rising-Stem Gate Valves:
1) Description: Iron body and bonnet and bronze seating material.
a) Standards: UL 262 and FMG approved.
b) Minimum Pressure Rating: 175 psig (1207 kPa).
c) End Connections: Flanged.
3. Bronze Gate Valves:
a. OS&Y, Rising-Stem Gate Valves:
1) Description: Bronze body and bonnet and bronze stem.
a) Standards: UL 262 and FMG approved.

b) Minimum Pressure Rating: 175 psig (1207 kPa).
c) End Connections: Threaded.

b. Nonrising-Stem Gate Valves:
1) Description: Class 125, Type 1, bronze with solid wedge, threaded ends, and malleable-iron handwheel.
a) Standard: MSS SP-80.

K. Gate Valve Accessories And Specialties
1. Tapping-Sleeve Assemblies:
a. Description: Sleeve and valve compatible with drilling machine.
1) Standard: MSS SP-60.
2) Tapping Sleeve: Cast- or ductile-iron or stainless-steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
3) Valve: AWWA, cast-iron, nonrising-stem, metal **OR** resilient, **as directed**,-seated gate valve with one raised face flange mating tapping-sleeve flange.
2. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5 inches (125 mm) in diameter.
a. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.
3. Indicator Posts: UL 789, FMG-approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.

L. Check Valves
1. AWWA Check Valves:
a. Description: Swing-check type with resilient seat. Include interior coating according to AWWA C550 and ends to match piping.
1) Standard: AWWA C508.
2) Pressure Rating: 175 psig (1207 kPa).
2. UL/FMG, Check Valves:
a. Description: Swing-check type with pressure rating; rubber-face checks, unless otherwise indicated; and ends matching piping.
1) Standards: UL 312 and FMG approved.
2) Pressure Rating: 175 psig (1207 kPa) **OR** 250 psig (1725 kPa), **as directed**.

M. Detector Check Valves
1. Detector Check Valves:
a. Description (with water meter): Galvanized cast-iron body, bolted cover with air-bleed device for access to internal parts, and flanged ends. Include one-piece bronze disc with bronze bushings, pivot, and replaceable seat. Include threaded bypass taps in inlet and outlet for bypass meter connection. Set valve to allow minimal water flow through bypass meter when major water flow is required.
1) Standards: UL 312 and FMG approved.
2) Pressure Rating: 175 psig (1207 kPa).
3) Water Meter: AWWA C700, disc type, at least one-fourth size of detector check valve. Include meter, bypass piping, gate valves, check valve, and connections to detector check valve.
b. Description (without water meter): Iron body, corrosion-resistant clapper ring and seat ring material, flanged ends, with connections for bypass and installation of water meter.
1) Standards: UL 312 and FMG approved.
2) Pressure Rating: 175 psig (1207 kPa).

N. Butterfly Valves
1. AWWA Butterfly Valves:

a. Description: Rubber seated.
1) Standard: AWWA C504.
2) Body: Cast or ductile iron.
3) Body Type: Wafer **OR** Flanged, **as directed**.
4) Pressure Rating: 150 psig (1035 kPa).

2. UL Butterfly Valves:
a. Description: Metal on resilient material seating.
1) Standards: UL 1091 and FMG approved.
2) Body: Cast or ductile iron.
3) Body Type: Wafer **OR** Flanged, **as directed**.
4) Pressure Rating: 175 psig (1207 kPa).

O. Plug Valves
1. Plug Valves:
a. Description: Resilient-seated eccentric.
1) Standard: MSS SP-108.
2) Body: Cast iron.
3) Pressure Rating: 175-psig (1207-kPa) minimum CWP.
4) Seat Material: Suitable for potable-water service.

P. Corporation Valves And Curb Valves
1. Service-Saddle Assemblies: Comply with AWWA C800. Include saddle and valve compatible with tapping machine.
a. Service Saddle: Copper alloy with seal and AWWA C800, threaded outlet for corporation valve.
b. Corporation Valve: Bronze body and ground-key plug, with AWWA C800, threaded inlet and outlet matching service piping material.
c. Manifold (if utility company requires multiple connections): Copper fitting with two to four inlets as required, with ends matching corporation valves and outlet matching service piping material.
2. Curb Valves: Comply with AWWA C800. Include bronze body, ground-key plug or ball, and wide tee head, with inlet and outlet matching service piping material.
3. Service Boxes for Curb Valves: Similar to AWWA M44 requirements for cast-iron valve boxes. Include cast-iron telescoping top section of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over curb valve and with a barrel approximately 3 inches (75 mm) in diameter.
a. Shutoff Rods: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve.

Q. Water Meters
1. Water meters will be furnished by utility company.
NOTE: If water meters are specified in this Section, delete paragraph above and retain and edit paragraphs and subparagraphs below.
2. Displacement-Type Water Meters:
a. Description: With bronze main case.
1) Standard: AWWA C700.
2) Registration: Flow in gallons (liters) **OR** cubic feet (cubic meters), **as directed**.
3. Turbine-Type Water Meters:
a. Description:
1) Standard: AWWA C701.
2) Registration: Flow in gallons (liters) **OR** cubic feet (cubic meters), **as directed**.
4. Compound-Type Water Meters:
a. Description:
1) Standard: AWWA C702.
2) Registration: Flow in gallons (liters) **OR** cubic feet (cubic meters), **as directed**.

5. Remote Registration System:
   a. Description: Utility company standard; direct-reading type. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.
      1) Standard: AWWA C706.
      2) Registration: Flow in gallons (liters) **OR** cubic feet (cubic meters), **as directed**.
6. Remote Registration System:
   a. Description: Utility company standard; encoder type. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.
      1) Standard: AWWA C707.
      2) Registration: Flow in gallons (liters) **OR** cubic feet (cubic meters), **as directed**.
      3) Data-Acquisition Units: Comply with utility company requirements for type and quantity.
         OR
         Visible Display Units: Comply with utility company requirements for type and quantity.

R. Detector-Type Water Meters
   1. Detector-Type Water Meters
   2. Description: Main line, proportional meter with second meter on bypass. Register flow in gallons (liters) **OR** cubic feet (cubic meters), **as directed**.
      a. Standards: AWWA C703, UL listed, and FMG approved.
      b. Pressure Rating: 150 psig (1035 kPa).
      c. Bypass Meter: AWWA C701, turbine **OR** AWWA C702, compound, **as directed**,-type, bronze case.
         1) Size: At least one-half nominal size of main-line meter.
   3. Description: Main-line turbine meter with strainer and second meter on bypass. Register flow in gallons (liters) **OR** cubic feet (cubic meters), **as directed**.
      a. Standards: AWWA C703, UL listed, and FMG approved.
      b. Pressure Rating: 175 psig (1207 kPa).
      c. Bypass Meter: AWWA C701, turbine-type, bronze case.
         1) Size: At least NPS 2 (DN 50).
   4. Remote Registration System:
      a. Description: Utility company standard; direct-reading type. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.
         1) Standard: AWWA C706.
         2) Registration: Flow in gallons (liters) **OR** cubic feet (cubic meters), **as directed**.
   5. Remote Registration System:
      a. Description: Utility company standard; encoder type. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.
         1) Standard: AWWA C707.
         2) Registration: Flow in gallons (liters) **OR** cubic feet (cubic meters), **as directed**.
         3) Data-Acquisition Units: Comply with utility company requirements for type and quantity.
            OR
            Visible Display Units: Comply with utility company requirements for type and quantity.

S. Pressure-Reducing Valves
   1. Water Regulators:
      a. Standard: ASSE 1003.
      b. Pressure Rating: Initial pressure of 150 psig (1035 kPa).
      c. Size: As directed by the manufacturer or as directed by the Owner.
      d. Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
      e. Design Inlet Pressure: As directed by the manufacturer or as directed by the Owner.
      f. Design Outlet Pressure Setting: As directed by the manufacturer or as directed by the Owner.

g. Body: Bronze with chrome-plated finish, **as directed**, for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved, **as directed**, for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).
h. Valves for Booster Heater Water Supply: Include integral bypass.
i. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).

2. Water Control Valves:
   a. Description: Pilot-operation, diaphragm-type, single-seated main water control valve with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot control valve, restrictor device, specialty fittings, and sensor piping.
      1) Pressure Rating: Initial pressure of 150 psig (1035 kPa) minimum.
      2) Main Valve Body: Cast- or ductile-iron body with AWWA C550 or FDA-approved, interior epoxy coating; or stainless-steel body.
         a) Size: As directed by the manufacturer or as directed by the Owner.
         b) Pattern: Angle **OR** Globe, **as directed**,-valve design.
         c) Trim: Stainless steel.
      3) Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
      4) Design Inlet Pressure: As directed by the manufacturer or as directed by the Owner.
      5) Design Outlet Pressure Setting: As directed by the manufacturer or as directed by the Owner.
      6) End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged, **as directed**, for NPS 2-1/2 (DN 65) and larger.

T. Relief Valves
1. Air-Release Valves:
   a. Description: Hydromechanical device to automatically release accumulated air.
      1) Standard: AWWA C512.
      2) Pressure Rating: 300 psig (2070 kPa), **as directed**.
      3) Body Material: Cast iron, **as directed**.
      4) Trim Material: Stainless steel, brass, or bronze, **as directed**.
      5) Water Inlet Size: As directed by the manufacturer or as directed by the Owner.
      6) Air Outlet Size: As directed by the manufacturer or as directed by the Owner.
      7) Orifice Size: As directed by the manufacturer or as directed by the Owner.
      8) Design Air-Release Capacity: As directed by the manufacturer or as directed by the Owner.
2. Air/Vacuum Valves:
   a. Description: Direct-acting, float-operated, hydromechanical device with large orifice to automatically release accumulated air or to admit air during filling of piping.
      1) Standard: AWWA C512.
      2) Pressure Rating: 300 psig (2070 kPa), **as directed**.
      3) Body Material: Cast iron, **as directed**.
      4) Trim Material: Stainless steel, brass, or bronze\, **as directed**.
      5) Inlet and Outlet Size: As directed by the manufacturer or as directed by the Owner.
      6) Orifice Size: As directed by the manufacturer or as directed by the Owner.
      7) Design Air Capacity: As directed by the manufacturer or as directed by the Owner.
3. Combination Air Valves:
   a. Description: Float-operated, hydromechanical device to automatically release accumulated air or to admit air.
      1) Standard: AWWA C512.
      2) Pressure Rating: 300 psig (2070 kPa), **as directed**.
      3) Body Material: Cast iron, **as directed**.
      4) Trim Material: Stainless steel, brass, or bronze, **as directed**.
      5) Inlet and Outlet Size: As directed by the manufacturer or as directed by the Owner.
      6) Orifice Size: As directed by the manufacturer or as directed by the Owner.
      7) Design Air Capacity: As directed by the manufacturer or as directed by the Owner.

U. Vacuum Breakers
1. Pressure Vacuum Breaker Assembly:
a. Standard: ASSE 1020.
b. Operation: Continuous-pressure applications.
c. Pressure Loss: 5 psig (35 kPa), **as directed,** maximum, through middle 1/3 of flow range.
d. Size: As directed by the manufacturer or as directed by the Owner.
e. Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
f. Selected Unit Flow Range Limits: As directed by the manufacturer or as directed by the Owner.
g. Pressure Loss at Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
h. Accessories: Ball valves on inlet and outlet.

V. Backflow Preventers
1. Reduced-Pressure-Principle Backflow Preventers:
a. Standard: ASSE 1013 **OR** AWWA C511, **as directed**.
b. Operation: Continuous-pressure applications.
c. Pressure Loss: 12 psig (83 kPa), **as directed,** maximum, through middle 1/3 of flow range.
d. Size: As directed by the manufacturer or as directed by the Owner.
e. Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
f. Selected Unit Flow Range Limits: As directed by the manufacturer or as directed by the Owner.
g. Pressure Loss at Design Flow Rate: As directed by the manufacturer or as directed by the Owner.for NPS 2 (DN 50) and smaller; As directed by the manufacturer or as directed by the Owner.for NPS 2-1/2 (DN 65) and larger.
h. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved **OR** steel with interior lining complying with AWWA C550 or that is FDA approved **OR** stainless steel, **as directed**, for NPS 2-1/2 (DN 65) and larger.
i. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged, **as directed**, for NPS 2-1/2 (DN 65) and larger.
j. Configuration: Designed for horizontal, straight through **OR** vertical inlet, horizontal center section, and vertical outlet **OR** vertical, **as directed**, flow.
k. Accessories:
1) Valves: Ball type with threaded ends on inlet and outlet of NPS 2 (DN 50) and smaller; OS&Y gate type with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.
2) Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.
2. Double-Check, Backflow-Prevention Assemblies:
a. Standard: ASSE 1015 **OR** AWWA C510, **as directed**.
b. Operation: Continuous-pressure applications, unless otherwise indicated.
c. Pressure Loss: 5 psig (35 kPa), **as directed**, maximum, through middle 1/3 of flow range.
d. Size: As directed by the manufacturer or as directed by the Owner.
e. Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
f. Selected Unit Flow Range Limits: As directed by the manufacturer or as directed by the Owner.
g. Pressure Loss at Design Flow Rate: As directed by the manufacturer or as directed by the Owner.for NPS 2 (DN 50) and smaller; As directed by the manufacturer or as directed by the Owner.for NPS 2-1/2 (DN 65) and larger.
h. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved **OR** steel with interior lining complying with AWWA C550 or that is FDA approved **OR** stainless steel, **as directed**, for NPS 2-1/2 (DN 65) and larger.
i. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged, **as directed**, for NPS 2-1/2 (DN 65) and larger.

j. Configuration: Designed for horizontal, straight through, **as directed**, flow.
k. Accessories: Ball valves with threaded ends on inlet and outlet of NPS 2 (DN 50) and smaller; OS&Y gate valves with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.

3. Reduced-Pressure-Detector, Fire-Protection Backflow Preventer Assemblies:
   a. Standards: ASSE 1047 and UL listed or FMG approved.
   b. Operation: Continuous-pressure applications.
   c. Pressure Loss: 12 psig (83 kPa), **as directed**, maximum, through middle 1/3 of flow range.
   d. Size: As directed by the manufacturer or as directed by the Owner.Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
   e. Selected Unit Flow Range Limits: As directed by the manufacturer or as directed by the Owner.
   f. Pressure Loss at Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
   g. Body: Cast iron with interior lining complying with AWWA C550 or that is FDA approved **OR** Steel with interior lining complying with AWWA C550 or that is FDA approved **OR** Stainless steel, **as directed**.
   h. End Connections: Flanged.
   i. Configuration: Designed for horizontal, straight through **OR** vertical inlet, horizontal center section, and vertical outlet **OR** vertical, **as directed**, flow.
   j. Accessories:
      1) Valves: UL 262, FMG-approved, OS&Y gate type with flanged ends on inlet and outlet.
      2) Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.
      3) Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.
4. Double-Check, Detector-Assembly Backflow Preventers:
   a. Standards: ASSE 1048 and UL listed or FMG approved.
   b. Operation: Continuous-pressure applications.
   c. Pressure Loss: 5 psig (35 kPa), **as directed**, maximum, through middle 1/3 of flow range.
   d. Size: As directed by the manufacturer or as directed by the Owner.
   e. Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
   f. Selected Unit Flow Range Limits: As directed by the manufacturer or as directed by the Owner.
   g. Pressure Loss at Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
   h. Body: Cast iron with interior lining complying with AWWA C550 or that is FDA approved **OR** Steel with interior lining complying with AWWA C550 or that is FDA approved **OR** Stainless steel, **as directed**.
   i. End Connections: Flanged.
   j. Configuration: Designed for horizontal, straight through **OR** vertical inlet, horizontal center section, and vertical outlet **OR** vertical, **as directed**, flow.
   k. Accessories:
      1) Valves: UL 262, FMG-approved, OS&Y gate type with flanged ends on inlet and outlet.
      2) Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.
5. Backflow Preventer Test Kits:
   a. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

W. Water Meter Boxes
1. Description: Cast-iron body and cover for disc-type water meter, with lettering "WATER METER" in cover; and with slotted, open-bottom base section of length to fit over service piping.

a. Option: Base section may be cast-iron, PVC, clay, or other pipe.

2. Description: Cast-iron body and double cover for disc-type water meter, with lettering "WATER METER" in top cover; and with separate inner cover; air space between covers; and slotted, open-bottom base section of length to fit over service piping.

3. Description: Polymer-concrete body and cover for disc-type water meter, with lettering "WATER" in cover; and with slotted, open-bottom base section of length to fit over service piping. Include vertical and lateral design loadings of 15,000 lb minimum over 10 by 10 inches (6800 kg minimum over 254 by 254 mm) square.

a. Use of this meter box is permitted in walks or unpaved areas away from traffic; do not use in roadways.

X. Concrete Vaults

1. Description: Precast, reinforced-concrete vault, designed for A-16 load designation according to ASTM C 857 and made according to ASTM C 858.

a. Ladder: ASTM A 36/A 36M, steel or polyethylene-encased steel steps.

b. Manhole: ASTM A 48/A 48M Class No. 35A minimum tensile strength, gray-iron traffic frame and cover.

1) Dimension: 24-inch (610-mm) minimum diameter, unless otherwise indicated.

c. Manhole: ASTM A 536, Grade 60-40-18, ductile-iron traffic frame and cover.

1) Dimension: 24-inch- (610-mm-) minimum diameter, unless otherwise indicated.

d. Drain: ASME A112.6.3, cast-iron floor drain with outlet of size indicated. Include body anchor flange, light-duty cast-iron grate, bottom outlet, and integral or field-installed bronze ball or clapper-type backwater valve.

Y. Protective Enclosures

1. Freeze-Protection Enclosures:

a. Description: Insulated enclosure designed to protect aboveground water piping, equipment, or specialties from freezing and damage, with heat source to maintain minimum internal temperature of 40 deg F (4 deg C) when external temperatures reach as low as minus 34 deg F (minus 36 deg C).

1) Standard: ASSE 1060.

2) Class I: For equipment or devices other than pressure or atmospheric vacuum breakers.

3) Class I-V: For pressure or atmospheric vacuum breaker equipment or devices. Include drain opening in housing.

a) Housing: Reinforced-aluminum **OR** -fiberglass, **as directed**, construction.

i. Size: Of dimensions indicated, but not less than those required for access and service of protected unit.

ii. Drain opening for units with drain connection.

iii. Access doors with locking devices.

iv. Insulation inside housing.

v. Anchoring devices for attaching housing to concrete base.

b) Electric heating cable or heater with self-limiting temperature control.

2. Weather-Resistant Enclosures:

a. Description: Uninsulated enclosure designed to protect aboveground water piping, equipment, or specialties from weather and damage.

1) Standard: ASSE 1060.

2) Class III: For equipment or devices other than pressure or atmospheric vacuum breakers.

3) Class III-V: For pressure or atmospheric vacuum breaker equipment or devices. Include drain opening in housing.

i. Housing: Reinforced-aluminum **OR** -fiberglass, **as directed**, construction.

ii. Size: Of dimensions indicated, but not less than those required for access and service of protected unit.

iii. Drain opening for units with drain connection.

iv. Access doors with locking devices.
v. Anchoring devices for attaching housing to concrete base.

3. Expanded-Metal Enclosures:
   a. Description: Enclosure designed to protect aboveground water piping, equipment, or specialties from damage.
      1) Material: ASTM F 1267, expanded metal side and top panels, of weight and with reinforcement of same metal at edges as required for rigidity.
      2) Type: Type I, expanded **OR** II, expanded and flattened, **as directed**.
      3) Class: Class 1, uncoated carbon steel **OR** 2, hot-dip, zinc-coated carbon steel **OR** 3, corrosion-resisting steel, **as directed**.
      4) Finish: Manufacturer's enamel paint.
      5) Size: Of dimensions indicated, but not less than those required for access and service of protected unit.
      6) Locking device.
      7) Lugs or devices for securing enclosure to base.
4. Enclosure Bases:
   a. Description: 4-inch- (100-mm-) **OR** 6-inch- (150-mm-), **as directed**, minimum thickness precast concrete, of dimensions required to extend at least 6 inches (150 mm) beyond edges of enclosure housings. Include openings for piping.

Z. Fire Hydrants
1. Dry-Barrel Fire Hydrants:
   a. Description (for AWWA dry-barrel fire hydrants): Freestanding, with one NPS 4-1/2 (DN 115) and two NPS 2-1/2 (DN 65) outlets, 5-1/4-inch (133-mm) main valve, drain valve, and NPS 6 (DN 150) mechanical-joint inlet. Include interior coating according to AWWA C550. Hydrant shall have cast-iron body, compression-type valve opening against pressure and closing with pressure.
      1) Standard: AWWA C502.
      2) Pressure Rating: 150 psig (1035 kPa) minimum **OR** 250 psig (1725 kPa), **as directed**.
      3) Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
      4) Operating and Cap Nuts: Pentagon, 1-1/2 inches (38 mm) point to flat.
      5) Direction of Opening: Open hydrant valve by turning operating nut to left or counterclockwise.
      6) Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.
   b. Description (for UL/FMG, dry-barrel fire hydrants): Freestanding, with one NPS 4-1/2 (DN 115) and two NPS 2-1/2 (DN 65) outlets, 5-1/4-inch (133-mm) main valve, drain valve, and NPS 6 (DN 150) mechanical-joint inlet. Hydrant shall have cast-iron body, compression-type valve opening against pressure and closing with pressure.
      1) Standards: UL 246, FMG approved.
      2) Pressure Rating: 150 psig (1035 kPa) minimum **OR** 250 psig (1725 kPa), **as directed**.
      3) Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
      4) Operating and Cap Nuts: Pentagon, 1-1/2 inches (38 mm) point to flat.
      5) Direction of Opening: Open hydrant valve by turning operating nut to left or counterclockwise.
      6) Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.
2. Wet-Barrel Fire Hydrants:
   a. Description (for AWWA wet-barrel fire hydrants): Freestanding, with one NPS 4-1/2 (DN 115) and two NPS 2-1/2 (DN 65) outlets, NPS 6 (DN 150) threaded or flanged inlet, and base section with NPS 6 (DN 150) mechanical-joint inlet. Include interior coating according to AWWA C550.
      1) Standard: AWWA C503.

2) Pressure Rating: 150 psig (1035 kPa) minimum.
3) Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
4) Operating and Cap Nuts: Pentagon, 1-1/2 inches (38 mm) point to flat.
5) Direction of Opening: Open hydrant valves by turning operating nut to left or counterclockwise.
6) Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.

b. Description (for UL/FMG, wet-barrel fire hydrants): Freestanding, with one NPS 4-1/2 (DN 115) and two NPS 2-1/2 (DN 65) outlets, NPS 6 (DN 150) threaded or flanged inlet, and base section with NPS 6 (DN 150) mechanical-joint inlet.
1) Standards: UL 246 and FMG approved.
2) Pressure Rating: 150 psig (1035 kPa) minimum.
3) Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
4) Operating and Cap Nuts: Pentagon, 1-1/2 inches (38 mm) point to flat.
5) Direction of Opening: Open hydrant valves by turning operating nut to left or counterclockwise.
6) Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.

AA. Flushing Hydrants
1. Post-Type Flushing Hydrants:
a. Description: Nonfreeze and drainable, of length required for shutoff valve installation below frost line.
1) Pressure Rating: 150 psig (1035 kPa) minimum.
2) Outlet: One, with horizontal discharge.
3) Hose Thread: NPS 2-1/2 (DN 65), with NFPA 1963 external hose thread for use by local fire department, and with cast-iron cap with brass chain.
4) Barrel: Cast-iron or steel pipe with breakaway feature.
5) Valve: Bronze body with bronze-ball or plunger closure, and automatic draining.
6) Security: Locking device for padlock.
7) Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.
8) Inlet: NPS 2 (DN 50) minimum.
9) Operating Wrench: One for each unit.
2. Ground-Type Flushing Hydrants:
a. Description: Nonfreeze and drainable, of length required for shutoff valve installation below frost line.
1) Pressure Rating: 150 psig (1035 kPa) minimum.
2) Outlet: One, with vertical **OR** angle, **as directed**, discharge.
3) Hose Thread: NPS 2-1/2 (DN 65), with NFPA 1963 external hose thread for use by local fire department, and with cast-iron cap with brass chain.
4) Barrel: Cast-iron or steel pipe.
5) Valve: Bronze body with bronze-ball or plunger closure, and automatic draining.
6) Inlet: NPS 2 (DN 50) minimum.
7) Hydrant Box: Cast iron with cover, for ground mounting.
8) Operating Wrench: One for each unit.
3. Post-Type Sampling Station:
a. Description: Nonfreeze and drainable, of length required for shutoff valve installation below frost line.
1) Pressure Rating: 100 psig (690 kPa) minimum.
2) Sampling Outlet: One unthreaded nozzle with handle.
3) Valve: Bronze body with bronze-ball or plunger closure. Include operating handle.
4) Drain: Tubing with separate manual vacuum pump.
5) Inlet: NPS 3/4 (DN 20) minimum.
6) Housing: Weatherproof material with locking device. Include anchor device.
7) Operating Wrench: One for each unit.

BB. Fire Department Connections
1. Fire Department Connections:
a. Description: Freestanding, with cast-bronze body, thread inlets according to NFPA 1963 and matching local fire department hose threads, and threaded bottom outlet. Include lugged caps, gaskets, and chains; lugged swivel connection and drop clapper for each hose-connection inlet; 18-inch- (460-mm-) high brass sleeve; and round escutcheon plate.
1) Standard: UL 405.
2) Connections: Two NPS 2-1/2 (DN 65) inlets and one NPS 4 (DN 100) **OR** NPS 6 (DN 150), **as directed**, outlet.
3) Connections: Three **OR** Four, **as directed**, NPS 2-1/2 (DN 65) inlets and one NPS 6 (DN 150) outlet.
4) Connections: Six NPS 2-1/2 (DN 65) inlets and one NPS 6 (DN 150) **OR** NPS 8 (DN 200), **as directed**, outlet.
5) Inlet Alignment: Inline, horizontal **OR** Square, **as directed**.
6) Finish Including Sleeve: Polished chrome-plated **OR** Rough chrome-plated **OR** Polished bronze, **as directed**.
7) Escutcheon Plate Marking: "AUTO SPKR" **OR** “STANDPIPE” **OR** “AUTO SPKR & STANDPIPE."

CC. Alarm Devices
1. Alarm Devices, General: UL 753 and FMG approved, of types and sizes to mate and match piping and equipment.
2. Water-Flow Indicators (can be used with wet-barrel fire hydrants): Vane-type water-flow detector, rated for 250-psig (1725-kPa) working pressure; designed for horizontal or vertical installation; with 2 single-pole, double-throw circuit switches to provide 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 when cover is removed.
3. Supervisory Switches: Single pole, double throw; designed to signal valve in other than fully open position. Mount on stem of OS&Y gate valves and on indicator posts.
4. Pressure Switches: Single pole, double throw; designed to signal increase in pressure. Mount on barrel of dry-barrel fire hydrants.

1.3 EXECUTION

A. Earthwork
1. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

B. Piping Applications
1. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.
2. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.
3. Do not use flanges or unions for underground piping.
4. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.
5. Underground water-service piping NPS 3/4 to NPS 3 (DN 20 to DN 80), **as directed**, shall be selected from the following, **as directed**:
a. Soft copper tube, ASTM B 88, Type K (ASTM B 88M, Type A) **OR** ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**; wrought-copper, solder-joint fittings; and brazed **OR** copper, pressure-seal fittings; and pressure-sealed, **as directed**, joints.
b. PE, ASTM pipe; insert fittings for PE pipe; and clamped **OR** molded PE fittings; and heat-fusion, **as directed**, joints.
c. PVC, Schedule 40 pipe; PVC, Schedule 40 **OR** Schedule 80 pipe; PVC, Schedule 80, **as directed**, socket fittings; and solvent-cemented joints.

d. NPS 1 to NPS 3 (DN 25 to DN 80) fiberglass, AWWA RTRP, Class 150 **OR** 200 **OR** 250, **as directed**; RTRF; and bonded joints.
e. Fiberglass, AWWA RTRP, Class 150 **OR** 200 **OR** 250, **as directed**; RTRF; and bonded joints.

6. Underground water-service piping NPS 4 to NPS 8 (DN 100 to DN 200), **as directed**, shall be selected from the following, **as directed**:
   a. Soft copper tube, ASTM B 88, Type K (ASTM B 88M,Type A) **OR** ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**; wrought-copper, solder-joint fittings; and brazed joints.
   b. Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed **OR** mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical **OR** grooved-end pipe; ductile-iron-pipe appurtenances; and grooved, **as directed**, joints.
   c. PE, AWWA pipe; PE, AWWA fittings; and heat-fusion joints.
   d. PVC, Schedule 40 pipe; PVC, Schedule 40 **OR** Schedule 80 pipe; PVC, Schedule 80, **as directed**, socket fittings; and solvent-cemented joints.
   e. NPS 4 and NPS 6 (DN 100 and DN 150): NPS 6 (DN 150) PVC, AWWA Class 150 pipe; PVC, AWWA Class 150 fabricated **OR** molded, **as directed**, fittings; and gasketed joints.
   f. NPS 8 (DN 200): PVC, AWWA Class 200 pipe; PVC, AWWA Class 200 fabricated **OR** push-on-joint, ductile-iron **OR** mechanical-joint, ductile-iron, **as directed**, fittings; and gasketed joints.
   g. Fiberglass, AWWA RTRP, Class 150 **OR** 200 **OR** 250, **as directed**; RTRF; and bonded joints.
7. Water Meter Box Water-Service Piping NPS 3/4 to NPS 2 (DN 20 to DN 50), **as directed**, shall be same as underground water-service piping.
8. Aboveground and Vault, **as directed**, Water-Service Piping NPS 3/4 to NPS 3 (DN 20 to DN 80), **as directed**, shall be selected from the following:

NOTE: Water-service piping materials listed in subparagraphs below are for potable-water service. They may not be suitable for fire-service mains.

   a. Hard copper tube, ASTM B 88, Type K (ASTM B 88M, Type A) **OR** ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**; wrought-copper, solder-joint fittings; and brazed **OR** copper, pressure-seal fittings; and pressure-sealed, **as directed**, joints.
   b. PVC, Schedule 80 pipe; PVC, Schedule 80 socket fittings; and solvent-cemented **OR** threaded fittings; and threaded, **as directed**, joints.
   c. NPS 1 to NPS 2 (DN 25 to DN 50) fiberglass, AWWA RTRP, Class 150 **OR** 200 **OR** 250, **as directed**; RTRF; and bonded joints.
9. Aboveground and vault, **as directed**, water-service piping NPS 4 to NPS 8 (DN 100 to DN 200), **as directed**, shall be selected from the following:
   a. Hard copper tube, ASTM B 88, Type K (ASTM B 88M, Type A) **OR** ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**; wrought-copper, solder-joint fittings; and brazed joints.
   b. Ductile-iron, grooved-end pipe; ductile-iron, grooved-end appurtenances; and grooved joints.
   c. PVC, Schedule 80 pipe; PVC, Schedule 80 socket fittings; and solvent-cemented **OR** threaded fittings; and threaded, **as directed**, joints.
   d. Fiberglass, AWWA RTRP, Class 150 **OR** 200 **OR** 250, **as directed**; RTRF; and bonded joints.
10. Underground Fire-Service-Main Piping NPS 4 to NPS 12 (DN 100 to DN 300), **as directed**, shall be selected from the following:

NOTE: Fire-service-main piping materials listed in subparagraphs below are for fire-protection water service. They may not be suitable for potable-water service.

   a. Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed **OR** mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical **OR** grooved-end pipe; ductile-iron-pipe appurtenances; and grooved, **as directed**, joints.
   b. PE, Class 150 **OR** 200, **as directed**, fire-service pipe; molded PE fittings; and heat-fusion joints.

c. PVC, AWWA Class 150 pipe listed for fire-protection service; PVC Class 150 fabricated or molded fittings; and gasketed joints.
d. PVC, AWWA Class 200 pipe listed for fire-protection service; PVC Class 200 fabricated fittings; and gasketed joints.
e. Fiberglass, AWWA, FMG-approved RTRP, Class 150 **OR** 200, **as directed**; RTRF; and gasketed joints.
f. Fiberglass, UL RTRP, Class 150 **OR** 200 **OR** 250, **as directed**; RTRF; and gasketed joints.

11. Aboveground and Vault, **as directed**, Fire-Service-Main Piping NPS 4 to NPS 12 (DN 100 to DN 300), **as directed**, shall be ductile-iron, grooved-end pipe; ductile-iron-pipe appurtenances; and grooved joints.
12. Underground Combined Water-Service and Fire-Service-Main Piping NPS 6 to NPS 12 (DN 150 to DN 300), **as directed**, shall be selected from the following:
    a. Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed **OR** mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical **OR** grooved-end pipe; ductile-iron-pipe appurtenances; and grooved, **as directed**, joints.
    b. PVC, AWWA Class 150 **OR** 200, **as directed**, pipe listed for fire-protection service; PVC fabricated or molded fittings of same class as pipe; and gasketed joints.
    c. Fiberglass, AWWA, FMG-approved RTRP, Class 150 **OR** 200, **as directed**; RTRF; and gasketed joints.
13. Aboveground and Vault, **as directed**, Combined Water Service and Fire-Service-Main Piping NPS 6 to NPS 12 (DN 150 to DN 300), **as directed**, shall be ductile-iron, grooved-end pipe; ductile-iron-pipe appurtenances; and grooved joints.

C. Valve Applications
1. General Application: Use mechanical-joint-end valves for NPS 3 (DN 80) and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 (DN 50) and smaller installation.
2. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
    a. Underground Valves, NPS 3 (DN 80) and Larger: AWWA, cast-iron, nonrising-stem, metal **OR** resilient **OR** high-pressure, resilient, **as directed**,-seated gate valves with valve box.
    b. Underground Valves, NPS 4 (DN 100) and Larger, for Indicator Posts: UL/FMG, cast-iron, nonrising-stem gate valves with indicator post.
    c. Use the following for valves in vaults and aboveground:
        1) Gate Valves, NPS 2 (DN 50) and Smaller: Bronze, nonrising **OR** rising, **as directed**, stem.
        2) Gate Valves, NPS 3 (DN 80) and Larger: AWWA, cast iron, OS&Y rising stem, metal seated **OR** AWWA, cast iron, OS&Y rising stem, resilient seated **OR** UL/FMG, cast iron, OS&Y rising stem, **as directed**.
        3) Check Valves: AWWA C508 **OR** UL/FMG, **as directed**, swing type.
    d. Pressure-Reducing Valves: Use for water-service piping in vaults and aboveground to control water pressure.
    e. Relief Valves: Use for water-service piping in vaults and aboveground.
        1) Air-Release Valves: To release accumulated air.
        2) Air/Vacuum Valves: To release or admit large volume of air during filling of piping.
        3) Combination Air Valves: To release or admit air.
    f. Detector Check Valves: Use for water-service piping in vaults and aboveground to detect unauthorized use of water.

D. Piping Systems - Common Requirements
1. See Division 22 Section "Common Work Results For Plumbing" for piping-system common requirements.

E. Piping Installation
1. Water-Main Connection (if tap is made by utility company): Arrange with utility company for tap of size and in location indicated in water main.
2. Water-Main Connection (if tap is made by Contractor): Tap water main according to requirements of water utility company and of size and in location indicated.
3. Make connections larger than NPS 2 (DN 50) with tapping machine according to the following:
   a. Install tapping sleeve and tapping valve according to MSS SP-60.
   b. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
   c. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.
   d. Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box.
4. Make connections NPS 2 (DN 50) and smaller with drilling machine according to the following:
   a. Install service-saddle assemblies and corporation valves in size, quantity, and arrangement required by utility company standards.
   b. Install service-saddle assemblies on water-service pipe to be tapped. Position outlets for corporation valves.
   c. Use drilling machine compatible with service-saddle assemblies and corporation valves. Drill hole in main. Remove drilling machine and connect water-service piping.
   d. Install corporation valves into service-saddle assemblies.
   e. Install manifold for multiple taps in water main.
   f. Install curb valve in water-service piping with head pointing up and with service box.
5. Comply with NFPA 24 for fire-service-main piping materials and installation.
   a. Install PE corrosion-protection encasement according to ASTM A 674 or AWWA C105.
   b. Install copper tube and fittings according to CDA's "Copper Tube Handbook."
6. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.
   a. If required, install PE corrosion-protection encasement according to ASTM A 674 or AWWA C105.
7. Install PE pipe according to ASTM D 2774 and ASTM F 645.
8. Install PVC, AWWA pipe according to ASTM F 645 and AWWA M23.
9. Install fiberglass AWWA pipe according to AWWA M45.
10. Bury piping with depth of cover over top at least 30 inches (750 mm), **as directed**, with top at least 12 inches (300 mm), **as directed**, below level of maximum frost penetration, and according to the following:
    a. Under Driveways: With at least 36 inches (910 mm), **as directed**, cover over top.
    b. Under Railroad Tracks: With at least 48 inches (1220 mm), **as directed**, cover over top.
    c. In Loose Gravelly Soil and Rock: With at least 12 inches (300 mm), **as directed**, additional cover.
11. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed.
12. Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.
    a. Terminate water-service piping at building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building-water-piping systems when those systems are installed.
13. Sleeves are specified in Division 22 Section "Common Work Results For Plumbing".
14. Mechanical sleeve seals are specified in Division 22 Section "Common Work Results For Plumbing".
15. For piping with gasketed joints: Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.
16. See Division 21 Section "Common Work Results For Fire Suppression" for fire-suppression-water piping inside the building.
17. See Division 22 Section "Common Work Results For Plumbing" for potable-water piping inside the building.

F. Joint Construction
1. See Division 22 Section "Common Work Results For Plumbing" for basic piping joint construction.
2. Make pipe joints according to the following:
   a. Copper-Tubing, Pressure-Sealed Joints: Use proprietary crimping tool and procedure recommended by copper, pressure-seal-fitting manufacturer.
   b. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
   c. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.
   d. Ductile-Iron Piping, Grooved Joints: Cut-groove pipe. Assemble joints with grooved-end, ductile-iron-piping couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions.
   e. PE Piping Insert-Fitting Joints: Use plastic insert fittings and fasteners according to fitting manufacturer's written instructions.
   f. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139 and pipe manufacturer's written instructions.
   g. Fiberglass Piping Bonded Joints: Use adhesive and procedure recommended by piping manufacturer.
   h. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure. Refer to Division 22 Section "Common Work Results For Plumbing" for joining piping of dissimilar metals.

G. Anchorage Installation
1. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
   a. Concrete thrust blocks.
   b. Locking mechanical joints.
   c. Set-screw mechanical retainer glands.
   d. Bolted flanged joints.
   e. Heat-fused joints.
   f. Pipe clamps and tie rods.
2. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
   a. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
   b. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.
   c. Bonded-Joint Fiberglass, Water-Service Piping: According to AWWA M45.
   d. Fire-Service-Main Piping: According to NFPA 24.
3. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

H. Valve Installation
1. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.
2. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.
3. UL/FMG, Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.
4. UL/FMG, Valves Other Than Gate Valves: Comply with NFPA 24.
5. MSS Valves: Install as component of connected piping system.
6. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.
7. Pressure-Reducing Valves: Install in vault or aboveground between shutoff valves. Install full-size valved bypass, **as directed**.
8. Relief Valves: Comply with AWWA C512. Install aboveground with shutoff valve on inlet.

I. Detector-Check Valve Installation

1. Install in vault or aboveground.
2. Install for proper direction of flow. Install bypass with water meter, gate valves on each side of meter, and check valve downstream from meter.
3. Support detector check valves, meters, shutoff valves, and piping on brick or concrete piers.

J. Water Meter Installation
1. If water meters are provided by the Contractor: Install water meters, piping, and specialties according to utility company's written instructions.
2. Water Meters: Install displacement **OR** turbine, **as directed**,-type water meters, NPS 2 (DN 50) and smaller, in meter boxes with shutoff valves on water meter inlets. Include valves on water meter outlets and valved bypass around meters unless prohibited by authorities having jurisdiction.
3. Water Meters: Install compound **OR** turbine, **as directed**,-type water meters, NPS 3 (DN 80) and larger, in meter vaults. Include shutoff valves on water meter inlets and outlets and valved bypass around meters. Support meters, valves, and piping on brick or concrete piers.
4. Water Meters: Install detector-type water meters in meter vault according to AWWA M6. Include shutoff valves on water meter inlets and outlets and full-size valved bypass around meters. Support meters, valves, and piping on brick or concrete piers.

K. Roughing-In For Water Meters
1. If Contractor is to rough-in for water meters to be installed by utility company: Rough-in piping and specialties for water meter installation according to utility company's written instructions.

L. Vacuum Breaker Assembly Installation
1. Install pressure vacuum breaker assemblies of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.
2. Do not install pressure vacuum breaker assemblies in vault or other space subject to flooding.

M. Backflow Preventer Installation
1. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.
2. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.
3. Do not install bypass piping around backflow preventers.
4. Support NPS 2-1/2 (DN 65) and larger backflow preventers, valves, and piping near floor and on brick or concrete piers.

N. Water Meter Box Installation
1. Install water meter boxes in paved areas flush with surface.
2. Install water meter boxes in grass or earth areas with top 2 inches (50 mm), **as directed**, above surface.

O. Concrete Vault Installation
1. Install precast concrete vaults according to ASTM C 891.

P. Protective Enclosure Installation
1. Install concrete base level and with top approximately 2 inches (50 mm), **as directed**, above grade.
2. Install protective enclosure over valves and equipment.
3. Anchor protective enclosure to concrete base.

Q. Fire Hydrant Installation
1. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.

2. Wet-Barrel Fire Hydrants: Install with valve below frost line. Provide for drainage.
3. AWWA Fire Hydrants: Comply with AWWA M17.
4. UL/FMG Fire Hydrants: Comply with NFPA 24.

R. Flushing Hydrant Installation
1. Install post-type flushing hydrants with valve below frost line and provide for drainage. Support in upright position. Include separate gate valve or curb valve and restrained joints in supply piping.
2. Install ground-type flushing hydrants with valve below frost line and provide for drainage. Install hydrant box flush with grade. Include separate gate valve or curb valve and restrained joints in supply piping.
3. Install sampling stations with valve below frost line and provide for drainage. Attach weather-resistant housing and support in upright position. Include separate curb valve in supply piping.

S. Fire Department Connection Installation
1. Install ball drip valves at each check valve for fire department connection to mains.
2. Install protective pipe bollards on two sides of **OR** on three sides of, **as directed**, each fire department connection. Pipe bollards are specified in Division 05 Section "Metal Fabrications".

T. Alarm Device Installation
1. General: Comply with NFPA 24 for devices and methods of valve supervision. Underground valves with valve box do not require supervision.
2. Supervisory Switches: Supervise valves in open position.
   a. Valves: Grind away portion of exposed valve stem. Bolt switch, with plunger in stem depression, to OS&Y gate-valve yoke.
   b. Indicator Posts: Drill and thread hole in upper-barrel section at target plate. Install switch, with toggle against target plate, on barrel of indicator post.
3. Locking and Sealing: Secure unsupervised valves as follows:
   a. Valves: Install chain and padlock on open OS&Y gate valve.
   b. Post Indicators: Install padlock on wrench on indicator post.
4. Pressure Switches: Drill and thread hole in exposed barrel of fire hydrant. Install switch.
5. Water-Flow Indicators: Install in water-service piping in vault. Select indicator with saddle and vane matching pipe size. Drill hole in pipe, insert vane, and bolt saddle to pipe.
6. Connect alarm devices to building fire alarm system. Wiring and fire-alarm devices are specified in Division 28.

U. Connections
1. Piping installation requirements are specified in other Division 22. Drawings indicate general arrangement of piping, fittings, and specialties.
2. See Division 22 Section "Common Work Results For Plumbing" for piping connections to valves and equipment.
3. Connect water-distribution piping to utility water main **OR** existing water main, **as directed**. Use tapping sleeve and tapping valve **OR** service clamp and corporation valve, **as directed**.
4. Connect water-distribution piping to interior domestic water **OR** fire-suppression, **as directed**, piping.
5. Connect waste piping from concrete vault drains to sanitary sewerage system. See Division 22 for connection to sanitary-sewer **OR** storm-drainage system. See Division 23 for connection to storm-sewer, **as directed**, piping.
6. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
7. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

V. Field Quality Control

1. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.
2. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.
   a. Increase pressure in 50-psig (350-kPa) increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig (0 kPa). Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts (1.89 L) per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.
3. Prepare reports of testing activities.

W. Identification
1. Install continuous underground detectable, **as directed**, warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Division 31 Section "Earth Moving".
2. Permanently attach equipment nameplate or marker indicating plastic water-service piping, on main electrical meter panel. See Division 22 Section "Common Work Results For Plumbing" for identifying devices.

NOTE: Delete paragraph above if metallic water-service piping without electrically insulated fittings will be used.

X. Cleaning
1. Clean and disinfect water-distribution piping as follows:
   a. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
   b. If fire-protection-water piping is not connected to potable-water supply, use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.
   c. If fire-protection-water piping is connected to potable-water supply, use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:
      1) Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours **OR** Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours, **as directed**.
      2) After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
      3) Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.
2. Prepare reports of purging and disinfecting activities.

END OF SECTION 21 05 19 00

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SECTION 21 05 19 00a - METERS AND GAGES FOR PLUMBING PIPING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for meters and gages for plumbing piping. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Bimetallic-actuated thermometers.
b. Filled-system thermometers.
c. Liquid-in-glass thermometers.
d. Light-activated thermometers.
e. Thermowells.
f. Dial-type pressure gages.
g. Gage attachments.
h. Test plugs.
i. Test-plug kits.
j. Sight flow indicators.

C. Submittals
1. Product Data: For each type of product indicated.
2. Product Certificates: For each type of meter and gage, from manufacturer.
3. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

1.2 PRODUCTS

A. Bimetallic-Actuated Thermometers
1. Standard: ASME B40.200.
2. Case: Liquid-filled and sealed type(s); stainless steel with 3-inch (76-mm) **OR** 5-inch (127-mm), **as directed**, nominal diameter.
3. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F (deg C) **OR** deg F and deg C, **as directed**.
4. Connector Type(s): Union joint, adjustable angle **OR** rigid, back **OR** rigid, bottom, **as directed**, with unified-inch screw threads.
5. Connector Size: 1/2 inch (13 mm), with ASME B1.1 screw threads.
6. Stem: 0.25 or 0.375 inch (6.4 or 9.4 mm) in diameter; stainless steel.
7. Window: Plain glass or plastic.
8. Ring: Stainless steel.
9. Element: Bimetal coil.
10. Pointer: Dark-colored metal.
11. Accuracy: Plus or minus 1 **OR** 1.5, **as directed**, percent of scale range.

B. Filled-System Thermometers
1. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:
a. Standard: ASME B40.200.
b. Case: Sealed type, cast aluminum or drawn steel; 4-1/2-inch (114-mm) **OR** 5-inch (127-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter.
c. Element: Bourdon tube or other type of pressure element.

d. Movement: Mechanical, dampening type, **as directed**, with link to pressure element and connection to pointer.
e. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
f. Pointer: Dark-colored metal.
g. Window: Glass or plastic.
h. Ring: Metal **OR** Stainless steel, **as directed**.
i. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device **OR** rigid, back **OR** rigid, bottom, **as directed**; with ASME B1.1 screw threads.
j. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
1) Design for Thermowell Installation: Bare stem.
k. Accuracy: Plus or minus 1 percent of scale range.

2. Direct-Mounted, Plastic-Case, Vapor-Actuated Thermometers:
a. Standard: ASME B40.200.
b. Case: Sealed type, plastic; 4-1/2-inch (114-mm) **OR** 5-inch (127-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter.
c. Element: Bourdon tube or other type of pressure element.
d. Movement: Mechanical, with link to pressure element and connection to pointer.
e. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
f. Pointer: Dark-colored metal.
g. Window: Glass or plastic.
h. Ring: Metal or plastic.
i. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device **OR** rigid, back **OR** rigid, bottom, **as directed**; with ASME B1.1 screw threads.
j. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
1) Design for Thermowell Installation: Bare stem.
k. Accuracy: Plus or minus 1 percent of scale range.

3. Remote-Mounted, Metal-Case, Vapor-Actuated Thermometers:
a. Standard: ASME B40.200.
b. Case: Sealed type, cast aluminum or drawn steel; 4-1/2-inch (114-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter with back **OR** front, **as directed**, flange and holes for panel mounting.
c. Element: Bourdon tube or other type of pressure element.
d. Movement: Mechanical, with link to pressure element and connection to pointer.
e. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
f. Pointer: Dark-colored metal.
g. Window: Glass or plastic.
h. Ring: Metal **OR** Stainless steel, **as directed**.
i. Connector Type(s): Union joint, back **OR** bottom, **as directed**; with ASME B1.1 screw threads.
j. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
1) Design for Thermowell Installation: Bare stem.
k. Accuracy: Plus or minus 1 percent of scale range.

4. Remote-Mounted, Plastic-Case, Vapor-Actuated Thermometers:
a. Standard: ASME B40.200.
b. Case: Sealed type, plastic; 4-1/2-inch (114-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter with back **OR** front, **as directed**, flange and holes for panel mounting.
c. Element: Bourdon tube or other type of pressure element.

d. Movement: Mechanical, with link to pressure element and connection to pointer.
e. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
f. Pointer: Dark-colored metal.
g. Window: Glass or plastic.
h. Ring: Metal or plastic.
i. Connector Type(s): Union joint, threaded, back **OR** bottom, **as directed**; with ASME B1.1 screw threads.
j. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
   1) Design for Thermowell Installation: Bare stem.
k. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

C. Liquid-In-Glass Thermometers
1. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:
   a. Standard: ASME B40.200.
   b. Case: Cast aluminum; 6-inch (152-mm) nominal size.
   c. Case Form: Back angle **OR** Straight, **as directed**, unless otherwise indicated.
   d. Tube: Glass with magnifying lens and blue or red organic liquid.
   e. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
   f. Window: Glass or plastic.
   g. Stem: Aluminum or brass and of length to suit installation.
      1) Design for Thermowell Installation: Bare stem.
   h. Connector: 3/4 inch (19 mm), with ASME B1.1 screw threads.
   i. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.
2. Plastic-Case, Compact-Style, Liquid-in-Glass Thermometers:
   a. Standard: ASME B40.200.
   b. Case: Plastic; 6-inch (152-mm) nominal size.
   c. Case Form: Back angle **OR** Straight, **as directed**, unless otherwise indicated.
   d. Tube: Glass with magnifying lens and blue or red organic liquid.
   e. Tube Background: Nonreflective with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
   f. Window: Glass or plastic.
   g. Stem: Aluminum or brass and of length to suit installation.
      1) Design for Thermowell Installation: Bare stem.
   h. Connector: 3/4 inch (19 mm), with ASME B1.1 screw threads.
   i. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.
3. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
   a. Standard: ASME B40.200.
   b. Case: Cast aluminum; 7-inch (178-mm) **OR** 9-inch (229-mm), **as directed**, nominal size unless otherwise indicated.
   c. Case Form: Adjustable angle **OR** Back angle **OR** Straight, **as directed**, unless otherwise indicated.
   d. Tube: Glass with magnifying lens and blue or red organic liquid.
   e. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
   f. Window: Glass or plastic.
   g. Stem: Aluminum and of length to suit installation.
      1) Design for Thermowell Installation: Bare stem.
   h. Connector: 1-1/4 inches (32 mm), with ASME B1.1 screw threads.
   i. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

4. Plastic-Case, Industrial-Style, Liquid-in-Glass Thermometers:
   a. Standard: ASME B40.200.
   b. Case: Plastic; 7-inch (178-mm) **OR** 9-inch (229-mm), **as directed**, nominal size unless otherwise indicated.
   c. Case Form: Adjustable angle **OR** Back angle **OR** Straight, **as directed**, unless otherwise indicated.
   d. Tube: Glass with magnifying lens and blue or red organic liquid.
   e. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
   f. Window: Glass or plastic.
   g. Stem: Aluminum **OR** Brass **OR** Stainless steel **OR** Aluminum, brass, or stainless steel, **as directed**, and of length to suit installation.
      1) Design for Thermowell Installation: Bare stem.
   h. Connector: 1-1/4 inches (32 mm), with ASME B1.1 screw threads.
   i. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

D. Light-Activated Thermometers
1. Direct-Mounted, Light-Activated Thermometers:
   a. Case: Plastic **OR** Metal, **as directed**; 7-inch (178-mm) **OR** 9-inch (229-mm), **as directed**, nominal size unless otherwise indicated.
   b. Scale(s): Deg F (Deg C) **OR** Deg F and deg C, **as directed**.
   c. Case Form: Adjustable angle.
   d. Connector: 1-1/4 inches (32 mm), with ASME B1.1 screw threads.
   e. Stem: Aluminum and of length to suit installation.
      1) Design for Thermowell Installation: Bare stem.
   f. Display: Digital.
   g. Accuracy: Plus or minus 2 deg F (1 deg C).
2. Remote-Mounted, Light-Activated Thermometers:
   a. Case: Plastic, for wall mounting.
   b. Scale(s): Deg F (Deg C) **OR** Deg F and deg C, **as directed**.
   c. Sensor: Bulb and thermister wire.
      1) Design for Thermowell Installation: Bare stem.
   d. Display: Digital.
   e. Accuracy: Plus or minus 2 deg F (1 deg C).

E. Thermowells
1. Thermowells:
   a. Standard: ASME B40.200.
   b. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
   c. Material for Use with Copper Tubing: CNR or CUNI.
   d. Material for Use with Steel Piping: CRES **OR** CSA, **as directed**.
   e. Type: Stepped shank unless straight or tapered shank is indicated.
   f. External Threads: NPS 1/2, NPS 3/4, or NPS 1, (DN 15, DN 20, or NPS 25,) ASME B1.20.1 pipe threads.
   g. Internal Threads: 1/2, 3/4, and 1 inch (13, 19, and 25 mm), with ASME B1.1 screw threads.
   h. Bore: Diameter required to match thermometer bulb or stem.
   i. Insertion Length: Length required to match thermometer bulb or stem.
   j. Lagging Extension: Include on thermowells for insulated piping and tubing.
   k. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
2. Heat-Transfer Medium: Mixture of graphite and glycerin.

F. Pressure Gages

1. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
   a. Standard: ASME B40.100.
   b. Case: Liquid-filled **OR** Sealed **OR** Open-front, pressure relief **OR** Solid-front, pressure relief, **as directed**, type(s); cast aluminum or drawn steel; 4-1/2-inch (114-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter.
   c. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
   d. Pressure Connection: Brass, with NPS 1/4 (DN 8) **OR** NPS 1/4 or NPS 1/2 (DN 8 or DN 15) **OR** NPS 1/2 (DN 15), **as directed**, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
   e. Movement: Mechanical, with link to pressure element and connection to pointer.
   f. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa) **OR** psi and kPa, **as directed**.
   g. Pointer: Dark-colored metal.
   h. Window: Glass or plastic.
   i. Ring: Metal **OR** Brass **OR** Stainless steel, **as directed**.
   j. Accuracy: Grade A, plus or minus 1 percent of middle half of **OR** Grade B, plus or minus 2 percent of middle half of **OR** Grade C, plus or minus 3 percent of middle half of **OR** Grade D, plus or minus 5 percent of whole, **as directed**, scale range.
2. Direct-Mounted, Plastic-Case, Dial-Type Pressure Gages:
   a. Standard: ASME B40.100.
   b. Case: Sealed type; plastic; 4-1/2-inch (114-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter.
   c. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
   d. Pressure Connection: Brass, with NPS 1/4 (DN 8) **OR** NPS 1/4 or NPS 1/2 (DN 8 or DN 15) **OR** NPS 1/2 (DN 15), **as directed**, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
   e. Movement: Mechanical, with link to pressure element and connection to pointer.
   f. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa) **OR** psi and kPa, **as directed**.
   g. Pointer: Dark-colored metal.
   h. Window: Glass or plastic.
   i. Accuracy: Grade A, plus or minus 1 percent of middle half of **OR** Grade B, plus or minus 2 percent of middle half of **OR** Grade C, plus or minus 3 percent of middle half of **OR** Grade D, plus or minus 5 percent of whole, **as directed**, scale range.
3. Remote-Mounted, Metal-Case, Dial-Type Pressure Gages:
   a. Standard: ASME B40.100.
   b. Case: Liquid-filled **OR** Sealed, **as directed**, type; cast aluminum or drawn steel **OR** metal, **as directed**; 4-1/2-inch (114-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter with back **OR** front, **as directed**, flange and holes for panel mounting.
   c. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
   d. Pressure Connection: Brass, with NPS 1/4 (DN 8) **OR** NPS 1/4 or NPS 1/2 (DN 8 or DN 15) **OR** NPS 1/2 (DN 15), **as directed**, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
   e. Movement: Mechanical, with link to pressure element and connection to pointer.
   f. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa) **OR** psi and kPa, **as directed**.
   g. Pointer: Dark-colored metal.
   h. Window: Glass or plastic.
   i. Ring: Metal **OR** Stainless steel, **as directed**.
   j. Accuracy: Grade A, plus or minus 1 percent of middle half of **OR** Grade B, plus or minus 2 percent of middle half of **OR** Grade C, plus or minus 3 percent of middle half of **OR** Grade D, plus or minus 5 percent of whole, **as directed**, scale range.
4. Remote-Mounted, Plastic-Case, Dial-Type Pressure Gages:
   a. Standard: ASME B40.100.
   b. Case: Sealed type; plastic; 4-1/2-inch (114-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter with back **OR** front, **as directed**, flange and holes for panel mounting.

c. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
d. Pressure Connection: Brass, with NPS 1/4 (DN 8) **OR** NPS 1/4 or NPS 1/2 (DN 8 or DN 15) **OR** NPS 1/2 (DN 15), **as directed**, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
e. Movement: Mechanical, with link to pressure element and connection to pointer.
f. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa) **OR** psi and kPa, **as directed**.
g. Pointer: Dark-colored metal.
h. Window: Glass or plastic.
i. Accuracy: Grade A, plus or minus 1 percent of middle half of **OR** Grade B, plus or minus 2 percent of middle half of **OR** Grade C, plus or minus 3 percent of middle half of **OR** Grade D, plus or minus 5 percent of whole, **as directed**, scale range.

G. Gage Attachments
1. Snubbers: ASME B40.100, brass; with NPS 1/4 (DN 8) **OR** NPS 1/4 or NPS 1/2 (DN 8 or DN 15) **OR** NPS 1/2 (DN 15), **as directed**, ASME B1.20.1 pipe threads and piston **OR** porous-metal, **as directed**,-type surge-dampening device. Include extension for use on insulated piping.
2. Valves: Brass ball **OR** Brass or stainless-steel needle, **as directed**, with NPS 1/4 (DN 8) **OR** NPS 1/4 or NPS 1/2 (DN 8 or DN 15) **OR** NPS 1/2 (DN 15), **as directed**, ASME B1.20.1 pipe threads.

H. Test Plugs
1. Description: Test-station fitting made for insertion into piping tee fitting.
2. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
3. Thread Size: NPS 1/4 (DN 8) or NPS 1/2 (DN 15), ASME B1.20.1 pipe thread.
4. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F (3450 kPa at 93 deg C).
5. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

I. Test-Plug Kits
1. Furnish one test-plug kit(s) containing one **OR** two, **as directed**, 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.
2. Low-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 25 to 125 deg F (minus 4 to plus 52 deg C).
3. 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).
4. 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).
5. Carrying Case: Metal or plastic, with formed instrument padding.

J. Sight Flow Indicators
1. Description: Piping inline-installation device for visual verification of flow.
2. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.
3. Minimum Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1034 kPa), **as directed**.
4. Minimum Temperature Rating: 200 deg F (93 deg C).
5. End Connections for NPS 2 (DN 50) and Smaller: Threaded.
6. End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged.

1.3 EXECUTION

A. Installation
1. Install thermowells with socket extending a minimum of 2 inches (51 mm) into fluid **OR** one-third of pipe diameter **OR** to center of pipe, **as directed**, and in vertical position in piping tees.
2. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
3. Install thermowells with extension on insulated piping.
4. Fill thermowells with heat-transfer medium.
5. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
6. 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.
7. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
8. Install remote-mounted pressure gages on panel.
9. Install valve and snubber in piping for each pressure gage for fluids.
10. Install test plugs in piping tees.
11. Install thermometers in the following locations:
    a. Inlet and outlet of each water heater.
    b. Inlets and outlets of each domestic water heat exchanger.
    c. Inlet and outlet of each domestic hot-water storage tank.
    d. Inlet and outlet of each remote domestic water chiller.
12. Install pressure gages in the following locations:
    a. Building water service entrance into building.
    b. Inlet and outlet of each pressure-reducing valve.
    c. Suction and discharge of each domestic water pump.

B. Connections
1. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

C. Adjusting
1. Adjust faces of meters and gages to proper angle for best visibility.

D. Thermometer Schedule
1. Thermometers at inlet and outlet of each domestic water heater shall be one of the following:
    a. Liquid-filled **OR** Sealed, **as directed**, bimetallic-actuated type.
    b. Direct **OR** Remote, **as directed**,-mounted, metal **OR** plastic, **as directed**,-case, vapor-actuated type.
    c. Compact **OR** Industrial, **as directed**,-style, liquid-in-glass type.
    d. Direct **OR** Remote, **as directed**,-mounted, light-activated type.
    e. Test plug with chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.
2. Thermometers at inlets and outlets of each domestic water heat exchanger shall be one of the following:
    a. Liquid-filled **OR** Sealed, **as directed**, bimetallic-actuated type.
    b. Direct **OR** Remote, **as directed**,-mounted, metal **OR** plastic, **as directed**,-case, vapor-actuated type.
    c. Compact **OR** Industrial, **as directed**,-style, liquid-in-glass type.
    d. Direct **OR** Remote, **as directed**,-mounted, light-activated type.
    e. Test plug with chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.
3. Thermometers at inlet and outlet of each domestic hot-water storage tank shall be one of the following:
    a. Liquid-filled **OR** Sealed, **as directed**, bimetallic-actuated type.

b. Direct **OR** Remote, **as directed**,-mounted, metal **OR** plastic, **as directed**,-case, vapor-actuated type.
c. Compact **OR** Industrial, **as directed**,-style, liquid-in-glass type.
d. Direct **OR** Remote, **as directed**,-mounted, light-activated type.
e. Test plug with chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.

4. Thermometers at inlet and outlet of each remote domestic water chiller shall be one of the following:
   a. Liquid-filled **OR** Sealed, **as directed**, bimetallic-actuated type.
   b. Direct **OR** Remote, **as directed**,-mounted, metal **OR** plastic, **as directed**,-case, vapor-actuated type.
   c. Compact **OR** Industrial, **as directed**,-style, liquid-in-glass type.
   d. Direct **OR** Remote, **as directed**,-mounted, light-activated type.
   e. Test plug with chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.
5. Thermometer stems shall be of length to match thermowell insertion length.

E. Thermometer Scale-Range Schedule
1. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F (Minus 20 to plus 50 deg C) **OR** 0 to 100 deg F and minus 20 to plus 50 deg C, **as directed**.
2. Scale Range for Domestic Cold-Water Piping: 0 to 150 deg F (Minus 20 to plus 70 deg C) **OR** 0 to 150 deg F and minus 20 to plus 70 deg C, **as directed**.
3. Scale Range for Domestic Cold-Water Piping: 30 to 240 deg F (0 to plus 115 deg C) **OR** 30 to 240 deg F and 0 to plus 115 deg C, **as directed**.
4. Scale Range for Domestic Hot-Water Piping: 0 to 250 deg F (0 to 150 deg C) **OR** 0 to 250 deg F and 0 to 150 deg C, **as directed**.
5. Scale Range for Domestic Hot-Water Piping: 20 to 240 deg F (0 to 150 deg C) **OR** 20 to 240 deg F and 0 to 150 deg C, **as directed**.
6. Scale Range for Domestic Hot-Water Piping: 30 to 240 deg F (0 to plus 115 deg C) **OR** 30 to 240 deg F and 0 to plus 115 deg C, **as directed**.
7. Scale Range for Domestic Cooled-Water Piping: 0 to 100 deg F (Minus 20 to plus 50 deg C) **OR** 0 to 100 deg F and minus 20 to plus 50 deg C, **as directed**.
8. Scale Range for Domestic Cooled-Water Piping: 0 to 150 deg F (Minus 20 to plus 70 deg C) **OR** 0 to 150 deg F and minus 20 to plus 70 deg C, **as directed**.

F. Pressure-Gage Schedule
1. Pressure gages at discharge of each water service into building shall be one of the following:
   a. Liquid-filled **OR** Sealed **OR** Open-front, pressure-relief **OR** Solid-front, pressure-relief, **as directed**, direct **OR** remote, **as directed**,-mounted, metal case.
   b. Sealed, direct **OR** remote, **as directed**,-mounted, plastic case.
   c. Test plug with chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.
2. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be one of the following:
   a. Liquid-filled **OR** Sealed **OR** Open-front, pressure-relief **OR** Solid-front, pressure-relief, **as directed**, direct **OR** remote, **as directed**,-mounted, metal case.
   b. Sealed, direct **OR** remote, **as directed**,-mounted, plastic case.
   c. Test plug with chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.
3. Pressure gages at suction and discharge of each domestic water pump shall be one of the following:
   a. Liquid-filled **OR** Sealed **OR** Open-front, pressure-relief **OR** Solid-front, pressure-relief, **as directed**, direct **OR** remote, **as directed**,-mounted, metal case.
   b. Sealed, direct **OR** remote, **as directed**,-mounted, plastic case.

c. Test plug with chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.

G. Pressure-Gage Scale-Range Schedule

1. Scale Range for Water Service Piping: 0 to 100 psi (0 to 600 kPa) **OR** 0 to 100 psi and 0 to 600 kPa, **as directed**.
2. Scale Range for Water Service Piping: 0 to 160 psi (0 to 1100 kPa) **OR** 0 to 160 psi and 0 to 1100 kPa, **as directed**.
3. Scale Range for Water Service Piping: 0 to 200 psi (0 to 1400 kPa) **OR** 0 to 200 psi and 0 to 1400 kPa, **as directed**.
4. Scale Range for Domestic Water Piping: 0 to 100 psi (0 to 600 kPa) **OR** 0 to 100 psi and 0 to 600 kPa, **as directed**.
5. Scale Range for Domestic Water Piping: 0 to 160 psi (0 to 1100 kPa) **OR** 0 to 160 psi and 0 to 1100 kPa, **as directed**.
6. Scale Range for Domestic Water Piping: 0 to 200 psi (0 to 1400 kPa) **OR** 0 to 200 psi and 0 to 1400 kPa, **as directed**.
7. Scale Range for Domestic Water Piping: 0 to 300 psi (0 to 2500 kPa) **OR** 0 to 300 psi and 0 to 2500 kPa, **as directed**.

END OF SECTION 21 05 19 00a

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SECTION 21 05 19 00b - METERS AND GAGES FOR HVAC PIPING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for meters and gages for HVAC piping. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Bimetallic-actuated thermometers.
b. Filled-system thermometers.
c. Liquid-in-glass thermometers.
d. Light-activated thermometers.
e. Thermowells.
f. Dial-type pressure gages.
g. Gage attachments.
h. Test plugs.
i. Test-plug kits.
j. Sight flow indicators.
k. Orifice flowmeters.
l. Pitot-tube flowmeters.
m. Turbine flowmeters.
n. Venturi flowmeters.
o. Vortex-shedding flowmeters.
p. Impeller-turbine, thermal-energy meters.
q. Ultrasonic, thermal-energy meters.

C. Submittals
1. Product Data: For each type of product indicated.
2. Wiring Diagrams: For power, signal, and control wiring.
3. Product Certificates: For each type of meter and gage, from manufacturer.
4. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

1.2 PRODUCTS

A. Bimetallic-Actuated Thermometers
1. Standard: ASME B40.200.
2. Case: Liquid-filled and sealed type(s); stainless steel with 3-inch (76-mm) **OR** 5-inch (127-mm), **as directed**, nominal diameter.
3. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F (deg C) **OR** deg F and deg C, **as directed**.
4. Connector Type(s): Union joint, adjustable angle **OR** rigid, back **OR** rigid, bottom, **as directed**, with unified-inch screw threads.
5. Connector Size: 1/2 inch (13 mm), with ASME B1.1 screw threads.
6. Stem: 0.25 or 0.375 inch (6.4 or 9.4 mm) in diameter; stainless steel.
7. Window: Plain glass or plastic.
8. Ring: Stainless steel.
9. Element: Bimetal coil.
10. Pointer: Dark-colored metal.

11. Accuracy: Plus or minus 1 **OR** 1.5, **as directed**, percent of scale range.

B. Filled-System Thermometers
1. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:
   a. Standard: ASME B40.200.
   b. Case: Sealed type, cast aluminum or drawn steel; 4-1/2-inch (114-mm) **OR** 5-inch (127-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter.
   c. Element: Bourdon tube or other type of pressure element.
   d. Movement: Mechanical, dampening type, **as directed**, with link to pressure element and connection to pointer.
   e. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
   f. Pointer: Dark-colored metal.
   g. Window: Glass or plastic.
   h. Ring: Metal **OR** Stainless steel.
   i. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device **OR** rigid, back **OR** rigid, bottom, **as directed**; with ASME B1.1 screw threads.
   j. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
      1) Design for Air-Duct Installation: With ventilated shroud.
      2) Design for Thermowell Installation: Bare stem.
   k. Accuracy: Plus or minus 1 percent of scale range.
2. Direct-Mounted, Plastic-Case, Vapor-Actuated Thermometers:
   a. Standard: ASME B40.200.
   b. Case: Sealed type, plastic; 4-1/2-inch (114-mm) **OR** 5-inch (127-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter.
   c. Element: Bourdon tube or other type of pressure element.
   d. Movement: Mechanical, with link to pressure element and connection to pointer.
   e. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
   f. Pointer: Dark-colored metal.
   g. Window: Glass or plastic.
   h. Ring: Metal or plastic.
   i. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device **OR** rigid, back **OR** rigid, bottom, **as directed**; with ASME B1.1 screw threads.
   j. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
      1) Design for Air-Duct Installation: With ventilated shroud.
      2) Design for Thermowell Installation: Bare stem.
   k. Accuracy: Plus or minus 1 percent of scale range.
3. Remote-Mounted, Metal-Case, Vapor-Actuated Thermometers:
   a. Standard: ASME B40.200.
   b. Case: Sealed type, cast aluminum or drawn steel; 4-1/2-inch (114-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter with back **OR** front, **as directed**, flange and holes for panel mounting.
   c. Element: Bourdon tube or other type of pressure element.
   d. Movement: Mechanical, with link to pressure element and connection to pointer.
   e. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
   f. Pointer: Dark-colored metal.
   g. Window: Glass or plastic.
   h. Ring: Metal **OR** Stainless steel, **as directed**.

i. Connector Type(s): Union joint, back **OR** bottom, **as directed**; with ASME B1.1 screw threads.
j. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
1) Design for Air-Duct Installation: With ventilated shroud.
2) Design for Thermowell Installation: Bare stem.
k. Accuracy: Plus or minus 1 percent of scale range.

4. Remote-Mounted, Plastic-Case, Vapor-Actuated Thermometers:
a. Standard: ASME B40.200.
b. Case: Sealed type, plastic; 4-1/2-inch (114-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter with back **OR** front, **as directed**, flange and holes for panel mounting.
c. Element: Bourdon tube or other type of pressure element.
d. Movement: Mechanical, with link to pressure element and connection to pointer.
e. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
f. Pointer: Dark-colored metal.
g. Window: Glass or plastic.
h. Ring: Metal or plastic.
i. Connector Type(s): Union joint, threaded, back **OR** bottom, **as directed**; with ASME B1.1 screw threads.
j. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
1) Design for Air-Duct Installation: With ventilated shroud.
2) Design for Thermowell Installation: Bare stem.
k. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

C. Liquid-In-Glass Thermometers
1. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:
a. Standard: ASME B40.200.
b. Case: Cast aluminum; 6-inch (152-mm) nominal size.
c. Case Form: Back angle **OR** Straight, **as directed**, unless otherwise indicated.
d. Tube: Glass with magnifying lens and blue or red, **as directed**, organic liquid.
e. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
f. Window: Glass or plastic.
g. Stem: Aluminum or brass and of length to suit installation.
1) Design for Air-Duct Installation: With ventilated shroud.
2) Design for Thermowell Installation: Bare stem.
h. Connector: 3/4 inch (19 mm), with ASME B1.1 screw threads.
i. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2. Plastic-Case, Compact-Style, Liquid-in-Glass Thermometers:
a. Standard: ASME B40.200.
b. Case: Plastic; 6-inch (152-mm) nominal size.
c. Case Form: Back angle **OR** Straight, **as directed**, unless otherwise indicated.
d. Tube: Glass with magnifying lens and blue or red, **as directed**, organic liquid.
e. Tube Background: Nonreflective with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
f. Window: Glass or plastic.
g. Stem: Aluminum or brass and of length to suit installation.
1) Design for Air-Duct Installation: With ventilated shroud.
2) Design for Thermowell Installation: Bare stem.
h. Connector: 3/4 inch (19 mm), with ASME B1.1 screw threads.
i. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

3. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
   a. Standard: ASME B40.200.
   b. Case: Cast aluminum; 7-inch (178-mm) **OR** 9-inch (229-mm), **as directed**, nominal size unless otherwise indicated.
   c. Case Form: Adjustable angle **OR** Back angle **OR** Straight, **as directed**, unless otherwise indicated.
   d. Tube: Glass with magnifying lens and blue or red, **as directed**, organic liquid.
   e. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
   f. Window: Glass or plastic.
   g. Stem: Aluminum and of length to suit installation.
      1) Design for Air-Duct Installation: With ventilated shroud.
      2) Design for Thermowell Installation: Bare stem.
   h. Connector: 1-1/4 inches (32 mm), with ASME B1.1 screw threads.
   i. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.
4. Plastic-Case, Industrial-Style, Liquid-in-Glass Thermometers:
   a. Standard: ASME B40.200.
   b. Case: Plastic; 7-inch (178-mm) **OR** 9-inch (229-mm), **as directed**, nominal size unless otherwise indicated.
   c. Case Form: Adjustable angle **OR** Back angle **OR** Straight, **as directed**, unless otherwise indicated.
   d. Tube: Glass with magnifying lens and blue or red, **as directed**, organic liquid.
   e. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) **OR** deg F and deg C, **as directed**.
   f. Window: Glass or plastic.
   g. Stem: Aluminum **OR** Brass **OR** Stainless steel, **as directed**, and of length to suit installation.
      1) Design for Air-Duct Installation: With ventilated shroud.
      2) Design for Thermowell Installation: Bare stem.
   h. Connector: 1-1/4 inches (32 mm), with ASME B1.1 screw threads.
   i. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

D. Light-Activated Thermometers
1. Direct-Mounted, Light-Activated Thermometers:
   a. Case: Plastic **OR** Metal, **as directed**; 7-inch (178-mm) **OR** 9-inch (229-mm), **as directed**, nominal size unless otherwise indicated.
   b. Scale(s): Deg F (Deg C) **OR** Deg F and deg C, **as directed**.
   c. Case Form: Adjustable angle.
   d. Connector: 1-1/4 inches (32 mm), with ASME B1.1 screw threads.
   e. Stem: Aluminum and of length to suit installation.
      1) Design for Air-Duct Installation: With ventilated shroud.
      2) Design for Thermowell Installation: Bare stem.
   f. Display: Digital.
   g. Accuracy: Plus or minus 2 deg F (1 deg C).
2. Remote-Mounted, Light-Activated Thermometers:
   a. Case: Plastic, for wall mounting.
   b. Scale(s): Deg F (Deg C) **OR** Deg F and deg C, **as directed**.
   c. Sensor: Bulb and thermister wire.
      1) Design for Air-Duct Installation: With ventilated shroud.
      2) Design for Thermowell Installation: Bare stem.
   d. Display: Digital.
   e. Accuracy: Plus or minus 2 deg F (1 deg C).

E. Duct-Thermometer Mounting Brackets
   1. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

F. Thermowells
   1. Thermowells:
      a. Standard: ASME B40.200.
      b. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
      c. Material for Use with Copper Tubing: CNR **OR** CUNI, **as directed**.
      d. Material for Use with Steel Piping: CRES **OR** CSA, **as directed**.
      e. Type: Stepped shank unless straight or tapered shank is indicated.
      f. External Threads: NPS 1/2, NPS 3/4, or NPS 1, (DN 15, DN 20, or NPS 25,) ASME B1.20.1 pipe threads.
      g. Internal Threads: 1/2, 3/4, and 1 inch (13, 19, and 25 mm), with ASME B1.1 screw threads.
      h. Bore: Diameter required to match thermometer bulb or stem.
      i. Insertion Length: Length required to match thermometer bulb or stem.
      j. Lagging Extension: Include on thermowells for insulated piping and tubing.
      k. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
   2. Heat-Transfer Medium: Mixture of graphite and glycerin.

G. Pressure Gages
   1. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
      1) Standard: ASME B40.100.
      2) Case: Liquid-filled **OR** Sealed **OR** Open-front, pressure relief **OR** Solid-front, pressure relief, **as directed**, type(s); cast aluminum or drawn steel; 4-1/2-inch (114-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter.
      3) Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
      4) Pressure Connection: Brass, with NPS 1/4 (DN 8) **OR** NPS 1/2 (DN 15), **as directed**, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
      5) Movement: Mechanical, with link to pressure element and connection to pointer.
      6) Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa) **OR** psi and kPa, **as directed**.
      7) Pointer: Dark-colored metal.
      8) Window: Glass or plastic.
      9) Ring: Metal **OR** Brass **OR** Stainless steel, **as directed**.
      10) Accuracy: Grade A, plus or minus 1 percent of middle half of **OR** Grade B, plus or minus 2 percent of middle half of **OR** Grade C, plus or minus 3 percent of middle half of **OR** Grade D, plus or minus 5 percent of whole, **as directed**, scale range.
   2. Direct-Mounted, Plastic-Case, Dial-Type Pressure Gages:
      a. Standard: ASME B40.100.
      b. Case: Sealed type; plastic; 4-1/2-inch (114-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter.
      c. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
      d. Pressure Connection: Brass, with NPS 1/4 (DN 8) **OR** NPS 1/2 (DN 15), **as directed**, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
      e. Movement: Mechanical, with link to pressure element and connection to pointer.
      f. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa) **OR** psi and kPa, **as directed**.
      g. Pointer: Dark-colored metal.
      h. Window: Glass or plastic.
      i. Accuracy: Grade A, plus or minus 1 percent of middle half of **OR** Grade B, plus or minus 2 percent of middle half of **OR** Grade C, plus or minus 3 percent of middle half of **OR** Grade D, plus or minus 5 percent of whole, **as directed**, scale range.

3. Remote-Mounted, Metal-Case, Dial-Type Pressure Gages:
   a. Standard: ASME B40.100.
   b. Case: Liquid-filled **OR** Sealed, **as directed**, type; cast aluminum or drawn steel **OR** metal, **as directed**; 4-1/2-inch (114-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter with back **OR** front, **as directed**, flange and holes for panel mounting.
   c. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
   d. Pressure Connection: Brass, with NPS 1/4 (DN 8) **OR** NPS 1/2 (DN 15), **as directed**, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
   e. Movement: Mechanical, with link to pressure element and connection to pointer.
   f. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa) **OR** psi and kPa, **as directed**.
   g. Pointer: Dark-colored metal.
   h. Window: Glass or plastic.
   i. Ring: Metal **OR** Stainless steel, **as directed**.
   j. Accuracy: Grade A, plus or minus 1 percent of middle half of **OR** Grade B, plus or minus 2 percent of middle half of **OR** Grade C, plus or minus 3 percent of middle half of **OR** Grade D, plus or minus 5 percent of whole, **as directed**, scale range.
4. Remote-Mounted, Plastic-Case, Dial-Type Pressure Gages:
   a. Standard: ASME B40.100.
   b. Case: Sealed type; plastic; 4-1/2-inch (114-mm) **OR** 6-inch (152-mm), **as directed**, nominal diameter with back **OR** front, **as directed**, flange and holes for panel mounting.
   c. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
   d. Pressure Connection: Brass, with NPS 1/4 (DN 8) **OR** NPS 1/2 (DN 15), **as directed**, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
   e. Movement: Mechanical, with link to pressure element and connection to pointer.
   f. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa) **OR** psi and kPa, **as directed**.
   g. Pointer: Dark-colored metal.
   h. Window: Glass or plastic.
   i. Accuracy: Grade A, plus or minus 1 percent of middle half of **OR** Grade B, plus or minus 2 percent of middle half of **OR** Grade C, plus or minus 3 percent of middle half of **OR** Grade D, plus or minus 5 percent of whole, **as directed**, scale range.

H. Gage Attachments
1. Snubbers: ASME B40.100, brass; with NPS 1/4 (DN 8) **OR** NPS 1/2 (DN 15), **as directed**, ASME B1.20.1 pipe threads and piston-type **OR** porous-metal-type, **as directed**, surge-dampening device. Include extension for use on insulated piping.
2. Siphons: Loop-shaped section of brass **OR** stainless-steel **OR** steel, **as directed**, pipe with NPS 1/4 (DN 8) **OR** NPS 1/2 (DN 15), **as directed**, pipe threads.
3. Valves: Brass ball **OR** Brass or stainless-steel needle, **as directed**, with NPS 1/4 (DN 8) **OR** NPS 1/2 (DN 15), **as directed**, ASME B1.20.1 pipe threads.

I. Test Plugs
1. Description: Test-station fitting made for insertion into piping tee fitting.
2. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
3. Thread Size: NPS 1/4 (DN 8) **OR** NPS 1/2 (DN 15), **as directed**, ASME B1.20.1 pipe thread.
4. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F (3450 kPa at 93 deg C).
5. Core Inserts: Chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber.

J. Test-Plug Kits
1. Furnish one test-plug kit(s) containing one **OR** two, **as directed**, 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.

2. Low-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 25 to 125 deg F (minus 4 to plus 52 deg C).
3. 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).
4. 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).
5. Carrying Case: Metal or plastic, with formed instrument padding.

K. Sight Flow Indicators
1. Description: Piping inline-installation device for visual verification of flow.
2. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.
3. Minimum Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1034 kPa), **as directed**.
4. Minimum Temperature Rating: 200 deg F (93 deg C).
5. End Connections for NPS 2 (DN 50) and Smaller: Threaded.
6. End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged.

L. Flowmeters
1. Orifice Flowmeters:
   a. Description: Flowmeter with sensor, hoses or tubing, fittings, valves, indicator, and conversion chart.
   b. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
   c. Sensor: Wafer-orifice-type, calibrated, flow-measuring element; for installation between pipe flanges.
      1) Design: Differential-pressure-type measurement for gas **OR** oil **OR** steam **OR** water, **as directed**.
      2) Construction: Cast-iron body, brass valves with integral check valves and caps, and calibrated nameplate.
      3) Minimum Pressure Rating: 300 psig (2070 kPa).
      4) Minimum Temperature Rating: 250 deg F (121 deg C).
   d. Permanent Indicators: Meter suitable for wall or bracket mounting, calibrated for connected sensor and having 6-inch- (152-mm-) diameter, or equivalent, dial with fittings and copper tubing for connecting to sensor.
      1) Scale: Gallons per minute (Liters per second).
      2) Accuracy: Plus or minus 1 percent between 20 and 80 percent of scale range.
   e. Portable Indicators: Hand-held, differential-pressure type, calibrated for connected sensor and having two 12-foot (3.7-m) hoses, with carrying case.
      1) Scale: Gallons per minute (Liters per second).
      2) Accuracy: Plus or minus 2 percent between 20 and 80 percent of scale range.
   f. Display: Shows rate of flow, with register to indicate total volume in gallons (liters).
   g. Conversion Chart: Flow rate data compatible with sensor and indicator.
   h. Operating Instructions: Include complete instructions with each flowmeter.
2. Pitot-Tube Flowmeters:
   a. Description: Flowmeter with sensor and indicator.
   b. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
   c. Sensor: Insertion type; for inserting probe into piping and measuring flow directly in gallons per minute (liters per second).
      1) Design: Differential-pressure-type measurement for oil **OR** water, **as directed**.
      2) Construction: Stainless-steel probe of length to span inside of pipe, with integral transmitter and direct-reading scale.
      3) Minimum Pressure Rating: 150 psig (1035 kPa).
      4) Minimum Temperature Rating: 250 deg F (121 deg C).

d. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
e. Integral Transformer: For low-voltage power connection.
f. Accuracy: Plus or minus 3 percent.
g. Display: Shows rate of flow, with register to indicate total volume in gallons (liters).
h. Operating Instructions: Include complete instructions with each flowmeter.

3. Turbine Flowmeters:
   a. Description: Flowmeter with sensor and indicator.
   b. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
   c. Sensor: Impeller turbine; for inserting into pipe fitting or for installing in piping and measuring flow directly in gallons per minute (liters per second).
      1) Design: Device or pipe fitting with inline turbine and integral direct-reading scale for gas **OR** oil **OR** steam **OR** water, **as directed**.
      2) Construction: Bronze or stainless-steel body, with plastic turbine or impeller.
      3) Minimum Pressure Rating: 150 psig (1035 kPa).
      4) Minimum Temperature Rating: 180 deg F (82 deg C).
   d. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
   e. Accuracy: Plus or minus 1-1/2 percent.
   f. Display: Shows rate of flow, with register to indicate total volume in gallons (liters).
   g. Operating Instructions: Include complete instructions with each flowmeter.
4. Venturi Flowmeters:
   a. Description: Flowmeter with calibrated flow-measuring element, hoses or tubing, fittings, valves, indicator, and conversion chart.
   b. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
   c. Sensor: Venturi-type, calibrated, flow-measuring element; for installation in piping.
      1) Design: Differential-pressure-type measurement for gas **OR** oil **OR** steam **OR** water, **as directed**.
      2) Construction: Bronze, brass, or factory-primed steel, with brass fittings and attached tag with flow conversion data.
      3) Minimum Pressure Rating: 250 psig (1725 kPa).
      4) Minimum Temperature Rating: 250 deg F (121 deg C).
      5) End Connections for NPS 2 (DN 50) and Smaller: Threaded.
      6) End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged or welded.
      7) Flow Range: Flow-measuring element and flowmeter shall cover operating range of equipment or system served.
   d. Permanent Indicators: Meter suitable for wall or bracket mounting, calibrated for connected flowmeter element, and having 6-inch- (152-mm-) diameter, or equivalent, dial with fittings and copper tubing for connecting to flowmeter element.
      1) Scale: Gallons per minute (Liters per second).
      2) Accuracy: Plus or minus 1 percent between 20 and 80 percent of scale range.
   e. Portable Indicators: Hand-held, differential-pressure type, calibrated for connected flowmeter element and having two 12-foot (3.7-m) hoses, with carrying case.
      1) Scale: Gallons per minute (Liters per second).
      2) Accuracy: Plus or minus 2 percent between 20 and 80 percent of scale range.
   f. Display: Shows rate of flow, with register to indicate total volume in gallons (liters).
   g. Conversion Chart: Flow rate data compatible with sensor.
   h. Operating Instructions: Include complete instructions with each flowmeter.
5. Vortex-Shedding Flowmeters:
   a. Description: Flowmeter with sensor and indicator.
   b. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
   c. Sensor: Inline type; for installing between pipe flanges and measuring flow directly in gallons per minute (liters per second).

1) Design: Flow obstruction device, vortex-measurement type for gas **OR** steam **OR** liquids, **as directed**.
2) Construction: Stainless-steel body, with integral transmitter and direct-reading scale.
3) Minimum Pressure Rating: 1000 psig (6900 kPa).
4) Minimum Temperature Rating: 500 deg F (260 deg C).
5) Integral Transformer: For low-voltage power operation.

d. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
e. Accuracy: Plus or minus 0.25 percent for liquids and 0.75 percent for gases.
f. Display: Shows rate of flow, with register to indicate total volume in gallons (liters).
g. Operating Instructions: Include complete instructions with each flowmeter.

M. Thermal-Energy Meters

1. Impeller-Turbine, Thermal-Energy Meters:
   a. Description: System with strainer, **as directed**, flow sensor, temperature sensors, transmitter, indicator, and connecting wiring.
   b. Flow Sensor: Impeller turbine with corrosion-resistant-metal body and transmitter; for installing in piping.
      1) Design: Total thermal-energy measurement.
      2) Minimum Pressure Rating: 150 psig (1035 kPa).
      3) Minimum Temperature Range: 40 to 250 deg F (5 to 121 deg C).
   c. Temperature Sensors: Insertion-type transducer.
   d. Indicator: Solid-state, integrating-type meter with integral battery pack, **as directed**; for wall mounting.
      1) Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or British thermal units (joules).
      2) Battery Pack: Five-year lithium battery.
   e. Accuracy: Plus or minus 1 percent.
   f. Display: Visually indicates total fluid volume in gallons (liters) and thermal-energy flow in kilowatts per hour or British thermal units (joules).
   g. Strainer: Full size of main line piping.
   h. Operating Instructions: Include complete instructions with each thermal-energy meter system.
2. Ultrasonic, Thermal-Energy Meters:
   a. Description: Meter with flow sensor, temperature sensors, transmitter, indicator, and connecting wiring.
   b. Flow Sensor: Transit-time ultrasonic type with transmitter.
   c. Temperature Sensors: Insertion-type or strap-on transducer.
   d. Indicator: Solid-state, integrating-type meter with integral battery pack, **as directed**.
      1) Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or British thermal units (joules).
      2) Battery Pack: Five-year lithium battery.
   e. Accuracy: Plus or minus 1 percent.
   f. Display: Visually indicates total fluid volume in gallons (liters) and thermal-energy flow in kilowatts per hour or British thermal units (joules).
   g. Operating Instructions: Include complete instructions with each thermal-energy meter system.

1.3 EXECUTION

A. Installation

1. Install thermowells with socket extending a minimum of 2 inches (51 mm) into fluid **OR** one-third of pipe diameter **OR** to center of pipe, **as directed**, and in vertical position in piping tees.
2. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

3. Install thermowells with extension on insulated piping.
4. Fill thermowells with heat-transfer medium.
5. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
6. 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.
7. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.
8. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
9. Install remote-mounted pressure gages on panel.
10. Install valve and snubber in piping for each pressure gage for fluids (except steam).
11. Install valve and syphon fitting in piping for each pressure gage for steam.
12. Install test plugs in piping tees.
13. Install flow indicators in piping systems in accessible positions for easy viewing.
14. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.
15. Install flowmeter elements in accessible positions in piping systems.
16. Install wafer-orifice flowmeter elements between pipe flanges.
17. Install differential-pressure-type flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.
18. Install permanent indicators on walls or brackets in accessible and readable positions.
19. Install connection fittings in accessible locations for attachment to portable indicators.
20. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.
21. Install thermometers in the following locations:
    a. Inlet and outlet of each hydronic zone.
    b. Inlet and outlet of each hydronic boiler.
    c. Two inlets and two outlets of each chiller.
    d. Inlet and outlet of each hydronic coil in air-handling units.
    e. Two inlets and two outlets of each hydronic heat exchanger.
    f. Inlet and outlet of each thermal-storage tank.
    g. Outside-, return-, supply-, and mixed-air ducts.
22. Install pressure gages in the following locations:
    a. Discharge of each pressure-reducing valve.
    b. Inlet and outlet of each chiller chilled-water and condenser-water connection.
    c. Suction and discharge of each pump.

B. Connections
1. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.
2. Connect flowmeter-system elements to meters.
3. Connect flowmeter transmitters to meters.
4. Connect thermal-energy meter transmitters to meters.

C. Adjusting
1. After installation, calibrate meters according to manufacturer's written instructions.
2. Adjust faces of meters and gages to proper angle for best visibility.

D. Thermometer Schedule
1. Thermometers at inlet and outlet of each hydronic zone shall be one of the following:
    a. Liquid-filled **OR** Sealed, **as directed**, bimetallic-actuated type.
    b. Direct-mounted **OR** Remote-mounted, **as directed**, metal-case **OR** plastic-case, **as directed**, vapor-actuated type.
    c. Compact-style **OR** Industrial-style, **as directed**, liquid-in-glass type.
    d. Direct-mounted **OR** Remote-mounted, **as directed**, light-activated type.
    e. Test plug with chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.

2. Thermometers at inlet and outlet of each hydronic boiler shall be one of the following:
   a. Liquid-filled **OR** Sealed, **as directed**, bimetallic-actuated type.
   b. Direct-mounted **OR** Remote-mounted, **as directed**, metal-case **OR** plastic-case, **as directed**, vapor-actuated type.
   c. Compact-style **OR** Industrial-style, **as directed**, liquid-in-glass type.
   d. Direct-mounted **OR** Remote-mounted, **as directed**, light-activated type.
   e. Test plug with chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.
3. Thermometers at inlets and outlets of each chiller shall be one of the following:
   a. Liquid-filled **OR** Sealed, **as directed**, bimetallic-actuated type.
   b. Direct-mounted **OR** Remote-mounted, **as directed**, metal-case **OR** plastic-case, **as directed**, vapor-actuated type.
   c. Compact-style **OR** Industrial-style, **as directed**, liquid-in-glass type.
   d. Direct-mounted **OR** Remote-mounted, **as directed**, light-activated type.
   e. Test plug with chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.
4. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems shall be one of the following:
   a. Liquid-filled **OR** Sealed, **as directed**, bimetallic-actuated type.
   b. Direct-mounted **OR** Remote-mounted, **as directed**, metal-case **OR** plastic-case, **as directed**, vapor-actuated type.
   c. Compact-style **OR** Industrial-style, **as directed**, liquid-in-glass type.
   d. Direct-mounted **OR** Remote-mounted, **as directed**, light-activated type.
   e. Test plug with chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.
5. Thermometers at inlets and outlets of each hydronic heat exchanger shall be one of the following:
   a. Liquid-filled **OR** Sealed, **as directed**, bimetallic-actuated type.
   b. Direct-mounted **OR** Remote-mounted, **as directed**, metal-case **OR** plastic-case, **as directed**, vapor-actuated type.
   c. Compact-style **OR** Industrial-style, **as directed**, liquid-in-glass type.
   d. Direct-mounted **OR** Remote-mounted, **as directed**, light-activated type.
   e. Test plug with chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.
6. Thermometers at inlet and outlet of each hydronic heat-recovery unit shall be one of the following:
   a. Liquid-filled **OR** Sealed, **as directed**, bimetallic-actuated type.
   b. Direct-mounted **OR** Remote-mounted, **as directed**, metal-case **OR** plastic-case, **as directed**, vapor-actuated type.
   c. Compact-style **OR** Industrial-style, **as directed**, liquid-in-glass type.
   d. Direct-mounted **OR** Remote-mounted, **as directed**, light-activated type.
   e. Test plug with chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.
7. Thermometers at inlet and outlet of each thermal-storage tank shall be one of the following:
   a. Liquid-filled **OR** Sealed, **as directed**, bimetallic-actuated type.
   b. Direct-mounted **OR** Remote-mounted, **as directed**, metal-case **OR** plastic-case, **as directed**, vapor-actuated type.
   c. Compact-style **OR** Industrial-style, **as directed**, liquid-in-glass type.
   d. Direct-mounted **OR** Remote-mounted, **as directed**, light-activated type.
   e. Test plug with chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.
8. Thermometers at outside-, return-, supply-, and mixed-air ducts shall be one of the following:
   a. Liquid-filled **OR** Sealed, **as directed**, bimetallic-actuated type.
   b. Direct-mounted **OR** Remote-mounted, **as directed**, metal-case **OR** plastic-case, **as directed**, vapor-actuated type.
   c. Compact-style **OR** Industrial-style, **as directed**, liquid-in-glass type.
   d. Direct-mounted **OR** Remote-mounted, **as directed**, light-activated type.
9. Thermometer stems shall be of length to match thermowell insertion length.

E. Thermometer Scale-Range Schedule

1. Scale Range for Chilled-Water Piping: Minus 40 to plus 160 deg F (Minus 40 to plus 100 deg C) **OR** Minus 40 to plus 160 deg F and minus 40 to plus 100 deg C, **as directed**.
2. Scale Range for Chilled-Water Piping: 0 to 100 deg F (Minus 20 to plus 50 deg C) **OR** 0 to 100 deg F and minus 20 to plus 50 deg C, **as directed**.
3. Scale Range for Chilled-Water Piping: 0 to 150 deg F (Minus 20 to plus 70 deg C) **OR** 0 to 150 deg F and minus 20 to plus 70 deg C, **as directed**.
4. Scale Range for Chilled-Water Piping: 0 to 250 deg F (0 to 150 deg C) **OR** 0 to 250 deg F and 0 to 150 deg C, **as directed**.
5. Scale Range for Condenser-Water Piping: 0 to 100 deg F (Minus 20 to plus 50 deg C) **OR** 0 to 100 deg F and minus 20 to plus 50 deg C, **as directed**.
6. Scale Range for Condenser-Water Piping: 0 to 150 deg F (Minus 20 to plus 70 deg C) **OR** 0 to 150 deg F and minus 20 to plus 70 deg C, **as directed**.
7. Scale Range for Condenser-Water Piping: 0 to 250 deg F (0 to 150 deg C) **OR** 0 to 250 deg F and 0 to 150 deg C, **as directed**.
8. Scale Range for Condenser-Water Piping: 20 to 240 deg F (0 to 150 deg C) **OR** 20 to 240 deg F and 0 to 150 deg C, **as directed**.
9. Scale Range for Condenser-Water Piping: 30 to 240 deg F (0 to plus 115 deg C) **OR** 30 to 240 deg F and 0 to plus 115 deg C, **as directed**.
10. Scale Range for Heating, Hot-Water Piping: 0 to 250 deg F (0 to 150 deg C) **OR** 0 to 250 deg F and 0 to 150 deg C, **as directed**.
11. Scale Range for Heating, Hot-Water Piping: 20 to 240 deg F (0 to 150 deg C) **OR** 20 to 240 deg F and 0 to 150 deg C, **as directed**.
12. Scale Range for Heating, Hot-Water Piping: 30 to 240 deg F (0 to plus 115 deg C) **OR** 30 to 240 deg F and 0 to plus 115 deg C, **as directed**.
13. Scale Range for Heating, Hot-Water Piping: 50 to 400 deg F (0 to 200 deg C) **OR** 50 to 400 deg F and 0 to 200 deg C, **as directed**.
14. Scale Range for Heating, Hot-Water Piping: 50 to 550 deg F (10 to 300 deg C) **OR** 50 to 550 deg F and 10 to 300 deg C, **as directed**.
15. Scale Range for Steam and Steam-Condensate Piping: 0 to 250 deg F (0 to 150 deg C) **OR** 0 to 250 deg F and 0 to 150 deg C, **as directed**.
16. Scale Range for Steam and Steam-Condensate Piping: 20 to 240 deg F (0 to 150 deg C) **OR** 20 to 240 deg F and 0 to 150 deg C, **as directed**.
17. Scale Range for Steam and Steam-Condensate Piping: 30 to 240 deg F (0 to plus 115 deg C) **OR** 30 to 240 deg F and 0 to plus 115 deg C, **as directed**.
18. Scale Range for Steam and Steam-Condensate Piping: 50 to 400 deg F (0 to 200 deg C) **OR** 50 to 400 deg F and 0 to 200 deg C, **as directed**.
19. Scale Range for Air Ducts: Minus 40 to plus 110 deg F (Minus 40 to plus 45 deg C) **OR** Minus 40 to plus 110 deg F and minus 40 to plus 45 deg C, **as directed**.
20. Scale Range for Air Ducts: Minus 40 to plus 160 deg F (Minus 40 to plus 100 deg C) **OR** Minus 40 to plus 160 deg F and minus 40 to plus 100 deg C, **as directed**.
21. Scale Range for Air Ducts: 0 to 100 deg F (Minus 20 to plus 50 deg C) **OR** 0 to 100 deg F and minus 20 to plus 50 deg C, **as directed**.
22. Scale Range for Air Ducts: 0 to 150 deg F (Minus 20 to plus 70 deg C) **OR** 0 to 150 deg F and minus 20 to plus 70 deg C, **as directed**.
23. Scale Range for Air Ducts: 0 to 250 deg F (0 to 150 deg C) **OR** 0 to 250 deg F and 0 to 150 deg C, **as directed**.
24. Scale Range for Air Ducts: 20 to 240 deg F (0 to 150 deg C) **OR** 20 to 240 deg F and 0 to 150 deg C, **as directed**.
25. Scale Range for Air Ducts: 30 to 240 deg F (0 to plus 115 deg C) **OR** 30 to 240 deg F and 0 to plus 115 deg C, **as directed.**
26. Scale Range for Air Ducts: 50 to 400 deg F (0 to 200 deg C) **OR** 50 to 400 deg F and 0 to 200 deg C, **as directed**.

F. Pressure-Gage Schedule

1. Pressure gages at discharge of each pressure-reducing valve shall be one of the following:
   a. Liquid-filled **OR** Sealed **OR** Open-front, pressure-relief **OR** Solid-front, pressure-relief, **as directed**, direct-mounted **OR** remote-mounted, **as directed**, metal case.
   b. Sealed, direct-mounted **OR** remote-mounted, **as directed**, plastic case.
   c. Test plug with chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.
2. Pressure gages at inlet and outlet of each chiller chilled-water and condenser-water connection shall be one of the following:
   a. Liquid-filled **OR** Sealed **OR** Open-front, pressure-relief **OR** Solid-front, pressure-relief, **as directed**, direct-mounted **OR** remote-mounted, **as directed**, metal case.
   b. Sealed, direct-mounted **OR** remote-mounted, **as directed**, plastic case.
   c. Test plug with chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.
3. Pressure gages at suction and discharge of each pump shall be one of the following:
   a. Liquid-filled **OR** Sealed **OR** Open-front, pressure-relief **OR** Solid-front, pressure-relief, **as directed**, direct-mounted **OR** remote-mounted, **as directed**, metal case.
   b. Sealed, direct-mounted **OR** remote-mounted, **as directed**, plastic case.
   c. Test plug with chlorosulfonated polyethylene synthetic **OR** EPDM, **as directed**, self-sealing rubber inserts.

G. Pressure-Gage Scale-Range Schedule
1. Scale Range for Chilled-Water Piping: 30 in. Hg to 15 psi (minus 100 to 0 kPa) **OR** 30 in. Hg to 15 psi and minus 100 to 0 kP, **as directed**.
2. Scale Range for Chilled-Water Piping: 0 to 30 psi (0 to 240 kPa) **OR** 0 to 30 psi and 0 to 240 kP, **as directed**.
3. Scale Range for Chilled-Water Piping: 0 to 100 psi (0 to 600 kPa) **OR** 0 to 100 psi and 0 to 600 kP, **as directed**.
4. Scale Range for Chilled-Water Piping: 0 to 160 psi (0 to 1100 kPa) **OR** 0 to 160 psi and 0 to 1100 kP, **as directed**.
5. Scale Range for Chilled-Water Piping: 0 to 200 psi (0 to 1400 kPa) **OR** 0 to 200 psi and 0 to 1400 kPa, **as directed**.
6. Scale Range for Chilled-Water Piping: 0 to 300 psi (0 to 2500 kPa) **OR** 0 to 300 psi and 0 to 2500 kPa, **as directed**.
7. Scale Range for Chilled-Water Piping: 0 to 600 psi (0 to 4000 kPa) **OR** 0 to 600 psi and 0 to 4000 kPa, **as directed**.
8. Scale Range for Condenser-Water Piping: 30 in. Hg to 15 psi (minus 100 to 0 kPa) **OR** 30 in. Hg to 15 psi and minus 100 to 0 kPa, **as directed**.
9. Scale Range for Condenser-Water Piping: 0 to 30 psi (0 to 240 kPa) **OR** 0 to 30 psi and 0 to 240 kPa, **as directed**.
10. Scale Range for Condenser-Water Piping: 0 to 100 psi (0 to 600 kPa) **OR** 0 to 100 psi and 0 to 600 kPa, **as directed**.
11. Scale Range for Condenser-Water Piping: 0 to 160 psi (0 to 1100 kPa) **OR** 0 to 160 psi and 0 to 1100 kPa, **as directed**.
12. Scale Range for Condenser-Water Piping: 0 to 200 psi (0 to 1400 kPa) **OR** 0 to 200 psi and 0 to 1400 kPa, **as directed**.
13. Scale Range for Condenser-Water Piping: 0 to 300 psi (0 to 2500 kPa) **OR** 0 to 300 psi and 0 to 2500 kPa, **as directed**.
14. Scale Range for Condenser-Water Piping: 0 to 600 psi (0 to 4000 kPa) **OR** 0 to 600 psi and 0 to 4000 kPa, **as directed**.
15. Scale Range for Heating, Hot-Water Piping: 30 in. Hg to 15 psi (minus 100 to 0 kPa) **OR** 30 in. Hg to 15 psi and minus 100 to 0 kPa, **as directed**.
16. Scale Range for Heating, Hot-Water Piping: 0 to 30 psi (0 to 240 kPa) **OR** 0 to 30 psi and 0 to 240 kPa, **as directed**.
17. Scale Range for Heating, Hot-Water Piping: 0 to 100 psi (0 to 600 kPa) **OR** 0 to 100 psi and 0 to 600 kPa, **as directed**.

18. Scale Range for Heating, Hot-Water Piping: 0 to 160 psi (0 to 1100 kPa) **OR** 0 to 160 psi and 0 to 1100 kPa, **as directed**.
19. Scale Range for Heating, Hot-Water Piping: 0 to 200 psi (0 to 1400 kPa) **OR** 0 to 200 psi and 0 to 1400 kPa, **as directed**.
20. Scale Range for Heating, Hot-Water Piping: 0 to 300 psi (0 to 2500 kPa) **OR** 0 to 300 psi and 0 to 2500 kPa, **as directed**.
21. Scale Range for Heating, Hot-Water Piping: 0 to 600 psi (0 to 4000 kPa) **OR** 0 to 600 psi and 0 to 4000 kPa, **as directed**.
22. Scale Range for Steam Piping: 30 in. Hg to 15 psi (minus 100 to 0 kPa) **OR** 30 in. Hg to 15 psi and minus 100 to 0 kPa, **as directed**.
23. Scale Range for Steam Piping: 0 to 30 psi (0 to 240 kPa) **OR** 0 to 30 psi and 0 to 240 kPa, **as directed**.
24. Scale Range for Steam Piping: 0 to 100 psi (0 to 600 kPa) **OR** 0 to 100 psi and 0 to 600 kPa, **as directed**.
25. Scale Range for Steam Piping: 0 to 160 psi (0 to 1100 kPa) **OR** 0 to 160 psi and 0 to 1100 kPa, **as directed**.
26. Scale Range for Steam Piping: 0 to 200 psi (0 to 1400 kPa) **OR** 0 to 200 psi and 0 to 1400 kPa, **as directed**.
27. Scale Range for Steam Piping: 0 to 300 psi (0 to 2500 kPa) **OR** 0 to 300 psi and 0 to 2500 kPa, **as directed**.
28. Scale Range for Steam Piping: 0 to 600 psi (0 to 4000 kPa) **OR** 0 to 600 psi and 0 to 4000 kPa, **as directed**.

H. Flowmeter Schedule
1. Flowmeters for Chilled-Water Piping: Orifice **OR** Pitot-tube **OR** Turbine **OR** Venturi **OR** Vortex-shedding, **as directed,** type.
2. Flowmeters for Condenser-Water Piping: Orifice **OR** Pitot-tube **OR** Turbine **OR** Venturi **OR** Vortex-shedding, **as directed,** type.
3. Flowmeters for Heating, Hot-Water Piping: Orifice **OR** Pitot-tube **OR** Turbine **OR** Venturi **OR** Vortex-shedding, **as directed,** type.
4. Flowmeters for Steam and Steam-Condensate Piping: Orifice **OR** Turbine **OR** Venturi **OR** Vortex-shedding, **as directed,** type.

I. Thermal-Energy Meter Schedule
1. Thermal-Energy Meters for Chilled-Water Piping: Impeller-turbine **OR** Ultrasonic, **as directed,** type.
2. Thermal-Energy Meters for Condenser-Water Piping: Impeller-turbine **OR** Ultrasonic, **as directed,** type.
3. Thermal-Energy Meters for Heating, Hot-Water Piping: Impeller-turbine **OR** Ultrasonic, **as directed,** type.
4. Thermal-Energy Meters for Steam and Steam-Condensate Piping: Impeller-turbine **OR** Ultrasonic, **as directed,** type.

END OF SECTION 21 05 19 00b

Task	Specification	Specification Description
21 05 19 00	01 22 16 00	No Specification Required

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SECTION 21 11 19 00 - FIRE-SUPPRESSION STANDPIPES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for fire-suppression standpipes. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Pipes, fittings, and specialties.
b. Fire-protection valves.
c. Hose connections.
d. Hose stations.
e. Monitors.
f. Fire-department connections.
g. Alarm devices.
h. Manual control stations.
i. Control panels.
j. Pressure gages.

C. Definitions
1. High-Pressure Standpipe Piping: Fire-suppression standpipe piping designed to operate at working pressure higher than standard 175 psig (1200 kPa), but not higher than 250 psig (1725 kPa) **OR** 300 psig (2070 kPa), **as directed**.
2. Standard-Pressure Standpipe Piping: Fire-suppression standpipe piping designed to operate at working pressure 175 psig (1200 kPa) maximum.

D. System Descriptions
1. Automatic Wet-Type, Class I Standpipe System: Includes NPS 2-1/2 (DN 65) hose connections. Has open water-supply valve with pressure maintained and is capable of supplying water demand.
2. Automatic Wet-Type, Class II Standpipe System: Includes NPS 1-1/2 (DN 40) hose stations. Has open water-supply valve with pressure maintained and is capable of supplying water demand.
3. Automatic Wet-Type, Class III Standpipe System: Includes NPS 1-1/2 (DN 40) hose stations and NPS 2-1/2 (DN 65) hose connections. Has open water-supply valve with pressure maintained and is capable of supplying water demand.
4. Automatic Dry-Type, Class I Standpipe System: Includes NPS 2-1/2 (DN 65) hose connections. Has open water-supply valve and dry-pipe valve with standpipes containing compressed air. Opening fire-hose valve releases compressed air and permits water pressure to open dry-pipe valve. Water then flows into standpipes.
5. Automatic Dry-Type, Class II Standpipe System: Includes NPS 1-1/2 (DN 40) hose stations. Has open water-supply valve and dry-pipe valve with standpipes containing compressed air. Opening fire-hose valve releases compressed air and permits water pressure to open dry-pipe valve. Water then flows into standpipes.
6. Automatic Dry-Type, Class III Standpipe System: Includes NPS 1-1/2 (DN 40) hose stations and NPS 2-1/2 (DN 65) hose connections. Has open water-supply valve and dry-pipe valve with standpipes containing compressed air. Opening fire-hose valve releases compressed air and permits water pressure to open dry-pipe valve. Water then flows into standpipes.
7. Semiautomatic Dry-Type, Class I Standpipe System: Includes NPS 2-1/2 (DN 65) hose connections. Has open water-supply valve and deluge valve with standpipes containing air.

Actuation of detection device permits water pressure to open deluge valve. Water then flows into standpipes.

8. Semiautomatic Dry-Type, Class II Standpipe System: Includes NPS 1-1/2 (DN 40) hose stations. Has open water-supply valve and deluge valve with standpipes containing air. Actuation of detection device permits water pressure to open deluge valve. Water then flows into standpipes.
9. Semiautomatic Dry-Type, Class III Standpipe System: Includes NPS 1-1/2 (DN 40) hose stations and NPS 2-1/2 (DN 65) hose connections. Has open water-supply valve and deluge valve with standpipes containing air. Actuation of detection device permits water pressure to open deluge valve. Water then flows into standpipes.
10. Manual Wet-Type, Class I Standpipe System: Includes NPS 2-1/2 (DN 65) hose connections. Has small water supply to maintain water in standpipes. Piping is wet, but water must be pumped into standpipes to satisfy demand.
11. Manual Dry-Type, Class I Standpipe System: Includes NPS 2-1/2 (DN 65) hose connections. Does not have permanent water supply. Piping is dry. Water must be pumped into standpipes to satisfy demand.

E. Performance Requirements
1. Standard-Pressure, Fire-Suppression Standpipe System Component: Listed for 175-psig (1200-kPa) minimum working pressure.
2. High-Pressure, Fire-Suppression Standpipe System Component: Listed for 250-psig (1725-kPa) minimum **OR** 300-psig (2070-kPa), **as directed**, working pressure.
3. Delegated Design: Design fire-suppression standpipes, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
4. Fire-suppression standpipe design shall be approved by authorities having jurisdiction.
   a. Minimum residual pressure at each hose-connection outlet is as follows:
      1) NPS 1-1/2 (DN 40) Hose Connections: 65 psig (450 kPa).
      2) NPS 2-1/2 (DN 65) Hose Connections: 100 psig (690 kPa).
   b. Maximum residual pressure at required flow at each hose-connection outlet is as follows unless otherwise indicated:
      1) NPS 1-1/2 (DN 40) Hose Connections: 100 psig (690 kPa).
      2) NPS 2-1/2 (DN 65) Hose Connections: 175 psig (1200 kPa).
5. Seismic Performance: Fire-suppression standpipes shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7.

F. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: For fire-suppression standpipes. Include plans, elevations, sections, details, and attachments to other work.
   a. Wiring Diagrams: For power, signal, and control wiring.
3. Delegated-Design Submittal: For standpipe 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.
4. Qualification Data: For qualified Installer and professional engineer.
5. Approved Standpipe Drawings: Working plans, prepared according to NFPA 14, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
6. Welding certificates.
7. Fire-hydrant flow test report.
8. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 14. Include "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Material and Test Certificate for Underground Piping."
9. Field quality-control reports.
10. Operation and Maintenance Data: For fire-suppression standpipes specialties to include in emergency, operation, and maintenance manuals.

G. Quality Assurance
1. Installer Qualifications:
a. Installer's responsibilities include designing, fabricating, and installing fire-suppression standpipes and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
1) Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
2. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. NFPA Standards: Fire-suppression standpipe equipment, specialties, accessories, installation, and testing shall comply with NFPA 14, "Installation of Standpipe and Hose Systems."

H. Project Conditions
1. Interruption of Existing Fire-Suppression Standpipe Service: Do not interrupt fire-suppression standpipe service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary fire-suppression standpipe service according to requirements indicated:
a. Notify the Owner no fewer than two days in advance of proposed interruption of fire-suppression standpipe service.
b. Do not proceed with interruption of fire-suppression standpipe service without the Owner's written permission.

1.2 PRODUCTS

A. Piping Materials
1. 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.

B. Steel Pipe And Fittings
1. Standard Weight, Galvanized- and Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.
2. Schedule 30, Galvanized- and Black-Steel Pipe: ASTM A 135; ASTM A 795/A 795M, Type E; or ASME B36.10M, wrought steel; with wall thickness not less than Schedule 30 and not more than Schedule 40. Pipe ends may be factory or field formed to match joining method.
3. Thinwall Galvanized- and Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, threadable, with wall thickness less than Schedule 30 and equal to or greater than Schedule 10. Pipe ends may be factory or field formed to match joining method.
4. Schedule 10, Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, Schedule 10 in NPS 5 (DN 125) and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10 (DN 150 to DN 250), plain end.
5. Nonstandard OD, Thinwall Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, thinwall, with plain ends and wall thickness less than Schedule 10.
6. Hybrid Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, lightwall, with wall thickness less than Schedule 10 and greater than Schedule 5.
7. Standard-Weight, Galvanized- and Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, seamless steel pipe with threaded ends.
8. Galvanized and Uncoated, Steel Couplings: ASTM A 865, threaded.
9. Galvanized and Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
10. Malleable- or Ductile-Iron Unions: UL 860.
11. Cast-Iron Flanges: ASME B16.1, Class 125.
12. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
13. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.

14. Grooved-Joint, Steel-Pipe Appurtenances:
    a. Pressure Rating: 175 psig (1200 kPa) **OR** 250 psig (1725 kPa) **OR** 300 psig (2070 kPa), **as directed**, minimum.
    b. 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.
    c. 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.

C. Copper Tube And Fittings
1. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) and ASTM B 88, Type M (ASTM B 88M, Type C) water tube, drawn temper.
2. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
3. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.
4. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
5. 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.
6. Grooved-Joint, Copper-Tube Appurtenances:
    a. Grooved-End, Copper Fittings: ASTM B 75 (ASTM B 75M), copper tube or ASTM B 584, bronze castings.
    b. Grooved-End-Tube Couplings: To fit copper tube dimensions, with design similar to AWWA C606. Include ferrous housing sections, EPDM-rubber gasket suitable for hot and cold water, and bolts and nuts.

D. Piping Joining Materials
1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free.
    a. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
    b. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.
2. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
3. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
4. 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.

E. Listed Fire-Protection Valves
1. General Requirements:
    a. Valves shall be UL listed or FM approved.
    b. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig (1200 kPa).
    c. Minimum Pressure Rating for High-Pressure Piping: 250 psig (1725 kPa) **OR** 300 psig (2070 kPa), **as directed**.
2. Ball Valves:
    a. Standard: UL 1091 except with ball instead of disc.
    b. Valves NPS 1-1/2 (DN 40) and Smaller: Bronze body with threaded ends.
    c. Valves NPS 2 and NPS 2-1/2 (DN 50 and DN 65): Bronze body with threaded ends or ductile-iron body with grooved ends.
    d. Valves NPS 3 (DN 80): Ductile-iron body with grooved ends.
3. Bronze Butterfly Valves:
    a. Standard: UL 1091.
    b. Pressure Rating: 175 psig (1200 kPa).
    c. Body Material: Bronze.
    d. End Connections: Threaded.

4. Iron Butterfly Valves:
   a. Standard: UL 1091.
   b. Pressure Rating: 175 psig (1200 kPa).
   c. Body Material: Cast or ductile iron.
   d. Style: Lug or wafer.
      OR
      End Connections: Grooved.
5. Check Valves:
   a. Standard: UL 312.
   b. Pressure Rating: 250 psig (1725 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
   c. Type: Swing check.
   d. Body Material: Cast iron.
   e. End Connections: Flanged or grooved.
6. Bronze OS&Y Gate Valves:
   a. Standard: UL 262.
   b. Pressure Rating: 175 psig (1200 kPa).
   c. Body Material: Bronze.
   d. End Connections: Threaded.
7. Iron OS&Y Gate Valves:
   a. Standard: UL 262.
   b. Pressure Rating: 250 psig (1725 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
   c. Body Material: Cast or ductile iron.
   d. End Connections: Flanged or grooved.
8. Indicating-Type Butterfly Valves:
   a. Standard: UL 1091.
   b. Pressure Rating: 175 psig (1200 kPa) minimum.
   c. Valves NPS 2 (DN 50) and Smaller:
      1) Valve Type: Ball or butterfly.
      2) Body Material: Bronze.
      3) End Connections: Threaded.
   d. Valves NPS 2-1/2 (DN 65) and Larger:
      1) Valve Type: Butterfly.
      2) Body Material: Cast or ductile iron.
      3) End Connections: Flanged, grooved, or wafer.
   e. Valve Operation: Integral electrical, 115-V ac, prewired, single-circuit, supervisory switch **OR** electrical, 115-V ac, prewired, two-circuit, supervisory switch **OR** visual, **as directed**, indicating device.
9. NRS Gate Valves:
   a. Standard: UL 262.
   b. Pressure Rating: 250 psig (1725 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
   c. Body Material: Cast iron with indicator post flange.
   d. Stem: Nonrising.
   e. End Connections: Flanged or grooved.
10. Indicator Posts:
   a. Standard: UL 789.
   b. Type: Horizontal for wall mounting.
   c. Body Material: Cast iron with extension rod and locking device.
   d. Operation: Wrench **OR** Hand wheel, **as directed**.

F. Trim And Drain Valves
1. General Requirements:
   a. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
   b. Pressure Rating: 175 psig (1200 kPa) minimum.
2. Angle Valves.
3. Ball Valves.

4. Globe Valves.
5. Plug Valves.

G. Specialty Valves
1. General Requirements:
   a. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
   b. Pressure Rating:
      1) Standard-Pressure Piping Specialty Valves: 175 psig (1200 kPa) minimum.
      2) High-Pressure Piping Specialty Valves: 250 psig (1725 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
   c. Body Material: Cast or ductile iron.
   d. Size: Same as connected piping.
   e. End Connections: Flanged or grooved.
2. Alarm Valves:
   a. Standard: UL 193.
   b. Design: For horizontal or vertical installation.
   c. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, **as directed**, and fill-line attachment with strainer.
   d. Drip Cup Assembly (if retarding chamber is required): Pipe drain without valves and separate from main drain piping.
   e. Drip Cup Assembly (if retarding chamber is not required): Pipe drain with check valve to main drain piping.
3. Dry-Pipe Valves:
   a. Standard: UL 260.
   b. Design: Differential-pressure type.
   c. Include UL 1486, quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
   d. Air-Pressure Maintenance Device:
      1) Standard: UL 260.
      2) Type: Automatic device to maintain minimum air pressure in piping.
      3) Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with 14- to 60-psig (95- to 410-kPa) adjustable range, and 175-psig (1200-kPa) **OR** 300-psig (2070-kPa), **as directed**, outlet pressure.
   e. Air Compressor:
      1) Standard: UL's "Fire Protection Equipment Directory" listing.
      2) Motor Horsepower: Fractional.
      3) Power: 120-V ac, 60 Hz, single phase.
4. Deluge Valves:
   a. Standard: UL 260.
   b. Design: Hydraulically operated, differential-pressure type.
   c. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, drip cup assembly piped without valves and separate from main drain line, fill-line attachment with strainer, and push-rod chamber supply connection.
   d. Wet, Pilot-Line Trim Set: Include gage to read push-rod chamber pressure, globe valve for manual operation of deluge valve, and connection for actuation device.
   e. Dry, Pilot-Line Trim Set: Include dry, pilot-line actuator; air- and water-pressure gages; low-air-pressure warning switch; air relief valve; and actuation device. Dry, pilot-line actuator includes cast-iron, operated, diaphragm-type valve with resilient facing plate, resilient diaphragm, and replaceable bronze seat. Valve includes threaded water and air inlets and water outlet. Loss of air pressure on dry, pilot-line side allows pilot-line actuator to open and causes deluge valve to open immediately.
   f. Air-Pressure Maintenance Device:

1) Standard: UL 260.
2) Type: Automatic device to maintain minimum air pressure in piping.
3) Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator, or switch to maintain pressure, strainer, pressure ratings with 14- to 60-psig (95- to 410-kPa) adjustable range, and 175-psig (1200-kPa) **OR** 300-psig (2070-kPa), **as directed**, outlet pressure.

g. Air Compressor:
1) Standard: UL's "Fire Protection Equipment Directory" listing.
2) Motor Horsepower: Fractional.
3) Power: 120-V ac, 60 Hz, single phase.

5. Pressure-Reducing Valves:
a. UL 668 hose valve, with integral UL 1468 reducing device.
b. Pressure Rating: 300 psig (2070 kPa) minimum.
c. Material: Brass or bronze.
d. Inlet: Female pipe threads.
e. Outlet: Threaded with or without adapter having male hose threads.
f. Pattern: Angle or gate.
g. Finish: Polished chrome plated **OR** Rough brass or bronze **OR** Rough chrome plated, **as directed**.

6. Automatic (Ball Drip) Drain Valves:
a. Standard: UL 1726.
b. Pressure Rating: 175 psig (1200 kPa) minimum.
c. Type: Automatic draining, ball check.
d. Size: NPS 3/4 (DN 20).
e. End Connections: Threaded.

H. Hose Connections
1. Adjustable-Valve Hose Connections:
a. Standard: UL 668 hose valve, with integral UL 1468 reducing or restricting pressure-control device, for connecting fire hose.
b. Pressure Rating: 300 psig (2070 kPa) minimum.
c. Material: Brass or bronze.
d. Size: NPS 1-1/2 or NPS 2-1/2 (DN 40 or DN 65), as indicated.
e. Inlet: Female pipe threads.
f. Outlet: Male hose threads with lugged cap, gasket, and chain. Include hose valve threads according to NFPA 1963 and matching local fire-department threads.
g. Pattern: Angle or gate.
h. Pressure-Control Device Type: Pressure reducing **OR** restricting, **as directed**.
i. Design Outlet Pressure Setting: as directed by the Owner.
j. Finish: Polished chrome plated **OR** Rough brass or bronze **OR** Rough chrome plated, **as directed**.

2. Nonadjustable-Valve Hose Connections:
a. Standard: UL 668 hose valve for connecting fire hose.
b. Pressure Rating: 300 psig (2070 kPa) minimum.
c. Material: Brass or bronze.
d. Size: NPS 1-1/2 or NPS 2-1/2 (DN 40 or DN 65), as indicated.
e. Inlet: Female pipe threads.
f. Outlet: Male hose threads with lugged cap, gasket, and chain. Include hose valve threads according to NFPA 1963 and matching local fire-department threads.
g. Pattern: Angle or gate.
h. Finish: Polished chrome plated **OR** Rough brass or bronze **OR** Rough chrome plated, **as directed**.

I. NPS 1-1/2 (DN 40) Rack-Type Hose Stations
1. Hose Rack:
a. Standard: UL 47.

b. Material: Brass or bronze with polished chrome-plated **OR** Steel with red-enamel, **as directed**, finish.
c. Type: Hose-rack assembly. Include hose valve, hose rack, water-retention device, hose pins, and hose.
d. Operation: Semiautomatic.
e. Sized to hold fire hose.

2. Hose Valve:
a. Standard: UL 668 NPS 1-1/2 (DN 40), for connecting fire hose.
b. Type: Adjustable **OR** Nonadjustable, **as directed**.
c. Pressure-Control Device: Not required **OR** Pressure reducing **OR** Pressure restricting, **as directed**.
d. Design Outlet Pressure Setting: Not applicable **OR as directed**.
e. Hose Valve and Trim Finish: Polished chrome plated **OR** Rough brass or bronze **OR** Rough chrome plated, **as directed**.
f. Pressure Rating: 300 psig (2070 kPa) minimum.
g. Pattern: Angle.
h. Material: Brass or bronze.
i. Pressure-Control Device: UL 1468 integral or for field installation if indicated.
j. Size: NPS 1-1/2 (DN 40).
k. Inlet: Female pipe threads.
l. Outlet: Male hose threads according to NFPA 1963 and matching local fire-department threads.

3. Hose:
a. Standards: NFPA 1961 and UL 219 lined fire hose with swivel inlet, coupling, gaskets, and nozzle.
b. Size: NPS 1-1/2 (DN 40).
c. Length: 50 feet (15 m) **OR** 75 feet (23 m) **OR** 100 feet (30 m), **as directed**.
d. Jacket: Combination of natural and synthetic threads **OR** Natural thread **OR** Synthetic thread, **as directed**.
e. Lining: Combination of rubber and plastic compounds **OR** Rubber compound **OR** Plastic compound, **as directed**.
f. Cover: Rubber, plastic, or combination of rubber and plastic compounds.
g. Nozzle: UL 401.
1) Material: Brass **OR** Polished brass **OR** Rough chrome-plated brass **OR** Polished chrome-plated brass **OR** Polycarbonate plastic, **as directed**.
2) Type: Plain, for nonadjustable water stream **OR** Spray, adjustable from shutoff to fog spray or straight stream **OR** Spray, adjustable from shutoff to full fog; for use on electrical fires, **as directed**.

J. NPS 1-1/2 BY NPS 2-1/2 (DN 40 BY DN 65) Rack-Type Hose Stations
1. Hose Rack:
a. Standard: UL 47.
b. Material: Brass or bronze with polished chrome-plated **OR** Steel with red-enamel, **as directed**, finish.
c. Type: Hose-rack assembly. Include hose valve, reducer adapter, hose rack, water-retention device, hose pins, and hose.
d. Operation: Semiautomatic.
e. Sized to hold fire hose.

2. Hose Valve:
a. Standard: UL 668, NPS 2-1/2 (DN 65), for connecting fire hose.
b. Type: Adjustable **OR** Nonadjustable, **as directed**.
c. Pressure-Control Device: Not required **OR** Pressure reducing **OR** Pressure restricting, **as directed**.
d. Design Outlet Pressure Setting: Not applicable **OR as directed**.

e. Hose Valve and Trim Finish: Polished chrome plated **OR** Rough brass or bronze **OR** Rough chrome plated, **as directed**.
f. Pressure Rating: 300 psig (2070 kPa) minimum.
g. Pattern: Angle.
h. Material: Brass or bronze.
i. Pressure-Control Device: UL 1468, integral or for field installation if indicated.
j. Size: NPS 2-1/2 (DN 65).
k. Inlet: Female pipe threads.
l. Outlet: Male hose threads according to NFPA 1963 and matching local fire-department threads.
m. Reducer Adapter: NPS 2-1/2 by NPS 1-1/2 (DN 65 by DN 40).

3. Hose:
a. Standards: NFPA 1961 and UL 219, lined fire hose with swivel inlet, coupling, gaskets, and nozzle.
b. Size: NPS 1-1/2 (DN 40).
c. Length: 50 feet (15 m) **OR** 75 feet (23 m) **OR** 100 feet (30 m), **as directed**.
d. Jacket: Combination of natural and synthetic threads **OR** Natural thread **OR** Synthetic thread, **as directed**.
e. Lining: Combination of rubber and plastic compounds **OR** Rubber compound **OR** Plastic compound, **as directed**.
f. Cover: Rubber, plastic, or combination of rubber and plastic compounds.
g. Nozzle: UL 401 spray nozzle unless plain nozzle is indicated.
1) Material: Brass **OR** Polished brass **OR** Rough chrome-plated brass **OR** Polished chrome-plated brass **OR** Polycarbonate plastic, **as directed**.
2) Type: Plain, for nonadjustable water stream **OR** Spray, adjustable from shutoff to fog spray or straight stream **OR** Spray, adjustable from shutoff to full fog; for use on electrical fires, **as directed**.

K. NPS 1-1/2 (DN 40) Reel-Type Hose Stations
1. Hose Reel:
a. Standard: UL 47.
b. Hose Reel and Bracket Material: Steel.
c. Type: Hose-reel assembly. Include hose valve, wall bracket, hose reel, water-retention device, hose pins, and hose.
d. Operation: Semiautomatic.
e. Sized to hold fire hose.
f. Finish: Red enamel.

2. Hose Valve:
a. Standard: UL 668, NPS 1-1/2 (DN 40), for connecting fire hose.
b. Type: Adjustable **OR** Nonadjustable, **as directed**.
c. Pressure-Control Device: Not required **OR** Pressure reducing **OR** Pressure restricting, **as directed**.
d. Design Outlet Pressure Setting: Not applicable **OR as directed**.
e. Hose Valve and Trim Finish: Polished chrome plated **OR** Rough brass or bronze **OR** Rough chrome plated, **as directed**.
f. Pressure Rating: 300 psig (2070 kPa) minimum.
g. Pattern: Angle.
h. Material: Brass or bronze.
i. Pressure-Control Device: UL 1468, integral or for field installation if indicated.
j. Size: NPS 1-1/2 (DN 40).
k. Inlet: Female pipe threads.
l. Outlet: Male hose threads according to NFPA 1963 and matching local fire-department threads.

3. Hose:
a. Standards: NFPA 1961 and UL 219 lined fire hose with swivel inlet, coupling, gaskets, and nozzle.

b. Size: NPS 1-1/2 (DN 40).
c. Length: 50 feet (15 m) **OR** 75 feet (23 m) **OR** 100 feet (30 m), **as directed**.
d. Jacket: Combination of natural and synthetic threads **OR** Natural thread **OR** Synthetic thread, **as directed**.
e. Lining: Combination of rubber and plastic compounds **OR** Rubber compound **OR** Plastic compound, **as directed**.
f. Cover: Rubber, plastic, or combination of rubber and plastic compounds.
g. Nozzle: UL 401.
1) Material: Brass **OR** Polished brass **OR** Rough chrome-plated brass **OR** Polished chrome-plated brass **OR** Polycarbonate plastic, **as directed**.
2) Type: Spray, adjustable from shutoff to fog spray or straight stream **OR** full fog; for use on electrical fires, **as directed**.

L. Monitors
1. Type: Stationary.
2. Nozzle: UL 401, NPS 2-1/2 (DN 65), brass, adjustable from fog spray to straight stream to shutoff.
3. Horizontal Rotation: 360 degrees with locking device.
4. Vertical Rotation: 80-degree elevation and 60-degree depression with locking device.
5. Waterway: Double **OR** Single, **as directed**, brass or stainless-steel tube.
6. Waterway Size: NPS 2-1/2 (DN 65) minimum.
7. Water Stream Flow: 500 gpm (31.5 L/s) **OR** 750 gpm (47.3 L/s) **OR** 1000 gpm (63 L/s), **as directed**.
8. Operation: Lever **OR** Wheel, **as directed**.
9. Base Inlet Size: NPS 2-1/2 (DN 65) **OR** NPS 3 (DN 80) **OR** NPS 4 (DN 100), **as directed**.
10. Finish: Red-painted body with brass trim.

M. Fire-Department Connections
1. Exposed-Type, Fire-Department Connection:
a. Standard: UL 405.
b. Type: Exposed, projecting, for wall mounting.
c. Pressure Rating: 175 psig (1200 kPa) minimum.
d. Body Material: Corrosion-resistant metal.
e. 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.
f. Caps: Brass, lugged type, with gasket and chain.
g. Escutcheon Plate: Round, brass, wall type.
h. Outlet: Back, with pipe threads.
i. Number of Inlets: Two **OR** Three, **as directed**.
j. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE" **OR** “STANDPIPE", **as directed**.
k. Finish: Polished chrome plated **OR** Rough brass or bronze **OR** Rough chrome plated, **as directed**.
l. Outlet Size: NPS 4 (DN 100) **OR** NPS 5 (DN 125) **OR** NPS 6 (DN 150), **as directed**.
2. Flush-Type, Fire-Department Connection:
a. Standard: UL 405.
b. Type: Flush, for wall mounting.
c. Pressure Rating: 175 psig (1200 kPa) minimum.
d. Body Material: Corrosion-resistant metal.
e. 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.
f. Caps: Brass, lugged type, with gasket and chain.
g. Escutcheon Plate: Rectangular, brass, wall type.

h. Outlet: With pipe threads.
i. Body Style: Horizontal **OR** Square **OR** Vertical, **as directed**.
j. Number of Inlets: Two **OR** Three **OR** Four **OR** Six, **as directed**.
k. Outlet Location: Back **OR** Bottom **OR** Left side **OR** Right side **OR** Top, **as directed**.
l. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE" **OR** "STANDPIPE", **as directed**.
m. Finish: Polished chrome plated **OR** Rough brass or bronze **OR** Rough chrome plated, **as directed**.
n. Outlet Size: NPS 4 (DN 100) **OR** NPS 5 (DN 125) **OR** NPS 6 (DN 150) **OR** NPS 8 (DN 200), **as directed**.

3. Yard-Type, Fire-Department Connection:
a. Standard: UL 405.
b. Type: Exposed, freestanding.
c. Pressure Rating: 175 psig (1200 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
d. Body Material: Corrosion-resistant metal.
e. 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.
f. Caps: Brass, lugged type, with gasket and chain.
g. Escutcheon Plate: Round, brass, floor type.
h. Outlet: Bottom, with pipe threads.
i. Number of Inlets: Two **OR** Three **OR** Four, **as directed**.
j. Sleeve: Brass **OR** Not required, **as directed**.
k. Sleeve Height: 18 inches (460 mm).
l. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE" **OR** "STANDPIPE", **as directed**.
m. Finish, Including Sleeve: Polished chrome plated **OR** Rough brass or bronze **OR** Rough chrome plated, **as directed**.
n. Outlet Size: NPS 4 (DN 100) **OR** NPS 5 (DN 125) **OR** NPS 6 (DN 150), **as directed**.

N. Alarm Devices
1. Alarm-device types shall match piping and equipment connections.
2. Water-Motor-Operated Alarm:
a. Standard: UL 753.
b. Type: Mechanically operated, with Pelton wheel.
c. Alarm Gong: Cast aluminum with red-enamel factory finish.
d. Size: 10-inch (250-mm) diameter.
e. Components: Shaft length, bearings, and sleeve to suit wall construction.
f. Inlet: NPS 3/4 (DN 20).
g. Outlet: NPS 1 (DN 25) drain connection.

3. Electrically Operated Alarm Bell:
a. Standard: UL 464.
b. Type: Vibrating, metal alarm bell.
c. Size: 6-inch (150-mm) minimum **OR** 8-inch (200-mm) minimum **OR** 10-inch (250-mm), **as directed**, diameter.
d. Finish: Red-enamel factory finish, suitable for outdoor use.

4. Water-Flow Indicators:
a. Standard: UL 346.
b. Water-Flow Detector: Electrically supervised.
c. 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.
d. Type: Paddle operated.
e. Pressure Rating: 250 psig (1725 kPa).
f. Design Installation: Horizontal or vertical.

5. Pressure Switches:
   a. Standard: UL 346.
   b. Type: Electrically supervised water-flow switch with retard feature.
   c. Components: Single-pole, double-throw switch with normally closed contacts.
   d. Design Operation: Rising pressure signals water flow.
6. Valve Supervisory Switches:
   a. Standard: UL 346.
   b. Type: Electrically supervised.
   c. Components: Single-pole, double-throw switch with normally closed contacts.
   d. Design: Signals that controlled valve is in other than fully open position.
7. Indicator-Post Supervisory Switches:
   a. Standard: UL 346.
   b. Type: Electrically supervised.
   c. Components: Single-pole, double-throw switch with normally closed contacts.
   d. Design: Signals that controlled indicator-post valve is in other than fully open position.

O. Manual Control Stations
1. Description: UL listed or FM approved, hydraulic operation, with union, NPS 1/2 (DN 15) pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

P. Control Panels
1. Description: Single-area, two-area, or single-area cross-zoned control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves. Panels contain power supply; battery charger; standby batteries; field-wiring terminal strip; electrically supervised solenoid valves and polarized fire-alarm bell; lamp test facility; single-pole, double-throw auxiliary alarm contacts; and rectifier.
   a. Panels: UL listed and FM approved when used with thermal detectors and Class A detector circuit wiring. Electrical characteristics are 120-V ac, 60 Hz, with 24-V dc rechargeable batteries.
   b. Manual Control Stations: Electric operation, metal enclosure, labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.
      OR
      Manual Control Stations: Hydraulic operation, with union, NPS 1/2 (DN 15) pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

Q. Pressure Gages
1. Standard: UL 393.
2. Dial Size: 3-1/2- to 4-1/2-inch (90- to 115-mm) diameter.
3. Pressure Gage Range: 0 to 250 psig (0 to 1725 kPa) minimum **OR** 0 to 300 psig (0 to 2070 kPa), **as directed**.
4. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.
5. Air System Piping Gage: Include retard feature, **as directed**, and "AIR" or "AIR/WATER" label on dial face.

R. Escutcheons
1. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.
2. One-Piece, Cast-Brass Escutcheons: Polished chrome-plated or rough-brass finish with set-screws.
3. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with chrome-plated finish.

4. One-Piece, Stamped-Steel Escutcheons: Chrome-plated finish with set-screw or spring clips.
5. Split-Casting, Cast-Brass Escutcheons: Polished chrome-plated or rough-brass finish with concealed hinge and set-screw.
6. Split-Plate, Stamped-Steel Escutcheons: Chrome-plated finish with concealed **OR** exposed-rivet, **as directed**, hinge, set-screw or spring clips.
7. One-Piece Floor Plates: Cast-iron flange with holes for fasteners, **as directed**.
8. Split-Casting Floor Plates: Cast brass with concealed hinge.

S. Sleeves
1. 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.
2. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
3. Molded-PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
4. Molded-PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.
5. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
6. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, standard weight, zinc coated, plain ends.
7. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   a. Underdeck Clamp: Clamping ring with set-screws.

T. Sleeve Seals
1. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   a. Sealing Elements: EPDM-rubber or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   b. Pressure Plates: Carbon steel **OR** Plastic **OR** Stainless steel, **as directed**.
   c. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating **OR** Stainless steel, **as directed**, of length required to secure pressure plates to sealing elements.

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

1.3 EXECUTION

A. Preparation
1. Perform fire-hydrant flow test according to NFPA 14 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
2. Report test results promptly and in writing.

B. Service-Entrance Piping
1. Connect fire-suppression standpipe piping to water-service piping at service entrance into building. Comply with requirements for exterior piping in Division 21 Section "Facility Fire-suppression Water-service Piping".
2. Install shutoff valve, backflow preventer, **as directed**, pressure gage, drain, and other accessories at connection to fire-suppression water-service piping. Comply with requirements for backflow preventers in Division 21 Section "Facility Fire-suppression Water-service Piping", **as directed**.
3. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

C. Water-Supply Connections
1. Connect fire-suppression standpipe piping to building's interior water-distribution piping. Comply with requirements for interior piping in Division 22 Section "Domestic Water Piping".
2. Install shutoff valve, backflow preventer, **as directed**, pressure gage, drain, and other accessories at connection to water-distribution piping. Comply with requirements for backflow preventers in Division 22 Section "Domestic Water Piping Specialties", **as directed**.
   OR
   Install shutoff valve, check valve, pressure gage, and drain at connection to water supply.

D. Piping Installation
1. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
   a. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with the Owner before deviating from approved working plans.
2. Piping Standard: Comply with requirements in NFPA 14 for installation of fire-suppression standpipe piping.
3. Install seismic restraints on piping. Comply with requirements in NFPA 13 for seismic-restraint device materials and installation.
4. Install listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
5. Install drain valves on standpipes. Extend drain piping to outside of building.
6. Install automatic (ball drip) drain valves to drain piping between fire-department connections and check valves. Drain to floor drain or outside building.
7. Install alarm devices in piping systems.
8. Install hangers and supports for standpipe system piping according to NFPA 14. Comply with requirements in NFPA 13 for hanger materials.
9. Install pressure gages on riser or feed main 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.
10. Drain dry-type standpipe system piping.
11. Pressurize and check dry-type standpipe system piping and air-pressure maintenance devices **OR** air compressors, **as directed**.
12. Fill wet-type standpipe system piping with water.
13. Install electric heating cables and pipe insulation on wet-type, fire-suppression standpipe piping in areas subject to freezing. Comply with requirements for heating cables in Division 21 Section "Heat Tracing For Fire-suppression Piping" and for piping insulation in Division 21 Section "Fire-suppression Systems Insulation".
14. Connect compressed-air supply to dry-pipe sprinkler piping.
    OR
    Connect air compressor to the following piping and wiring:
    a. Pressure gages and controls.
    b. Electrical power system.
    c. Fire-alarm devices, including low-pressure alarm.

E. Joint Construction
1. 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.
2. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
3. 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.
4. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

5. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
6. 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.
7. 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:
   a. Apply appropriate tape or thread compound to external pipe threads.
   b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
8. 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.
9. 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.
10. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
    a. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
11. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.
12. Copper-Tubing Grooved Joints: Roll rounded-edge groove in end of tube according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
13. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

F. Valve And Specialties Installation
1. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 14 and authorities having jurisdiction.
2. 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.
3. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
4. Specialty Valves:
   a. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
   b. Alarm Valves: Install bypass check valve and retarding chamber drain-line connection.
   c. Dry-Pipe and Deluge Valves: Install trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
      1) Install air compressor and compressed-air supply piping.
         OR
         Air-Pressure Maintenance Device: Install shutoff valves to permit servicing without shutting down sprinkler system; bypass valve for quick system filling; pressure regulator or switch to maintain system pressure; strainer; pressure ratings with 14- to 60-psig (95- to 410-kPa) adjustable range; and 175-psig (1200-kPa) maximum inlet pressure.
      2) Install compressed-air supply piping from building's compressed-air piping system.

G. Hose-Connection Installation
1. Install hose connections adjacent to standpipes.
2. Install freestanding hose connections for access and minimum passage restriction.
3. Install NPS 1-1/2 (DN 40) hose-connection valves with flow-restricting device.

4. Install NPS 2-1/2 (DN 65) hose connections with quick-disconnect NPS 2-1/2 by NPS 1-1/2 (DN 65 by DN 40) reducer adapter and flow-restricting device.
5. Install wall-mounted-type hose connections in cabinets. Include pipe escutcheons, with finish matching valves, inside cabinet where water-supply piping penetrates cabinet. Install valves at angle required for connection of fire hose. Comply with requirements for cabinets in Division 10 Section "Fire Extinguisher Cabinets".

H. Hose-Station Installation
1. Install freestanding hose stations for access and minimum passage restriction.
2. Install NPS 1-1/2 (DN 40) hose-station valves with flow-restricting device unless otherwise indicated.
3. Install NPS 2-1/2 (DN 65) hose connections with quick-disconnect NPS 2-1/2 by NPS 1-1/2 (DN 65 by DN 40) reducer adapter and flow-restricting device unless otherwise indicated.
4. Install freestanding hose stations with support or bracket attached to standpipe.
5. Install wall-mounted, rack hose stations in cabinets. Include pipe escutcheons, with finish matching valves, inside cabinet where water-supply piping penetrates cabinet. Install valves at angle required for connection of fire hose. Comply with requirements for cabinets in Division 10 Section "Fire Extinguisher Cabinets".
6. Install hose-reel hose stations on wall with bracket.

I. Monitor Installation
1. Install monitors on standpipe piping.

J. Fire-Department Connection Installation
1. Install wall-type, fire-department connections.
2. Install yard-type, fire-department connections in concrete slab support. Comply with requirements for concrete in Division 03 Section "Cast-in-place Concrete".
   a. Install two **OR** three, **as directed**, protective pipe bollards around **OR** on sides of, **as directed**, each fire-department connection. Comply with requirements for bollards in Division 05 Section "Metal Fabrications".
3. Install automatic (ball drip) drain valve at each check valve for fire-department connection.

K. Escutcheon Installation
1. Install escutcheons for penetrations of walls, ceilings, and floors.
2. Escutcheons for New Piping:
   a. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
   b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** stamped steel with set-screw **OR** stamped steel with set-screw or spring clips **OR** stamped steel with spring clips, **as directed**.
   c. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** One piece or split casting, cast brass with polished chrome-plated finish **OR** Split casting, cast brass with polished chrome-plated finish **OR** One piece, stamped steel with set-screw **OR** One piece or split plate, stamped steel with set-screw **OR** Split plate, stamped steel with set-screw, **as directed**.
   d. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish **OR** cast brass with rough-brass finish **OR** stamped steel with set-screw **OR** stamped steel with spring clips **OR** stamped steel with set-screw or spring clips, **as directed**.
   e. Bare Piping in Equipment Rooms: One piece, cast brass **OR** stamped steel with set-screw **OR** stamped steel with spring clips **OR** stamped steel with set-screw or spring clips, **as directe**.
   f. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.
3. Escutcheons for Existing Piping:
   a. Chrome-Plated Piping: Split casting, cast brass with chrome-plated finish.

b. Insulated Piping: Split plate, stamped steel with concealed or exposed-rivet hinge and spring clips.
c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and spring clips, **as directed**.
d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and set-screw, **as directed**.
e. Bare Piping in Unfinished Service Spaces: Split casting, cast brass with polished chrome-plated finish **OR** casting, cast brass with rough-brass finish **OR** plate, stamped steel with concealed hinge and set-screw or spring clips **OR** plate, stamped steel with concealed or exposed-rivet hinge and set-screw or spring clips **OR** plate, stamped steel with exposed-rivet hinge and set-screw or spring clips, **as directed**.
f. Bare Piping in Equipment Rooms: Split casting, cast brass **OR** plate, stamped steel with set-screw or spring clips, **as directed**.
g. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.

L. Sleeve Installation
1. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.
2. Sleeves are not required for core-drilled holes.
3. Permanent sleeves are not required for holes formed by removable PE sleeves.
4. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.
5. Install sleeves in new partitions, slabs, and walls as they are built.
6. 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".
7. 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".
8. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals.
9. Seal space outside of sleeves in concrete slabs and walls with grout.
10. 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.
11. Install sleeve materials according to the following applications:
    a. Sleeves for Piping Passing through Concrete Floor Slabs: Molded PE **OR** Molded PVC **OR** Galvanized-steel pipe, **as directed**.
    b. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Galvanized-steel pipe **OR** Stack sleeve fittings, **as directed**.
        1) Extend sleeves 2 inches (50 mm) above finished floor level.
        2) 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".
    c. Sleeves for Piping Passing through Gypsum-Board Partitions:
        1) PVC-pipe **OR** Galvanized-steel-pipe, **as directed**, sleeves for pipes smaller than NPS 6 (DN 150).
        2) Galvanized-steel-sheet sleeves for pipes NPS 6 (DN 150) and larger.
        3) Exception: Sleeves are not required for water-supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.
    d. Sleeves for Piping Passing through Concrete Roof Slabs: Molded PE **OR** Molded PVC **OR** Galvanized-steel pipe, **as directed**.
    e. Sleeves for Piping Passing through Exterior Concrete Walls:
        1) Galvanized-steel-pipe sleeves for pipes smaller than NPS 6 (DN 150).

2) Cast-iron wall pipe sleeves for pipes NPS 6 (DN 150) and larger.
3) 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.

f. Sleeves for Piping Passing through Interior Concrete Walls:
1) PVC-pipe **OR** Galvanized-steel-pipe, **as directed**, sleeves for pipes smaller than NPS 6 (DN 150).
2) Galvanized-steel-sheet sleeves for pipes NPS 6 (DN 150) and larger.

12. 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".

M. Sleeve Seal Installation
1. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.
2. 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.

N. Identification
1. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 14.
2. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification For Electrical Systems".

O. Field Quality Control
1. Perform tests and inspections.
2. Tests and Inspections:
a. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
b. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
c. Flush, test, and inspect standpipe systems according to NFPA 14, "System Acceptance" Chapter.
d. Energize circuits to electrical equipment and devices.
e. Start and run air compressors.
f. Coordinate with fire-alarm tests. Operate as required.
g. Coordinate with fire-pump tests. Operate as required.
h. Verify that equipment hose threads are same as local fire-department equipment.
3. Fire-suppression standpipe system will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports.

P. Demonstration
1. Train the Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

Q. Piping Schedule
1. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends; cast-iron threaded fittings; and threaded **OR** grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved, **as directed**, joints.
2. Standard-pressure, wet-type, fire-suppression standpipe piping, NPS 4 (DN 100) and smaller, shall be one of the following:
a. Standard-weight or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
b. Standard-weight **OR** Schedule 30 or thinwall, **as directed**, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.

c. Standard-weight or Schedule 30, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
d. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
e. Standard-weight or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
f. Thinwall **OR** Schedule 10, **as directed**, **OR** nonstandard OD, thinwall or hybrid, **as directed**, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
g. Thinwall **OR** Schedule 10, **as directed**, **OR** nonstandard OD, thinwall or hybrid, **as directed**, black-steel pipe with plain ends; welding fittings; and welded joints.
h. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with plain ends; cast- or wrought-copper solder-joint fittings; and brazed joints.
i. Type L (Type B) **OR** Type M (Type B), **as directed**, hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.

3. Standard-pressure, wet-type, fire-suppression standpipe piping, NPS 5 to NPS 8 (DN 125 to DN 200), shall be one of the following:
   a. Standard-weight **OR** Schedule 30, **as directed**, or thinwall, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
   b. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
   c. Standard-weight or Schedule 30, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   d. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   e. Standard-weight or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
   f. Thinwall **OR** Schedule 10, **as directed**, or hybrid black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   g. Thinwall **OR** Schedule 10, **as directed**, or hybrid black-steel pipe with plain ends; welding fittings; and welded joints.
   h. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with plain ends; cast- or wrought-copper solder-joint fittings; and brazed joints.
   i. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.
4. Standard-pressure, wet-type, fire-suppression standpipe piping, NPS 10 and NPS 12 (DN 250 and DN 300), shall be one of the following:
   a. Standard-weight or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
   b. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
   c. Standard-weight or Schedule 30, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   d. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   e. Standard-weight or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
   f. Thinwall **OR** Schedule 10, **as directed**, **OR** nonstandard OD, thinwall or hybrid, **as directed**, black-steel pipe with plain ends; welding fittings; and welded joints.

5. High-pressure, wet-type, fire-suppression standpipe piping, NPS 4 (DN 100) and smaller, shall be one of the following:
   a. Standard-weight or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
   b. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
   c. Standard-weight or Schedule 30, black-steel pipe with cut-grooved **OR** roll-grooved, **as directed**, ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   d. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   e. Standard-weight or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
   f. Thinwall **OR** Schedule 10, **as directed**, **OR** nonstandard OD, thinwall or hybrid, **as directed**, black-steel pipe with plain ends; welding fittings; and welded joints.
6. High-pressure, wet-type, fire-suppression standpipe piping, NPS 5 (DN 125) and larger, shall be one of the following:
   a. Standard-weight or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
   b. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
   c. Standard-weight or Schedule 30, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   d. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   e. Standard-weight or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
   f. Thinwall **OR** Schedule 10, **as directed**, **OR** nonstandard OD, thinwall or hybrid, **as directed**, black-steel pipe with plain ends; welding fittings; and welded joints.
7. Standard-pressure, dry-type, fire-suppression standpipe piping, NPS 4 (DN 100) and smaller, shall be one of the following:
   a. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
   b. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   c. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with plain ends; cast- or wrought-copper solder-joint fittings; and brazed joints.
   d. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.
8. Standard-pressure, dry-type, fire-suppression standpipe piping, NPS 5 and NPS 6 (DN 125 and DN 150), shall be one of the following:
   a. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
   b. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   c. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with plain ends; cast- or wrought-copper solder-joint fittings; and brazed joints.
   d. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.

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Task	Specification	Specification Description
21 12 13 00	21 11 19 00	Fire-Suppression Standpipes
21 12 23 00	21 11 19 00	Fire-Suppression Standpipes
21 12 29 00	01 22 16 00	No Specification Required
21 12 29 00	21 11 19 00	Fire-Suppression Standpipes

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SECTION 21 13 13 00 - WET-PIPE FIRE-SUPPRESSION SPRINKLERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for wet-pipe fire-suppression sprinklers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Pipes, fittings, and specialties.
b. Fire-protection valves.
c. Fire-department connections.
d. Sprinklers.
e. Excess-pressure pumps.
f. Alarm devices.
g. Manual control stations.
h. Control panels.
i. Pressure gages.

C. Definitions
1. High-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure higher than standard 175 psig (1200 kPa), but not higher than 250 psig (1725 kPa) **OR** 300 psig (2070 kPa), **as directed**.
2. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175 psig (1200 kPa) maximum.

D. System Descriptions
1. 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.
2. Deluge Sprinkler System: Open sprinklers are attached to piping connected to water supply through deluge valve. Fire-detection system, in same area as sprinklers, opens valve. Water flows into piping system and discharges from attached sprinklers when valve opens.

E. Performance Requirements
1. Standard-Pressure Piping System Component: Listed for 175-psig (1200-kPa) minimum working pressure.
2. High-Pressure Piping System Component: Listed for 250-psig (1725-kPa) minimum **OR** 300-psig (2070-kPa), **as directed**, working pressure.
3. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
4. Sprinkler system design shall be approved by authorities having jurisdiction.
a. Margin of Safety for Available Water Flow and Pressure: 10 **OR** 20, **as directed**, percent, including losses through water-service piping, valves, and backflow preventers.
b. Sprinkler Occupancy Hazard Classifications:
1) Automobile Parking Areas: Ordinary Hazard, Group 1.
2) Building Service Areas: Ordinary Hazard, Group 1.
3) Churches: Light Hazard.
4) Electrical Equipment Rooms: Ordinary Hazard, Group 1.
5) Dry Cleaners: Ordinary Hazard, Group 2.

6) General Storage Areas: Ordinary Hazard, Group 1.
7) Laundries: Ordinary Hazard, Group 1.
8) Libraries except Stack Areas: Light Hazard.
9) Library Stack Areas: Ordinary Hazard, Group 2.
10) Machine Shops: Ordinary Hazard, Group 2.
11) Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
12) Office and Public Areas: Light Hazard.
13) Plastics Processing Areas: Extra Hazard, Group 2.
14) Printing Plants: Extra Hazard, Group 1.
15) Repair Garages: Ordinary Hazard, Group 2.
16) Residential Living Areas: Light Hazard.
17) Restaurant Service Areas: Ordinary Hazard, Group 1.
18) Solvent Cleaning Areas: Extra Hazard, Group 2.
19) Upholstering Plants: Extra Hazard, Group 1.

c. Minimum Density for Automatic-Sprinkler Piping Design:
1) Residential (Dwelling) Occupancy: 0.05 gpm over 400-sq. ft. (2.04 mm/min. over 37.2-sq. m) area.
2) Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. (4.1 mm/min. over 139-sq. m) area.
3) Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. (6.1 mm/min. over 139-sq. m) area.
4) Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. (8.1 mm/min. over 139-sq. m) area.
5) Extra-Hazard, Group 1 Occupancy: 0.30 gpm over 2500-sq. ft. (12.2 mm/min. over 232-sq. m) area.
6) Extra-Hazard, Group 2 Occupancy: 0.40 gpm over 2500-sq. ft. (16.3 mm/min. over 232-sq. m) area.
7) Special Occupancy Hazard: As determined by authorities having jurisdiction.

d. Minimum Density for Deluge-Sprinkler Piping Design:
1) Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm (6.1 mm/min.) over entire area.
2) Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm (8.1 mm/min.) over entire area.
3) Extra-Hazard, Group 1 Occupancy: 0.30 gpm (12.2 mm/min.) over entire area.
4) Extra-Hazard, Group 2 Occupancy: 0.40 gpm (16.3 mm/min.) over entire area.
5) Special Occupancy Hazard: As determined by authorities having jurisdiction.

e. Maximum Protection Area per Sprinkler: Per UL listing.
OR
Maximum Protection Area per Sprinkler:
1) Residential Areas: 400 sq. ft. (37 sq. m).
2) Office Spaces: 120 sq. ft. (11.1 sq. m) **OR** 225 sq. ft. (20.9 sq. m), **as directed**.
3) Storage Areas: 130 sq. ft. (12.1 sq. m).
4) Mechanical Equipment Rooms: 130 sq. ft. (12.1 sq. m).
5) Electrical Equipment Rooms: 130 sq. ft. (12.1 sq. m).
6) Other Areas: According to NFPA 13 recommendations unless otherwise indicated.

f. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated:
1) Light-Hazard Occupancies: 100 gpm (6.3 L/s) for 30 minutes.
2) Ordinary-Hazard Occupancies: 250 gpm (15.75 L/s) for 60 to 90 minutes.
3) Extra-Hazard Occupancies: 500 gpm (31.5 L/s) for 90 to 120 minutes.

5. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7.

F. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:

a. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content and chemical components.

3. Shop Drawings: For wet-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.
   a. Wiring Diagrams: For power, signal, and control wiring.
4. 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.
5. Qualification Data: For qualified Installer and professional engineer, **as directed**.
6. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
7. Welding certificates.
8. Fire-hydrant flow test report.
9. 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."
10. Field quality-control reports.
11. Operation and maintenance data.

G. Quality Assurance
1. Installer Qualifications:
   a. 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.
      1) Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
2. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
   a. NFPA 13, "Installation of Sprinkler Systems."
   b. NFPA 13R, "Installation of Sprinkler Systems in Residential Occupancies up to and Including Four Stories in Height."
   c. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."

H. Project Conditions
1. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:
   a. Notify the Owner no fewer than two days in advance of proposed interruption of sprinkler service.
   b. Do not proceed with interruption of sprinkler service without the Owner's written permission.

1.2 PRODUCTS

A. Piping Materials
1. 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.

B. Steel Pipe And Fittings
1. Standard Weight, Galvanized- and Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.

2. Schedule 30, Galvanized- and Black-Steel Pipe: ASTM A 135; ASTM A 795/A 795M, Type E; or ASME B36.10M, wrought steel; with wall thickness not less than Schedule 30 and not more than Schedule 40. Pipe ends may be factory or field formed to match joining method.
3. Thinwall Galvanized- and Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, threadable, with wall thickness less than Schedule 30 and equal to or greater than Schedule 10. Pipe ends may be factory or field formed to match joining method.
4. Schedule 10, Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, Schedule 10 in NPS 5 (DN 125) and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10 (DN 150 to DN 250), plain end.
5. Nonstandard OD, Thinwall Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, thinwall, with plain ends and wall thickness less than Schedule 10.
6. Hybrid Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, lightwall, with wall thickness less than Schedule 10 and greater than Schedule 5.
7. Schedule 5 Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, lightwall, with plain ends.
8. Galvanized- and Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.
9. Galvanized and Uncoated, Steel Couplings: ASTM A 865, threaded.
10. Galvanized and Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
11. Malleable- or Ductile-Iron Unions: UL 860.
12. Cast-Iron Flanges: ASME 16.1, Class 125.
13. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
14. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.
15. Grooved-Joint, Steel-Pipe Appurtenances:
    a. Pressure Rating: 175 psig (1200 kPa) **OR** 250 psig (1725 kPa) **OR** 300 psig (2070 kPa), **as directed**, minimum.
    b. 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.
    c. 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.
16. 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.

C. Copper Tube And Fittings
1. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) and ASTM B 88, Type M (ASTM B 88M, Type C) water tube, drawn temper.
2. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
3. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.
4. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
5. 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.
6. Copper Pressure-Seal Fittings:
    a. Standard: UL 213.
    b. NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
    c. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Cast-bronze fitting with EPDM-rubber O-ring seal in each end.
7. Grooved-Joint, Copper-Tube Appurtenances:
    a. Grooved-End, Copper Fittings: ASTM B 75 (ASTM B 75M), copper tube or ASTM B 584, bronze castings.

b. Grooved-End-Tube Couplings: To fit copper-tube dimensions, with design similar to AWWA C606. Include ferrous housing sections, EPDM-rubber gasket suitable for hot and cold water, and bolts and nuts.

8. Copper-Tube, Extruded-Tee Connections:
   a. Description: Tee formed in copper tube according to ASTM F 2014.

D. CPVC Pipe And Fittings
1. CPVC Pipe: ASTM F 442/F 442M and UL 1821, SDR 13.5, for 175-psig (1200-kPa) rated pressure at 150 deg F (62 deg C), with plain ends. Include "LISTED" and "CPVC SPRINKLER PIPE" markings.
2. CPVC Fittings: UL listed or FM approved, for 175-psig (1200-kPa) rated pressure at 150 deg F (62 deg C), socket type. Include "LISTED" and "CPVC SPRINKLER FITTING" markings.
   a. NPS 3/4 to NPS 1-1/2 (DN 20 to DN 40): ASTM F 438 and UL 1821, Schedule 40, socket type.
   b. NPS 2 to NPS 3 (DN 50 to DN 80): ASTM F 439 and UL 1821, Schedule 80, socket type.
   c. CPVC-to-Metal Transition Fittings: CPVC, one piece, with dimensions equivalent to pipe; one end with threaded brass insert, and one socket end.
   d. CPVC-to-Metal Transition Unions: CPVC, with dimensions equivalent to pipe; one end with threaded brass insert, and one socket end.
   e. Flanges: CPVC, one or two pieces.

E. Piping Joining Materials
1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free.
   a. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
   b. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.
2. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
3. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
4. 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.
5. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493, solvent cement recommended by pipe and fitting manufacturer, and made for joining CPVC sprinkler pipe and fittings. Include cleaner or primer recommended by pipe and fitting manufacturer.
   a. Use solvent cement that has a VOC content of 490 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 650 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Plastic, Pipe-Flange Gasket, and Bolts and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

F. Cover System For Sprinkler Piping
1. Description: System of support brackets and covers made to protect sprinkler piping.
2. Brackets: Glass-reinforced nylon.
3. Covers: Extruded PVC sections of length, shape, and size required for size and routing of CPVC piping.

G. Listed Fire-Protection Valves
1. General Requirements:
   a. Valves shall be UL listed or FM approved.
   b. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig (1200 kPa).
   c. Minimum Pressure Rating for High-Pressure Piping: 250 psig (1725 kPa) **OR** 300 psig (2070 kPa), **as directed**.
2. Ball Valves:

a. Standard: UL 1091 except with ball instead of disc.
b. Valves NPS 1-1/2 (DN 40) and Smaller: Bronze body with threaded ends.
c. Valves NPS 2 and NPS 2-1/2 (DN 50 and DN 65): Bronze body with threaded ends or ductile-iron body with grooved ends.
d. Valves NPS 3 (DN 80): Ductile-iron body with grooved ends.

3. Bronze Butterfly Valves:
   a. Standard: UL 1091.
   b. Pressure Rating: 175 psig (1200 kPa).
   c. Body Material: Bronze.
   d. End Connections: Threaded.
4. Iron Butterfly Valves:
   a. Standard: UL 1091.
   b. Pressure Rating: 175 psig (1200 kPa).
   c. Body Material: Cast or ductile iron.
   d. Style: Lug or wafer.
      OR
      End Connections: Grooved.
5. Check Valves:
   a. Standard: UL 312.
   b. Pressure Rating: 250 psig (1725 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
   c. Type: Swing check.
   d. Body Material: Cast iron.
   e. End Connections: Flanged or grooved.
6. Bronze OS&Y Gate Valves:
   a. Standard: UL 262.
   b. Pressure Rating: 175 psig (1200 kPa).
   c. Body Material: Bronze.
   d. End Connections: Threaded.
7. Iron OS&Y Gate Valves:
   a. Standard: UL 262.
   b. Pressure Rating: 250 psig (1725 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
   c. Body Material: Cast or ductile iron.
   d. End Connections: Flanged or grooved.
8. Indicating-Type Butterfly Valves:
   a. Standard: UL 1091.
   b. Pressure Rating: 175 psig (1200 kPa) minimum.
   c. Valves NPS 2 (DN 50) and Smaller:
      1) Valve Type: Ball or butterfly.
      2) Body Material: Bronze.
      3) End Connections: Threaded.
   d. Valves NPS 2-1/2 (DN 65) and Larger:
      1) Valve Type: Butterfly.
      2) Body Material: Cast or ductile iron.
      3) End Connections: Flanged, grooved, or wafer.
   e. Valve Operation: Integral electrical, 115-V ac, prewired, single-circuit, supervisory switch **OR** electrical, 115-V ac, prewired, two-circuit, supervisory switch **OR** visual, **as directed**, indicating device.
9. NRS Gate Valves:
   a. Standard: UL 262.
   b. Pressure Rating: 250 psig (1725 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
   c. Body Material: Cast iron with indicator post flange.
   d. Stem: Nonrising.
   e. End Connections: Flanged or grooved.
10. Indicator Posts:
    a. Standard: UL 789.

b. Type: Horizontal for wall mounting.
c. Body Material: Cast iron with extension rod and locking device.
d. Operation: Wrench **OR** Hand wheel, **as directed**.

H. Trim And Drain Valves
1. General Requirements:
a. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
b. Pressure Rating: 175 psig (1200 kPa) minimum.
2. Angle Valves.
3. Ball Valves.
4. Globe Valves.
5. Plug Valves.

I. Specialty Valves
1. General Requirements:
a. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
b. Pressure Rating:
1) Standard-Pressure Piping Specialty Valves: 175 psig (1200 kPa) minimum.
2) High-Pressure Piping Specialty Valves: 250 psig (1725 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
c. Body Material: Cast or ductile iron.
d. Size: Same as connected piping.
e. End Connections: Flanged or grooved.
2. Alarm Valves:
a. Standard: UL 193.
b. Design: For horizontal or vertical installation.
c. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, **as directed**, and fill-line attachment with strainer.
d. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
OR
Drip Cup Assembly: Pipe drain with check valve to main drain piping.
3. Deluge Valves:
a. Standard: UL 260.
b. Design: Hydraulically operated, differential-pressure type.
c. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, drip cup assembly piped without valves and separate from main drain line, fill-line attachment with strainer, and push-rod chamber supply connection.
d. Wet, Pilot-Line Trim Set: Include gage to read push-rod chamber pressure, globe valve for manual operation of deluge valve, and connection for actuation device.
4. Automatic (Ball Drip) Drain Valves:
a. Standard: UL 1726.
b. Pressure Rating: 175 psig (1200 kPa) minimum.
c. Type: Automatic draining, ball check.
d. Size: NPS 3/4 (DN 20).
e. End Connections: Threaded.

J. Fire-Department Connections
1. Exposed-Type, Fire-Department Connection:
a. Standard: UL 405.
b. Type: Exposed, projecting, for wall mounting.
c. Pressure Rating: 175 psig (1200 kPa) minimum.
d. Body Material: Corrosion-resistant metal.

e. 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.
f. Caps: Brass, lugged type, with gasket and chain.
g. Escutcheon Plate: Round, brass, wall type.
h. Outlet: Back, with pipe threads.
i. Number of Inlets: Two **OR** Three, **as directed**.
j. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE" **OR** "AUTO SPKR", **as directed**.
k. Finish: Polished chrome plated **OR** Rough brass or bronze **OR** Rough chrome plated, **as directed**.
l. Outlet Size: NPS 4 (DN 100) **OR** NPS 5 (DN 125) **OR** NPS 6 (DN 150), **as directed**.

2. Flush-Type, Fire-Department Connection:
a. Standard: UL 405.
b. Type: Flush, for wall mounting.
c. Pressure Rating: 175 psig (1200 kPa) minimum.
d. Body Material: Corrosion-resistant metal.
e. 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.
f. Caps: Brass, lugged type, with gasket and chain.
g. Escutcheon Plate: Rectangular, brass, wall type.
h. Outlet: With pipe threads.
i. Body Style: Horizontal **OR** Square **OR** Vertical, **as directed**.
j. Number of Inlets: Two **OR** Three **OR** Four **OR** Six, **as directed**.
k. Outlet Location: Back **OR** Bottom **OR** Left side **OR** Right side **OR** Top, **as directed**.
l. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE" **OR "**AUTO SPKR", **as directed**.
m. Finish: Polished chrome plated **OR** Rough brass or bronze **OR** Rough chrome plated, **as directed**.
n. Outlet Size: NPS 4 (DN 100) **OR** NPS 5 (DN 125) **OR** NPS 6 (DN 150) **OR** NPS 8 (DN 200), **as directed**.

3. Yard-Type, Fire-Department Connection:
a. Standard: UL 405.
b. Type: Exposed, freestanding.
c. Pressure Rating: 175 psig (1200 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
d. Body Material: Corrosion-resistant metal.
e. 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.
f. Caps: Brass, lugged type, with gasket and chain.
g. Escutcheon Plate: Round, brass, floor type.
h. Outlet: Bottom, with pipe threads.
i. Number of Inlets: Two **OR** Three **OR** Four, **as directed**.
j. Sleeve: Brass **OR** Not required, **as directed**.
k. Sleeve Height: 18 inches (460 mm).
l. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE" **OR** "AUTO SPKR", **as directed**.
m. Finish, Including Sleeve: Polished chrome plated **OR** Rough brass or bronze **OR** Rough chrome plated, **as directed**.
n. Outlet Size: NPS 4 (DN 100) **OR** NPS 5 (DN 125) **OR** NPS 6 (DN 150), **as directed**.

K. Sprinkler Specialty Pipe Fittings
1. Branch Outlet Fittings:
a. Standard: UL 213.

b. Pressure Rating: 175 psig (1200 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
c. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
d. Type: Mechanical-T and -cross fittings.
e. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
f. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
g. Branch Outlets: Grooved, plain-end pipe, or threaded.

2. Flow Detection and Test Assemblies:
a. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
b. Pressure Rating: 175 psig (1200 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
c. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
d. Size: Same as connected piping.
e. Inlet and Outlet: Threaded.

3. Branch Line Testers:
a. Standard: UL 199.
b. Pressure Rating: 175 psig (1200 kPa).
c. Body Material: Brass.
d. Size: Same as connected piping.
e. Inlet: Threaded.
f. Drain Outlet: Threaded and capped.
g. Branch Outlet: Threaded, for sprinkler.

4. Sprinkler Inspector's Test Fittings:
a. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
b. Pressure Rating: 175 psig (1200 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
c. Body Material: Cast- or ductile-iron housing with sight glass.
d. Size: Same as connected piping.
e. Inlet and Outlet: Threaded.

5. Adjustable Drop Nipples:
a. Standard: UL 1474.
b. Pressure Rating: 250 psig (1725 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
c. Body Material: Steel pipe with EPDM-rubber O-ring seals.
d. Size: Same as connected piping.
e. Length: Adjustable.
f. Inlet and Outlet: Threaded.

6. Flexible, Sprinkler Hose Fittings:
a. Standard: UL 1474.
b. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
c. Pressure Rating: 175 psig (1200 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
d. Size: Same as connected piping, for sprinkler.

L. Sprinklers
1. General Requirements:
a. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
b. Pressure Rating for Residential Sprinklers: 175 psig (1200 kPa) maximum.
c. Pressure Rating for Automatic Sprinklers: 175 psig (1200 kPa) minimum.
d. Pressure Rating for High-Pressure Automatic Sprinklers: 250 psig (1725 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.

2. Automatic Sprinklers with Heat-Responsive Element:
a. Early-Suppression, Fast-Response Applications: UL 1767.
b. Nonresidential Applications: UL 199.
c. Residential Applications: UL 1626.

d. 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.

3. Open Sprinklers with Heat-Responsive Element Removed: UL 199.
   a. Characteristics:
      1) Nominal 1/2-inch (12.7-mm) Orifice: With Discharge Coefficient K between 5.3 and 5.8.
      2) Nominal 17/32-inch (13.5-mm) Orifice: With Discharge Coefficient K between 7.4 and 8.2.
4. Sprinkler Finishes:
   a. Chrome plated.
   b. Bronze.
   c. Painted.
5. Special Coatings:
   a. Wax.
   b. Lead.
   c. Corrosion-resistant paint.
6. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
   a. Ceiling Mounting: Chrome-plated steel, one piece, flat **OR** Chrome-plated steel, two piece, with 1-inch (25-mm) vertical adjustment **OR** Plastic, white finish, one piece, flat, **as directed**.
   b. Sidewall Mounting: Chrome-plated steel **OR** Plastic, white finish, **as directed**, one piece, flat.
7. Sprinkler Guards:
   a. Standard: UL 199.
   b. Type: Wire cage with fastening device for attaching to sprinkler.

M. Excess-Pressure Pumps
1. Pump: Factory-fabricated, positive-displacement, gear type.
   a. Pump and Motor: Directly connected.
   b. Motor: Comply with requirements in Division 21 Section "Common Work Results For Fire Suppression".
2. Miscellaneous Components: Wet-pipe kit of switches, fittings, valves, mounting brackets, and connections for power, hydraulic piping, and wiring from alarm devices.
3. Motor Control: Differential-pressure switch.
4. Lights: To indicate sprinkler system's operating condition.
   a. White Light: Pressure is normal.
   b. Red Light: Pressure is low.
5. Capacity: 2.0 gpm at 75-psig (0.13 L/s at 520-kPa) differential pressure and 1/3 hp **OR** 1.85 gpm at 100-psig (0.12 L/s at 690-kPa) differential pressure and 1/2 hp **OR** 3.5 gpm at 100-psig (0.22 L/s at 690-kPa) differential pressure and 1/2 hp, **as directed**.

N. Alarm Devices
1. Alarm-device types shall match piping and equipment connections.
2. Water-Motor-Operated Alarm:
   a. Standard: UL 753.
   b. Type: Mechanically operated, with Pelton wheel.
   c. Alarm Gong: Cast aluminum with red-enamel factory finish.
   d. Size: 10-inch (250-mm) diameter.
   e. Components: Shaft length, bearings, and sleeve to suit wall construction.
   f. Inlet: NPS 3/4 (DN 20).
   g. Outlet: NPS 1 (DN 25) drain connection.
3. Electrically Operated Alarm Bell:

a. Standard: UL 464.
b. Type: Vibrating, metal alarm bell.
c. Size: 6-inch (150-mm) minimum-diameter **OR** 8-inch (200-mm) minimum-diameter **OR** 10-inch (250-mm) diameter, **as directed**.
d. Finish: Red-enamel factory finish, suitable for outdoor use.

4. Water-Flow Indicators:
   a. Standard: UL 346.
   b. Water-Flow Detector: Electrically supervised.
   c. 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.
   d. Type: Paddle operated.
   e. Pressure Rating: 250 psig (1725 kPa).
   f. Design Installation: Horizontal or vertical.
5. Pressure Switches:
   a. Standard: UL 346.
   b. Type: Electrically supervised water-flow switch with retard feature.
   c. Components: Single-pole, double-throw switch with normally closed contacts.
   d. Design Operation: Rising pressure signals water flow.
6. Valve Supervisory Switches:
   a. Standard: UL 346.
   b. Type: Electrically supervised.
   c. Components: Single-pole, double-throw switch with normally closed contacts.
   d. Design: Signals that controlled valve is in other than fully open position.
7. Indicator-Post Supervisory Switches:
   a. Standard: UL 346.
   b. Type: Electrically supervised.
   c. Components: Single-pole, double-throw switch with normally closed contacts.
   d. Design: Signals that controlled indicator-post valve is in other than fully open position.

O. Manual Control Stations
1. Description: UL listed or FM approved, hydraulic operation, with union, NPS 1/2 (DN 15) pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

P. Control Panels
1. Description: Single-area, two-area, or single-area cross-zoned control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves. Panels contain power supply; battery charger; standby batteries; field-wiring terminal strip; electrically supervised solenoid valves and polarized fire-alarm bell; lamp test facility; single-pole, double-throw auxiliary alarm contacts; and rectifier.
   a. Panels: UL listed and FM approved when used with thermal detectors and Class A detector circuit wiring. Electrical characteristics are 120-V ac, 60 Hz, with 24-V dc rechargeable batteries.
   b. Manual Control Stations: Electric operation, metal enclosure, labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.
      OR
      Manual Control Stations: Hydraulic operation, with union, NPS 1/2 (DN 15) pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

Q. Pressure Gages

1. Standard: UL 393.
2. Dial Size: 3-1/2- to 4-1/2-inch (90- to 115-mm) diameter.
3. Pressure Gage Range: 0 to 250 psig (0 to 1725 kPa) minimum **OR** 0 to 300 psig (0 to 2070 kPa), **as directed**.
4. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.
5. Air System Piping Gage: Include retard feature, **directed**, and "AIR" or "AIR/WATER" label on dial face.

R. Escutcheons
1. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.
2. One-Piece, Cast-Brass Escutcheons: Polished chrome-plated **OR** rough-brass, **as directed**, finish with set-screws.
3. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with chrome-plated finish.
4. One-Piece, Stamped-Steel Escutcheons: Chrome-plated finish with set-screw **OR** spring clips, **as directed**.
5. Split-Casting, Cast-Brass Escutcheons: Polished chrome-plated **OR** rough-brass, **as directed**, finish with concealed hinge and set-screw.
6. Split-Plate, Stamped-Steel Escutcheons: Chrome-plated finish with concealed **OR** exposed-rivet, **as directed**, hinge, set-screw **OR** spring clips, **as directed**.
7. One-Piece Floor Plates: Cast-iron flange with holes for fasteners, **as directed**.
8. Split-Casting Floor Plates: Cast brass with concealed hinge.

S. Sleeves
1. 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.
2. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
3. Molded-PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
4. Molded-PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.
5. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
6. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, standard weight, zinc coated, plain ends.
7. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   a. Underdeck Clamp: Clamping ring with set-screws.

T. Sleeve Seals
1. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   a. Sealing Elements: EPDM-rubber or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   b. Pressure Plates: Carbon steel **OR** Plastic **OR** Stainless steel, **as directed**.
   c. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating **OR** Stainless steel, **as directed**, of length required to secure pressure plates to sealing elements.

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

1.3 EXECUTION

A. Preparation
1. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
2. Report test results promptly and in writing.

B. Service-Entrance Piping
1. Connect sprinkler piping to water-service piping for service entrance to building. Comply with requirements for exterior piping in Division 21 Section "Facility Fire-suppression Water-service Piping".
2. Install shutoff valve, backflow preventer, **as directed**, pressure gage, drain, and other accessories indicated at connection to water-service piping. Comply with requirements for backflow preventers in Division 21 Section "Facility Fire-suppression Water-service Piping", **as directed**.
OR
Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

C. Water-Supply Connections
1. Connect sprinkler piping to building's interior water-distribution piping. Comply with requirements for interior piping in Division 22 Section "Domestic Water Piping".
2. Install shutoff valve, backflow preventer, **as directed**, pressure gage, drain, and other accessories indicated at connection to water-distribution piping. Comply with requirements for backflow preventers in Division 22 Section "Domestic Water Piping Specialties", **as directed**.
OR
Install shutoff valve, check valve, pressure gage, and drain at connection to water supply.

D. Piping Installation
1. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
   a. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with the Owner before deviating from approved working plans.
2. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.
3. Install seismic restraints on piping. Comply with requirements for seismic-restraint device materials and installation in NFPA 13.
4. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
5. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
6. 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.
7. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
8. Install sprinkler piping with drains for complete system drainage.
9. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
10. 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.
11. Install alarm devices in piping systems.
12. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
13. 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.

14. Pressurize and check preaction sprinkler system piping and air-pressure maintenance devices **OR** air compressors, **as directed**.
15. Fill sprinkler system piping with water.
16. Install electric heating cables and pipe insulation on sprinkler piping in areas subject to freezing. Comply with requirements for heating cables in Division 21 Section "Heat Tracing For Fire-suppression Piping" and for piping insulation in Division 21 Section "Fire-suppression Systems Insulation".

E. Joint Construction
1. 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.
2. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
3. 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.
4. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
5. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
6. 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.
7. 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:
   a. Apply appropriate tape or thread compound to external pipe threads.
   b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
8. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.
9. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
10. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
    a. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
11. 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.
12. 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.
13. Steel-Piping, Pressure-Sealed Joints: Join Schedule 5 steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
14. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.
15. Copper-Tubing Grooved Joints: Roll rounded-edge groove in end of tube according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
16. Copper-Tubing, Pressure-Sealed Joints: Join copper tube and copper pressure-seal fittings with tools recommended by fitting manufacturer.
17. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
18. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

19. Plastic-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
    a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
    b. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

F. Installation Of Cover System For Sprinkler Piping
1. Install cover system, brackets, and cover components for sprinkler piping according to manufacturer's "Installation Manual" and with NFPA 13 or NFPA 13R for supports.

G. Valve And Specialties Installation
1. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
2. 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.
3. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
4. Specialty Valves:
    a. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
    b. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.
    c. Deluge Valves: Install in vertical position, in proper direction of flow, and in main supply to deluge system. Install trim sets for drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

H. Excess-Pressure Pump Installation
1. Assemble components and mount on wood backing. Comply with requirements in Division 06 Section "Rough Carpentry" for wood backing material and installation.
2. Install excess-pressure pumps, controls, devices, and supports for sprinkler piping application.
    a. Mounting: Install on wall, where indicated **OR** attached to water-supply pipe, **as directed**.

I. Sprinkler Installation
1. Install sprinklers in suspended ceilings in center of narrow dimension of, **as directed**, acoustical ceiling panels.
2. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.
3. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.

J. Fire-Department Connection Installation
1. Install wall-type, fire-department connections.
2. Install yard-type, fire-department connections in concrete slab support. Comply with requirements for concrete in Division 03 Section "Cast-in-place Concrete".
    a. Install two **OR** three, **as directed**, protective pipe bollards around **OR** on sides of, **as directed**, each fire-department connection. Comply with requirements for bollards in Division 05 Section "Metal Fabrications".
3. Install automatic (ball drip) drain valve at each check valve for fire-department connection.

K. Escutcheon Installation
1. Install escutcheons for penetrations of walls, ceilings, and floors.
2. Escutcheons for New Piping:
    a. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
    b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** stamped steel with set-screw **OR** stamped steel with set-screw or spring clips **OR** stamped steel with spring clips, **as directed**.

c. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** One piece or split casting, cast brass with polished chrome-plated finish **OR** Split casting, cast brass with polished chrome-plated finish **OR** One piece, stamped steel with set-screw **OR** One piece or split plate, stamped steel with set-screw **OR** Split plate, stamped steel with set-screw, **as directed**.

d. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish **OR** cast brass with rough-brass finish **OR** stamped steel with set-screw **OR** stamped steel with spring clips **OR** stamped steel with set-screw or spring clips, **as directed**.

e. Bare Piping in Equipment Rooms: One piece, cast brass **OR** stamped steel with set-screw **OR** stamped steel with spring clips **OR** stamped steel with set-screw or spring clips, **as directed**.

f. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

3. Escutcheons for Existing Piping:

a. Chrome-Plated Piping: Split casting, cast brass with chrome-plated finish.

b. Insulated Piping: Split plate, stamped steel with concealed or exposed-rivet hinge and spring clips.

c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and spring clips, **as directed**.

d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and set-screw, **as directed**.

e. Bare Piping in Unfinished Service Spaces: Split casting, cast brass with polished chrome-plated finish **OR** casting, cast brass with rough-brass finish **OR** plate, stamped steel with concealed hinge and set-screw or spring clips **OR** plate, stamped steel with concealed or exposed-rivet hinge and set-screw or spring clips **OR** plate, stamped steel with exposed-rivet hinge and set-screw or spring clips, **as directed**.

f. Bare Piping in Equipment Rooms: Split casting, cast brass **OR** plate, stamped steel with set-screw or spring clips, **as directed**.

g. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.

L. Sleeve Installation

1. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.
2. Sleeves are not required for core-drilled holes.
3. Permanent sleeves are not required for holes formed by removable PE sleeves.
4. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.
5. Install sleeves in new partitions, slabs, and walls as they are built.
6. 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".
7. 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".
8. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals.
9. Seal space outside of sleeves in concrete slabs and walls with grout.
10. 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.
11. Install sleeve materials according to the following applications:

a. Sleeves for Piping Passing through Concrete Floor Slabs: Molded PE **OR** Molded PVC **OR** Galvanized-steel pipe, **as directed**.

b. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Galvanized-steel pipe **OR** Stack sleeve fittings, **as directed**.

1) Extend sleeves 2 inches (50 mm) above finished floor level.
2) 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".

c. Sleeves for Piping Passing through Gypsum-Board Partitions:
1) PVC-pipe **OR** Galvanized-steel-pipe, **as directed**, sleeves for pipes smaller than NPS 6 (DN 150).
2) Galvanized-steel-sheet sleeves for pipes NPS 6 (DN 150) and larger.
3) Exception: Sleeves are not required for water-supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.

d. Sleeves for Piping Passing through Concrete Roof Slabs: Molded PE **OR** Molded PVC **OR** Galvanized-steel pipe, **as directed**.

e. Sleeves for Piping Passing through Exterior Concrete Walls:
1) Galvanized-steel-pipe sleeves for pipes smaller than NPS 6 (DN 150).
2) Cast-iron wall-pipe sleeves for pipes NPS 6 (DN 150) and larger.
3) 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.

f. Sleeves for Piping Passing through Interior Concrete Walls:
1) PVC-pipe **OR** Galvanized-steel-pipe, **as directed**, sleeves for pipes smaller than NPS 6 (DN 150).
2) Galvanized-steel-sheet sleeves for pipes NPS 6 (DN 150) and larger.

12. 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".

M. Sleeve Seal Installation
1. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.
2. 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.

N. Identification
1. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
2. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification For Electrical Systems".

O. Field Quality Control
1. Perform tests and inspections.
2. Tests and Inspections:
a. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
b. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
c. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
d. Energize circuits to electrical equipment and devices.
e. Start and run excess-pressure pumps.
f. Coordinate with fire-alarm tests. Operate as required.
g. Coordinate with fire-pump tests. Operate as required.
h. Verify that equipment hose threads are same as local fire-department equipment.
3. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports.

P. Cleaning
1. Clean dirt and debris from sprinklers.
2. Remove and replace sprinklers with paint other than factory finish.

Q. Piping Schedule
1. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends; cast-iron threaded fittings; and threaded **OR** grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved, **as directed**, joints.
2. Sprinkler specialty fittings may be used, downstream of control vales, instead of specified fittings.
3. Copper-tube, extruded-tee connections may be used for tee branches in copper tubing instead of specified copper fittings. Branch-connection joints must be brazed.
4. CPVC pipe; Schedule 40 **OR** Schedule 80, **as directed**, CPVC fittings; and solvent-cemented joints may be used for light-hazard and residential occupancies.
5. Standard-pressure, wet-pipe sprinkler system, NPS 2 (DN 50) and smaller, shall be one of the following:
   a. Standard-weight or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
   b. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
   c. Standard-weight or Schedule 30, black-steel pipe with plain ends; uncoated, plain-end-pipe fittings; and twist-locked joints.
   d. Standard-weight or Schedule 30, galvanized-steel pipe with plain ends; galvanized, plain-end-pipe fittings; and twist-locked joints.
   e. Standard-weight or Schedule 30, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   f. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   g. Standard-weight or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
   h. Thinwall **OR** Schedule 10, **as directed**, nonstandard OD, thinwall or hybrid black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   i. Thinwall **OR** Schedule 10, **as directed**, or hybrid black-steel pipe with plain ends; uncoated, plain-end-pipe fittings; and twist-locked joints.
   j. Thinwall **OR** Schedule 10, **as directed**, nonstandard OD, thinwall or hybrid black-steel pipe with plain ends; welding fittings; and welded joints.
   k. Schedule 5 steel pipe; steel pressure-seal fittings; and pressure-sealed joints.
   l. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with plain ends; cast- or wrought-copper solder-joint fittings; and brazed joints.
   m. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with plain ends; copper pressure-seal fittings; and pressure-sealed joints.
   n. NPS 2 (DN 50), Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.
6. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be one of the following:
   a. Standard-weight or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
   b. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
   c. Standard-weight or Schedule 30, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

d. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
e. Standard-weight or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
f. Thinwall **OR** Schedule 10, **as directed**, nonstandard OD, thinwall or hybrid black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
g. Thinwall **OR** Schedule 10, **as directed**, nonstandard OD, thinwall or hybrid black-steel pipe with plain ends; welding fittings; and welded joints.
h. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with plain ends; cast- or wrought-copper solder-joint fittings; and brazed joints.
i. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with plain ends; copper pressure-seal fittings; and pressure-sealed joints.
j. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.

7. Standard-pressure, wet-pipe sprinkler system, NPS 5 (DN 125) and larger, shall be one of the following:
   a. Standard-weight or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
   b. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
   c. Standard-weight or Schedule 30, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   d. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   e. Standard-weight or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
   f. Thinwall **OR** Schedule 10, **as directed**, or hybrid black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   g. Thinwall **OR** Schedule 10, **as directed**, or hybrid black-steel pipe with plain ends; welding fittings; and welded joints.
   h. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with plain ends; cast- or wrought-copper solder-joint fittings; and brazed joints.
   i. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.
8. High-pressure, wet-pipe sprinkler system, NPS 4 (DN 100) and smaller, shall be one of the following:
   a. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
   b. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   c. Standard-weight or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
   d. Thinwall **OR** Schedule 10, **as directed**, or hybrid black-steel pipe with plain ends; welding fittings; and welded joints.
9. High-pressure, wet-pipe sprinkler system, NPS 5 (DN 125) and larger, shall be one of the following:
   a. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.

b. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
c. Standard-weight or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
d. Thinwall **OR** Schedule 10, **as directed**, or hybrid black-steel pipe with plain ends; welding fittings; and welded joints.

R. Sprinkler Schedule
1. Use sprinkler types in subparagraphs below for the following applications:
a. Rooms without Ceilings: Upright sprinklers.
b. Rooms with Suspended Ceilings: Pendent sprinklers **OR** Recessed sprinklers **OR** Flush sprinklers **OR** Concealed sprinklers, **as directed**.
c. Wall Mounting: Sidewall sprinklers.
d. Spaces Subject to Freezing: Upright sprinklers **OR** Pendent, dry sprinklers **OR** Sidewall, dry sprinklers, **as directed**.
e. Deluge-Sprinkler Systems: Upright and pendent, open sprinklers.
f. Special Applications: Extended-coverage, flow-control, and quick-response sprinklers where indicated.
2. Provide sprinkler types in subparagraphs below with finishes indicated.
a. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
b. Flush Sprinklers: Bright chrome, with painted white escutcheon.
c. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
d. Residential Sprinklers: Dull chrome.
e. 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 13 13 00

SECTION 21 13 16 00 - DRY-PIPE FIRE-SUPPRESSION SPRINKLERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for dry-pipe fire-suppression sprinklers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Pipes, fittings, and specialties.
b. Fire-protection valves.
c. Fire-department connections.
d. Sprinkler specialty pipe fittings.
e. Sprinklers.
f. Alarm devices.
g. Manual control stations.
h. Control panels.
i. Pressure gages.

C. Definitions
1. Standard-Pressure Sprinkler Piping: Dry-pipe sprinkler system piping designed to operate at working pressure 175 psig (1200 kPa) maximum.

D. System Descriptions
1. Dry-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing compressed air. Opening of sprinklers releases compressed air and permits water pressure to open dry-pipe valve. Water then flows into piping and discharges from sprinklers that are open.
2. Combined Dry-Pipe and Preaction Sprinkler System: Automatic sprinklers are attached to piping containing compressed air. Fire-detection system in same area as sprinklers actuates tripping devices that open dry-pipe valve without loss of air pressure and actuates fire alarm. Water discharges from sprinklers that have opened.
3. Single-Interlock Preaction Sprinkler System: Automatic sprinklers are attached to piping containing low-pressure air. Actuation of fire-detection system in same area as sprinklers opens deluge valve, permitting water to flow into piping and to discharge from sprinklers that have opened.
4. Double-Interlock Preaction Sprinkler System: Automatic sprinklers are attached to piping containing low-pressure air. Actuation of a fire-detection system in the same area as sprinklers opens the deluge valve permitting water to flow into the sprinkler piping; a closed solenoid valve in the sprinkler piping is opened by another fire-detection device; then water will discharge from sprinklers that have opened.

E. Performance Requirements
1. Standard-Pressure Piping System Component: Listed for 175-psig (1200-kPa) minimum working pressure.
2. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
3. Sprinkler system design shall be approved by authorities having jurisdiction.
a. Margin of Safety for Available Water Flow and Pressure: 10 **OR** 20, **as directed**, percent, including losses through water-service piping, valves, and backflow preventers.
b. Sprinkler Occupancy Hazard Classifications:
1) Automobile Parking Areas: Ordinary Hazard, Group 1.

2) Building Service Areas: Ordinary Hazard, Group 1.
3) Churches: Light Hazard.
4) Electrical Equipment Rooms: Ordinary Hazard, Group 1.
5) Dry Cleaners: Ordinary Hazard, Group 2.
6) General Storage Areas: Ordinary Hazard, Group 1.
7) Laundries: Ordinary Hazard, Group 1.
8) Libraries Except Stack Areas: Light Hazard.
9) Library Stack Areas: Ordinary Hazard, Group 2.
10) Machine Shops: Ordinary Hazard, Group 2.
11) Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
12) Office and Public Areas: Light Hazard.
13) Plastics Processing Areas: Extra Hazard, Group 2.
14) Printing Plants: Extra Hazard, Group 1.
15) Repair Garages: Ordinary Hazard, Group 2.
16) Restaurant Service Areas: Ordinary Hazard, Group 1.
17) Solvent Cleaning Areas: Extra Hazard, Group 2.
18) Upholstering Plants: Extra Hazard, Group 1.

c. Minimum Density for Automatic-Sprinkler Piping Design:
1) Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. (4.1 mm/min. over 139-sq. m) area.
2) Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. (6.1 mm/min. over 139-sq. m) area.
3) Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. (8.1 mm/min. over 139-sq. m) area.
4) Extra-Hazard, Group 1 Occupancy: 0.30 gpm over 2500-sq. ft. (12.2 mm/min. over 232-sq. m) area.
5) Extra-Hazard, Group 2 Occupancy: 0.40 gpm over 2500-sq. ft. (16.3 mm/min. over 232-sq. m) area.
6) Special Occupancy Hazard: As determined by authorities having jurisdiction.

d. Maximum Protection Area per Sprinkler: Per UL listing.
OR
Maximum Protection Area per Sprinkler:
1) Office Spaces: 120 sq. ft. (11.1 sq. m) **OR** 225 sq. ft. (20.9 sq. m), **as directed**.
2) Storage Areas: 130 sq. ft. (12.1 sq. m).
3) Mechanical Equipment Rooms: 130 sq. ft. (12.1 sq. m).
4) Electrical Equipment Rooms: 130 sq. ft. (12.1 sq. m).
5) Other Areas: According to NFPA 13 recommendations unless otherwise indicated.

e. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated:
1) Light-Hazard Occupancies: 100 gpm (6.3 L/s) for 30 minutes.
2) Ordinary-Hazard Occupancies: 250 gpm (15.75 L/s) for 60 to 90 minutes.
3) Extra-Hazard Occupancies: 500 gpm (31.5 L/s) for 90 to 120 minutes.

4. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7.

F. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: For dry-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.
a. Wiring Diagrams: For power, signal, and control wiring.
3. 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.
4. Qualification Data: For qualified Installer and professional engineer, **as directed**.

5. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
6. Fire-hydrant flow test report.
7. 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."
8. Field quality-control reports.
9. Operation and maintenance data.

G. Quality Assurance
1. Installer Qualifications:
   a. 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.
      1) Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
2. 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.
3. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
   a. NFPA 13, "Installation of Sprinkler Systems."
   b. NFPA 13R, "Installation of Sprinkler Systems in Residential Occupancies up to and Including Four Stories in Height."
   c. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."

H. Project Conditions
1. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:
   a. Notify the Owner no fewer than two days in advance of proposed interruption of sprinkler service.
   b. Do not proceed with interruption of sprinkler service without the Owner's written permission.

1.2 PRODUCTS

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

B. Steel Pipe And Fittings
1. Standard Weight, Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.
2. Schedule 30, Galvanized-Steel Pipe: ASTM A 135; ASTM A 795/A 795M, Type E; or ASME B36.10M, wrought steel; with wall thickness not less than Schedule 30 and not more than Schedule 40. Pipe ends may be factory or field formed to match joining method.
3. Thinwall Galvanized-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, threadable, with wall thickness less than Schedule 30 and equal to or greater than Schedule 10. Pipe ends may be factory or field formed to match joining method.
4. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.
5. Galvanized, Steel Couplings: ASTM A 865, threaded.
6. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
7. Malleable- or Ductile-Iron Unions: UL 860.
8. Cast-Iron Flanges: ASME B16.1, Class 125.

9. Plain-End-Pipe Fittings: UL 213, ductile-iron body with retainer lugs that require one-quarter turn or screwed retainer pin to secure pipe in fitting.
10. Grooved-Joint, Steel-Pipe Appurtenances:
    a. Pressure Rating: 175 psig (1200 kPa) **OR** 250 psig (1725 kPa) **OR** 300 psig (2070 kPa), **as directed**, minimum.
    b. Galvanized, 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.
    c. 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.

C. Copper Tube And Fittings
1. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) and ASTM B 88, Type M (ASTM B 88M, Type C) water tube, drawn temper.
2. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
3. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.
4. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
5. 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.
6. Copper Pressure-Seal Fittings:
    a. Standard: UL 213.
    b. NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
    c. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Cast-bronze fitting with EPDM-rubber O-ring seal in each end.
7. Grooved-Joint, Copper-Tube Appurtenances:
    a. Grooved-End, Copper Fittings: ASTM B 75 (ASTM B 75M), copper tube or ASTM B 584, bronze castings.
    b. Grooved-End-Tube Couplings: To fit copper tube, with dimensions and design similar to AWWA C606. Include ferrous housing sections, EPDM-rubber gasket suitable for hot and cold water, and bolts and nuts.
8. Copper-Tube, Extruded-Tee Connections:
    a. Description: Tee formed in copper tube according to ASTM F 2014.

D. Piping Joining Materials
1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free.
    a. Class 125, Cast-Iron and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
    b. Class 250, Cast-Iron and Class 300, Raised-Face Flanges: Ring-type gaskets.
2. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
3. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

E. Listed Fire-Protection Valves
1. General Requirements:
    a. Valves shall be UL listed or FM approved.
    b. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig (1200 kPa).
2. Ball Valves:
    a. Standard: UL 1091 except with ball instead of disc.
    b. Valves NPS 1-1/2 (DN 40) and Smaller: Bronze body with threaded ends.
    c. Valves NPS 2 and NPS 2-1/2 (DN 50 and DN 65): Bronze body with threaded ends or ductile-iron body with grooved ends.
    d. Valves NPS 3 (DN 80): Ductile-iron body with grooved ends.

F. Bronze Butterfly Valves:

a. Standard: UL 1091.
b. Pressure Rating: 175 psig (1200 kPa).
c. Body Material: Bronze.
d. End Connections: Threaded.

G. Iron Butterfly Valves:
a. Standard: UL 1091.
b. Pressure Rating: 175 psig (1200 kPa).
c. Body Material: Cast or ductile iron.
d. Style: Lug or wafer.
OR
End Connections: Grooved.

H. Check Valves:
a. Standard: UL 312
b. Pressure Rating: 250 psig (1725 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
c. Type: Swing check.
d. Body Material: Cast iron.
e. End Connections: Flanged or grooved.

2. Bronze OS&Y Gate Valves:
a. Standard: UL 262.
b. Pressure Rating: 175 psig (1200 kPa).
c. Body Material: Bronze.
d. End Connections: Threaded.

3. Iron OS&Y Gate Valves:
a. Standard: UL 262.
b. Pressure Rating: 250 psig (1725 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
c. Body Material: Cast or ductile iron.
d. End Connections: Flanged or grooved.

4. Indicating-Type Butterfly Valves:
a. Standard: UL 1091.
b. Pressure Rating: 175 psig (1200 kPa) minimum.
c. Valves NPS 2 (DN 50) and Smaller:
1) Valve Type: Ball or butterfly.
2) Body Material: Bronze.
3) End Connections: Threaded.
d. Valves NPS 2-1/2 (DN 65) and Larger:
1) Valve Type: Butterfly.
2) Body Material: Cast or ductile iron.
3) End Connections: Flanged, grooved, or wafer.
e. Valve Operation: Integral electrical, 115-V ac, prewired, single-circuit, supervisory switch **OR** electrical, 115-V ac, prewired, two-circuit, supervisory switch **OR** visual, **as directed**, indicating device.

5. NRS Gate Valves:
a. Standard: UL 262.
b. Pressure Rating: 250 psig (1725 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
c. Body Material: Cast iron with indicator post flange.
d. Stem: Nonrising.
e. End Connections: Flanged or grooved.

6. Indicator Posts:
a. Standard: UL 789.
b. Type: Horizontal for wall mounting.
c. Body Material: Cast iron with extension rod and locking device.
d. Operation: Wrench **OR** Hand wheel, **as directed**.

I. Trim And Drain Valves

1. General Requirements:
   a. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
   b. Pressure Rating: 175 psig (1200 kPa) minimum.
2. Angle Valves.
3. Ball Valves.
4. Globe Valves.
5. Plug Valves.

J. Specialty Valves
1. General Requirements:
   a. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
   b. Pressure Rating:
      1) Standard-Pressure Piping Specialty Valves: 175 psig (1200 kPa) minimum.
      2) High-Pressure Piping Specialty Valves: 250 psig (1725 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
   c. Body Material: Cast or ductile iron.
   d. Size: Same as connected piping.
   e. End Connections: Flanged or grooved.
2. Dry-Pipe Valves:
   a. Standard: UL 260
   b. Design: Differential-pressure type.
   c. Include UL 1486, quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
   d. Air-Pressure Maintenance Device:
      1) Standard: UL 260.
      2) Type: Automatic device to maintain minimum air pressure in piping.
      3) Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with 14- to 60-psig (95- to 410-kPa) adjustable range, and 175-psig (1200-kPa) **OR** 300-psig (2070-kPa), **as directed**, outlet pressure.
   e. Air Compressor:
      1) Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
      2) Motor Horsepower: Fractional.
      3) Power: 120-V ac, 60 Hz, single phase.
3. Deluge Valves:
   a. Standard: UL 260.
   b. Design: Hydraulically operated, differential-pressure type.
   c. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, drip cup assembly piped without valves and separate from main drain line, fill-line attachment with strainer, and push-rod chamber supply connection.
   d. Dry, Pilot-Line Trim Set: Include dry, pilot-line actuator; air- and water-pressure gages; low-air-pressure warning switch; air relief valve; and actuation device. Dry, pilot-line actuator includes cast-iron, operated, diaphragm-type valve with resilient facing plate, resilient diaphragm, and replaceable bronze seat. Valve includes threaded water and air inlets and water outlet. Loss of air pressure on dry, pilot-line side allows pilot-line actuator to open and causes deluge valve to open immediately.
   e. Air-Pressure Maintenance Device:
      1) Standard: UL 260.
      2) Type: Automatic device to maintain minimum air pressure in piping.
      3) Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure,

strainer, pressure ratings with 14- to 60-psig (95- to 410-kPa) adjustable range, and 175-psig (1200-kPa) **OR** 300-psig (2070-kPa), **as directed**, outlet pressure.

f. Air Compressor:
   1) Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
   2) Motor Horsepower: Fractional.
   3) Power: 120-V ac, 60 Hz, single phase.

4. Automatic (Ball Drip) Drain Valves:
   a. Standard: UL 1726.
   b. Pressure Rating: 175 psig (1200 kPa) minimum.
   c. Type: Automatic draining, ball check.
   d. Size: NPS 3/4 (DN 20).
   e. End Connections: Threaded.

K. Fire-Department Connections
1. Exposed-Type, Fire-Department Connection:
   a. Standard: UL 405.
   b. Type: Exposed, projecting, for wall mounting.
   c. Pressure Rating: 175 psig (1200 kPa) minimum.
   d. Body Material: Corrosion-resistant metal.
   e. 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.
   f. Caps: Brass, lugged type, with gasket and chain.
   g. Escutcheon Plate: Round, brass, wall type.
   h. Outlet: Back, with pipe threads.
   i. Number of Inlets: Two **OR** Three, **as directed**.
   j. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE" **OR** "AUTO SPKR", **as directed**.
   k. Finish: Polished chrome plated **OR** Rough brass or bronze **OR** Rough chrome plated, **as directed**.
   l. Outlet Size: NPS 4 (DN 100) **OR** NPS 5 (DN 125) **OR** NPS 6 (DN 150), **as directed**.
2. Flush-Type, Fire-Department Connection:
   a. Standard: UL 405.
   b. Type: Flush, for wall mounting.
   c. Pressure Rating: 175 psig (1200 kPa) minimum.
   d. Body Material: Corrosion-resistant metal.
   e. 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.
   f. Caps: Brass, lugged type, with gasket and chain.
   g. Escutcheon Plate: Rectangular, brass, wall type.
   h. Outlet: With pipe threads.
   i. Body Style: Horizontal **OR** Square **OR** Vertical, **as directed**.
   j. Number of Inlets: Two **OR** Three **OR** Four **OR** Six, **as directed**.
   k. Outlet Location: Back **OR** Bottom **OR** Left side **OR** Right side **OR** Top, **as directed**.
   l. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE" **OR** "AUTO SPKR", **as directed**.
   m. Finish: Polished chrome plated **OR** Rough brass or bronze **OR** Rough chrome plated, **as directed**.
   n. Outlet Size: NPS 4 (DN 100) **OR** NPS 5 (DN 125) **OR** NPS 6 (DN 150) **OR** NPS 8 (DN 200), **as directed**.
3. Yard-Type, Fire-Department Connection:
   a. Standard: UL 405.
   b. Type: Exposed, freestanding.
   c. Pressure Rating: 175 psig (1200 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.

d. Body Material: Corrosion-resistant metal.
e. 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.
f. Caps: Brass, lugged type, with gasket and chain.
g. Escutcheon Plate: Round, brass, floor type.
h. Outlet: Bottom, with pipe threads.
i. Number of Inlets: Two **OR** Three **OR** Four, **as directed**.
j. Sleeve: Brass **OR** Not required, **as directed**.
k. Sleeve Height: 18 inches (460 mm).
l. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE" **OR** "AUTO SPKR", **as directed**.
m. Finish, Including Sleeve: Polished chrome plated **OR** Rough brass or bronze **OR** Rough chrome plated, **as directed**.
n. Outlet Size: NPS 4 (DN 100) **OR** NPS 5 (DN 125) **OR** NPS 6 (DN 150), **as directed**.

L. Sprinkler Specialty Pipe Fittings
1. General Requirements for Dry-Pipe-System Fittings: UL listed for dry-pipe service.
2. Branch Outlet Fittings:
a. Standard: UL 213.
b. Pressure Rating: 175 psig (1200 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
c. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
d. Type: Mechanical-T and -cross fittings.
e. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
f. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
g. Branch Outlets: Grooved, plain-end pipe, or threaded.
3. Flow Detection and Test Assemblies:
a. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
b. Pressure Rating: 175 psig (1200 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
c. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
d. Size: Same as connected piping.
e. Inlet and Outlet: Threaded.
4. Branch Line Testers:
a. Standard: UL 199.
b. Pressure Rating: 175 psig (1200 kPa) minimum.
c. Body Material: Brass.
d. Size: Same as connected piping.
e. Inlet: Threaded.
f. Drain Outlet: Threaded and capped.
g. Branch Outlet: Threaded, for sprinkler.
5. Sprinkler Inspector's Test Fittings:
a. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
b. Pressure Rating: 175 psig (1200 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
c. Body Material: Cast- or ductile-iron housing with sight glass.
d. Size: Same as connected piping.
e. Inlet and Outlet: Threaded.
6. Adjustable Drop Nipples:
a. Standard: UL 1474.
b. Pressure Rating: 250 psig (1725 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
c. Body Material: Steel pipe with EPDM O-ring seals.
d. Size: Same as connected piping.
e. Length: Adjustable.

f. Inlet and Outlet: Threaded.

7. Flexible, Sprinkler Hose Fittings:
   a. Standard: UL 1474.
   b. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
   c. Pressure Rating: 175 psig (1200 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
   d. Size: Same as connected piping, for sprinkler.

M. Sprinklers
1. General Requirements:
   a. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
   b. Pressure Rating for Residential Sprinklers: 175 psig (1200 kPa) maximum.
   c. Pressure Rating for Automatic Sprinklers: 175 psig (1200 kPa) minimum.
   d. Pressure Rating for High-Pressure Automatic Sprinklers: 250 psig (1725 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
2. Automatic Sprinklers with Heat-Responsive Element:
   a. Nonresidential Applications: UL 199.
   b. Residential Applications: UL 1626.
   c. 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.
3. Sprinkler Finishes:
   a. Chrome plated.
   b. Bronze.
   c. Painted.
4. Special Coatings:
   a. Wax.
   b. Lead.
   c. Corrosion-resistant paint.
5. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
   a. Ceiling Mounting: Chrome-plated steel, one piece, flat **OR** Chrome-plated steel, two piece, with 1-inch (25-mm) vertical adjustment **OR** Plastic, white finish, one piece, flat, **as directed**.
   b. Sidewall Mounting: Chrome-plated steel **OR** Plastic, white finish, **as directed**, one piece, flat.
6. Sprinkler Guards:
   a. Standard: UL 199.
   b. Type: Wire cage with fastening device for attaching to sprinkler.

N. Alarm Devices
1. Alarm-device types shall match piping and equipment connections.
2. Water-Motor-Operated Alarm:
   a. Standard: UL 753.
   b. Type: Mechanically operated, with Pelton wheel.
   c. Alarm Gong: Cast aluminum with red-enamel factory finish.
   d. Size: 10-inch (250-mm) diameter.
   e. Components: Shaft length, bearings, and sleeve to suit wall construction.
   f. Inlet: NPS 3/4 (DN 20).
   g. Outlet: NPS 1 (DN 25) drain connection.
3. Electrically Operated Alarm Bell:
   a. Standard: UL 464.
   b. Type: Vibrating, metal alarm bell.

c. Size: 6-inch (150-mm) minimum **OR** 8-inch (200-mm) minimum **OR** 10-inch (250-mm), **as directed**, diameter.
d. Finish: Red-enamel factory finish, suitable for outdoor use.

4. Pressure Switches:
   a. Standard: UL 346.
   b. Type: Electrically supervised water-flow switch with retard feature.
   c. Components: Single-pole, double-throw switch with normally closed contacts.
   d. Design Operation: Rising pressure signals water flow.
5. Valve Supervisory Switches:
   a. Standard: UL 346.
   b. Type: Electrically supervised.
   c. Components: Single-pole, double-throw switch with normally closed contacts.
   d. Design: Signals that controlled valve is in other than fully open position.
6. Indicator-Post Supervisory Switches:
   a. Standard: UL 346.
   b. Type: Electrically supervised.
   c. Components: Single-pole, double-throw switch with normally closed contacts.
   d. Design: Signals that controlled indicator-post valve is in other than fully open position.

O. Manual Control Stations
1. Description: UL listed or FM Global approved, hydraulic operation, with union, NPS 1/2 (DN 15) pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

P. Control Panels
1. Description: Single-area, two-area, or single-area cross-zoned type control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves. Panels contain power supply; battery charger; standby batteries; field-wiring terminal strip; electrically supervised solenoid valves and polarized fire-alarm bell; lamp test facility; single-pole, double-throw auxiliary alarm contacts; and rectifier.

2. Panels: UL listed and FM Global approved when used with thermal detectors and Class A detector circuit wiring. Electrical characteristics are 120-V ac, 60 Hz, with 24-V dc rechargeable batteries.
   a. Manual Control Stations: Electric operation, metal enclosure, labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.
      OR
      Manual Control Stations: Hydraulic operation, with union, NPS 1/2 (DN 15) pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

Q. Pressure Gages
1. Standard: UL 393.
2. Dial Size: 3-1/2- to 4-1/2-inch (90- to 115-mm) diameter.
3. Pressure Gage Range: 0 to 250 psig (0 to 1725 kPa) minimum **OR** 0 to 300 psig (0 to 2070 kPa), **as directed**.
4. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.
5. Air System Piping Gage: Include retard feature, **as directed**, and "AIR" or "AIR/WATER" label on dial face.

R. Escutcheons
1. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.

2. One-Piece, Cast-Brass Escutcheons: Polished chrome-plated or rough-brass finish with set-screws.
3. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with chrome-plated finish.
4. One-Piece, Stamped-Steel Escutcheons: Chrome-plated finish with set-screw or spring clips.
5. Split-Casting, Cast-Brass Escutcheons: Polished chrome-plated or rough-brass finish with concealed hinge and set-screw.
6. Split-Plate, Stamped-Steel Escutcheons: Chrome-plated finish with concealed **OR** exposed-rivet, **as directed**, hinge, set-screw or spring clips.
7. One-Piece Floor Plates: Cast-iron flange with holes for fasteners, **as directed**.
8. Split-Casting Floor Plates: Cast brass with concealed hinge.

S. Sleeves
1. 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.
2. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
3. Molded-PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
4. Molded-PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.
5. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
6. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, standard weight, zinc coated, plain ends.
7. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   a. Underdeck Clamp: Clamping ring with set-screws.

T. Sleeve Seals
1. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   a. Sealing Elements: EPDM-rubber or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   b. Pressure Plates: Carbon steel **OR** Plastic **OR** Stainless steel, **as directed**.
   c. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating **OR** Stainless steel, **as directed**, of length required to secure pressure plates to sealing elements.

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

1.3 EXECUTION

A. Preparation
1. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
2. Report test results promptly and in writing.

B. Service-Entrance Piping
1. Connect sprinkler piping to water-service piping for service entrance to building. Comply with requirements in Division 21 Section "Facility Fire-suppression Water-service Piping" for exterior piping.

2. Install shutoff valve, backflow preventer, **as directed**, pressure gage, drain, and other accessories indicated at connection to water-service piping. Comply with requirements in Division 21 Section "Facility Fire-suppression Water-service Piping" for backflow preventers, **as directed**.
3. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

C. Water-Supply Connections
1. Connect sprinkler piping to building's interior water-distribution piping. Comply with requirements in Division 22 Section "Domestic Water Piping" for interior piping.
2. Install shutoff valve, backflow preventer, **as directed**, pressure gage, drain, and other accessories indicated at connection to water-distribution piping. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for backflow preventers, **as directed**.
3. Install shutoff valve, check valve, pressure gage, and drain at connection to water supply.

D. Piping Installation
1. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
   a. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with the Owner before deviating from approved working plans.
2. Piping Standard: Comply with requirements in NFPA 13 for installation of sprinkler piping.
3. Install seismic restraints on piping. Comply with requirements in NFPA 13 for seismic-restraint device materials and installation.
4. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
5. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
6. 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.
7. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
8. Install sprinkler piping with drains for complete system drainage.
9. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
10. Install automatic (ball drip) drain valves to drain piping between fire-department connections and check valves. Drain to floor drain or to outside building.
11. Connect compressed-air supply to dry-pipe sprinkler piping.
    OR
    Connect air compressor to the following piping and wiring:
    a. Pressure gages and controls.
    b. Electrical power system.
    c. Fire-alarm devices, including low-pressure alarm.
12. Install alarm devices in piping systems.
13. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements in NFPA 13 for hanger materials.
14. 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.
15. Drain dry-pipe sprinkler piping.
16. Pressurize and check dry-pipe sprinkler system piping and air-pressure maintenance devices **OR** air compressors, **as directed**.

E. Joint Construction

1. 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.
2. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
3. 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.
4. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
5. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
6. 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.
7. 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:
   a. Apply appropriate tape or thread compound to external pipe threads.
   b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
8. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.
9. 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.
10. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.
11. Copper-Tubing Grooved Joints: Roll rounded-edge groove in end of tube according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
12. Copper-Tubing, Pressure-Sealed Joints: Join copper tube and copper pressure-seal fittings with tools recommended by fitting manufacturer.
13. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
14. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

F. Valve And Specialties Installation
1. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
2. 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.
3. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
4. Specialty Valves:
   a. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
   b. Dry-Pipe and Deluge Valves: Install trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
      1) Install air compressor and compressed-air supply piping.
      2) Air-Pressure Maintenance Device: Install shutoff valves to permit servicing without shutting down sprinkler system; bypass valve for quick system filling; pressure regulator or switch to maintain system pressure; strainer; pressure ratings with 14- to 60-psig (95- to 410-kPa) adjustable range; and 175-psig (1200-kPa) maximum inlet pressure.
      3) Install compressed-air supply piping from building's compressed-air piping system.

G. Sprinkler Installation
1. Install sprinklers in suspended ceilings in center of narrow dimension of, **as directed**, acoustical ceiling panels.
2. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.
3. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.

H. Fire-Department Connection Installation
1. Install wall-type, fire-department connections.
2. Install yard-type, fire-department connections in concrete slab support. Comply with requirements for concrete in Division 03 Section "Cast-in-place Concrete".
   a. Install two **OR** three, **as directed**, protective pipe bollards around **OR** on sides of, **as directed**, each fire-department connection. Comply with requirements for bollards in Division 05 Section "Metal Fabrications".
3. Install automatic (ball drip) drain valve at each check valve for fire-department connection.

I. Escutcheon Installation
1. Install escutcheons for penetrations of walls, ceilings, and floors.
2. Escutcheons for New Piping:
   a. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
   b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** stamped steel with set-screw **OR** stamped steel with set-screw or spring clips **OR** stamped steel with spring clips, **as directed**.
   c. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** One piece or split casting, cast brass with polished chrome-plated finish **OR** Split casting, cast brass with polished chrome-plated finish **OR** One piece, stamped steel with set-screw **OR** One piece or split plate, stamped steel with set-screw **OR** Split plate, stamped steel with set-screw, **as directed**.
   d. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish **OR** cast brass with rough-brass finish **OR** stamped steel with set-screw **OR** stamped steel with spring clips **OR** stamped steel with set-screw or spring clips, **as directed**.
   e. Bare Piping in Equipment Rooms: One piece, cast brass **OR** stamped steel with set-screw **OR** stamped steel with spring clips **OR** stamped steel with set-screw or spring clips, **as directed**.
   f. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.
3. Escutcheons for Existing Piping:
   a. Chrome-Plated Piping: Split casting, cast brass with chrome-plated finish.
   b. Insulated Piping: Split plate, stamped steel with concealed or exposed-rivet hinge and spring clips.
   c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and spring clips, **as directed**.
   d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and set-screw, **as directed**.
   e. Bare Piping in Unfinished Service Spaces: Split casting, cast brass with polished chrome-plated finish **OR** casting, cast brass with rough-brass finish **OR** plate, stamped steel with concealed hinge and set-screw or spring clips **OR** plate, stamped steel with concealed or exposed-rivet hinge and set-screw or spring clips **OR** plate, stamped steel with exposed-rivet hinge and set-screw or spring clips, **as directed**.
   f. Bare Piping in Equipment Rooms: Split casting, cast brass **OR** plate, stamped steel with set-screw or spring clips, **as directed**.
   g. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.

J. Sleeve Installation
1. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.
2. Sleeves are not required for core-drilled holes.
3. Permanent sleeves are not required for holes formed by removable PE sleeves.
4. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.
5. Install sleeves in new partitions, slabs, and walls as they are built.
6. For interior wall penetrations, 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".
7. 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".
8. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals.
9. Seal space outside of sleeves in concrete slabs and walls with grout.
10. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe unless otherwise indicated.
11. Install sleeve materials according to the following applications:
    a. Sleeves for Piping Passing through Concrete Floor Slabs: Molded PE **OR** Molded PVC **OR** Galvanized-steel pipe, **as directed**.
    b. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Galvanized-steel pipe **OR** Stack sleeve fittings, **as directed**.
        1) Extend sleeves 2 inches (50 mm) above finished floor level.
        2) 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".
    c. Sleeves for Piping Passing through Gypsum-Board Partitions:
        1) PVC-pipe **OR** Galvanized-steel-pipe, **as directed**, sleeves for pipes smaller than NPS 6 (DN 150).
        2) Galvanized-steel-sheet sleeves for pipes NPS 6 (DN 150) and larger.
        3) Exception: Sleeves are not required for water-supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.
    d. Sleeves for Piping Passing through Concrete Roof Slabs: Molded PE **OR** Molded PVC **OR** Galvanized-steel pipe, **as directed**.
    e. Sleeves for Piping Passing through Exterior Concrete Walls:
        1) Galvanized-steel-pipe sleeves for pipes smaller than NPS 6 (DN 150).
        2) Cast-iron wall pipe sleeves for pipes NPS 6 (DN 150) and larger.
        3) Install sleeves that are large enough to provide 1-inch (25-mm) annular clear space between sleeve and pipe when sleeve seals are used.
    f. Sleeves for Piping Passing through Interior Concrete Walls:
        1) PVC-pipe **OR** Galvanized-steel pipe, **as directed**, sleeves for pipes smaller than NPS 6 (DN 150).
        2) Galvanized-steel-sheet sleeves for pipes NPS 6 (DN 150) and larger.
12. 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" for firestop materials and installations.

K. Sleeve Seal Installation
1. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.
2. 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.

L. Identification
1. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
2. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification For Electrical Systems".

M. Field Quality Control
1. Perform tests and inspections.
2. Tests and Inspections:
   a. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
   b. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   c. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
   d. Energize circuits to electrical equipment and devices.
   e. Start and run air compressors.
   f. Coordinate with fire-alarm tests. Operate as required.
   g. Coordinate with fire-pump tests. Operate as required.
   h. Verify that equipment hose threads are same as local fire-department equipment.
3. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports.

N. Cleaning
1. Clean dirt and debris from sprinklers.
2. Remove and replace sprinklers with paint other than factory finish.

O. Demonstration
1. Train the Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

P. Piping Schedule
1. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends; cast-iron threaded fittings; and threaded **OR** grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved, **as directed**, joints.
2. Sprinkler specialty fittings may be used, downstream of control vales, instead of specified fittings.
3. Copper-tube, extruded-tee connections may be used for tee branches in copper tubing instead of specified copper fittings. Branch-connection joints must be brazed.
4. Standard-pressure, dry-pipe sprinkler system, NPS 2 (DN 50) and smaller, shall be one of the following:
   a. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
   b. Standard-weight **OR** Schedule 30 **OR** thinwall, **as directed**, galvanized-steel pipe with plain ends; plain-end-pipe fittings; and twist-locked joints.
   c. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   d. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with plain ends; cast- or wrought-copper solder-joint fittings; and brazed joints.
   e. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with plain ends; copper pressure-seal fittings; and pressure-sealed joints.
   f. NPS 2 (DN 50), Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.

5. Standard-pressure, dry-pipe sprinkler system, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be one of the following:
   a. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
   b. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   c. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with plain ends; cast- or wrought-copper solder-joint fittings; and brazed joints.
   d. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with plain ends; copper pressure-seal fittings; and pressure-sealed joints.
   e. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.
6. Standard-pressure, dry-pipe sprinkler system, NPS 5 and NPS 6 (DN 125 and DN 150), shall be one of the following:
   a. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
   b. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   c. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with plain ends; cast- or wrought-copper solder-joint fittings; and brazed joints.
   d. Type L (Type B) **OR** Type M (Type C), **as directed**, hard copper tube with roll-grooved ends; copper, grooved-end fittings; grooved-end-tube couplings; and grooved joints.

Q. Sprinkler Schedule
1. Use sprinkler types in subparagraphs below for the following applications:
   a. Rooms without Ceilings: Upright sprinklers.
   b. Rooms with Suspended Ceilings: Dry pendent sprinklers **OR** Dry recessed sprinklers **OR** Dry flush sprinklers **OR** Dry concealed sprinklers, **as directed**.
   c. Wall Mounting: Dry sidewall sprinklers.
   d. Spaces Subject to Freezing: Upright sprinklers **OR** Dry pendent sprinklers **OR** Dry sidewall sprinklers**, as directed**.
   e. Special Applications: Extended-coverage and quick-response sprinklers where indicated.
2. Provide sprinkler types in subparagraphs below with finishes indicated.
   a. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
   b. Flush Sprinklers: Bright chrome, with painted white escutcheon.
   c. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
   d. 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 13 16 00

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SECTION 21 13 39 00 - FOAM FIRE EXTINGUISHING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for foam fire extinguishing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes fixed, low-expansion, AFFF fire-extinguishing systems and the following:
   a. Concentrate piping and piping specialties.
   b. Proportioning tanks and proportioning devices.
   c. Foam concentrate.
   d. Discharge devices.
   e. Monitoring and alarm devices.

C. Definitions
1. AFFF: Aqueous film-forming foam.
2. AR-AFFF: Alcohol-resistant aqueous film-forming foam.
3. ATS: Acceptance Testing Specifications.

D. System Description
1. Description: Engineered, fixed, wet-pipe **OR** dry-pipe, **OR** preaction, **OR** deluge, **as directed**, automatically actuated, low-expansion, AFFF **OR** AR-AFFF, **as directed**, fire-extinguishing system for flammable-liquid fires. System includes diaphragm proportioning tanks and devices as described in NFPA 16.

E. Performance Requirements
1. Standard Piping System Component Working Pressure: Listed for at least 175 psig (1200 kPa).
2. Minimum design parameters to be used with the approval of authorities having jurisdiction are as follows:
   a. Solution: 3 percent foam-water solution.
   b. Sprinkler Spacing: Maximum of 100 sq. ft. (9.5 sq. m) per sprinkler, and maximum 12-foot (3.7-m) spacing.
   c. Design Density: Minimum 0.16 gpm/sq. ft. (0.108 L/s per sq. m).
   d. Foam Supply: Minimum 10-minute discharge time.
   e. Water Supply: Minimum 60 minutes.
   f. Remote Area: Minimum 5000-sq. ft. (476-sq. m) design area for closed-sprinkler systems. Open-sprinkler systems shall discharge over the entire system area.
   g. Sprinkler Temperature Rating: Maximum 250 to 300 deg F (121 to 149 deg C) at a roof or ceiling, and 135 to 170 deg F (57 to 77 deg C) for intermediate sprinklers.
3. Seismic Performance: Fire-suppression piping shall be capable of withstanding the effects of earthquake motions determined according to NFPA 13.

F. Submittals
1. Product Data: For the following:
   a. Piping and equipment seismic restraints.
   b. Valves.
   c. Proportioning tanks and proportioning devices.
   d. Foam concentrate.
   e. Discharge devices. Include flow characteristics.
   f. Monitoring and alarm devices. Include electrical data.

2. Shop Drawings: Signed and sealed by a qualified professional engineer. Include the following for each hazard area, drawn to scale:
   a. Include plans, elevations, sections, details, and attachments to other work. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   b. Wiring Diagrams: Power, signal, and control wiring.
   c. Design Calculations: For amount of foam concentrate required for each hazard area.
   d. Plans: Show the following:
      1) Foam-solution proportioning tanks and devices, piping, discharge devices, monitoring and alarm devices, and accessories.
      2) Method of attaching hangers to building structure.
      3) Fire alarm panel.
      4) Equipment and furnishings.
3. Permit-Approved Drawings: Working plans, prepared according to NFPA 16, that have been approved by authorities having jurisdiction. Include design calculations.
4. Welding certificates.
5. Field quality-control test reports.
6. Operation and Maintenance Data: For foam fire extinguishing to include in emergency, operation, and maintenance manuals.

G. Quality Assurance
1. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
2. 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.
3. FMG Compliance: Provide components that are FMG approved and that are listed in FMG's "Fire Protection Approval Guide."
4. UL Compliance: Provide equipment listed in UL's "Fire Protection Equipment Directory."

1.2 PRODUCTS

A. Pipe And Fittings
1. Steel Pipe: ASTM A 53/A 53M, ASTM A 135, ASTM A 106, or ASTM A 795, Type E or S, Grade A or B, Schedule 40, with factory- or field-formed threaded ends.
   a. Cast-Iron Threaded Flanges: ASME B16.1.
   b. Malleable-Iron Threaded Fittings: ASME B16.3.
   c. Gray-Iron Threaded Fittings: ASME B16.4.
   d. Butt-Weld Fittings: ASTM A 234/A 234M, Grade WPB, Schedule 40, carbon-steel butt-weld fittings.
   e. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe. Include ends matching joining method.
   f. Steel Threaded Couplings: ASTM A 865.
2. Stainless Steel: ASTM A 312/A 312M, Schedule 40, with factory-formed threaded or beveled ends; ASTM A 376/A 376M for seamless pipe; or ASTM A 213/A 213M, ASTM A 249/A 249M, and ASTM A 269 for seamless and welded tubing.
   a. Class 150 Threaded Fittings: ASME B16.3 and MSS SP 114.
   b. Butt-Weld Fittings: ASTM A 403/A 403M.
   c. Flanges, Forged Fittings and Flanges, and Socket-Weld Fittings: ASTM A 182/A 182M.
   d. Bar Stock and Compression Fittings: ASTM A 276 and ASTM A 479/A 479M.
3. Red Brass Pipe: ASTM B 43, Schedule 40, with factory- or field-formed threaded ends.
   a. Threaded Flanges and Fittings: ASTM B 584.
4. Refer to Division 21 Section "Common Work Results For Fire Suppression" for basic joining materials.

B. Valves
1. Ball Valves: Bronze body with threaded or flanged ends. Comply with UL 1091, except with stainless-steel ball instead of disc.

C. Specialties
1. Concentrate Storage Tank: Buna-N, bladder-type proportioning tank complying with UL 162 and ASME Boiler and Pressure Vessel Code: Section VIII. Include bladder, internal piping, fill and drain, pipe assembly, glass sight gage, piping, and valves. Concentrate to be contained in the bladder.
   a. Orientation: Horizontal design with saddle **OR** Vertical design with skirt, **as directed**, support.
2. Proportioning Controller: Venturi type complying with UL 162 and of capacity to match design at minimum and maximum flow.
3. Concentrate Control Valve: Water-operated ball or deluge valve designed to open with flow through the proportioning controller.
4. Concentrate Strainers: Bronze body and stainless-steel mesh strainer with minimum 0.125-inch (3.2-mm) perforations to remove solids that would block system components.
5. Provide devices that comply with NFPA 16, are compatible with the foam concentrate, and are designed to be drained and cleaned.

D. Foam Concentrate
1. Description: AFFF **OR** AR-AFFF, **as directed**, liquid concentrate, complying with NFPA 11 and UL 162, for making foam-water fire-extinguishing foam solution.

E. Pressure Gages
1. Description: Comply with UL 393, with 3-1/2-inch- (90-mm-) minimum diameter dial, 0- to 300-psig (0- to 2070-kPa) dial range, and caption "WATER" or "CONCENTRATE" on dial face.

F. Discharge Devices
1. General: Discharge devices shall be listed and approved by UL and FMG.
2. Sprinklers: Closed **OR** Open, **as directed**, air-aspirating **OR** non-air-aspirating, **as directed**, type complying with UL 162 and suitable for discharging foam.
3. Spray Nozzles: Foam-water spray nozzles including foam generator and distributing deflector complying with UL 162 and designed to distribute foam or water in the absence of foam solution in a special pattern peculiar to a particular head.

G. Monitoring Devices
1. Valve Supervisory Switches: UL 753, electrical, single pole, double throw, with normally closed contacts. Include design that signals controlled valve is in other than fully open position.

H. Alarm Devices
1. Description: UL listed or FMG approved, low voltage, and surface mounting. Alarm and monitoring devices are specified in Division 28 Section(s) "Digital, Addressable Fire-alarm System" OR "Zoned (dc Loop) Fire-alarm System".

1.3 EXECUTION

A. Concentrate Storage Tank Installation
1. Install proportioning tanks on concrete bases. Concrete bases are specified in Division 21 Section "Common Work Results For Fire Suppression".
2. Install tanks 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.
3. Install seismic restraints for tanks. Anchor tanks to substrate.

B. Piping Applications
1. Flanged pipe and fittings and flanged joints may be used to connect to specialties and accessories and where required for maintenance.
2. AFFF-Concentrate Piping: Steel pipe, malleable- or cast-iron threaded fittings, and threaded joints.
3. AFFF-Concentrate Piping: Steel pipe with welded fittings and joints.
4. AR-AFFF-Concentrate Piping: Brass **OR** Stainless-steel, **as directed**, pipe, threaded fittings, and joints.
5. AR-AFFF-Concentrate Piping: Stainless-steel pipe with welded fittings and joints.
6. Foam-solution piping is specified in Division 21 Section "Wet-pipe Sprinkler Systems".

C. Piping Installation
1. Install piping and other components level and plumb.
2. Refer to Division 21 Section "Common Work Results For Fire Suppression" for basic pipe installation and joint construction.
3. Install proportioning tanks anchored to substrate.
4. Install pipe and fittings, valves, and discharge devices according to requirements listed in NFPA 16, "Installation of Deluge Foam-Water Sprinkler and Foam-Water Spray Systems."
   a. Support piping using supports and methods according to NFPA 13.
   b. Install seismic restraints for proportioning tanks and piping systems.
   c. Install monitoring and alarm devices according to NFPA 16 and NFPA 72.

D. Connections
1. Piping installation requirements are specified in Division 21 Section "Wet-pipe Sprinkler Systems". Drawings indicate general arrangement of piping, fittings, and specialties.
2. Provide concentrate control, maintenance service, and drain valves with piping to permit maintenance of the foam concentrate with continuous sprinkler system service.
3. Install proportioning controller in fire-suppression piping to provide coverage to area indicated on Drawings.
4. Install piping adjacent to equipment to allow service and maintenance.
5. Connect electrical devices to building's fire alarm system. Electrical power, wiring, and devices are specified in Division 28 Section(s) "Digital, Addressable Fire-alarm System" OR "Zoned (dc Loop) Fire-alarm System".

E. Labeling
1. Install labeling on piping, equipment, and panels according to Division 22 Section "Identification For Plumbing Piping And Equipment".

F. Charging System
1. Fill proportioning tanks with foam concentrate after field quality-control testing is complete and satisfactory results have been achieved.

G. Field Quality Control
1. Inspection: Engage the services of a qualified professional engineer to inspect installed fire-extinguishing systems, prepare installation report, and certify that installation complies with the Contract Documents, calculations, and requirements of authorities having jurisdiction.
2. Comply with operating instructions and procedures in NFPA 16, "Acceptance Tests" Chapter. Include the following tests and inspections to demonstrate compliance with requirements:
   a. Check mechanical items.
   b. Inspect equipment and fire-extinguishing foam concentrate, and check mountings for adequate anchoring to substrate.
   c. Check electrical systems.
   d. Flush piping.
   e. Perform acceptance test.
   f. Perform pressure test.

g. Perform operating test.
h. Perform discharge test.
i. Correct malfunctioning equipment, then retest to demonstrate compliance. Replace equipment that cannot be satisfactorily corrected or does not perform as specified and indicated, then retest to demonstrate compliance. Repeat procedure until satisfactory results are obtained.
   1) Report test results promptly and in writing and authorities having jurisdiction.

3. Perform the following field tests and inspections and prepare test reports:
   a. After installing foam fire-extinguishing piping system and after electrical circuitry has been energized, test for compliance with requirements.
   b. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, "Inspection and Test Procedures" and "System Function Tests." Certify compliance with test parameters.
   c. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   d. Operational Test: After electrical circuitry has been energized, start systems to confirm proper unit operation.
   e. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
4. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 21 13 39 00

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SECTION 21 16 00 00 - PRESSURE-MAINTENANCE PUMPS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for pressure-maintenance pumps. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Multistage, pressure-maintenance pumps.
b. Regenerative-turbine, pressure-maintenance pumps.
c. Submersible, pressure-maintenance pumps.
d. Vertical-turbine, pressure-maintenance pumps.

C. Performance Requirements
1. Pump Equipment, Accessory, and Specialty Pressure Rating: 175 psig (1200 kPa) minimum unless higher pressure rating is indicated.

D. Submittals
1. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, performance curves, electrical characteristics, and furnished specialties and accessories.
2. Shop Drawings: For pumps, accessories, and specialties. Include plans, elevations, sections, details, and attachments to other work.
a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
b. Wiring Diagrams: For power, signal, and control wiring.
3. Field quality-control reports.
4. Operation and maintenance data.

E. Quality Assurance
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.

1.2 PRODUCTS

A. Multistage, Pressure-Maintenance Pumps
1. Description: Factory-assembled and -tested, multistage, barrel-type vertical pump as defined in HI 2.1-2.2 and HI 2.3; designed for surface installation with pump and motor direct coupled and mounted vertically.
2. Pump Construction:
a. Barrel: Stainless steel.
b. Suction and Discharge Chamber: Cast iron with flanged inlet and outlet.
c. Pump Head/Motor Mount: Cast iron.
d. Impellers: Stainless steel, balanced, and keyed to shaft.
e. Pump Shaft: Stainless steel.
f. Seal: Mechanical type with carbon rotating face and silicon-carbide stationary seat.
g. Intermediate Chamber Bearings: Aluminum-oxide ceramic or bronze.
h. Chamber-Base Bearing: Tungsten carbide.
i. O-Rings: EPDM or NBR.

3. Motor: Single speed with permanently lubricated ball bearings and rigidly mounted to pump head. Comply with requirements in Division 15 Section "Common Motor Requirements for Fire Suppression Equipment."
   a. Power Cord: Factory-connected to motor for field connection to controller and at least 10 feet (3 m) long.
4. Nameplate: Permanently attached to pump and indicating capacity and characteristics.

B. Regenerative-Turbine, Pressure-Maintenance Pumps
1. Description: Factory-assembled and -tested, close-coupled, single-stage, regenerative-turbine centrifugal pump as defined in HI 1.1-1.2 and HI 1.3; with pump and motor mounted horizontally.
2. Pump Construction:
   a. Casing: Radially split, cast iron, with threaded inlet and outlet.
   b. Impeller: Bronze, balanced, and keyed to shaft.
   c. Pump Shaft: Stainless steel **OR** steel, **as directed**, with deflector.
   d. Shaft Sleeve: Bronze.
   e. Seal: Mechanical type with spring-loaded rotating head.
3. Motor: Single speed with permanently lubricated ball bearings. Comply with requirements in Division 15 Section "Common Motor Requirements for Fire Suppression Equipment."
   a. Power Cord: Factory-connected to motor for field connection to controller and at least 10 feet (3 m) long.
4. Nameplate: Permanently attached to pump and indicating capacity and characteristics.

C. Submersible, Pressure-Maintenance Pumps
1. Description: Factory-assembled and -tested, vertical, multistage, submersible pump as defined in HI 2.1-2.2 and HI 2.3; with pump motor mounted below pump.
2. Pump Construction:
   a. Pump Head or Elbow: Cast iron, for surface discharge, with flanged or threaded connections.
   b. Pump Shaft: Stainless steel.
   c. Bearings: Bronze.
   d. Bowl Section: Multiple cast-iron bowls with closed-type bronze or stainless-steel impellers.
   e. Column Pipe: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with threaded ends and cast-iron or steel fittings, in sections 10 feet (3 m) or less, with strainer of cast or fabricated bronze or stainless steel between pump and bowl section.
3. Motor: Single speed with permanently lubricated ball bearings and capable of continuous operation under water. Comply with requirements in Division 15 Section "Common Motor Requirements for Fire Suppression Equipment."
   a. Power Cord: Capable of continuous under-water operation, factory-connected to motor for field connection to controller, and at least 10 feet (3 m) long.
4. Base: Cast iron or steel with hole for electrical cable.
5. Nameplate: Permanently attached to pump and indicating capacity and characteristics.

D. Vertical-Turbine, Pressure-Maintenance Pumps
1. Description: Factory-assembled and -tested, vertical, multistage, open-line-shaft turbine pump as defined in HI 2.1-2.2 and HI 2.3; with pump motor mounted above pump head.
2. Pump Construction:
   a. Pump Head: Cast iron, for surface discharge, with flange except connections may be threaded in sizes in which flanges are not available.
   b. Pump Head Seal: Stuffing box and stuffing.
   c. For static water levels of 50 feet (15 m) or less and for water-lubricated bearings.
      1) Line Shaft: Stainless steel or steel, with corrosion-resistant shaft sleeves.
      2) Line Shaft Bearings: Rubber sleeve, water lubricated.
   d. For static water levels between 50 and 200 feet (15 and 61 m) and for oil-lubricated bearings.
      1) Line Shaft: Steel.

2) Line Shaft Bearings: Corrosion resistant, oil lubricated.

e. Impeller Shaft: Monel metal or stainless steel.

f. Bowl Section: Multiple cast-iron bowls with closed-type bronze or stainless-steel impellers.

g. Column Pipe: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with threaded ends and cast-iron or steel fittings, in sections 10 feet (3 m) or less, with strainer of cast or fabricated bronze or stainless steel at bottom.

3. Motor: Single speed with permanently lubricated ball bearings. Comply with requirements in Division 15 Section "Common Motor Requirements for Fire Suppression Equipment."

a. Power Cord: Factory-connected to motor for field connection to controller and at least 10 feet (3 m) long.

4. Base: Cast iron or steel with hole for electrical cable.

5. Nameplate: Permanently attached to pump and indicating capacity and characteristics.

E. Motors

1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 15 Section "Common Motor Requirements for Fire Suppression 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.

b. Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 16 Sections.

1.3 EXECUTION

A. Equipment Installation

1. NFPA Standard: Comply with NFPA 20 for installation of pressure-maintenance pumps.

2. Base-Mounted Pump Mounting: Install pumps on concrete bases. Comply with requirements for concrete bases specified in Division 3 Section "Cast-in-Place Concrete."

a. 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.

b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

d. Install anchor bolts to elevations required for proper attachment to supported equipment.

e. Attach pumps to equipment base using anchor bolts.

3. Install multistage and regenerative-turbine, pressure-maintenance pumps according to HI 1.4.

4. Install submersible and vertical-turbine, pressure-maintenance pumps according to HI 2.4.

B. Field Quality Control

1. Perform tests and inspections.

a. 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. Tests and Inspections:

a. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

b. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3. Pressure-maintenance pumps will be considered defective if they do not pass tests and inspections.

4. Prepare test and inspection reports.

C. Adjusting

1. Lubricate pumps as recommended by manufacturer.

2. Set field-adjustable pressure-switch ranges as indicated.

END OF SECTION 21 16 00 00

SECTION 21 16 00 00a - CONTROLLERS FOR FIRE-PUMP DRIVERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for controllers for fire-pump drivers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Full-service, full-voltage **OR** reduced-voltage, **as directed**, controllers rated 600 V and less.
b. Limited-service controllers rated 600 V and less.
c. Controllers for diesel-drive fire pumps.
d. Remote alarm panels.
e. Low-suction-shutdown panels.

C. Definitions
1. ATS: Automatic transfer switch(es).
2. ECM: Electronic control module.
3. MCCB: Molded-case circuit breaker.
4. N.O.: Normally open.

D. Performance Requirements
1. Seismic Performance: Fire-pump controllers and alarm panels shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

E. Submittals
1. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories**.**
2. Shop Drawings: For each type of product indicated. Include dimensioned plans, elevations, sections, details, and attachments to other work, including required clearances and service spaces around controller enclosures.
a. Show tabulations of the following:
1) Each installed unit's type and details.
2) Enclosure types and details for types other than NEMA 250, Type 2.
3) Factory-installed devices.
4) Nameplate legends.
5) Short-circuit current (withstand) rating of integrated unit.
6) Features, characteristics, ratings, and factory settings of individual overcurrent protective devices.
7) Specified modifications.
b. Detail equipment assemblies and indicate dimensions, weights, loads, method of field assembly, components, and location and size of each field connection.
c. Schematic and Connection Diagrams: For power, signal, alarm, and control wiring and for pressure-sensing tubing.
3. Qualification Data: For qualified testing agency.
4. Seismic Qualification Certificates: For each type of product indicated, from manufacturer.

a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

5. Product Certificates: For each type of product indicated, from manufacturer.
6. Manufacturer's factory test reports of fully assembled and tested equipment.
7. Source quality-control reports.
8. Field quality-control reports.
9. Operation and Maintenance Data: For each type of product indicated to include in emergency, operation, and maintenance manuals. Include the following:
   a. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
   b. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor-based logic controls.

F. Quality Assurance
1. Testing Agency Qualifications: Member company of an NRTL.
2. Source Limitations: Obtain fire-pump controllers and all associated equipment from single source or producer.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. Comply with standards of authorities having jurisdiction pertaining to materials and installation.
5. Comply with NFPA 20 and NFPA 70.
6. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces defined in Division 16 Section "Vibration and Seismic Controls for Electrical Systems."

G. Delivery, Storage, And Handling
1. Store controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.
2. If stored in areas subject to weather, protect controllers from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install temporary electric heating, with at least 250 W per controller **OR** connect factory-installed space heaters to temporary electrical service, **as directed**.

H. Project Conditions
1. Environmental Limitations:
   a. Ambient Temperature Rating: Not less than 40 deg F (5 deg C) and not exceeding 122 deg F (50 deg C) unless otherwise indicated.
   b. Altitude Rating: Not exceeding 6600 feet (2010 m) unless otherwise indicated.
2. Interruption of Existing Electric Service: Notify the Owner no fewer than seven days in advance of proposed interruption of electric service, and comply with NFPA 70E.

I. Coordination
1. Coordinate layout and installation of controllers with other construction including conduit, piping, fire-pump equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels. Ensure that controllers are within sight of fire-pump drivers.
2. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.2 PRODUCTS

A. Full-Service Controllers
1. General Requirements for Full-Service Controllers:
   a. Comply with NFPA 20 and UL 218.
   b. Listed by an NRTL for electric-motor driver for fire-pump service.
   c. Combined automatic and nonautomatic **OR** Nonautomatic, **as directed**, operation.
   d. Factory assembled, wired, and tested; continuous-duty rated.
   e. Service Equipment Label: NRTL labeled for use as service equipment.
2. Method of Starting:
   a. Pressure **OR** Nonpressure, **as directed**,-switch actuated.
      1) Water-pressure-actuated switch and pressure transducer with independent high- and low-calibrated adjustments responsive to water pressure in fire-suppression piping.
      2) System pressure recorder, electric ac driven, with spring backup.
      3) Programmable minimum-run-time relay to prevent short cycling.
      4) Programmable timer for weekly tests.
   b. Magnetic Controller: Across-the-line **OR** Autotransformer **OR** Part-winding **OR** Primary-resistor **OR** Wye-delta (open transition) **OR** Wye-delta (closed transition), **as directed**, type.
      OR
      Solid-State Controller: Reduced-voltage type.
   c. Emergency Start: Mechanically operated start handle that closes and retains the motor RUN contactor independent of all electric or pressure actuators.
3. Method of Stopping: Automatic and nonautomatic shutdown after automatic starting **OR** Nonautomatic, **as directed**.
4. Capacity: Rated for fire-pump-driver horsepower and short-circuit-current (withstand) rating equal to or greater than short-circuit current available at controller location.
5. Method of Isolation and Overcurrent Protection: Interlocked isolating switch and nonthermal MCCB; with a common, externally mounted operating handle, and providing locked-rotor protection.
6. Door-Mounted Operator Interface and Controls:
   a. Monitor, display, and control the devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used.
   b. Method of Control and Indication:
      1) Microprocessor-based logic controller, with multiline digital readout.
      2) Membrane keypad.
      3) LED alarm and status indicating lights.
   c. Local and Remote, **as directed**, Alarm and Status Indications:
      1) Controller power on.
      2) Motor running condition.
      3) Loss-of-line power.
      4) Line-power phase reversal.
      5) Line-power single-phase condition.
   d. Audible alarm, with silence push button.
   e. Nonautomatic START and STOP push buttons or switches.
7. Optional Features:
   a. Extra Output Contacts:
      1) One N.O. contact(s) for motor running condition.
      2) One set(s) of contacts for loss-of-line power.
      3) One each, Form C contacts for high and low reservoir level.
   b. Local alarm bell.
   c. Door-mounted thermal or impact printer for alarm and status logs.
   d. Operator Interface Communications Ports: USB, Ethernet, and RS485.
8. ATS:
   a. Complies with NFPA 20, UL 218, and UL 1008.

b. Integral with controller as a listed combination fire-pump controller and power transfer switch.
c. Automatically transfers fire-pump controller from normal power supply to alternate power supply in event of power failure.
d. Allows manual transfer from one source to the other.
e. Alternate-Source Isolating and Disconnecting Means: Integral molded-case switch, with an externally mounted operating handle.
OR
Alternate-Source Isolating and Disconnecting Means: Mechanically interlocked isolation switch and circuit breaker rated at a minimum of 115 percent of rated motor full-load current, with an externally mounted operating handle; circuit breaker shall be provided with nonthermal sensing, instantaneous-only short-circuit overcurrent protection to comply with available fault currents.
f. Local and Remote, **as directed**, Alarm and Status Indications:
1) Normal source available.
2) Alternate source available.
3) In normal position.
4) In alternate position.
5) Isolating means open.
g. Audible alarm, with silence push button.
h. Nonautomatic (manual, nonelectric) means of transfer.
i. Engine test push button.
j. Start generator output contacts.
k. Timer for weekly generator tests.

B. Limited-Service Controllers
1. General Requirements for Limited-Service Controllers:
a. Comply with NFPA 20 and UL 218.
b. Listed by an NRTL for electric-motor driver for fire-pump service.
c. Combined automatic and nonautomatic **OR** Nonautomatic, **as directed**, operation.
d. Factory assembled, wired, and tested; continuous-duty rated.
e. Service Equipment Label: NRTL labeled for use as service equipment.
2. Method of Starting:
a. Pressure **OR** Nonpressure, **as directed**,-switch actuated.
1) Water-pressure-actuated switch and pressure transducer with independent high- and low-calibrated adjustments responsive to water pressure in fire-suppression piping.
2) System pressure recorder, electric ac driven, with spring backup.
3) Programmable minimum-run-time relay to prevent short cycling.
4) Programmable timer for weekly tests.
b. Across-the-line magnetic controller.
c. Emergency Start: Mechanically operated start handle that closes and retains the motor RUN contactor independent of all electric or pressure actuators.
3. Method of Stopping: Automatic and nonautomatic shutdown after automatic starting **OR** Nonautomatic, **as directed**.
4. Capacity: Rated for fire-pump-driver horsepower and short-circuit-current (withstand) rating equal to or greater than short-circuit current available at controller location.
5. Method of Isolation and Overcurrent Protection: Inverse-time, nonadjustable MCCB, with an externally mounted operating handle.
6. Door-Mounted Operator Interface and Controls:
a. Monitor, display, and control the devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used.
b. Method of Control and Indication:
1) Microprocessor-based logic controller, with multiline LCD digital readout.
2) Membrane keypad.

3) LED alarm and status indicating lights.

c. Local and Remote, **as directed** Alarm and Status Indications:

1) Controller power on.
2) Motor running condition.
3) Loss-of-line power.
4) Line-power phase reversal.
5) Line-power single-phase condition.

d. Audible alarm, with silence push button.

e. Nonautomatic START and STOP push buttons.

7. Optional Features:

a. Extra Output Contacts:

1) One N.O. contact(s) for motor running condition.
2) One set(s) of contacts for loss-of-line power.
3) One each, Form C contacts for high and low reservoir level.

b. Local alarm bell.

c. Door-mounted thermal or impact printer for alarm and status logs.

d. Operator Interface Communications Ports: USB, Ethernet, and RS485.

8. ATS:

a. Complies with NFPA 20, UL 218, and UL 1008.

b. Integral with controller as a listed combination fire-pump controller and power transfer switch.

c. Automatically transfers fire-pump controller from normal power supply to alternate power supply in event of power failure.

d. Allows manual transfer from one source to the other.

e. Alternate-Source Isolating and Disconnecting Means: Integral molded-case switch, with an externally mounted operating handle.

OR

Alternate-Source Isolating and Disconnecting Means: Mechanically interlocked isolation switch and circuit breaker rated at a minimum of 115 percent of rated motor full-load current, with an externally mounted operating handle; circuit breaker shall be provided with nonthermal sensing, instantaneous-only short-circuit overcurrent protection to comply with available fault currents.

f. Local and Remote, **as directed**, Alarm and Status Indications:

1) Normal source available.
2) Alternate source available.
3) In normal position.
4) In alternate position.
5) Isolating means open.

g. Audible alarm, with silence push button.

h. Nonautomatic (manual, nonelectric) means of transfer.

i. Engine test push button.

j. Start generator output contacts.

k. Timer for weekly generator tests.

C. Standalone ATS

1. General Requirements for Standalone ATS:

a. Complies with NFPA 20, UL 218, and UL 1008.

b. Listed by an NRTL for fire-pump service.

c. Automatic and nonautomatic operation.

d. Separate from controller and individually listed as a fire-pump-controller power transfer switch.

e. Automatically transfers fire-pump controller from normal power supply to alternate power supply in event of power failure.

f. Allows manual transfer from one source to the other; factory assembled, wired, and tested.

2. Capacity: Rated for fire-pump-driver horsepower and short-circuit-current (withstand) rating equal to or greater than short-circuit current available at ATS location.

3. Alternate-Source Isolating and Disconnecting Means: Integral molded-case switch, with an externally mounted operating handle.
4. Alternate-Source Isolating and Disconnecting Means:
   a. Mechanically interlocked isolation switch and circuit breaker rated at a minimum of 115 percent of rated motor full-load current.
   b. Externally mounted operating handle.
   c. Circuit breaker provided with nonthermal sensing, instantaneous-only, short-circuit overcurrent protection.
   d. Equipped with a voltage surge arrester.
5. Door-Mounted Operator Interface and Controls:
   a. Monitor, display, and control devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used.
   b. Method of Control and Indication:
      1) Microprocessor-based logic controller, with multiline LCD readout.
      2) Membrane keypad.
      3) LED alarm and status indicating lights.
   c. Local and Remote, **as directed**, Alarm and Status Indications:
      1) Normal source available.
      2) Alternate source available.
      3) In normal position.
      4) In alternate position.
      5) Isolating means open.
   d. Audible alarm, with silence push button.
   e. Nonautomatic (manual, nonelectric) means of transfer.
   f. Engine test push button.
   g. Start generator output contacts.
   h. Timer for weekly generator tests
6. Optional Features:
   a. Extra Output Contacts:
      1) One each, Form A; isolating means open.
      2) One each, Form C; in normal or alternate position
   b. Door-mounted thermal or impact printer for alarm and status logs.
   c. Operator Interface Communications Ports: USB, Ethernet, and RS485.

D. Controllers For Diesel-Drive Fire Pumps
1. General Requirements for Controllers:
   a. Comply with NFPA 20 and UL 218.
   b. Listed by an NRTL for diesel-engine driver for fire-pump service.
   c. Combined automatic and nonautomatic **OR** Nonautomatic, ,**as directed** operation.
   d. Factory assembled, wired, and tested.
2. Method of Starting:
   a. Pressure **OR** Nonpressure, **as directed**,-switch actuated.
      1) Water-pressure-actuated switch and pressure transducer with independent high- and low-calibrated adjustments responsive to water pressure in fire-suppression piping.
      2) System pressure recorder, electric ac driven, with spring backup.
      3) Programmable minimum-run-time relay to prevent short cycling.
      4) Programmable timer for weekly tests.
   b. Dual, redundant dc-voltage battery units, with automatic changeover.
   c. Emergency Control: Bypasses all automatic control circuits during manual starting and running.
   d. Automatic engine start on loss of ac power to the controller.
3. Method of Stopping: Automatic and nonautomatic shutdown after automatic starting **OR** Nonautomatic, **as directed**.
4. Door-Mounted Operator Interface and Controls:

a. Monitor, display, and control devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used.
b. Method of Control and Indication:
   1) Microprocessor-based logic controller, with multiline LCD readout.
   2) Membrane keypad.
   3) LED alarm and status indicating lights.
c. Local and Remote, **as directed**, Alarm and Status Indications:
   1) Controller power on.
   2) Engine-lubrication-system critically low oil pressure.
   3) Engine-jacket coolant high temperature.
   4) Engine fail-to-start.
   5) Engine overspeed shutdown.
   6) Low fuel level.
   7) Missing or failed battery.
   8) Battery charger failure.
   9) System overpressure.
   10) ECM selector switch in alternate ECM position.
   11) Fuel injector malfunction.
d. Audible alarm.
e. Nonautomatic START and STOP push buttons or switches.

5. Optional Features:
   a. Extra Output Contacts:
      1) One Form C contacts for low pump-room temperature.
      2) One each, Form C contacts for high and low fuel levels.
      3) One each, Form C contacts for high and low reservoir levels.
   b. Door-mounted thermal or impact printer for alarm and status logs.
   c. Operator Interface Communications Ports: USB, Ethernet, and RS485.
   d. Powered louver contacts.
   e. Powered engine-oil heater contacts.
6. Battery Charger System:
   a. Built-in, independent, dual battery chargers with automatic changeover; 12-V dc **OR** 24-V dc, **as directed**, for lead-acid **OR** nickel-cadmium, **as directed**, batteries.
   b. Standard: UL 1236.

E. Remote Alarm Panels
1. General Requirements for Remote Alarm Panels: Comply with NFPA 20 and UL 218; listed by an NRTL for fire-pump service.
2. General Requirements for Remote Alarm Panels: Factory assembled, wired, and tested.
3. Supervisory and Normal Control Voltage: 120-V ac **OR** 240-V ac, **as directed**; single **OR** dual, **as directed**, source.
4. Audible and Visual Alarm and Status Indications:
   a. Driver running.
   b. Loss of phase.
   c. Phase reversal.
   d. Supervised power on.
   e. Common **OR** Separate, **as directed**, trouble on the controller.
   f. Controller connected to alternate power source.
5. Audible and Visual Alarm and Status Indications: Manufacturer's standard indicating lights; push-to-test **OR** non-push-to-test, with separate test push button, **as directed**.
   a. Engine running.
   b. Controller main switch turned to the off or manual position.
   c. Supervised power on.
   d. Common **OR** Separate, **as directed**, trouble on the controller or engine.
   e. Common pump room trouble.
   f. Controller connected to alternate power source.
6. Audible alarm, with silence push button.

7. Pump REMOTE START push button.

F. Low-Suction-Shutdown Panels
1. General Requirements for Low-Suction-Shutdown Panels:
   a. Listed by an NRTL for fire-pump service.
   b. Factory assembled, wired, and tested.
   c. Prevents automatic start of fire pump, and shuts down automatically started fire pump, on low-suction pressure.
   d. Automatic **OR** Manual, **as directed**, reset.
2. Operation: External contact input **OR** Integral pressure switch, **as directed**.
3. Supervisory and Normal Control Voltage: 120-V ac **OR** 240-V ac, **as directed**; single **OR** dual, **as directed**, source.
4. Include audible and visual alarms and status indications, with silence push button, for the following conditions:
   a. Control power available.
   b. Low-suction pressure.
   c. Normal-suction pressure.

G. Enclosures
1. Fire-Pump Controllers, ATS, Remote Alarm Panels, and Low-Suction-Shutdown Panels: NEMA 250, to comply with environmental conditions at installed locations and NFPA 20.
   a. Indoor, Dry and Clean Locations: Type 1 (IEC IP10).
   b. Indoor Locations Subject to Dripping Noncorrosive Liquids: Type 2 (IEC IP11).
   c. Outdoor Locations: Type 3R (IEC IP14) **OR** Type 4 (IEC IP56) **OR** Type 4X (IEC IP56), **as directed**.
   d. Other Wet or Damp, Indoor Locations: Type 4 (IEC IP56) **OR** Type 4X (IEC IP56), **as directed**.
   e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12 (IEC IP12).
2. Enclosure Color: Manufacturer's standard "fire-pump-controller red".
3. Nameplates: Comply with NFPA 20; complete with capacity, characteristics, approvals, listings, and other pertinent data.
4. Optional Features:
   a. Floor stands, 12 inches (305 mm) high, for floor-mounted controllers.
   b. Space heater, 120-V ac **OR** 240-V ac, **as directed**, with humidistat, **as directed**, with thermostat, **as directed**.
   c. Tropicalization.

H. Source Quality Control
1. Testing: Test and inspect fire-pump controllers according to requirements in NFPA 20 and UL 218.
   a. Verification of Performance: Rate controllers according to operation of functions and features specified.
2. Fire-pump controllers will be considered defective if they do not pass tests and inspections.
3. Prepare test and inspection reports.

1.3 EXECUTION

A. Examination
1. Examine areas and surfaces to receive equipment, with Installer present, for compliance with requirements and other conditions affecting performance.
2. Examine equipment before installation. Reject equipment that is wet or damaged by moisture or mold.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Controller Installation
   1. Install controllers within sight of their respective drivers.
   2. Connect controllers to their dedicated pressure-sensing lines.
   3. Wall-Mounting Controllers: Install controllers on walls with disconnect operating handles not higher than 79 inches (2006 mm) above finished floor, and bottom of enclosure not less than 12 inches (305 mm) above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Division 16 Section "Hangers and Supports for Electrical Systems."
   4. Floor-Mounting Controllers: Install controllers on 4-inch (100-mm) nominal-thickness concrete bases, using floor stands high enough so that the bottom of enclosure cabinet is not less than 12 inches (305 mm) above finished floor. Comply with requirements for concrete bases specified in Division 3 Section "Cast-in-Place Concrete."
      a. 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.
      b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
      c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
      d. Install anchor bolts to elevations required for proper attachment to supported equipment.
   5. Seismic Bracing: Comply with requirements specified in Division 16 Section "Vibration and Seismic Controls for Electrical Systems."
   6. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
   7. Comply with NEMA ICS 15.

C. Standalone ATS Installation
   1. Wall-Mounting ATS: Install ATS on walls with disconnect operating handles not higher than 79 inches (2006 mm) above finished floor, and bottom of enclosure not less than 12 inches (305 mm) above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For ATS not on walls, provide freestanding racks complying with Division 16 Section "Hangers and Supports for Electrical Systems."
   2. Floor-Mounting ATS: Install ATS on 4-inch (100-mm) nominal-thickness concrete bases, using floor stands high enough so that the bottom of enclosure cabinet is not less than 12 inches (305 mm) above finished floor. Comply with requirements for concrete bases specified in Division 3 Section "Cast-in-Place Concrete."
      a. 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.
      b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
      c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
      d. Install anchor bolts to elevations required for proper attachment to supported equipment.
   3. Seismic Bracing: Comply with requirements specified in Division 16 Section "Vibration and Seismic Controls for Electrical Systems."
   4. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Remote Alarm And Low-Suction-Shutdown, **as directed**, Panel Installation
   1. Install panels on walls with tops not higher than 72 inches (1829 mm) above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For ATS not on walls, provide freestanding racks complying with Division 16 Section "Hangers and Supports for Electrical Systems."

E. Power Wiring Installation

1. Install power wiring between controllers and their services or sources, and between controllers and their drivers. Comply with requirements in NFPA 20, NFPA 70, and Division 16 Section "Conductors and Cables."
2. Comply with NECA 1.

F. Control And Alarm Wiring Installation
1. Install wiring between controllers and remote devices and facility's central monitoring system, **as directed**. Comply with requirements in NFPA 20, NFPA 70, and Division 16 Section "Control-Voltage Electrical Power Cables."
2. Install wiring between remote alarm and low-suction-shutdown, **as directed**, panels and controllers. Comply with requirements in NFPA 20, NFPA 70, and Division 16 Section "Control-Voltage Electrical Power Cables."
3. Install wiring between controllers and the building's fire-alarm system. Comply with requirements specified in Division 13 Section "Digital, Addressable Fire-Alarm System."
4. Bundle, train, and support wiring in enclosures.
5. Connect remote manual and automatic activation devices where applicable.

G. Identification
1. Comply with requirements in NFPA 20 for marking fire-pump controllers.
2. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification in NFPA 20 and as specified in Division 16 Section "Electrical Identification."

H. Field Quality Control
1. Perform tests and inspections.
2. Acceptance Testing Preparation:
   a. Inspect and Test Each Component:
      1) Inspect wiring, components, connections, and equipment installations. Test and adjust components and equipment.
      2) Test insulation resistance for each element, component, connecting supply, feeder, and control circuits.
      3) Test continuity of each circuit.
   b. Verify and Test Each Electric-Driver Controller:
      1) Verify that voltages at controller locations are within plus 10 or minus 1 percent of motor nameplate rated voltages, with motors off. If outside this range for any motor, notify the Owner before starting the motor(s).
      2) Test each motor for proper phase rotation.
   c. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
   d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Field Acceptance Tests:
   a. Do not begin field acceptance testing until suction piping has been flushed and hydrostatically tested and the certificate for flushing and testing has been submitted to the Owner and authorities having jurisdiction.
   b. Prior to starting, notify authorities having jurisdiction of the time and place of the acceptance testing.
   c. Engage manufacturer's factory-authorized service representative to be present during the testing.
   d. Perform field acceptance tests as outlined in NFPA 20.
4. Controllers will be considered defective if they do not pass tests and inspections.
5. Prepare test and inspection reports.

I. Startup Service
1. Perform startup service.
   a. Complete installation and startup checks according to manufacturer's written instructions.

J. Adjusting
   1. Adjust controllers and battery charger systems, **as directed**, to function smoothly and as recommended by manufacturer.
   2. Set field-adjustable switches, auxiliary relays, time-delay relays, and timers.
   3. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Final Completion.
   4. Set field-adjustable pressure switches.

K. Protection
   1. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.
   2. Replace controllers whose interiors have been exposed to water or other liquids prior to Final Completion.

L. Demonstration
   1. Train the Owner's maintenance personnel to adjust, operate, and maintain controllers, remote alarm panels, **as directed**, low-suction-shutdown panels, **as directed**, and to use and reprogram microprocessor-based controls within this equipment, **as directed**.

END OF SECTION 21 16 00 00a

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SECTION 21 22 16 00 - CLEAN-AGENT EXTINGUISHING SYSTEMS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for clean-agent extinguishing systems. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes clean-agent extinguishing systems and the following:
   a. Piping and piping specialties.
   b. Extinguishing-agent containers.
   c. Extinguishing agent.
   d. Detection and alarm devices.
   e. Control and alarm panels.
   f. Accessories.
   g. Connection devices for and wiring between system components.
   h. Connection devices for power and integration into building's fire alarm system.

C. Definitions
1. ATS: Acceptance Testing Specifications.
2. EPO: Emergency Power Off.

D. System Description
1. Clean-agent fire-extinguishing system shall be an engineered system for total flooding of the hazard area including the room cavity below the ceiling and below the raised floor. Provide separate zones above and below the raised floor. If smoke is detected below the raised floor, agent shall be discharged in the underfloor zone only. If smoke is detected above the raised floor, agent shall be discharged in zones above and below the floor.

E. Performance Requirements
1. Design clean-agent extinguishing system and obtain approval from authorities having jurisdiction. Design system for Class A, B, or C fires as appropriate for areas being protected and include safety factor. Use clean agent indicated and in concentration suitable for normally occupied areas.
2. Performance Requirements: Discharge HFC 227ea within 10 seconds and maintain 7.1 percent concentration by volume at 70 deg F (21 deg C) for 10-minute holding time in hazard areas.
   a. HFC 227ea concentration in hazard areas greater than 9.0 percent immediately after discharge or less than 5.8 percent throughout holding time will not be accepted without written authorization from the Owner and authorities having jurisdiction.
   b. System Capabilities: Minimum 620-psig (4278-kPa) calculated working pressure and 360-psig (2484-kPa) initial charging pressure.
3. Performance Requirements: Discharge IG-541 within 60 seconds and maintain 38 percent concentration by volume at 70 deg F (21 deg C) for 10-minute holding time in hazard areas.
   a. IG-541 concentration in hazard areas greater than 40 percent immediately after discharge or less than 32 percent throughout holding time will not be accepted without written authorization from the Owner and authorities having jurisdiction.
   b. System Capabilities: Minimum 2175-psig (15-MPa) calculated working pressure upstream from orifice union, minimum 1000-psig (6895-kPa) calculated working pressure downstream from orifice union, and 2175-psig (15-MPa) initial charging pressure.

4. Cross-Zoned Detection: Devices located in two separate zones. Sound alarm on activating single-detection device, and discharge extinguishing agent on actuating single-detection device in other zone.
   OR
   Verified Detection: Devices located in single zone. Sound alarm on activating single-detection device, and discharge extinguishing agent on actuating second-detection device.
5. System Operating Sequence: As follows:
   a. Actuating First Detector: Visual indication on annunciator panel, energize audible alarm and visual alarms (slow pulse), shut down air-conditioning and ventilating systems serving protected area, close doors in protected area, and send signal to fire alarm system.
   b. Actuating Second Detector: Visual indication on annunciator panel, energize audible and visual alarms (fast pulse), shut down power to protected equipment, start time delay for extinguishing-agent discharge for 30 seconds, and discharge extinguishing agent. On agent discharge, release preaction valve to allow water to fill sprinkler system.
   c. Extinguishing-agent discharge will operate audible alarms and strobe lights inside and outside the protected area.
6. System Operating Sequence: System shall be cross-zoned, air-sampling detectors and photoelectric detectors reporting to a fully programmable microprocessor-based control panel programmed to operate as follows:
   a. If one photoelectric detector and air-sampling detector reaches the third detection level (Fire 1), agent discharge will be initiated as described for the third detection level (Fire 1) below.
   b. Air-Sampling System:
      1) First Detection Level (Alert): Mild audible and visual indication on annunciator panel. Strobe lights flash slowly in the protected area.
      2) Second Detection Level (Action): Strong audible and visual indication on annunciator panel. Strobe lights flash rapidly in the protected area.
      3) Third Detection Level (Fire 1): Strong audible and visual indication on annunciator panel. Energize horn(s), bell(s), and strobe light(s) in the protected area and outside entry doors. Shut down air-conditioning and ventilating systems serving the protected area, and close doors in the protected area. Send signal to fire alarm system, initiate 30-second time delay for extinguishing-agent discharge, and discharge extinguishing agent. At agent discharge, terminate power to equipment in the protected area, and release preaction valve to allow water flow to sprinkler system.
      4) Fourth Detection Level (Fire 2): Same as Fire 1.
7. Manual stations shall immediately discharge extinguishing agent when activated.
8. Operating abort switches will delay extinguishing-agent discharge while being activated, and switches must be reset to prevent agent discharge. Release of hand pressure on the switch will cause agent discharge if the time delay has expired.
9. EPO: Will terminate power to protected equipment immediately on actuation.
10. Low-Agent Pressure Switch: Initiate trouble alarm if sensing less than set pressure.
11. Power Transfer Switch: Transfer from normal to stand-by power source.
12. Seismic Performance: Fire-suppression piping and containers shall be capable of withstanding the effects of earthquake motions determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."

F. Submittals
   1. Product Data: For each product indicated.
   2. LEED Submittal:
      a. Product Data for Credit EA 4: Documentation required by Credit EA 4 indicating that clean agents comply.
   3. Shop Drawings: Signed and sealed by a qualified professional engineer. Include design calculations.

4. Permit Approved Drawings: Working plans, prepared according to NFPA 2001, that have been approved by authorities having jurisdiction. Include design calculations.
5. Field quality-control test reports.
6. Maintenance Data: For components to include in maintenance manuals.

G. Quality Assurance
1. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of clean-agent extinguishing systems that are similar to those indicated for this Project in material, design, and extent.
2. 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.

1.2 PRODUCTS

A. Piping Materials
1. Refer to Part 1.3 piping applications Article retained for applications of pipe, tube, fitting, and joining materials.
2. Piping, Valves, and Discharge Nozzles: Comply with types and standards listed in NFPA 2001, Section "Distribution," for charging pressure of system.

B. Pipe And Fittings
1. Steel Pipe: ASTM A 53/A 53M, Type S, Grade B or ASTM A 106, Grade B; Schedule 40, or Schedule 80, seamless steel pipe.
   a. Threaded Fittings:
      1) Malleable-Iron Fittings: ASME B16.3, Class 300.
      2) Flanges and Flanged Fittings: ASME B16.5, Class 300, unless Class 600 is indicated.
   b. Forged-Steel Welding Fittings: ASME B16.11, Class 3000, socket pattern.
   c. Grooved-End Fittings: FMG approved and NRTL listed, ASTM A 47/A 47M malleable iron or ASTM A 536 ductile iron, with dimensions matching steel pipe and ends factory grooved according to AWWA C606.

   Plain-End, Hard Copper Tube: ASTM B 88, Type K **OR** L, **as directed**, (ASTM B 88M, Type A **OR** B, **as directed**,), water tube, drawn temper.
   d. Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper alloy, pressure.
   e. Bronze Flanges and Flanged Fittings: ASME B16.24, Class 300.
2. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   a. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness, unless thickness or specific material is indicated.
3. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.
4. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing.
5. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
6. Steel, Keyed Couplings: UL 213, AWWA C606, approved or listed for clean-agent service, and matching steel-pipe dimensions. Include ASTM A 536, ductile-iron housing, rubber gasket, and steel bolts and nuts.

C. Valves
1. General: Brass; suitable for intended operation.
2. Container Valves: With rupture disc or solenoid and manual-release lever, capable of immediate and total agent discharge and suitable for intended flow capacity.

3. Valves in Sections of Closed Piping and Manifolds: Fabricate to prevent entrapment of liquid, or install valve and separate pressure relief device.
4. Valves in Manifolds: Check valve; installed to prevent loss of extinguishing agent when container is removed from manifold.

D. Extinguishing-Agent Containers
1. Description: Steel tanks complying with ASME Boiler and Pressure Vessel Code: Section VIII, for unfired pressure vessels. Include minimum working-pressure rating that matches system charging pressure, valve, pressure switch, and pressure gage.
   a. Finish: Red **OR** Manufacturer's standard color, **as directed**, enamel or epoxy paint.
   b. Manifold: Fabricate with valves, pressure switches, and connections for multiple storage containers, as indicated.
      OR
      Manifold: Fabricate with valves, pressure switches, selector switch, and connections for main- and reserve-supply banks of multiple storage containers.
   c. Storage-Tank Brackets: Factory- or field-fabricated retaining brackets consisting of steel straps and channels; suitable for container support, maintenance, and tank refilling or replacement.

E. Fire-Extinguishing Clean Agent
1. Clean Agent: HFC 227ea, heptafluoropropane.
   OR
   Clean Agent: IG-541, mixture of nitrogen, argon, and carbon dioxide inert gases.

F. Discharge Nozzles
1. Equipment manufacturer's standard one-piece brass or aluminum alloy of type, discharge pattern, and capacity required for application.

G. Manifold And Orifice Unions
1. Description: NRTL-listed device with minimum 2175-psig (15-MPa) pressure rating, to control flow and reduce pressure of IG-541 gas in piping.
   a. NPS 2 (DN 50) and Smaller: Piping assembly with orifice, sized for system design requirements.
   b. NPS 2-1/2 (DN 65) and Larger: Piping assembly with nipple, sized for system design requirements.

H. Control Panels
1. Description: FMG approved or NRTL listed, including equipment and features required for testing, supervising, and operating fire-extinguishing system.
2. Power Requirements: 120/240-V ac; with electrical contacts for connection to system components and fire alarm system, and transformer or rectifier as needed to produce power at voltage required for accessories and alarm devices.
3. Enclosure: NEMA ICS 6, Type 1, enameled-steel cabinet.
   a. Mounting: Recessed flush with surface **OR** Surface, **as directed**.
4. Supervised Circuits: Separate circuits for each independent hazard area.
   a. Detection circuits equal to the required number of zones, or addressable devices assigned to the required number of zones.
   b. Manual pull-station circuit.
   c. Alarm circuit.
   d. Release circuit.
   e. Abort circuit.
   f. EPO circuit.
5. Provide the following control-panel features:
   a. Electrical contacts for shutting down fans, activating dampers, and operating system electrical devices.

b. Automatic switchover to standby power at loss of primary power.
c. Storage container, low-pressure indicator.
d. Service disconnect to interrupt system operation for maintenance with visual status indication on the annunciator panel.

6. Annunciator Panel: Graphic type showing protected, hazard-area plans and locations of detectors, abort, EPO, and manual stations. Include lamps to indicate device-initiating alarm, electrical contacts for connection to control panel, and stainless-steel or aluminum enclosure.
7. Standby Power: Lead-acid or nickel-cadmium batteries with capacity to operate system for 72 hours and alarm for minimum of 15 minutes. Include automatic battery charger, with varying charging rate between trickle and high depending on battery voltage, that is capable of maintaining batteries fully charged. Include manual voltage control, dc voltmeter, dc ammeter, electrical contacts for connection to control panel, and suitable enclosure.

I. Detection Devices
1. Description: Comply with NFPA 2001 and NFPA 72, and include the following types:
a. Ionization Detectors: Comply with UL 268, dual-chamber type, having sampling and referencing chambers, with smoke-sensing element.
b. Photoelectric Detectors: Comply with UL 268, consisting of LED light source and silicon photodiode receiving element.
c. Remote Air-Sampling Detector System: Includes air-sampling pipe network, a laser-based photoelectric detector, a sample transport fan, and a control unit.
1) Comply with UL 268 and NRTL listed, operating at 24-V dc, nominal.
2) Pipe Network: CPVC tubing connects control unit with calibrated sampling holes.
3) Smoke Detector: Particle-counting type with continuous laser beam. Sensitivity adjustable to a minimum of four preset values.
4) Sample Transport Fan: Centrifugal type, creating a minimum static pressure of 0.05-inch wg (12.5 Pa) at all sampling ports.
5) Control Unit: Multizone unit as indicated on Drawings. Provides same system power supply, supervision, and alarm features as specified for the control panel plus separate trouble indication for airflow and detector problems.
6) Signals to the Central Fire Alarm Control Panel: Any type of local system trouble is reported to the central fire alarm control panel as a composite "trouble" signal. Alarms on each system zone are individually reported to the central fire alarm control panel as separately identified zones.

J. Manual Stations
1. General Description: Surface **OR** Semirecessed, **as directed**, FMG approved or NRTL listed, with clear plastic hinged cover, 120-V ac or low voltage compatible with controls. Include contacts for connection to control panel.
2. Manual Release: "MANUAL RELEASE" caption, and red finish. Unit can manually discharge extinguishing agent with operating device that remains engaged until unlocked.
3. Abort Switch: "ABORT" caption, momentary contact, with green finish.
4. EPO Switch: "EPO" caption, with yellow finish.

K. Switches
1. Description: FMG approved or NRTL listed, where available, 120-V ac or low voltage compatible with controls. Include contacts for connection to control panel.
a. Low-Agent Pressure Switches: Pneumatic operation.
b. Power Transfer Switches: Key-operation selector, for transfer of release circuit signal from main supply to reserve supply.
c. Door Closers: Magnetic retaining and release device or electrical interlock to cause the door operator to drive the door closed.

L. Alarm Devices
1. Description: FMG approved or NRTL listed, low voltage, and surface mounting, unless otherwise indicated.

2. Bells: Minimum 6-inch (150-mm) diameter.
3. Horns: 90 to 94 dBA.
4. Strobe Lights: Translucent lens, with "FIRE" or similar caption.

M. Electrical Power And Wiring
1. Electrical power, wiring, and devices are specified in Division 22.

1.3 EXECUTION

A. Piping Applications
1. Flanged pipe and fittings and flanged joints may be used to connect to specialties and accessories and where required for maintenance.
2. Fittings Working Pressure: 620 psig (4278 kPa) minimum.
3. Flanged Joints: Class 300 minimum.
4. NPS 2 (DN 50) and Smaller: ASTM B 88, Type K **OR** L, **as directed**, (ASTM B 88M, Type A **OR** B, **as directed**,) copper tube; copper, solder-joint fittings; and brazed joints.
OR
NPS 2 (DN 50) and Smaller: Schedule 40, steel pipe; malleable-iron threaded fittings; and threaded joints.
5. NPS 2-1/2 and NPS 3 (DN 65 and DN 80): ASTM B 88, Type K **OR** L, **as directed**, (ASTM B 88M, Type A **OR** B, **as directed**,) copper tube; copper, solder-joint fittings; and brazed joints.
OR
NPS 2-1/2 and NPS 3 (DN 65 and DN 80): Schedule 40, steel pipe; forged-steel welding fittings; and welded joints.
OR
NPS 2-1/2 and NPS 3 (DN 65 and DN 80): Schedule 40, steel pipe; steel, grooved-end fittings; steel, keyed couplings; and grooved joints.
6. NPS 4 (DN 100) and Larger: Schedule 40, steel pipe; steel, grooved-end fittings; steel, keyed couplings; and grooved joints.
OR
NPS 4 (DN 100) and Larger: Schedule 40, steel pipe; forged-steel welding fittings; and welded joints.

B. Piping Applications
1. Piping between Storage Containers and Orifice Union:
a. Flanged pipe and fittings and flanged joints may be used to connect to specialties and accessories and where required for maintenance.
b. Fittings Working Pressure: 2175 psig (15 MPa) minimum.
c. Flanged Joints: Class 600 minimum.
d. All Sizes: Schedule 80, steel pipe; forged-steel welding fittings; and welded joints.
2. Piping Downstream from Orifice Union:
a. Flanged pipe and fittings and flanged joints may be used to connect to specialties and accessories and where required for maintenance.
b. Fittings Working Pressure: 1000 psig (6900 kPa) minimum.
c. Flanged Joints: Class 300 minimum.
d. All Sizes: Schedule 40 **OR** 80, **as directed**, steel pipe; forged-steel welding fittings; and welded joints.

C. Clean-Agent Extinguishing Piping Installation
1. Install clean-agent extinguishing piping and other components level and plumb and according to manufacturers' written instructions.
2. Refer to Division 21 Section "Common Work Results For Fire Suppression" for basic pipe installation and joint construction.

3. Grooved Piping Joints: Groove pipe ends according to AWWA C606 dimensions. Assemble grooved-end steel pipe and steel, grooved-end fittings with steel, keyed couplings and lubricant according to manufacturer's written instructions.
4. Install extinguishing-agent containers anchored to substrate.
5. Install pipe and fittings, valves, and discharge nozzles according to requirements listed in NFPA 2001, Section "Distribution," and in ASME B31.1.
    a. Install valves designed to prevent entrapment of liquid or install pressure relief devices in valved sections of piping systems.
    b. Support piping using supports and methods according to NFPA 13.
    c. Install seismic restraints for extinguishing-agent containers and piping systems.
    d. Install control panels, detection system components, alarms, and accessories, complying with requirements of NFPA 2001, Section "Detection, Actuation, and Control Systems," as required for supervised system application.

D. Connections
1. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to extinguishing-agent containers to allow service and maintenance.
3. Connect electrical devices to control panel and to building's fire alarm system. Electrical power, wiring, and devices are specified in Division 28 Section(s) "Digital, Addressable Fire-alarm System" OR "Zoned (dc Loop) Fire-alarm System".

E. Labeling
1. Install labeling on piping, extinguishing-agent containers, other equipment, and panels according to NFPA 2001.
2. Install signs at entry doors for protected areas to warn occupants that they are entering a room protected with a clean-agent fire extinguishing system.
3. Install signs at entry doors to advise persons outside the room the meaning of the horn(s), bell(s), and strobe light(s) outside the protected space.

F. Field Quality Control
1. Comply with operating instructions and procedures of NFPA 2001, Section "Approval of Installations." Include the following tests and inspections to demonstrate compliance with requirements:
    a. Check mechanical items.
    b. Inspect extinguishing-agent containers and extinguishing agent, and check mountings for adequate anchoring to substrate.
    c. Check electrical systems.
    d. Check enclosure integrity. Comply with NFPA 2001, Section "Enclosure Inspection," and Appendix C, "Enclosure Integrity Procedure."
    e. Perform functional pre-discharge test.
    f. Perform system functional operational test including, EPO, abort, and manual release.
    g. Check remote monitoring operations.
    h. Check control-panel primary power source.
    i. Perform "puff" test on piping system, using nitrogen.
2. Perform field-acceptance tests of each clean-agent extinguishing system when installation is complete. Perform system testing only after hazard-area enclosure construction has been completed and openings sealed. Comply with operating instructions and procedures of NFPA 2001, Section "Approval of Installations." Include the following to demonstrate compliance with requirements:
    a. Perform functional predischarge test.
    b. Perform system functional operational test.
    c. Check remote monitoring operations.
    d. Check control-panel primary power source.
    e. Perform "puff" test on piping system, using nitrogen.

3. Correct malfunctioning equipment, then retest to demonstrate compliance. Replace equipment that cannot be corrected or does not perform as specified and indicated, then retest to demonstrate compliance. Repeat procedure until satisfactory results are obtained.
   a. Report test results promptly and in writing to the Owner and authorities having jurisdiction.
4. Perform the following field tests and inspections and prepare test reports:
   a. After installing clean-agent extinguishing piping system and after electrical circuitry has been energized, test for compliance with requirements.
   b. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections "Inspection and Test Procedures" and "System Function Tests." Certify compliance with test parameters.
   c. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   d. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.
   e. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Remove and replace malfunctioning units and retest as specified above.

G. Cleaning
1. Each pipe section shall be cleaned internally after preparation and before assembly by means of swabbing, using a suitable nonflammable cleaner. Pipe network shall be free of particulate matter and oil residue before installing nozzles or discharge devices.

H. System Filling
1. Preparation:
   a. Verify that piping system installation is completed and cleaned.
   b. Check for complete enclosure integrity.
   c. Check operation of ventilation and exhaust systems.
2. Filling Procedures:
   a. Fill extinguishing-agent containers with extinguishing agent and pressurize to indicated charging pressure.
   b. Install filled extinguishing-agent containers.
   c. Energize circuits.
   d. Adjust operating controls.

I. Demonstration
1. Train the Owner's maintenance personnel to adjust, operate, and maintain clean-agent extinguishing systems.

END OF SECTION 21 22 16 00

Task	Specification	Specification Description
21 22 16 00	01 22 16 00	No Specification Required
21 24 00 00	08 16 13 00c	Fiberglass Reinforced Polyester (FRP) Flush Doors
21 24 16 00	08 16 13 00c	Fiberglass Reinforced Polyester (FRP) Flush Doors

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SECTION 21 31 13 00 - ELECTRIC-DRIVE, CENTRIFUGAL FIRE PUMPS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for electric-drive, centrifugal fire pumps. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. End-suction, In-line, and Split-case fire pumps.
b. Fire-pump accessories and specialties.
c. Flowmeter systems.

C. Performance Requirements
1. Seismic Performance: Fire pumps shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Pump Equipment, Accessory, and Specialty Pressure Rating: 175 psig (1200 kPa) minimum unless higher pressure rating is indicated.

D. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: For fire pumps, motor drivers, and fire-pump accessories and specialties. Include plans, elevations, sections, details, and attachments to other work.
a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
b. Wiring Diagrams: For power, signal, and control wiring.
3. Seismic Qualification Certificates: For fire pumps, accessories, and components, from manufacturer.
a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
4. Product Certificates: For each fire pump, from manufacturer.
5. Source quality-control reports.
6. Field quality-control reports.
7. Operation and maintenance data.

E. Quality Assurance
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. NFPA Compliance: Comply with NFPA 20, "Installation of Stationary Pumps for Fire Protection."

1.2 PRODUCTS

A. General Requirements For Centrifugal Fire Pumps

1. Description: Factory-assembled and -tested fire-pump and driver unit.
2. Base: Fabricated and attached to fire-pump and driver unit with reinforcement to resist movement of pump during seismic events when base is anchored to building substrate.
3. Finish: Red paint applied to factory-assembled and -tested unit before shipping.

B. End-Suction Fire Pumps
1. Pump:
   a. Standard: UL 448, for end-suction pumps for fire service.
   b. Casing: Radially split case, cast iron with ASME B16.1 pipe-flange connections.
   c. Impeller: Cast bronze, statically and dynamically balanced, and keyed to shaft.
   d. Wear Rings: Replaceable bronze.
   e. Shaft and Sleeve: Steel shaft with bronze sleeve.
      1) Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
      2) Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.
   f. Mounting: Pump and driver shafts are horizontal, with pump and driver on same base.
2. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.
3. Driver:
   a. Standard: UL 1004A.
   b. Type: Electric motor; NEMA MG 1, polyphase Design B.

C. In-Line Fire Pumps
1. Pump:
   a. Standard: UL 448, for in-line pumps for fire service.
   b. Casing: Radially split case, cast iron with ASME B16.1 pipe-flange connections.
   c. Impeller: Cast bronze, statically and dynamically balanced, and keyed to shaft.
   d. Wear Rings: Replaceable bronze.
   e. Shaft and Sleeve: Steel shaft with bronze sleeve.
      1) Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
      2) Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.
   f. Mounting: Pump and driver shaft is vertical, with motor above pump and pump on base.
2. Coupling: None or rigid.
3. Driver:
   a. Standard: UL 1004A.
   b. Type: Electric motor; NEMA MG 1, polyphase Design B.

D. Horizontally Mounted, Single-Stage, Split-Case Fire Pumps
1. Pump:
   a. Standard: UL 448, for split-case pumps for fire service.
   b. Casing: Axially split case, cast iron with ASME B16.1 pipe-flange connections.
   c. Impeller: Cast bronze, statically and dynamically balanced, and keyed to shaft.
   d. Wear Rings: Replaceable bronze.
   e. Shaft and Sleeve: Steel shaft with bronze sleeve.
      1) Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
      2) Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.
   f. Mounting: Pump and driver shafts are horizontal, with pump and driver on same base.
2. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.
3. Driver:
   a. Standard: UL 1004A.
   b. Type: Electric motor; NEMA MG 1, polyphase Design B.

E. Horizontally Mounted, Multistage, Split-Case Fire Pumps
1. Pump:
a. Standard: UL 448, for split-case pumps for fire service.
b. Number of Stages: Two.
c. Casing: Axially split case, cast iron with ASME B16.1 pipe-flange connections.
d. Impeller: Cast bronze, statically and dynamically balanced, and keyed to shaft.
e. Wear Rings: Replaceable bronze.
f. Shaft and Sleeve: Steel shaft with bronze sleeve.
1) Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
2) Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.
g. Mounting: Pump and driver shafts are horizontal, with pump and driver on same base.
2. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.
3. Driver:
a. Standard: UL 1004A.
b. Type: Electric motor; NEMA MG 1, polyphase Design B.

F. Vertically Mounted, Single-Stage, Split-Case Fire Pumps
1. Pump:
a. Standard: UL 448, for split-case pumps for fire service.
b. Casing: Axially split case, cast iron with ASME B16.1 pipe-flange connections.
c. Impeller: Cast bronze, statically and dynamically balanced, and keyed to shaft.
d. Wear Rings: Replaceable bronze.
e. Shaft and Sleeve: Steel shaft with bronze sleeve.
1) Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
2) Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.
f. Mounting: Pump and driver shafts are vertical, with motor above pump and pump on base.
2. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.
3. Driver:
a. Standard: UL 1004A.
b. Type: Electric motor; NEMA MG 1, polyphase Design B.

G. Fire-Pump Accessories And Specialties
1. Automatic Air-Release Valves: Comply with NFPA 20 for installation in fire-pump casing.
2. Circulation Relief Valves: UL 1478, brass, spring loaded; for installation in pump discharge piping.
3. Relief Valves:
a. Description: UL 1478, bronze or cast iron, spring loaded; for installation in fire-suppression water-supply piping.
4. Inlet Fitting: Eccentric tapered reducer at pump suction inlet.
5. Outlet Fitting: Concentric tapered reducer at pump discharge outlet.
6. Discharge Cone: Closed **OR** Open, **as directed**, type.
7. Hose Valve Manifold Assembly:
a. Standard: Comply with requirements in NFPA 20.
b. Header Pipe: ASTM A 53/A 53M, Schedule 40, galvanized steel with ends threaded according to ASME B1.20.1.
c. Header Pipe Fittings: ASME B16.4, galvanized cast-iron threaded fittings.
d. Automatic Drain Valve: UL 1726.
e. Manifold:
1) Test Connections: Comply with UL 405 except provide outlets without clappers instead of inlets.
2) Body: Flush type, brass or ductile iron, with number of outlets required by NFPA 20.

3) Nipples: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with ends threaded according to ASME B1.20.1.
4) Adapters and Caps with Chain: Brass or bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
5) Escutcheon Plate: Brass or bronze; rectangular.
6) Hose Valves: UL 668, bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
7) Exposed Parts Finish: Polished **OR** Rough, **as directed**, brass, chrome plated, **as directed**.
8) Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."

OR

Manifold:

1) Test Connections: Comply with UL 405 except provide outlets without clappers instead of inlets.
2) Body: Exposed type, brass, with number of outlets required by NFPA 20.
3) Escutcheon Plate: Brass or bronze; round.
4) Hose Valves: UL 668, bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads. Include caps and chains.
5) Exposed Parts Finish: Polished **OR** Rough, **as directed**, brass, chrome plated, **as directed**.
6) Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."

H. Flowmeter Systems
1. Description: UL-listed or FM-Approved, fire-pump flowmeter system with capability to indicate flow to not less than 175 percent of fire-pump rated capacity.
2. Pressure Rating: 175 psig (1200 kPa) minimum **OR** 250 psig (1725 kPa), **as directed**.
3. Sensor: Annubar probe, orifice plate, or venturi unless otherwise indicated. Sensor size shall match pipe, tubing, flowmeter, and fittings.
4. Permanently Mounted Flowmeter: Compatible with flow sensor; with dial not less than 4-1/2 inches (115 mm) in diameter. Include bracket or device for wall mounting.
   a. Tubing Package: NPS 1/8 or NPS 1/4 (DN 6 or DN 10) soft copper **OR** plastic, **as directed**, tubing with copper or brass fittings and valves.

   OR

   Portable Flowmeter: Compatible with flow sensor; with dial not less than 4-1/2 inches (115 mm) in diameter and with two 12-foot- (3.7-m-) long hoses in carrying case.

I. Grout
1. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
2. Characteristics: Nonshrink and recommended for interior and exterior applications.
3. Design Mix: 5000-psi (34-MPa), 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

J. Source Quality Control
1. Testing: Test and inspect fire pumps according to UL 448 requirements for "Operation Test" and "Manufacturing and Production Tests."
   a. Verification of Performance: Rate fire pumps according to UL 448.
2. Fire pumps will be considered defective if they do not pass tests and inspections.
3. Prepare test and inspection reports.

1.3 EXECUTION

A. Installation

1. Fire-Pump Installation Standard: Comply with NFPA 20 for installation of fire pumps, relief valves, and related components.
2. Equipment Mounting: Install fire pumps on concrete bases. Comply with requirements for concrete bases specified in Division 03 Section "Cast-in-place Concrete".
   a. 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.
   b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   d. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install fire-pump suction and discharge piping equal to or larger than sizes required by NFPA 20.
4. Support piping and pumps separately so weight of piping does not rest on pumps.
5. Install valves that are same size as connecting piping. Comply with requirements for fire-protection valves specified in Division 21 Section(s) "Fire-suppression Standpipes" OR "Wet-pipe Sprinkler Systems", **as directed**.
6. Install pressure gages on fire-pump suction and discharge flange pressure-gage tappings. Comply with requirements for pressure gages specified in Division 21 Section(s) "Fire-suppression Standpipes" OR "Wet-pipe Sprinkler Systems", **as directed**.
7. Install piping hangers and supports, anchors, valves, gages, and equipment supports according to NFPA 20.
8. Install flowmeters and sensors. Install flowmeter-system components and make connections according to NFPA 20 and manufacturer's written instructions.
9. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.
10. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

B. Alignment
1. Align end-suction and split-case pump and driver shafts after complete unit has been leveled on concrete base, grout has set, and anchor bolts have been tightened.
2. After alignment is correct, tighten anchor bolts evenly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place. Tighten anchor bolts after grout has hardened. Check alignment and make required corrections.
3. Align piping connections.
4. Align pump and driver shafts for angular and parallel alignment according to HI 1.4 and to tolerances specified by manufacturer.

C. Connections
1. Comply with requirements for piping and valves specified in Division 21 Section(s) "Fire-suppression Standpipes" OR "Wet-pipe Sprinkler Systems", **as directed**. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to pumps and equipment to allow service and maintenance.
3. Connect relief-valve discharge to drainage piping or point of discharge.
4. Connect flowmeter-system meters, sensors, and valves to tubing.
5. Connect fire pumps to their controllers.

D. Identification
1. Identify system components. Comply with requirements for fire-pump marking according to NFPA 20.

E. Field Quality Control
1. Test each fire pump with its controller as a unit. Comply with requirements for electric-motor-driver fire-pump controllers specified in Division 21 Section(s) "Electric-drive, Centrifugal Fire Pumps" OR "Diesel-drive, Centrifugal Fire Pumps" OR "Electric-drive, Vertical-turbine Fire Pumps" OR "Diesel-drive, Vertical-turbine Fire Pumps".

2. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
3. Perform tests and inspections.
   a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
4. Tests and Inspections:
   a. After installing components, assemblies, and equipment including controller, test for compliance with requirements.
   b. Test according to NFPA 20 for acceptance and performance testing.
   c. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   d. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   e. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Components, assemblies, and equipment will be considered defective if they do not pass tests and inspections.
6. Prepare test and inspection reports.
7. Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of fire-pump test water. Hoses are for tests only and do not convey to the Owner.

F. Demonstration
   1. Train the Owner's maintenance personnel to adjust, operate, and maintain fire pumps.

END OF SECTION 21 31 13 00

Task	Specification	Specification Description
21 31 13 00	21 16 00 00	Pressure-Maintenance Pumps
21 31 13 00	21 16 00 00a	Controllers for Fire-Pump Drivers

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SECTION 21 31 16 00 - DIESEL-DRIVE, CENTRIFUGAL FIRE PUMPS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for diesel-drive, centrifugal fire pumps. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
   a. End-suction and Split-case fire pumps.
   b. Fire-pump accessories and specialties.
   c. Flowmeter systems.

C. Performance Requirements
1. Seismic Performance: Fire pumps shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Pump Equipment, Accessory, and Specialty Pressure Rating: 175 psig (1200 kPa) minimum unless higher pressure rating is indicated.

D. Submittals
1. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, performance curves, electrical characteristics, and furnished specialties and accessories.
2. Shop Drawings: For fire pumps, engine drivers, and fire-pump accessories and specialties. Include plans, elevations, sections, details, and attachments to other work.
   a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   b. Wiring Diagrams: For power, signal, and control wiring.
3. Seismic Qualification Certificates: For fire pumps, accessories, and components, from manufacturer.
   a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
4. Product Certificates: For each fire pump, from manufacturer.
5. Source quality-control reports.
6. Field quality-control reports.
7. Operation and maintenance data.

E. Quality Assurance
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. NFPA Compliance: Comply with NFPA 20, "Installation of Stationary Pumps for Fire Protection."

1.2 PRODUCTS

A. General Requirements For Centrifugal Fire Pumps
   1. Description: Factory-assembled and -tested fire-pump and driver unit.
   2. Base: Fabricated and attached to fire-pump and driver unit with reinforcement to resist movement of pump during seismic events when base is anchored to building substrate.
   3. Finish: Red paint applied to factory-assembled and -tested unit before shipping.

B. End-Suction Fire Pumps
   1. Pump:
      a. Standard: UL 448, for end-suction pumps for fire service.
      b. Casing: Radially split case, cast iron with ASME B16.1 pipe-flange connections.
      c. Impeller: Cast bronze, statically and dynamically balanced, and keyed to shaft.
      d. Wear Rings: Replaceable bronze.
      e. Shaft and Sleeve: Steel shaft with bronze sleeve.
         1) Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
         2) Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.
      f. Mounting: Pump and driver shafts are horizontal, with pump and driver on same base.
   2. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.
   3. Driver:
      a. Standard: UL 1247.
      b. Type: Diesel engine.
      c. Emergency Manual Operator: Factory wired for starting and operating standby engine in case of malfunction in main controller or wiring.
      d. Engine Cooling System: Factory-installed radiator.
         1) Coolant: Type recommended by driver manufacturer.
         OR
         Engine Cooling System: Factory-installed water piping, valves, strainer, pressure regulator, heat exchanger, coolant pump, bypass piping, and fittings.
         1) Piping: ASTM B 88, Type L (ASTM B 88M, Type B), copper water tube; ASME B16.22, wrought-copper, solder-joint pressure fittings; AWS A5.8/A5.8M, BCuP Series brazing filler metal; and brazed joints.
      e. Engine-Jacket Water Heater: Factory-installed electric elements.
      f. Dual Batteries: Lead-acid-storage type with 100 percent standby reserve capacity.
      g. Fuel System: Comply with NFPA 20.
         1) Fuel Storage Tank: Size indicated but not less than required by NFPA 20. Include floor legs, direct-reading level gage, and secondary containment tank with capacity at least equal to fuel storage tank.
      h. Exhaust System: ASTM A 53/A 53M, Type E or S, Schedule 40, black steel pipe; ASME B16.9, weld-type pipe fittings; ASME B16.5, steel flanges; and ASME B16.21, nonmetallic gaskets. Fabricate double-wall, ventilated thimble from steel pipe.
         1) Exhaust Connector: Flexible type.
         2) Exhaust Silencer: Industrial **OR** Residential, **as directed**, type.

C. Single-Stage, Split-Case Fire Pumps
   1. Pump:
      a. Standard: UL 448, for split-case pumps for fire service.
      b. Casing: Axially split case, cast iron with ASME B16.1 pipe-flange connections.
      c. Impeller: Cast bronze, statically and dynamically balanced, and keyed to shaft.
      d. Wear Rings: Replaceable bronze.
      e. Shaft and Sleeve: Steel shaft with bronze sleeve.
         1) Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
         2) Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.
      f. Mounting: Pump and driver shafts are horizontal, with pump and driver on same base.

2. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.
3. Driver:
   a. Standard: UL 1247.
   b. Type: Diesel engine.
   c. Emergency Manual Operator: Factory wired for starting and operating standby engine in case of malfunction in main controller or wiring.
   d. Engine Cooling System: Factory-installed radiator.
      1) Coolant: Type recommended by driver manufacturer.

      OR

      Engine Cooling System: Factory-installed water piping, valves, strainer, pressure regulator, heat exchanger, coolant pump, bypass piping, and fittings.
      1) Piping: ASTM B 88, Type L (ASTM B 88M, Type B), copper water tube; ASME B16.22, wrought-copper, solder-joint pressure fittings; AWS A5.8/A5.8M, BCuP Series brazing filler metal; and brazed joints.
   e. Engine-Jacket Water Heater: Factory-installed electric elements.
   f. Dual Batteries: Lead-acid-storage type with 100 percent standby reserve capacity.
   g. Fuel System: Comply with NFPA 20.
      1) Fuel Storage Tank: Size indicated but not less than required by NFPA 20. Include floor legs, direct-reading level gage, and secondary containment tank with capacity at least equal to fuel storage tank.
   h. Exhaust System: ASTM A 53/A 53M, Type E or S, Schedule 40, black steel pipe; ASME B16.9, weld-type pipe fittings; ASME B16.5, steel flanges; and ASME B16.21, nonmetallic gaskets. Fabricate double-wall, ventilated thimble from steel pipe.
      1) Exhaust Connector: Flexible type.
      2) Exhaust Silencer: Industrial **OR** Residential, **as directed**, type.

D. Multistage, Split-Case Fire Pumps
1. Pump:
   a. Standard: UL 448, for split-case pumps for fire service.
   b. Number Stages: Two.
   c. Casing: Axially split case, cast iron with ASME B16.1 pipe-flange connections.
   d. Impeller: Cast bronze, statically and dynamically balanced, and keyed to shaft.
   e. Wear Rings: Replaceable bronze.
   f. Shaft and Sleeve: Steel shaft with bronze sleeve.
      1) Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
      2) Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.
   g. Mounting: Pump and driver shafts are horizontal, with pump and driver on same base.
2. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.
3. Driver:
   a. Standard: UL 1247.
   b. Type: Diesel engine.
   c. Emergency Manual Operator: Factory wired for starting and operating standby engine in case of malfunction in main controller or wiring.
   d. Engine Cooling System: Factory-installed radiator.
      1) Coolant: Type recommended by driver manufacturer.

      OR

      Engine Cooling System: Factory-installed water piping, valves, strainer, pressure regulator, heat exchanger, coolant pump, bypass piping, and fittings.
      1) Piping: ASTM B 88, Type L (ASTM B 88M, Type B), copper water tube; ASME B16.22, wrought-copper, solder-joint pressure fittings; AWS A5.8/A5.8M, BCuP Series brazing filler metal; and brazed joints.
   e. Engine-Jacket Water Heater: Factory-installed electric elements.
   f. Dual Batteries: Lead-acid-storage type with 100 percent standby reserve capacity.

g. Fuel System: Comply with NFPA 20.
   1) Fuel Storage Tank: Size indicated but not less than required by NFPA 20. Include floor legs, direct-reading level gage, and secondary containment tank with capacity at least equal to fuel storage tank.

h. Exhaust System: ASTM A 53/A 53M, Type E or S, Schedule 40, black steel pipe; ASME B16.9, weld-type pipe fittings; ASME B16.5, steel flanges; and ASME B16.21, nonmetallic gaskets. Fabricate double-wall, ventilated thimble from steel pipe.
   1) Exhaust Connector: Flexible type.
   2) Exhaust Silencer: Industrial **OR** Residential, **as directed**, type.

E. Fire-Pump Accessories And Specialties
1. Automatic Air-Release Valves: Comply with NFPA 20 for installation in fire-pump casing.
2. Circulation Relief Valves: UL 1478, brass, spring loaded; for installation in pump discharge piping.
3. Relief Valves:
   a. Description: UL 1478, bronze or cast iron, spring loaded; for installation in fire-suppression water-supply piping.
4. Inlet Fitting: Eccentric tapered reducer at pump suction inlet.
5. Outlet Fitting: Concentric tapered reducer at pump discharge outlet.
6. Discharge Cone: Closed **OR** Open, **as directed**, type.
7. Hose Valve Manifold Assembly:
   a. Standard: Comply with requirements in NFPA 20.
   b. Header Pipe: ASTM A 53/A 53M, Schedule 40, galvanized steel with ends threaded according to ASME B1.20.1.
   c. Header Pipe Fittings: ASME B16.4, galvanized cast-iron threaded fittings.
   d. Automatic Drain Valve: UL 1726.
   e. Manifold:
      1) Test Connections: Comply with UL 405 except provide outlets without clappers instead of inlets.
      2) Body: Flush type, brass or ductile iron, with number of outlets required by NFPA 20.
      3) Nipples: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with ends threaded according to ASME B1.20.1.
      4) Adapters and Caps with Chain: Brass or bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
      5) Escutcheon Plate: Brass or bronze; rectangular.
      6) Hose Valves: UL 668, bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
      7) Exposed Parts Finish: Polished **OR** Rough, **as directed**, brass, **as directed**, chrome plated, **as directed**.
      8) Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."

      OR

      Manifold:
      1) Test Connections: Comply with UL 405 except provide outlets without clappers instead of inlets.
      2) Body: Exposed type, brass, with number of outlets required by NFPA 20.
      3) Escutcheon Plate: Brass or bronze; round.
      4) Hose Valves: UL 668, bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads. Include caps and chains.
      5) Exposed Parts Finish: Polished **OR** Rough, **as directed**, brass, **as directed**, chrome plated, **as directed**.
      6) Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."

F. Flowmeter Systems
1. Description: UL-listed or FM-Approved, fire-pump flowmeter system with capability to indicate flow to not less than 175 percent of fire-pump rated capacity.

2. Pressure Rating: 175 psig (1200 kPa) minimum **OR** 250 psig (1725 kPa), **as directed**.
3. Sensor: Annubar probe, orifice plate, or venturi unless otherwise indicated. Sensor size shall match pipe, tubing, flowmeter, and fittings.
4. Permanently Mounted Flowmeter: Compatible with flow sensor; with dial not less than 4-1/2 inches (115 mm) in diameter. Include bracket or device for wall mounting.
   a. Tubing Package: NPS 1/8 or NPS 1/4 (DN 6 or DN 10) soft copper **OR** plastic, **as directed**, tubing with copper or brass fittings and valves.

   OR

   Portable Flowmeter: Compatible with flow sensor; with dial not less than 4-1/2 inches (115 mm) in diameter and with two 12-foot- (3.7-m-) long hoses in carrying case.

G. Grout
1. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
2. Characteristics: Nonshrink and recommended for interior and exterior applications.
3. Design Mix: 5000-psi (34-MPa), 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

H. Source Quality Control
1. Testing: Test and inspect fire pumps according to UL 448 requirements for "Operation Test" and "Manufacturing and Production Tests."
   a. Verification of Performance: Rate fire pumps according to UL 448.
2. Fire pumps will be considered defective if they do not pass tests and inspections.
3. Prepare test and inspection reports.

1.3 EXECUTION

A. Installation
1. Fire-Pump Installation Standard: Comply with NFPA 20 for installation of fire pumps, relief valves, and related components.
2. Equipment Mounting: Install fire pumps on concrete bases. Comply with requirements for concrete bases specified in Division 03 Section "Cast-in-place Concrete".
   a. 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.
   b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   d. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install fire-pump suction and discharge piping equal to or larger than sizes required by NFPA 20.
4. Support piping and pumps separately so weight of piping does not rest on pumps.
5. Install valves that are same size as connecting piping. Comply with requirements for fire-protection valves specified in Division 21 Section(s) "Fire-suppression Standpipes" OR "Wet-pipe Sprinkler Systems", **as directed**.
6. Install pressure gages on fire-pump suction and discharge flange pressure-gage tappings. Comply with requirements for pressure gages specified in Division 21 Section(s) "Fire-suppression Standpipes" OR "Wet-pipe Sprinkler Systems", **as directed**.
7. Install piping hangers and supports, anchors, valves, gages, and equipment supports according to NFPA 20.
8. Install fuel system according to NFPA 20.
9. Install water supply and drain piping for diesel-engine heat exchangers. Extend drain piping from heat exchangers to point of disposal.
10. Install exhaust-system piping for diesel engines. Extend to point of termination outside structure. Install pipe and fittings with welded joints; install components having flanged connections with gasketed joints.

11. Install condensate-drain piping for diesel-engine exhaust system. Extend drain piping from low points of exhaust system to condensate traps and to point of disposal.
12. Install flowmeters and sensors. Install flowmeter-system components and make connections according to NFPA 20 and manufacturer's written instructions.
13. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.
14. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

B. Alignment
1. Align end-suction and split-case pump and driver shafts after complete unit has been leveled on concrete base, grout has set, and anchor bolts have been tightened.
2. After alignment is correct, tighten anchor bolts evenly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place. Tighten anchor bolts after grout has hardened. Check alignment and make required corrections.
3. Align piping connections.
4. Align pump and driver shafts for angular and parallel alignment according to HI 1.4 and to tolerances specified by manufacturer.

C. Connections
1. Comply with requirements for piping and valves specified in Division 21 Section(s) "Fire-suppression Standpipes" OR "Wet-pipe Sprinkler Systems", **as directed**. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to pumps and equipment to allow service and maintenance.
3. Connect relief-valve discharge to drainage piping or point of discharge.
4. Connect flowmeter-system meters, sensors, and valves to tubing.
5. Connect fire pumps to their controllers.

D. Identification
1. Identify system components. Comply with requirements for fire-pump marking according to NFPA 20.

E. Field Quality Control
1. Test each fire pump with its controller as a unit. Comply with requirements for diesel-engine-driver fire-pump controllers specified in Division 21 Section(s) "Electric-drive, Centrifugal Fire Pumps" OR "Diesel-drive, Centrifugal Fire Pumps" OR "Electric-drive, Vertical-turbine Fire Pumps" OR "Diesel-drive, Vertical-turbine Fire Pumps".
2. Perform tests and inspections.
   a. 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. Tests and Inspections:
   a. After installing components, assemblies, and equipment including controller, test for compliance with requirements.
   b. Test according to NFPA 20 for acceptance and performance testing.
   c. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   d. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   e. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
4. Components, assemblies, and equipment will be considered defective if they do not pass tests and inspections.
5. Prepare test and inspection reports.

6. Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of fire-pump test water. Hoses are for tests only and do not convey to the Owner.

F. Startup Service
1. Perform startup service.
a. Complete installation and startup checks according to manufacturer's written instructions.

G. Demonstration
1. Train the Owner's maintenance personnel to adjust, operate, and maintain fire pumps.

END OF SECTION 21 31 16 00

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Task	Specification	Specification Description
21 31 16 00	21 16 00 00	Pressure-Maintenance Pumps
21 31 16 00	21 16 00 00a	Controllers for Fire-Pump Drivers

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SECTION 22 01 40 00 - EMERGENCY PLUMBING FIXTURES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for emergency plumbing fixtures. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work

B. Summary
1. This Section includes the following emergency plumbing fixtures:
a. Emergency showers.
b. Eyewash equipment.
c. Self-contained eyewash equipment.
d. Personal eyewash equipment.
e. Eye/face wash equipment.
f. Hand-held drench hoses.
g. Combination units.
h. Water-tempering equipment.

C. Definitions
1. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.
2. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.
3. Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid-solution supply.
4. Tepid: Moderately warm.

D. Submittals
1. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.
2. Shop Drawings: Diagram power, signal, and control wiring.
3. Operation and maintenance data.

E. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."
3. 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 plumbing fixtures for people with disabilities.
4. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

1.2 PRODUCTS

A. Emergency Showers:
1. Description: Plumbed, single-shower-head horizontal, wall-mounting **OR** vertical, ceiling-mounting **OR** freestanding, **as directed,** emergency shower.
a. Capacity: Deliver potable water at rate not less than 20 gpm (76 L/min.) for at least 15 minutes.

b. Supply Piping: NPS 1 (DN 25) **OR** NPS 1-1/4 (DN 32) **OR** galvanized steel **OR** chrome-plated brass or stainless steel **OR** PVC, **as directed,** with flow regulator and stay-open control valve.
c. Control-Valve Actuator: Pull rod **OR** chain, **as directed**.
d. Shower Head: 8-inch (200-mm) minimum diameter, chrome-plated brass or stainless steel **OR** plastic, **as directed**.

2. Description: Plumbed, multiple-spray emergency shower with eight **OR** 12 **OR** 16, **as directed,** small shower heads or nozzles.
   a. Capacity: Deliver potable water at rate not less than 20 gpm (76 L/min.) for at least 15 minutes.
   b. Supply Piping: NPS 1-1/4 (DN 32) minimum galvanized **OR** chrome-plated brass or stainless, **as directed,** steel with flow regulator and stay-open control valve.
   c. Control-Valve Actuator: Paddle **OR** Treadle, **as directed**.
3. Description: Plumbed, freeze-protected, freestanding emergency shower.
   a. Capacity: Deliver potable water at rate not less than 20 gpm (76 L/min.) for at least 15 minutes.
   b. Supply Piping: NPS 1-1/4 (DN 32) galvanized steel with flow regulator and stay-open control valve.
   c. Control-Valve Actuator: Pull rod **OR** chain, **as directed**.
   d. Shower Head: 8-inch (200-mm) minimum diameter, chrome-plated brass or stainless steel **OR** plastic, **as directed**.
   e. Heating System: 120 **OR** 240, **as directed**,-V ac electric; and insulation with protective jacket.

B. Eyewash Equipment
1. Description: Plumbed, freestanding eyewash equipment.
   a. Capacity: Deliver potable water at rate not less than 0.4 gpm (1.5 L/min.) for at least 15 minutes.
   b. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
   c. Control-Valve Actuator: Paddle **OR** Push bar **OR** Treadle, **as directed**.
   d. Receptor: Chrome-plated brass or stainless-steel **OR** Plastic, **as directed,** bowl.
   e. Drain Piping: NPS 1-1/4 (DN 32) minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2 **OR** Omit drain piping **OR** Include galvanized-steel indirect connection to drainage system, **as directed**.
2. Description: Plumbed, accessible, **as directed**, wall-mounting eyewash equipment with receptor and wall bracket.
   a. Capacity: Deliver potable water at rate not less than 0.4 gpm (1.5 L/min.) for at least 15 minutes.
   b. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
   c. Control-Valve Actuator: Paddle.
   d. Receptor: Chrome-plated brass or stainless-steel **OR** Plastic, **as directed,** bowl.
   e. Drain Piping: NPS 1-1/4 (DN 32) minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2.
3. Description: Plumbed, accessible, **as directed**, wall-mounting eyewash equipment with wall bracket.
   a. Capacity: Deliver potable water at rate not less than 0.4 gpm (1.5 L/min.) for at least 15 minutes.
   b. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
   c. Control-Valve Actuator: Paddle **OR** Movement sensor, **as directed**.
4. Description: Plumbed, adjacent-to-sink, swivel, counter-mounting eyewash equipment.
   a. Capacity: Deliver potable water at rate not less than 0.4 gpm (1.5 L/min.) for at least 15 minutes.

b. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
c. Control-Valve Actuator: Paddle.

C. Self-Contained Eyewash Equipment:
1. Description: Portable, pressurized, self-contained eyewash equipment.
a. Capacity: Deliver flushing fluid at rate not less than 0.4 gpm (1.5 L/min.) for at least 15 minutes.
b. Tank: 10 gal. (3.8 L), stainless steel, cylindrical, and suitable for on-floor installation.
c. Flushing Fluid: Medically acceptable solution manufactured and labeled according to applicable regulations.
d. Piping: Chrome-plated copper alloy or stainless steel with flow regulator and stay-open control valve.
e. Control-Valve Actuator: Paddle.
f. Spray Heads: Twin with covers.
2. Description: Static, nonpressurized, self-contained eyewash equipment.
a. Capacity: Deliver flushing fluid at rate not less than 0.4 gpm (1.5 L/min.) for at least 15 minutes.
b. Tank: 14 gal. (53 L) minimum, plastic, and suitable for shelf mounting.
c. Flushing Fluid: Medically acceptable solution manufactured and labeled according to applicable regulations.
d. Actuator: Pull-down front panel.
e. Spray Heads: Protected, twin.
3. Description: Freeze-protected, static, nonpressurized, self-contained eyewash equipment with heating system.
a. Capacity: Deliver flushing fluid at rate not less than 0.4 gpm (1.5 L/min.) for at least 15 minutes.
b. Tank: 14 gal. (53 L) minimum **OR** 20 gal. (76 L) minimum, **as directed**, plastic, and suitable for shelf mounting.
c. Flushing Fluid: Medically acceptable solution manufactured and labeled according to applicable regulations.
d. Actuator: Pull-down front panel.
e. Spray Heads: Protected, twin.
f. Heating System: Electric, 120-V ac; and insulation with protective jacket.

D. Personal Eyewash Equipment:
1. Description: Portable, pressurized, personal eyewash equipment with spray heads.
a. Capacity: Deliver flushing fluid at rate not less than 0.4 gpm (1.5 L/min.), **as directed**.
b. Tank: 5 gal. (19 L), stainless steel, cylindrical, and with base suitable for on-floor installation.
c. Flushing Fluid: Medically acceptable solution manufactured and labeled according to applicable regulations.
d. Piping: Chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
e. Control-Valve Actuator: Paddle.
f. Spray Heads: Twin with covers.
2. Description: Portable, pressurized, personal eyewash equipment with spray heads and drench hose.
a. Capacity: Deliver flushing fluid at rate not less than 0.4 gpm (1.5 L/min.), **as directed**.
b. Tank: 5 gal. (19 L), stainless steel, cylindrical, and with base suitable for on-floor installation.
c. Flushing Fluid: Medically acceptable solution manufactured and labeled according to applicable regulations.
d. Piping: Chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
e. Spray-Head, Control-Valve Actuator: Paddle.

f. Spray Heads: Twin with covers.
g. Drench Hose: Rubber or plastic.
1) Control-Valve Actuator: Hand-held squeeze valve.
2) Spray Head: Single with cover.

E. Eye/Face Wash Equipment:
1. Description: Plumbed, freestanding, pedestal eye/face wash equipment.
a. Capacity: Deliver potable water at rate not less than 3.0 gpm (11.4 L/min.) for at least 15 minutes.
b. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
c. Control-Valve Actuator: Paddle **OR** Push bar **OR** Treadle, **as directed**.
d. Receptor: Chrome-plated brass or stainless-steel **OR** Plastic, **as directed,** bowl.
e. Drain Piping: NPS 1-1/4 (DN 32) minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2. Include galvanized-steel indirect connection to drainage system.
2. Description: Plumbed, accessible, **as directed**, wall-mounting eye/face wash equipment with receptor and wall bracket.
a. Capacity: Deliver potable water at rate not less than 3.0 gpm (11.4 L/min.) for at least 15 minutes.
b. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
c. Control-Valve Actuator: Paddle.
d. Receptor: Chrome-plated brass or stainless-steel **OR** Plastic, **as directed,** bowl.
e. Drain Piping: NPS 1-1/4 (DN 32) minimum, chrome-plated brass, receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2.
3. Description: Plumbed, accessible, **as directed**, wall-mounting eye/face wash equipment without receptor and with wall bracket.
a. Capacity: Deliver potable water at rate not less than 3.0 gpm (11.4 L/min.) for at least 15 minutes.
b. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
c. Control-Valve Actuator: Paddle.
4. Description: Plumbed, adjacent-to-sink, swivel, counter-mounting eye/face wash equipment.
a. Capacity: Deliver potable water at rate not less than 3.0 gpm (11.4 L/min.) for at least 15 minutes.
b. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
c. Control-Valve Actuator: Paddle.

F. Hand-Held Drench Hoses:
1. Description: Plumbed, wall-mounting, hand-held drench hose with wall bracket.
a. Capacity: Deliver potable water at rate not less than 3.0 gpm (11.4 L/min.) for at least 15 minutes.
b. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
c. Control-Valve Actuator: Paddle.
d. Hose: Coiled **OR** Plain, **as directed**, rubber or plastic.
e. Spray Heads: Single **OR** Twin, **as directed**.
2. Description: Plumbed, counter-mounting, hand-held drench hose.
a. Capacity: Deliver potable water at rate not less than 3.0 gpm (11.4 L/min.) for at least 15 minutes.
b. Supply Fitting: NPS 1/2 (DN 15) brass with flow regulator.
c. Hose: Rubber or plastic.
d. Control-Valve Actuator: Hand-held squeeze valve.

e. Spray Heads: Single **OR** Twin, **as directed**.

G. Combination Units:
1. Description: Plumbed, accessible, **as directed,** freestanding, with emergency shower and eyewash **OR** eye/face wash **OR** drench hose, **as directed,** equipment.
   a. Piping: Galvanized steel **OR** Chrome-plated brass or stainless steel **OR** PVC, **as directed**.
      1) Unit Supply: NPS 1-1/4 (DN 32) minimum **OR** NPS 1-1/2 (DN 40), **as directed,** from top **OR** side, **as directed**.
      2) Unit Drain: Outlet at side near bottom.
      3) Shower Supply: NPS 1 (DN 25) with flow regulator and stay-open control valve.
      4) Eyewash **OR** Eye/Face Wash **OR** Drench Hose, **as directed,** Supply: NPS 1/2 (DN 15) with flow regulator and stay-open control valve.
   b. Shower Capacity: Deliver potable water at rate not less than 20 gpm (76 L/min.) for at least 15 minutes.
      1) Control-Valve Actuator: Pull rod **OR** Pull chain **OR** Treadle, **as directed**.
      2) Shower Head: 8-inch (200-mm) minimum diameter, chrome-plated brass or stainless steel **OR** plastic, **as directed**.
   c. Eyewash Equipment: With capacity to deliver potable water at rate not less than 0.4 gpm (1.5 L/min.) for at least 15 minutes.
      1) Control-Valve Actuator: Paddle **OR** Push bar, **as directed**.
      2) Receptor: Chrome-plated brass or stainless-steel **OR** Plastic, **as directed,** bowl.
   d. Eye/Face Wash Equipment: With capacity to deliver potable water at rate not less than 3.0 gpm (11.4 L/min.) for at least 15 minutes.
      1) Control-Valve Actuator: Paddle **OR** Push bar, **as directed**.
      2) Receptor: Chrome-plated brass or stainless-steel **OR** Plastic, **as directed,** bowl.
   e. Hand-Held Drench Hose: With capacity to deliver potable water at rate not less than 3.0 gpm (11.4 L/min.) for at least 15 minutes.
      1) Hose: Rubber or plastic.
      2) Control-Valve Actuator: Hand-held squeeze valve.
      3) Spray Head(s): Single **OR** Twin, **as directed**.
2. Description: Plumbed, accessible, **as directed,** freeze-protected, freestanding, with emergency shower and eye/face wash equipment.
   a. Piping: Galvanized steel.
      1) Unit Supply: NPS 1-1/4 (DN 32) minimum **OR** NPS 1-1/2 (DN 40), **as directed,** from top **OR** side **OR** bottom, **as directed**.
      2) Shower Supply: NPS 1 (DN 25) with flow regulator and stay-open control valve.
      3) Eye/Face Wash Supply: NPS 1/2 (DN 15) with flow regulator and stay-open control valve.
   b. Heating System: Electric, 120 **OR** 240, **as directed**,-V ac; and insulation with protective jacket.
   c. Shower Capacity: Deliver potable water at rate not less than 20 gpm (76 L/min.) for at least 15 minutes.
      1) Control-Valve Actuator: Pull rod **OR** Pull chain **OR** Treadle, **as directed**.
      2) Shower Head: 8-inch (200-mm) minimum diameter, chrome-plated brass or stainless steel **OR** plastic, **as directed**.
   d. Eye/Face Wash Equipment: With capacity to deliver potable water at rate not less than 3.0 gpm (11.4 L/min.) for at least 15 minutes.
      1) Control-Valve Actuator: Paddle **OR** Push bar, **as directed**.

H. Water-Tempering Equipment:
1. Description: Factory-fabricated, hot- and cold-water-tempering equipment with thermostatic mixing valve.
   a. Thermostatic Mixing Valve: Designed to provide 85 deg F (29 deg C) tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F (3 deg C) throughout required 15-minute test period, and in case of unit failure to continue

cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.

2. Description: Factory-fabricated, steam and cold-water, water-tempering equipment with thermostatic mixing valve.
   a. Thermostatic Mixing Valve: Designed to provide 85 deg F (29 deg C) tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F (3 deg C) throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, steam controls, heat exchanger, high-temperature-limit and freeze-protection devices, metal piping, and corrosion-resistant enclosure.
3. Description: Factory-fabricated, water-tempering equipment with electric heating.
   a. Heating System: Electric, designed to provide 85 deg F (29 deg C) tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F (3 deg C) throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, heating coils, high-temperature-limit device, metal piping, and corrosion-resistant enclosure.
      1) Electrical Characteristics: 208-V ac, 38 **OR** 220-V ac, 40 **OR** 277-V ac, 32, **as directed,** A, single phase, 60 Hz.

1.3 EXECUTION

A. Installation
1. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.
2. Install fixtures level and plumb.
3. Fasten fixtures to substrate.
4. Install shutoff valves in water-supply piping to fixtures. Use ball, gate, or globe valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Valves are specified in Division 22 Section "General-duty Valves For Plumbing Piping".
   a. Exception: Omit shutoff valve on supply to group of plumbing fixtures that includes emergency plumbing fixture.
   b. Exception: Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.
5. Install shutoff valve and strainer in steam piping and shutoff valve in condensate return piping.
6. Install dielectric fitting in supply piping to fixture if piping and fixture connections are made of different metals. Dielectric fittings are specified in Division 22 Section "Common Work Results For Plumbing".
7. Install thermometers in supply and outlet piping connections to water-tempering equipment. Thermometers are specified in Division 22 Section "Meters And Gages For Plumbing Piping".
8. Install trap and waste to wall on drain outlet of fixture receptors that are indicated to be directly connected to drainage system.
9. Install indirect waste piping to wall on drain outlet of fixture receptors that are indicated to be indirectly connected to drainage system. Drainage piping is specified in Division 22 Section "Sanitary Waste And Vent Piping".
10. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Escutcheons are specified in Division 22 Section "Common Work Results For Plumbing".
11. Fill self-contained fixtures with flushing fluid.
12. Install equipment nameplates or equipment markers on fixtures and equipment signs on water-tempering equipment. Identification materials are specified in Division 22 Section "Identification For Plumbing Piping And Equipment".
13. Piping installation requirements are specified in other Division 14. Drawings indicate general arrangement of piping, fittings, and specialties.
14. Connect cold-water-supply piping to plumbed emergency plumbing fixtures not having water-tempering equipment.

15. Connect hot- and cold-water-supply piping to hot- and cold-water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures.
16. Connect cold-water and steam supply and condensate return piping to steam and cold-water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures.
17. Connect cold water and electrical power to electric heating water-tempering equipment.
18. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary drainage and vent piping.
19. Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to sanitary or storm drainage piping.
20. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
21. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

B. Field Quality Control
1. Electrical-Component Testing: After electrical circuitry has been energized, test for compliance with requirements.
   a. Test and adjust controls and safeties.
2. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

C. Adjusting
1. Adjust or replace fixture flow regulators for proper flow.
2. Adjust equipment temperature settings.

END OF SECTION 22 01 40 00

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Task	Specification	Specification Description
22 01 40 00	10 28 19 16	Plumbing Fixtures
22 05 19 00	01 22 16 00	No Specification Required
22 05 19 00	21 05 19 00	Water Distribution
22 05 19 00	21 05 19 00a	Meters and Gages for Plumbing Piping
22 05 19 00	21 05 19 00b	Meters and Gages for HVAC Piping

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SECTION 22 05 23 00 - PIPED UTILITIES BASIC MATERIALS AND METHODS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for piped utilities - basic materials and methods. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Piping joining materials.
b. Transition fittings.
c. Dielectric fittings.
d. Sleeves.
e. Identification devices.
f. Grout.
g. Flowable fill.
h. Piped utility demolition.
i. Piping system common requirements.
j. Equipment installation common requirements.
k. Painting.
l. Concrete bases.
m. Metal supports and anchorages.

C. Definitions
1. Exposed Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions.
2. Concealed 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.
3. ABS: Acrylonitrile-butadiene-styrene plastic.
4. CPVC: Chlorinated polyvinyl chloride plastic.
5. PE: Polyethylene plastic.
6. PVC: Polyvinyl chloride plastic.

D. Submittals
1. Product Data: For the following:
a. Dielectric fittings.
b. Identification devices.
2. Welding certificates.

E. Quality Assurance
1. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. Steel Piping Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
a. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
b. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
3. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

F. Delivery, Storage, And Handling
1. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
2. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.2 PRODUCTS

A. Piping Joining Materials
1. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   a. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch (3.2-mm) maximum thickness, unless otherwise indicated.
      1) Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      2) Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
   b. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
3. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
4. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
5. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
6. 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.
7. Solvent Cements for Joining Plastic Piping:
   a. ABS Piping: ASTM D 2235.
   b. CPVC Piping: ASTM F 493.
   c. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
   d. PVC to ABS Piping Transition: ASTM D 3138.
8. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

B. Transition Fittings
1. Transition Fittings, General: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
2. Transition Couplings NPS 1-1/2 (DN 40) and Smaller:
   a. Underground Piping: Manufactured piping coupling or specified piping system fitting.
   b. Aboveground Piping: Specified piping system fitting.
3. AWWA Transition Couplings NPS 2 (DN 50) and Larger:
   a. Description: AWWA C219, metal sleeve-type coupling for underground pressure piping.
4. Plastic-to-Metal Transition Fittings:
   a. Description: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint or threaded end.
5. Plastic-to-Metal Transition Unions:
   a. Description: MSS SP-107, CPVC and PVC four-part union. Include brass or stainless-steel threaded end, solvent-cement-joint or threaded plastic end, rubber O-ring, and union nut.
6. Flexible Transition Couplings for Underground Nonpressure Drainage Piping:
   a. Description: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

C. Dielectric Fittings
1. Dielectric Fittings, General: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.
2. Dielectric Unions:
   a. Description: Factory fabricated, union, NPS 2 (DN 50) and smaller.
      1) Pressure Rating: 150 psig (1035 kPa) minimum **OR** 250 psig (1725 kPa), **as directed**, at 180 deg F (82 deg C).
      2) End Connections: Solder-joint copper alloy and threaded ferrous; threaded ferrous.
3. Dielectric Flanges:
   a. Description: Factory-fabricated, bolted, companion-flange assembly, NPS 2-1/2 to NPS 4 (DN 65 to DN 100) and larger.
      1) Pressure Rating: 150 psig (1035 kPa) minimum **OR** 175 psig (1200 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
      2) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
4. Dielectric-Flange Kits:
   a. Description: Nonconducting materials for field assembly of companion flanges, NPS 2-1/2 (DN 65) and larger.
      1) Pressure Rating: 150 psig (1035 kPa) minimum.
      2) Gasket: Neoprene or phenolic.
      3) Bolt Sleeves: Phenolic or polyethylene.
      4) Washers: Phenolic with steel backing washers.
5. Dielectric Couplings:
   a. Description: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining, NPS 3 (DN 80) and smaller.
      1) Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
      2) End Connections: Threaded.
6. Dielectric Nipples:
   a. Description: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining.
      1) Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
      2) End Connections: Threaded or grooved.

D. Sleeves
1. Mechanical sleeve seals for pipe penetrations are specified in Division 22 Section "Common Work Results For Plumbing".
2. Galvanized-Steel Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
3. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized, plain ends.
4. Cast-Iron Sleeves: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
5. Molded PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.
6. PVC Pipe Sleeves: ASTM D 1785, Schedule 40.
7. Molded PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

E. Identification Devices
1. Equipment Nameplates: Metal permanently fastened to equipment with data engraved or stamped.
   a. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and essential data.
   b. Location: Accessible and visible.
2. Stencils: Standard stencils prepared with letter sizes complying with recommendations in ASME A13.1. Minimum letter height is 1-1/4 inches (30 mm) for ducts, and 3/4 inch (20 mm) for access door signs and similar operational instructions.
   a. Material: Fiberboard **OR** Brass, **as directed**.

b. Stencil Paint: Exterior, oil-based, alkyd-gloss black enamel, unless otherwise indicated. Paint may be in pressurized spray-can form.
c. Identification Paint: Exterior, oil-based, alkyd enamel in colors according to ASME A13.1, unless otherwise indicated.

3. Snap-on Plastic Pipe Markers: Manufacturer's standard preprinted, semirigid, snap-on type. Include color-coding according to ASME A13.1, unless otherwise indicated.
4. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, color-coded, pressure-sensitive-vinyl type with permanent adhesive.
5. Pipes with OD, Including Insulation, Less Than 6 Inches (150 mm): Full-band pipe markers, extending 360 degrees around pipe at each location.
6. Pipes with OD, Including Insulation, 6 Inches (150 mm) and Larger: Either full-band or strip-type pipe markers, at least three times letter height and of length required for label.
7. Lettering: Manufacturer's standard preprinted captions as selected by the Owner.
8. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
   a. Arrows: Either integrally with piping system service lettering to accommodate both directions of flow, or as separate unit on each pipe marker to indicate direction of flow.
9. Plastic Tape: Manufacturer's standard color-coded, pressure-sensitive, self-adhesive vinyl tape, at least 3 mils (0.08 mm) thick.
   a. Width: 1-1/2 inches (40 mm) on pipes with OD, including insulation, less than 6 inches (150 mm); 2-1/2 inches (65 mm) for larger pipes.
   b. Color: Comply with ASME A13.1, unless otherwise indicated.
10. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) sequenced numbers. Include 5/32-inch (4-mm) hole for fastener.
    a. Material: 0.032-inch- (0.8-mm-) thick, polished brass **OR** aluminum, **as directed**.
    b. Material: 0.0375-inch- (1-mm-) thick stainless steel.
    c. Material: 3/32-inch- (2.4-mm-) thick plastic laminate with 2 black surfaces and a white inner layer.
    d. Material: Valve manufacturer's standard solid plastic.
    e. Size: 1-1/2 inches (40 mm) in diameter, unless otherwise indicated.
    f. Shape: As indicated for each piping system.
11. Valve Tag Fasteners: Brass, wire-link or beaded chain; or brass S-hooks.
12. Engraved Plastic-Laminate Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.
    a. Engraving: Engraver's standard letter style, of sizes and with terms to match equipment identification.
    b. Thickness: 1/16 inch (1.6 mm), for units up to 20 sq. in. (130 sq. cm) or 8 inches (200 mm) in length, and 1/8 inch (3 mm) for larger units.
    c. Fasteners: Self-tapping, stainless-steel screws or contact-type permanent adhesive.
13. Plastic Equipment Markers: Manufacturer's standard laminated plastic, in the following color codes:
    a. Green: Cooling equipment and components.
    b. Yellow: Heating equipment and components.
    c. Brown: Energy reclamation equipment and components.
    d. Blue: Equipment and components that do not meet criteria above.
    e. Hazardous Equipment: Use colors and designs recommended by ASME A13.1.
    f. Terminology: Match schedules as closely as possible. Include the following:
       1) Name and plan number.
       2) Equipment service.
       3) Design capacity.
       4) Other design parameters such as pressure drop, entering and leaving conditions, and speed.

g. Size: 2-1/2 by 4 inches (65 by 100 mm) for control devices, dampers, and valves; 4-1/2 by 6 inches (115 by 150 mm) for equipment.

14. Plasticized Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with mat finish suitable for writing.
    a. Size: 3-1/4 by 5-5/8 inches (83 by 143 mm).
    b. Fasteners: Brass grommets and wire.
    c. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.
15. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in piped utility identification with corresponding designations indicated. Use numbers, letters, and terms indicated for proper identification, operation, and maintenance of piped utility systems and equipment.
    a. Multiple Systems: Identify individual system number and service if multiple systems of same name are indicated.

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

G. Flowable Fill
1. Description: Low-strength-concrete, flowable-slurry mix.
    a. Cement: ASTM C 150, Type I, portland.
    b. Density: 115- to 145-lb/cu. ft. (1840- to 2325-kg/cu. m).
    c. Aggregates: ASTM C 33, natural sand, fine and crushed gravel or stone, coarse
    OR
    Aggregates: ASTM C 33, natural sand, fine with admixture, ASTM C 618, fly-ash mineral.
    d. Water: Comply with ASTM C 94/C 94M.
    e. Strength: 100 to 200 psig (690 to 1380 kPa) at 28 days.

1.3 EXECUTION

A. Piped Utility Demolition
1. Refer to Division 01 Section(s) "Cutting And Patching" AND Division 02 Section(s) "Selective Structure Demolition" for general demolition requirements and procedures.
2. Disconnect, demolish, and remove piped utility systems, equipment, and components indicated to be removed.
    a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
    b. Piping to Be Abandoned in Place: Drain piping. Fill abandoned piping with flowable fill, and cap or plug piping with same or compatible piping material.
    c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
    d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make operational.
    e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to the Owner.
3. 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.

B. Dielectric Fitting Applications
1. Dry Piping Systems: Connect piping of dissimilar metals with the following:
    a. NPS 2 (DN 50) and Smaller: Dielectric unions.
    b. NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Dielectric flanges or dielectric flange kits.

2. Wet Piping Systems: Connect piping of dissimilar metals with the following:
   a. NPS 2 (DN 50) and Smaller: Dielectric couplings **OR** dielectric nipples, **as directed**.
   b. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Dielectric nipples.
   c. NPS 2-1/2 to NPS 8 (DN 65 to DN 200): Dielectric nipples or dielectric flange kits.
   d. NPS 10 and NPS 12 (DN 250 and DN 300): Dielectric flange kits.

C. Piping Installation
1. Install piping according to the following requirements and Division 33 specifying piping systems.
2. 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 the Coordination Drawings.
3. 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.
4. Install piping to permit valve servicing.
5. Install piping at indicated slopes.
6. Install piping free of sags and bends.
7. Install fittings for changes in direction and branch connections.
8. Select system components with pressure rating equal to or greater than system operating pressure.
9. Sleeves are not required for core-drilled holes, unless directed otherwise.
10. Permanent sleeves are not required for holes formed by removable PE sleeves, unless directed otherwise.
11. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
    a. Cut sleeves to length for mounting flush with both surfaces.
       1) Exception: Extend sleeves installed in floors of equipment areas or other wet areas 2 inches (50 mm) above finished floor level.
    b. Install sleeves in new walls and slabs as new walls and slabs are constructed.
       1) PVC **OR** Steel, **as directed**, Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
       2) Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.
12. Verify final equipment locations for roughing-in.
13. Refer to equipment specifications in other Sections for roughing-in requirements.

D. Piping Joint Construction
1. Join pipe and fittings according to the following requirements and Division 33 specifying piping systems.
2. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
3. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
4. 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:
   a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
5. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1.1 "Quality Assurance" Article.
6. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
7. Grooved Joints: Assemble joints with grooved-end pipe coupling with coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

8. 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 (0.20 percent maximum lead content) complying with ASTM B 32.
9. 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.
10. Pressure-Sealed Joints: Assemble joints for plain-end copper tube and mechanical pressure seal fitting with proprietary crimping tool to according to fitting manufacturer's written instructions.
11. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
    a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
    b. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 appendixes.
    c. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
    d. 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.
    e. PVC Nonpressure Piping: Join according to ASTM D 2855.
    f. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.
12. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
13. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.
14. Plastic Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
    a. Plain-End PE Pipe and Fittings: Use butt fusion.
    b. Plain-End PE Pipe and Socket Fittings: Use socket fusion.
15. Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

E. Piping Connections
1. Make connections according to the following, unless otherwise indicated:
    a. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
    b. 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.
    c. Install dielectric fittings at connections of dissimilar metal pipes.

F. Equipment Installation
1. Install equipment level and plumb, unless otherwise indicated.
2. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference with other installations. Extend grease fittings to an accessible location.
3. Install equipment to allow right of way to piping systems installed at required slope.

G. Painting
1. Painting of piped utility systems, equipment, and components is specified in Division 09.
2. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

H. Identification
1. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.
    a. Stenciled Markers: According to ASME A13.1.
    b. Plastic markers, with application systems. Install on insulation segment if required for hot noninsulated piping.
    c. Locate pipe markers on exposed piping according to the following:
        1) Near each valve and control device.

2) Near each branch, excluding short takeoffs for equipment and terminal units. Mark each pipe at branch if flow pattern is not obvious.
3) Near locations where pipes pass through walls or floors or enter inaccessible enclosures.
4) At manholes and similar access points that permit view of concealed piping.
5) Near major equipment items and other points of origination and termination.

2. Equipment: Install engraved plastic-laminate sign or equipment marker on or near each major item of equipment.
   a. Lettering Size: Minimum 1/4 inch (6.4 mm) high for name of unit if viewing distance is less than 24 inches (610 mm), 1/2 inch (13 mm) high for distances up to 72 inches (1800 mm), and proportionately larger lettering for greater distances. Provide secondary lettering two-thirds to three-fourths of size of principal lettering.
   b. Text of Signs: Provide name of identified unit. Include text to distinguish among multiple units, inform user of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
3. Adjusting: Relocate identifying devices that become visually blocked by work of this or other Divisions.

I. Concrete Bases
1. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
   a. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
   b. 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 base.
   c. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   d. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   e. Install anchor bolts to elevations required for proper attachment to supported equipment.
   f. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
   g. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-place Concrete".

J. Erection Of Metal Supports And Anchorages
1. Refer to Division 05 Section "Metal Fabrications" for structural steel.
2. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor piped utility materials and equipment.
3. Field Welding: Comply with AWS D1.1/D1.1M.

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

END OF SECTION 22 05 23 00

SECTION 22 05 23 00a - GENERAL-DUTY VALVES FOR PLUMBING PIPING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of general-duty valves for plumbing piping. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Definitions
1. CWP: Cold working pressure.
2. EPDM: Ethylene propylene copolymer rubber.
3. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
4. NRS: Nonrising stem.
5. OS&Y: Outside screw and yoke.
6. RS: Rising stem.
7. SWP: Steam working pressure.

C. Submittals
1. Product Data: For each type of valve indicated.

D. Quality Assurance
1. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
2. ASME Compliance:
   a. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   b. ASME B31.1 for power piping valves.
   c. ASME B31.9 for building services piping valves.
3. NSF Compliance: NSF 61 for valve materials for potable-water service.

E. Delivery, Storage, And Handling
1. Prepare valves for shipping as follows:
   a. Protect internal parts against rust and corrosion.
   b. Protect threads, flange faces, grooves, and weld ends.
   c. Set angle, gate, and globe valves closed to prevent rattling.
   d. Set ball and plug valves open to minimize exposure of functional surfaces.
   e. Set butterfly valves closed or slightly open.
   f. Block check valves in either closed or open position.
2. Use the following precautions during storage:
   a. Maintain valve end protection.
   b. 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.
3. 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.

1.2 PRODUCTS

A. General Requirements For Valves
1. Refer to valve schedule articles for applications of valves.
2. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
3. Valve Sizes: Same as upstream piping unless otherwise indicated.

4. Valve Actuator Types:
   a. Gear Actuator: For quarter-turn valves NPS 8 (DN 200) and larger.
   b. Handwheel: For valves other than quarter-turn types.
   c. Handlever: For quarter-turn valves NPS 6 (DN 150) and smaller except plug valves, **as directed**.
   d. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 5 **OR** 10, **as directed**, plug valves, for each size square plug-valve head.
   e. 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.
5. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:
   a. Gate Valves: With rising stem.
   b. 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.
   c. Butterfly Valves: With extended neck.
6. Valve-End Connections:
   a. Flanged: With flanges according to ASME B16.1 for iron valves.
   b. Grooved: With grooves according to AWWA C606.
   c. Solder Joint: With sockets according to ASME B16.18.
   d. Threaded: With threads according to ASME B1.20.1.
7. Valve Bypass and Drain Connections: MSS SP-45.

B. Bronze Angle Valves
1. Class 125, Bronze Angle Valves with Bronze Disc:
   a. Description:
      1) Standard: MSS SP-80, Type 1.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
      4) Ends: Threaded.
      5) Stem and Disc: Bronze.
      6) Packing: Asbestos free.
      7) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.
2. Class 125, Bronze Angle Valves with Nonmetallic Disc:
   a. Description:
      1) Standard: MSS SP-80, Type 2.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
      4) Ends: Threaded.
      5) Stem: Bronze.
      6) Disc: PTFE or TFE.
      7) Packing: Asbestos free.
      8) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.
3. Class 150, Bronze Angle Valves with Bronze Disc:
   a. Description:
      1) Standard: MSS SP-80, Type 1.
      2) CWP Rating: 300 psig (2070 kPa).
      3) Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
      4) Ends: Threaded.
      5) Stem and Disc: Bronze.
      6) Packing: Asbestos free.
      7) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.
4. Class 150, Bronze Angle Valves with Nonmetallic Disc:
   a. Description:
      1) Standard: MSS SP-80, Type 2.
      2) CWP Rating: 300 psig (2070 kPa).

3) Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
4) Ends: Threaded.
5) Stem: Bronze.
6) Disc: PTFE or TFE.
7) Packing: Asbestos free.
8) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.

C. Brass Ball Valves
1. Two-Piece, Full-Port, Brass Ball Valves with Brass Trim:
a. Description:
1) Standard: MSS SP-110.
2) SWP Rating: 150 psig (1035 kPa).
3) CWP Rating: 600 psig (4140 kPa).
4) Body Design: Two piece.
5) Body Material: Forged brass.
6) Ends: Threaded.
7) Seats: PTFE or TFE.
8) Stem: Brass.
9) Ball: Chrome-plated brass.
10) Port: Full.
2. Two-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim:
a. Description:
1) Standard: MSS SP-110.
2) SWP Rating: 150 psig (1035 kPa).
3) CWP Rating: 600 psig (4140 kPa).
4) Body Design: Two piece.
5) Body Material: Forged brass.
6) Ends: Threaded.
7) Seats: PTFE or TFE.
8) Stem: Stainless steel.
9) Ball: Stainless steel, vented.
10) Port: Full.
3. Two-Piece, Regular-Port, Brass Ball Valves with Brass Trim:
a. Description:
1) Standard: MSS SP-110.
2) SWP Rating: 150 psig (1035 kPa).
3) CWP Rating: 600 psig (4140 kPa).
4) Body Design: Two piece.
5) Body Material: Forged brass.
6) Ends: Threaded.
7) Seats: PTFE or TFE.
8) Stem: Brass.
9) Ball: Chrome-plated brass.
10) Port: Regular.
4. Two-Piece, Regular-Port, Brass Ball Valves with Stainless-Steel Trim:
a. Description:
1) Standard: MSS SP-110.
2) SWP Rating: 150 psig (1035 kPa).
3) CWP Rating: 600 psig (4140 kPa).
4) Body Design: Two piece.
5) Body Material: Brass or bronze.
6) Ends: Threaded.
7) Seats: PTFE or TFE.
8) Stem: Stainless steel.
9) Ball: Stainless steel, vented.
10) Port: Regular.

5. Three-Piece, Full-Port, Brass Ball Valves with Brass Trim:
   a. Description:
      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig (1035 kPa).
      3) CWP Rating: 600 psig (4140 kPa).
      4) Body Design: Three piece.
      5) Body Material: Forged brass.
      6) Ends: Threaded.
      7) Seats: PTFE or TFE.
      8) Stem: Brass.
      9) Ball: Chrome-plated brass.
      10) Port: Full.
6. Three-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim:
   a. Description:
      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig (1035 kPa).
      3) CWP Rating: 600 psig (4140 kPa).
      4) Body Design: Three piece.
      5) Body Material: Forged brass.
      6) Ends: Threaded.
      7) Seats: PTFE or TFE.
      8) Stem: Stainless steel.
      9) Ball: Stainless steel, vented.
      10) Port: Full.

D. Bronze Ball Valves
1. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
   a. Description:
      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig (1035 kPa).
      3) CWP Rating: 600 psig (4140 kPa).
      4) Body Design: Two piece.
      5) Body Material: Bronze.
      6) Ends: Threaded.
      7) Seats: PTFE or TFE.
      8) Stem: Bronze.
      9) Ball: Chrome-plated brass.
      10) Port: Full.
2. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
   a. Description:
      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig (1035 kPa).
      3) CWP Rating: 600 psig (4140 kPa).
      4) Body Design: Two piece.
      5) Body Material: Bronze.
      6) Ends: Threaded.
      7) Seats: PTFE or TFE.
      8) Stem: Stainless steel.
      9) Ball: Stainless steel, vented.
      10) Port: Full.
3. Two-Piece, Regular-Port, Bronze Ball Valves with Bronze Trim:
   a. Description:
      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig (1035 kPa).
      3) CWP Rating: 600 psig (4140 kPa).

4) Body Design: Two piece.
5) Body Material: Bronze.
6) Ends: Threaded.
7) Seats: PTFE or TFE.
8) Stem: Bronze.
9) Ball: Chrome-plated brass.
10) Port: Regular.

4. Two-Piece, Regular-Port, Bronze Ball Valves with Stainless-Steel Trim:
   a. Description:
      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig (1035 kPa).
      3) CWP Rating: 600 psig (4140 kPa).
      4) Body Design: Two piece.
      5) Body Material: Bronze.
      6) Ends: Threaded.
      7) Seats: PTFE or TFE.
      8) Stem: Stainless steel.
      9) Ball: Stainless steel, vented.
      10) Port: Regular.
5. Three-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
   a. Description:
      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig (1035 kPa).
      3) CWP Rating: 600 psig (4140 kPa).
      4) Body Design: Three piece.
      5) Body Material: Bronze.
      6) Ends: Threaded.
      7) Seats: PTFE or TFE.
      8) Stem: Bronze.
      9) Ball: Chrome-plated brass.
      10) Port: Full.
6. Three-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
   a. Description:
      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig (1035 kPa).
      3) CWP Rating: 600 psig (4140 kPa).
      4) Body Design: Three piece.
      5) Body Material: Bronze.
      6) Ends: Threaded.
      7) Seats: PTFE or TFE.
      8) Stem: Stainless steel.
      9) Ball: Stainless steel, vented.
      10) Port: Full.

E. Iron Ball Valves
1. Class 125, Iron Ball Valves:
   a. Description:
      1) Standard: MSS SP-72.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Design: Split body.
      4) Body Material: ASTM A 126, gray iron.
      5) Ends: Flanged.
      6) Seats: PTFE or TFE.
      7) Stem: Stainless steel.
      8) Ball: Stainless steel.
      9) Port: Full.

F. Iron, Single-Flange Butterfly Valves
1. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:
   a. Description:
      1) Standard: MSS SP-67, Type I.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
      4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
      5) Seat: EPDM.
      6) Stem: One- or two-piece stainless steel.
      7) Disc: Aluminum bronze.
2. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Aluminum-Bronze Disc:
   a. Description:
      1) Standard: MSS SP-67, Type I.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
      4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
      5) Seat: NBR.
      6) Stem: One- or two-piece stainless steel.
      7) Disc: Aluminum bronze.
3. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Ductile-Iron Disc:
   a. Description:
      1) Standard: MSS SP-67, Type I.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
      4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
      5) Seat: EPDM.
      6) Stem: One- or two-piece stainless steel.
      7) Disc: Nickel-plated or -coated, **as directed**, ductile iron.
4. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Ductile-Iron Disc:
   a. Description:
      1) Standard: MSS SP-67, Type I.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
      4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
      5) Seat: NBR.
      6) Stem: One- or two-piece stainless steel.
      7) Disc: Nickel-plated or -coated, **as directed**, ductile iron.
5. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Stainless-Steel Disc:
   a. Description:
      1) Standard: MSS SP-67, Type I.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
      4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
      5) Seat: EPDM.
      6) Stem: One- or two-piece stainless steel.
      7) Disc: Stainless steel.
6. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Stainless-Steel Disc:
   a. Description:
      1) Standard: MSS SP-67, Type I.
      2) CWP Rating: 200 psig (1380 kPa).

3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
5) Seat: NBR.
6) Stem: One- or two-piece stainless steel.
7) Disc: Stainless steel.

G. Iron, Grooved-End Butterfly Valves
1. 175 CWP, Iron, Grooved-End Butterfly Valves:
a. Description:
1) Standard: MSS SP-67, Type I.
2) CWP Rating: 175 psig (1200 kPa).
3) Body Material: Coated, ductile iron.
4) Stem: Two-piece stainless steel.
5) Disc: Coated, ductile iron.
6) Seal: EPDM.
2. 300 CWP, Iron, Grooved-End Butterfly Valves:
a. Description:
1) Standard: MSS SP-67, Type I.
2) NPS 8 (DN 200) and Smaller CWP Rating: 300 psig (2070 kPa).
3) NPS 10 (DN 250) and Larger CWP Rating: 200 psig (1380 kPa).
4) Body Material: Coated, ductile iron.
5) Stem: Two-piece stainless steel.
6) Disc: Coated, ductile iron.
7) Seal: EPDM.

H. Bronze Lift Check Valves
1. Class 125, Lift Check Valves with Bronze Disc:
a. Description:
1) Standard: MSS SP-80, Type 1.
2) CWP Rating: 200 psig (1380 kPa).
3) Body Design: Vertical flow.
4) Body Material: ASTM B 61 or ASTM B 62, bronze.
5) Ends: Threaded.
6) Disc: Bronze.
2. Class 125, Lift Check Valves with Nonmetallic Disc:
a. Description:
1) Standard: MSS SP-80, Type 2.
2) CWP Rating: 200 psig (1380 kPa).
3) Body Design: Vertical flow.
4) Body Material: ASTM B 61 or ASTM B 62, bronze.
5) Ends: Threaded.
6) Disc: NBR, PTFE, or TFE.

I. Bronze Swing Check Valves
1. Class 125, Bronze Swing Check Valves with Bronze Disc:
a. Description:
1) Standard: MSS SP-80, Type 3.
2) CWP Rating: 200 psig (1380 kPa).
3) Body Design: Horizontal flow.
4) Body Material: ASTM B 62, bronze.
5) Ends: Threaded.
6) Disc: Bronze.
2. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:
a. Description:
1) Standard: MSS SP-80, Type 4.

2) CWP Rating: 200 psig (1380 kPa).
3) Body Design: Horizontal flow.
4) Body Material: ASTM B 62, bronze.
5) Ends: Threaded.
6) Disc: PTFE or TFE.

3. Class 150, Bronze Swing Check Valves with Bronze Disc:
   a. Description:
      1) Standard: MSS SP-80, Type 3.
      2) CWP Rating: 300 psig (2070 kPa).
      3) Body Design: Horizontal flow.
      4) Body Material: ASTM B 62, bronze.
      5) Ends: Threaded.
      6) Disc: Bronze.
4. Class 150, Bronze Swing Check Valves with Nonmetallic Disc:
   a. Description:
      1) Standard: MSS SP-80, Type 4.
      2) CWP Rating: 300 psig (2070 kPa).
      3) Body Design: Horizontal flow.
      4) Body Material: ASTM B 62, bronze.
      5) Ends: Threaded.
      6) Disc: PTFE or TFE.

J. Iron Swing Check Valves
1. Class 125, Iron Swing Check Valves with Metal Seats:
   a. Description:
      1) Standard: MSS SP-71, Type I.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Design: Clear or full waterway.
      4) Body Material: ASTM A 126, gray iron with bolted bonnet.
      5) Ends: Flanged.
      6) Trim: Bronze.
      7) Gasket: Asbestos free.
2. Class 125, Iron Swing Check Valves with Nonmetallic-to-Metal Seats:
   a. Description:
      1) Standard: MSS SP-71, Type I.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Design: Clear or full waterway.
      4) Body Material: ASTM A 126, gray iron with bolted bonnet.
      5) Ends: Flanged.
      6) Trim: Composition.
      7) Seat Ring: Bronze.
      8) Disc Holder: Bronze.
      9) Disc: PTFE or TFE.
      10) Gasket: Asbestos free.
3. Class 250, Iron Swing Check Valves with Metal Seats:
   a. Description:
      1) Standard: MSS SP-71, Type I.
      2) CWP Rating: 500 psig (3450 kPa).
      3) Body Design: Clear or full waterway.
      4) Body Material: ASTM A 126, gray iron with bolted bonnet.
      5) Ends: Flanged.
      6) Trim: Bronze.
      7) Gasket: Asbestos free.

K. Iron Swing Check Valves With Closure Control

1. Class 125, Iron Swing Check Valves with Lever- and Spring-Closure Control:
   a. Description:
      1) Standard: MSS SP-71, Type I.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Design: Clear or full waterway.
      4) Body Material: ASTM A 126, gray iron with bolted bonnet.
      5) Ends: Flanged.
      6) Trim: Bronze.
      7) Gasket: Asbestos free.
      8) Closure Control: Factory-installed, exterior lever and spring.
2. Class 125, Iron Swing Check Valves with Lever- and Weight-Closure Control:
   a. Description:
      1) Standard: MSS SP-71, Type I.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Design: Clear or full waterway.
      4) Body Material: ASTM A 126, gray iron with bolted bonnet.
      5) Ends: Flanged.
      6) Trim: Bronze.
      7) Gasket: Asbestos free.
      8) Closure Control: Factory-installed, exterior lever and weight.

L. Iron, Grooved-End Swing Check Valves
1. 300 CWP, Iron, Grooved-End Swing Check Valves:
   a. Description:
      1) CWP Rating: 300 psig (2070 kPa).
      2) Body Material: ASTM A 536, ductile iron.
      3) Seal: EPDM.
      4) Disc: Spring-operated, ductile iron or stainless steel.

M. Iron, Center-Guided Check Valves
1. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
   a. Description:
      1) Standard: MSS SP-125.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Material: ASTM A 126, gray iron.
      4) Style: Compact wafer.
      5) Seat: Bronze.
2. Class 125, Iron, Globe, Center-Guided Check Valves with Metal Seat:
   a. Description:
      1) Standard: MSS SP-125.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Material: ASTM A 126, gray iron.
      4) Style: Globe, spring loaded.
      5) Ends: Flanged.
      6) Seat: Bronze.
3. Class 150, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
   a. Description:
      1) Standard: MSS SP-125.
      2) CWP Rating: 300 psig (2070 kPa).
      3) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
      4) Style: Compact wafer.
      5) Seat: Bronze.
4. Class 150, Iron, Globe, Center-Guided Check Valves with Metal Seat:
   a. Description:
      1) Standard: MSS SP-125.
      2) CWP Rating: 300 psig (2070 kPa).

3) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
4) Style: Globe, spring loaded.
5) Ends: Flanged.
6) Seat: Bronze.

5. Class 250, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
   a. Description:
      1) Standard: MSS SP-125.
      2) CWP Rating: 400 psig (2760 kPa).
      3) Body Material: ASTM A 126, gray iron.
      4) Style: Compact wafer, spring loaded.
      5) Seat: Bronze.
6. Class 250, Iron, Globe, Center-Guided Check Valves with Metal Seat:
   a. Description:
      1) Standard: MSS SP-125.
      2) CWP Rating: 400 psig (2760 kPa).
      3) Body Material: ASTM A 126, gray iron.
      4) Style: Globe, spring loaded.
      5) Ends: Flanged.
      6) Seat: Bronze.
7. Class 300, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
   a. Description:
      1) Standard: MSS SP-125.
      2) CWP Rating: 500 psig (3450 kPa).
      3) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
      4) Style: Compact wafer, spring loaded.
      5) Seat: Bronze.
8. Class 300, Iron, Globe, Center-Guided Check Valves with Metal Seat:
   a. Description:
      1) Standard: MSS SP-125.
      2) CWP Rating: 500 psig (3450 kPa).
      3) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
      4) Style: Globe, spring loaded.
      5) Ends: Flanged.
      6) Seat: Bronze.
9. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
   a. Description:
      1) Standard: MSS SP-125.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Material: ASTM A 126, gray iron.
      4) Style: Compact wafer.
      5) Seat: EPDM **OR** NBR, **as directed**.
10. Class 125, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
    a. Description:
       1) Standard: MSS SP-125.
       2) CWP Rating: 200 psig (1380 kPa).
       3) Body Material: ASTM A 126, gray iron.
       4) Style: Globe, spring loaded.
       5) Ends: Flanged.
       6) Seat: EPDM **OR** NBR, **as directed**.
11. Class 150, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
    a. Description:
       1) Standard: MSS SP-125.
       2) CWP Rating: 300 psig (2070 kPa).
       3) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
       4) Style: Compact wafer.

5) Seat: EPDM **OR** NBR, **as directed**.

12. Class 150, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
    a. Description:
        1) Standard: MSS SP-125.
        2) CWP Rating: 300 psig (2070 kPa).
        3) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
        4) Style: Globe, spring loaded.
        5) Ends: Flanged.
        6) Seat: EPDM **OR** NBR, **as directed**.
13. Class 250, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
    a. Description:
        1) Standard: MSS SP-125.
        2) CWP Rating: 400 psig (2760 kPa).
        3) Body Material: ASTM A 126, gray iron.
        4) Style: Compact wafer, spring loaded.
        5) Seat: EPDM **OR** NBR, **as directed**.
14. Class 250, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
    a. Description:
        1) Standard: MSS SP-125.
        2) CWP Rating: 400 psig (2760 kPa).
        3) Body Material: ASTM A 126, gray iron.
        4) Style: Globe, spring loaded.
        5) Ends: Flanged.
        6) Seat: EPDM **OR** NBR, **as directed**.
15. Class 300, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
    a. Description:
        1) Standard: MSS SP-125.
        2) CWP Rating: 500 psig (3450 kPa).
        3) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
        4) Style: Compact wafer, spring loaded.
        5) Seat: EPDM **OR** NBR, **as directed**.
16. Class 300, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
    a. Description:
        1) Standard: MSS SP-125.
        2) CWP Rating: 500 psig (3450 kPa).
        3) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
        4) Style: Globe, spring loaded.
        5) Ends: Flanged.
        6) Seat: EPDM **OR** NBR, **as directed**.

N. Iron, Plate-Type Check Valves
1. Class 125, Iron, Dual-Plate Check Valves with Metal Seat:
    a. Description:
        1) Standard: API 594.
        2) CWP Rating: 200 psig (1380 kPa).
        3) Body Design: Wafer, spring-loaded plates.
        4) Body Material: ASTM A 126, gray iron.
        5) Seat: Bronze.
2. Class 150, Iron, Dual-Plate Check Valves with Metal Seat:
    a. Description:
        1) Standard: API 594.
        2) CWP Rating: 300 psig (2070 kPa).
        3) Body Design: Wafer, spring-loaded plates.
        4) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
        5) Seat: Bronze.
3. Class 250, Iron, Dual-Plate Check Valves with Metal Seat:

a. Description:
   1) Standard: API 594.
   2) CWP Rating: 400 psig (2760 kPa).
   3) Body Design: Wafer, spring-loaded plates.
   4) Body Material: ASTM A 126, gray iron.
   5) Seat: Bronze.

4. Class 300, Iron, Dual-Plate Check Valves with Metal Seat:
   a. Description:
      1) Standard: API 594.
      2) CWP Rating: 500 psig (3450 kPa).
      3) Body Design: Wafer, spring-loaded plates.
      4) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
      5) Seat: Bronze.
5. Class 125, Iron, Single-Plate Check Valves with Resilient Seat:
   a. Description:
      1) Standard: API 594.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Design: Wafer, spring-loaded plate.
      4) Body Material: ASTM A 126, gray iron.
      5) Seat: EPDM **OR** NBR, **as directed**.
6. Class 125, Iron, Dual-Plate Check Valves with Resilient Seat:
   a. Description:
      1) Standard: API 594.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Design: Wafer, spring-loaded plates.
      4) Body Material: ASTM A 126, gray iron.
      5) Seat: EPDM **OR** NBR, **as directed**.
7. Class 150, Iron, Dual-Plate Check Valves with Resilient Seat:
   a. Description:
      1) Standard: API 594.
      2) CWP Rating: 300 psig (2070 kPa).
      3) Body Design: Wafer, spring-loaded plates.
      4) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
      5) Seat: EPDM **OR** NBR, **as directed**.
8. Class 250, Iron, Wafer, Single-Plate Check Valves with Resilient Seat:
   a. Description:
      1) Standard: API 594.
      2) CWP Rating: 400 psig (2760 kPa).
      3) Body Design: Wafer, spring-loaded plate.
      4) Body Material: ASTM A 126, gray iron.
      5) Seat: EPDM **OR** NBR, **as directed**.
9. Class 250, Iron, Dual-Plate Check Valves with Resilient Seat:
   a. Description:
      1) Standard: API 594.
      2) CWP Rating: 400 psig (2760 kPa).
      3) Body Design: Wafer, spring-loaded plates.
      4) Body Material: ASTM A 126, gray iron.
      5) Seat: EPDM **OR** NBR, **as directed**.
10. Class 300, Iron, Dual-Plate Check Valves with Resilient Seat:
   a. Description:
      1) Standard: API 594.
      2) CWP Rating: 500 psig (3450 kPa).
      3) Body Design: Wafer, spring-loaded plates.
      4) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
      5) Seat: EPDM **OR** NBR, **as directed**.

O. Bronze Gate Valves
1. Class 125, NRS Bronze Gate Valves:
a. Description:
1) Standard: MSS SP-80, Type 1.
2) CWP Rating: 200 psig (1380 kPa).
3) Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
4) Ends: Threaded or solder joint, **as directed**.
5) Stem: Bronze.
6) Disc: Solid wedge; bronze.
7) Packing: Asbestos free.
8) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.
2. Class 125, RS Bronze Gate Valves:
a. Description:
1) Standard: MSS SP-80, Type 2.
2) CWP Rating: 200 psig (1380 kPa).
3) Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
4) Ends: Threaded or solder joint, **as directed**.
5) Stem: Bronze.
6) Disc: Solid wedge; bronze.
7) Packing: Asbestos free.
8) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.
3. Class 150, NRS Bronze Gate Valves:
a. Description:
1) Standard: MSS SP-80, Type 1.
2) CWP Rating: 300 psig (2070 kPa).
3) Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
4) Ends: Threaded.
5) Stem: Bronze.
6) Disc: Solid wedge; bronze.
7) Packing: Asbestos free.
8) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.
4. Class 150, RS Bronze Gate Valves:
a. Description:
1) Standard: MSS SP-80, Type 2.
2) CWP Rating: 300 psig (2070 kPa).
3) Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
4) Ends: Threaded.
5) Stem: Bronze.
6) Disc: Solid wedge; bronze.
7) Packing: Asbestos free.
8) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.

P. Iron Gate Valves
1. Class 125, NRS, Iron Gate Valves:
a. Description:
1) Standard: MSS SP-70, Type I.
2) CWP Rating: 200 psig (1380 kPa).
3) Body Material: ASTM A 126, gray iron with bolted bonnet.
4) Ends: Flanged.
5) Trim: Bronze.
6) Disc: Solid wedge.
7) Packing and Gasket: Asbestos free.
2. Class 125, OS&Y, Iron Gate Valves:
a. Description:
1) Standard: MSS SP-70, Type I.
2) CWP Rating: 200 psig (1380 kPa).

3) Body Material: ASTM A 126, gray iron with bolted bonnet.
4) Ends: Flanged.
5) Trim: Bronze.
6) Disc: Solid wedge.
7) Packing and Gasket: Asbestos free.

3. Class 250, NRS, Iron Gate Valves:
   a. Description:
      1) Standard: MSS SP-70, Type I.
      2) CWP Rating: 500 psig (3450 kPa).
      3) Body Material: ASTM A 126, gray iron with bolted bonnet.
      4) Ends: Flanged.
      5) Trim: Bronze.
      6) Disc: Solid wedge.
      7) Packing and Gasket: Asbestos free.
4. Class 250, OS&Y, Iron Gate Valves:
   a. Description:
      1) Standard: MSS SP-70, Type I.
      2) CWP Rating: 500 psig (3450 kPa).
      3) Body Material: ASTM A 126, gray iron with bolted bonnet.
      4) Ends: Flanged.
      5) Trim: Bronze.
      6) Disc: Solid wedge.
      7) Packing and Gasket: Asbestos free.

Q. Bronze Globe Valves
1. Class 125, Bronze Globe Valves with Bronze Disc:
   a. Description:
      1) Standard: MSS SP-80, Type 1.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
      4) Ends: Threaded or solder joint, **as directed**.
      5) Stem and Disc: Bronze.
      6) Packing: Asbestos free.
      7) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.
2. Class 125, Bronze Globe Valves with Nonmetallic Disc:
   a. Description:
      1) Standard: MSS SP-80, Type 2.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
      4) Ends: Threaded or solder joint, **as directed**.
      5) Stem: Bronze.
      6) Disc: PTFE or TFE.
      7) Packing: Asbestos free.
      8) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.
3. Class 150, Bronze Globe Valves with Nonmetallic Disc:
   a. Description:
      1) Standard: MSS SP-80, Type 2.
      2) CWP Rating: 300 psig (2070 kPa).
      3) Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
      4) Ends: Threaded.
      5) Stem: Bronze.
      6) Disc: PTFE or TFE.
      7) Packing: Asbestos free.
      8) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.

R. Iron Globe Valves
1. Class 125, Iron Globe Valves:
a. Description:
1) Standard: MSS SP-85, Type I.
2) CWP Rating: 200 psig (1380 kPa).
3) Body Material: ASTM A 126, gray iron with bolted bonnet.
4) Ends: Flanged.
5) Trim: Bronze.
6) Packing and Gasket: Asbestos free.
2. Class 250, Iron Globe Valves:
a. Description:
1) Standard: MSS SP-85, Type I.
2) CWP Rating: 500 psig (3450 kPa).
3) Body Material: ASTM A 126, gray iron with bolted bonnet.
4) Ends: Flanged.
5) Trim: Bronze.
6) Packing and Gasket: Asbestos free.

S. Lubricated Plug Valves
1. Class 125, Regular-Gland, Lubricated Plug Valves with Threaded Ends:
a. Description:
1) Standard: MSS SP-78, Type II.
2) CWP Rating: 200 psig (1380 kPa).
3) Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
4) Pattern: Regular or short **OR** Venturi, **as directed**.
5) Plug: Cast iron or bronze with sealant groove.
2. Class 125, Regular-Gland, Lubricated Plug Valves with Flanged Ends:
a. Description:
1) Standard: MSS SP-78, Type II.
2) CWP Rating: 200 psig (1380 kPa).
3) Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
4) Pattern: Regular or short **OR** Venturi, **as directed**.
5) Plug: Cast iron or bronze with sealant groove.
3. Class 125, Cylindrical, Lubricated Plug Valves with Threaded Ends:
a. Description:
1) Standard: MSS SP-78, Type IV.
2) CWP Rating: 200 psig (1380 kPa).
3) Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
4) Pattern: Regular or short **OR** Venturi, **as directed**.
5) Plug: Cast iron or bronze with sealant groove.
4. Class 125, Cylindrical, Lubricated Plug Valves with Flanged Ends:
a. Description:
1) Standard: MSS SP-78, Type IV.
2) CWP Rating: 200 psig (1380 kPa).
3) Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
4) Pattern: Regular or short **OR** Venturi, **as directed**.
5) Plug: Cast iron or bronze with sealant groove.
5. Class 250, Regular-Gland, Lubricated Plug Valves with Threaded Ends:
a. Description:
1) Standard: MSS SP-78, Type II.
2) CWP Rating: 400 psig (2760 kPa).

3) Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
4) Pattern: Regular or short **OR** Venturi, **as directed**.
5) Plug: Cast iron or bronze with sealant groove.

6. Class 250, Regular-Gland, Lubricated Plug Valves with Flanged Ends:
   a. Description:
      1) Standard: MSS SP-78, Type II.
      2) CWP Rating: 400 psig (2760 kPa).
      3) Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
      4) Pattern: Regular or short **OR** Venturi, **as directed**.
      5) Plug: Cast iron or bronze with sealant groove.
7. Class 250, Cylindrical, Lubricated Plug Valves with Threaded Ends:
   a. Description:
      1) Standard: MSS SP-78, Type IV.
      2) CWP Rating: 400 psig (2760 kPa).
      3) Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
      4) Pattern: Regular or short **OR** Venturi, **as directed**.
      5) Plug: Cast iron or bronze with sealant groove.
8. Class 250, Cylindrical, Lubricated Plug Valves with Flanged Ends:
   a. Description:
      1) Standard: MSS SP-78, Type IV.
      2) CWP Rating: 400 psig (2760 kPa).
      3) Body Material: ASTM A 48/A 48M or ASTM A 126, Grade 40 cast iron with lubrication-sealing system.
      4) Pattern: Regular or short **OR** Venturi, **as directed**.
      5) Plug: Cast iron or bronze with sealant groove.

T. Chainwheels
1. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
   a. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
   b. Attachment: For connection to ball **OR** butterfly **OR** plug, **as directed**, valve stems.
   c. Sprocket Rim with Chain Guides: Ductile iron **OR** Cast iron **OR** Aluminum **OR** Bronze, **as directed**, of type and size required for valve. Include zinc coating, **as directed**.
   d. Chain: Hot-dip, galvanized steel **OR** Brass **OR** Stainless steel, **as directed**, of size required to fit sprocket rim.

1.3 EXECUTION

A. Valve Installation
1. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
2. Locate valves for easy access and provide separate support where necessary.
3. Install valves in horizontal piping with stem at or above center of pipe.
4. Install valves in position to allow full stem movement.
5. Install chainwheels on operators for ball **OR** butterfly **OR** gate **OR** globe **OR** plug, **as directed**, 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.
6. Install check valves for proper direction of flow and as follows:
   a. Swing Check Valves: In horizontal position with hinge pin level.
   b. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
   c. Lift Check Valves: With stem upright and plumb.

B. Adjusting
1. 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.

C. General Requirements For Valve Applications
1. If valve applications are not indicated, use the following:
   a. Shutoff Service: Ball **OR** butterfly **OR** gate **OR** plug, **as directed**, valves.
   b. Butterfly Valve Dead-End Service: Single-flange (lug) type.
   c. Throttling Service: Globe **OR** angle **OR** ball **OR** butterfly, **as directed**, valves.
   d. Pump-Discharge Check Valves:
      1) NPS 2 (DN 50) and Smaller: Bronze swing check valves with bronze **OR** nonmetallic, **as directed**, disc.
      2) NPS 2-1/2 (DN 65) and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal **OR** resilient, **as directed**,-seat check valves.
      3) NPS 2-1/2 (DN 65) and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.
2. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
3. Select valves, except wafer types, with the following end connections:
   a. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
   b. 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.
   c. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
   d. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
   e. 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.
   f. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.
   g. For Grooved-End Copper Tubing and Steel Piping: Valve ends may be grooved.

D. Low-Pressure, Compressed-Air Valve Schedule (150 psig (1035 kPa) Or Less)
1. Pipe NPS 2 (DN 50) and Smaller:
   a. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
   b. Ball Valves: One **OR** Two **OR** Three, **as directed**, piece, full **OR** regular **OR** reduced, **as directed**, port, brass **OR** bronze, **as directed**, with brass **OR** bronze **OR** stainless-steel, **as directed**, trim.
   c. Bronze Lift Check Valves: Class 125, bronze **OR** nonmetallic, **as directed**, disc.
   d. Bronze Swing Check Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
   e. Bronze Gate Valves: Class 125 **OR** Class 150, **as directed**, NRS **OR** RS, **as directed**.
2. Pipe NPS 2-1/2 (DN 65) and Larger:
   a. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
   b. Iron, Single-Flange Butterfly Valves: 200 CWP, NBR seat, aluminum-bronze **OR** ductile-iron **OR** stainless-steel, **as directed**, disc.
   c. Iron, Grooved-End Butterfly Valves: 175 **OR** 300, **as directed**, CWP.
   d. Iron Swing Check Valves: Class 125 **OR** Class 250, **as directed**, metal **OR** nonmetallic-to-metal, **as directed**, seats.
   e. Iron, Grooved-End Swing Check Valves: 300 CWP.
   f. Iron, Center-Guided Check Valves: Class 125 **OR** Class 150 **OR** Class 250 **OR** Class 300, **as directed**, compact-wafer **OR** globe, **as directed**, metal **OR** resilient, **as directed**, seat.
   g. Iron, Plate-Type Check Valves: Class 125 **OR** Class 150 **OR** Class 250 **OR** Class 300, **as directed**; single **OR** dual, **as directed**, plate; metal **OR** resilient, **as directed**, seat.
   h. Iron Gate Valves: Class 125 **OR** Class 250, **as directed**, NRS **OR** OS&Y, **as directed**,.

E. High-Pressure, Compressed-Air Valve Schedule (150 to 200 psig (1035 to 1380 kPa))
1. Pipe NPS 2 (DN 50) and Smaller:
   a. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
   b. Ball Valves: One **OR** Two **OR** Three, **as directed**, piece, full **OR** regular **OR** reduced, **as directed**, port, brass **OR** bronze, **as directed**, with brass **OR** bronze **OR** stainless-steel, **as directed**, trim.
   c. Bronze Lift Check Valves: Class 125, bronze **OR** nonmetallic, **as directed**, disc.
   d. Bronze Swing Check Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
   e. Bronze Gate Valves: Class 125 **OR** Class 150, **as directed**, NRS **OR** RS, **as directed**.
2. Pipe NPS 2-1/2 (DN 65) and Larger:
   a. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
   b. Iron, Single-Flange Butterfly Valves: 200 CWP, NBR seat, aluminum-bronze **OR** ductile-iron **OR** stainless-steel, **as directed**, disc.
   c. Iron, Grooved-End Butterfly Valves: 175 **OR** 300, **as directed**, CWP.
   d. Iron Swing Check Valves: Class 125 **OR** Class 250, **as directed**, metal **OR** nonmetallic-to-metal, **as directed**, seats.
   e. Iron, Grooved-End Swing Check Valves: 300 CWP.
   f. Iron, Center-Guided Check Valves: Class 125 **OR** Class 150 **OR** Class 250 **OR** Class 300, **as directed**, compact-wafer **OR** globe, **as directed**, metal **OR** resilient, **as directed**, seat.
   g. Iron, Plate-Type Check Valves: Class 125 **OR** Class 150 **OR** Class 250 **OR** Class 300, **as directed**; single **OR** dual, **as directed**, plate; metal **OR** resilient, **as directed**, seat.
   h. Iron Gate Valves: Class 125 **OR** Class 250, **as directed**, NRS **OR** OS&Y, **as directed**.

F. Domestic, Hot- And Cold-Water Valve Schedule
1. Pipe NPS 2 (DN 50) and Smaller:
   a. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
   b. Bronze Angle Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
   c. Ball Valves: One **OR** Two **OR** Three, **as directed**, piece, full **OR** regular **OR** reduced, **as directed**, port, brass **OR** bronze, **as directed**, with brass **OR** bronze **OR** stainless-steel, **as directed**, trim.
   d. Bronze Swing Check Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
   e. Bronze Gate Valves: Class 125 **OR** Class 150, **as directed**, NRS **OR** RS, **as directed**,.
   f. Bronze Globe Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
2. Pipe NPS 2-1/2 (DN 65) and Larger:
   a. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
   b. Iron Ball Valves: Class 150.
   c. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM **OR** NBR, **as directed**, seat, aluminum-bronze **OR** ductile-iron **OR** stainless-steel, **as directed**, disc.
   d. Iron, Grooved-End Butterfly Valves: 175 **OR** 300, **as directed**, CWP.
   e. Iron Swing Check Valves: Class 125 **OR** Class 250, **as directed**, metal **OR** nonmetallic-to-metal, **as directed**, seats.
   f. Iron Swing Check Valves with Closure Control: Class 125, lever and spring **OR** weight, **as directed**.
   g. Iron, Grooved-End Swing Check Valves: 300 CWP.
   h. Iron, Center-Guided Check Valves: Class 125 **OR** Class 150 **OR** Class 250 **OR** Class 300, **as directed**, compact-wafer **OR** globe, **as directed**, metal **OR** resilient, **as directed**, seat.

i. Iron, Plate-Type Check Valves: Class 125 **OR** Class 150 **OR** Class 250 **OR** Class 300, **as directed**; single **OR** dual, **as directed**, plate; metal **OR** resilient, **as directed**, seat.
j. Iron Gate Valves: Class 125 **OR** Class 250, **as directed**, NRS **OR** OS&Y, **as directed**.
k. Iron Globe Valves: Class 125 **OR** Class 250, **as directed**.

G. Sanitary-Waste And Storm-Drainage Valve Schedule
1. Pipe NPS 2 (DN 50) and Smaller:
a. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
b. Bronze Angle Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic **OR** stainless-steel, **as directed**, disc.
c. Ball Valves: One **OR** Two **OR** Three, **as directed**, piece, full **OR** regular **OR** reduced, **as directed**, port, brass **OR** bronze, **as directed**, with brass **OR** bronze **OR** stainless-steel, **as directed**, trim.
d. Bronze Swing Check Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
e. Bronze Gate Valves: Class 125 **OR** Class 150, **as directed**, NRS **OR** RS, **as directed**.
f. Bronze Globe Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
2. Pipe NPS 2-1/2 (DN 65) and Larger:
a. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
b. Iron Ball Valves: Class 150.
c. Iron Swing Check Valves: Class 125 **OR** Class 250, **as directed**, metal **OR** nonmetallic-to-metal, **as directed**, seats.
d. Iron Swing Check Valves with Closure Control: Class 125, lever and spring **OR** weight, **as directed**.
e. Iron, Grooved-End Swing Check Valves: 300 CWP.
f. Iron Gate Valves: Class 125 **OR** Class 250, **as directed**, NRS **OR** OS&Y, **as directed**.
g. Iron Globe Valves: Class 125 **OR** Class 250, **as directed**.
h. Lubricated Plug Valves: Class 125 **OR** Class 250, **as directed**, regular gland **OR** cylindrical, **as directed**, threaded **OR** flanged, **as directed**.

END OF SECTION 22 05 23 00a

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SECTION 22 05 23 00b - GENERAL-DUTY VALVES FOR HVAC PIPING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of general-duty valves for HVAC piping. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Bronze angle valves.
b. Brass ball valves.
c. Bronze ball valves.
d. Iron ball valves.
e. Iron, single-flange butterfly valves.
f. Iron, grooved-end butterfly valves.
g. High-performance butterfly valves.
h. Bronze lift check valves.
i. Bronze swing check valves.
j. Iron swing check valves.
k. Iron swing check valves with closure control.
l. Iron, grooved-end swing-check valves.
m. Iron, center-guided check valves.
n. Iron, plate-type check valves.
o. Bronze gate valves.
p. Iron gate valves.
q. Bronze globe valves.
r. Iron globe valves.
s. Lubricated plug valves.
t. Eccentric plug valves.
u. Chainwheels.

C. Definitions
1. CWP: Cold working pressure.
2. EPDM: Ethylene propylene copolymer rubber.
3. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
4. NRS: Nonrising stem.
5. OS&Y: Outside screw and yoke.
6. RS: Rising stem.
7. SWP: Steam working pressure.

D. Submittals
1. Product Data: For each type of valve indicated.

E. Quality Assurance
1. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
2. ASME Compliance:
a. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
b. ASME B31.1 for power piping valves.
c. ASME B31.9 for building services piping valves.

F. Delivery, Storage, And Handling
1. Prepare valves for shipping as follows:
a. Protect internal parts against rust and corrosion.
b. Protect threads, flange faces, grooves, and weld ends.
c. Set angle, gate, and globe valves closed to prevent rattling.
d. Set ball and plug valves open to minimize exposure of functional surfaces.
e. Set butterfly valves closed or slightly open.
f. Block check valves in either closed or open position.
2. Use the following precautions during storage:
a. Maintain valve end protection.
b. 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.
3. 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.

1.2 PRODUCTS

A. General Requirements For Valves
1. Refer to HVAC valve schedule articles for applications of valves.
2. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
3. Valve Sizes: Same as upstream piping unless otherwise indicated.
4. Valve Actuator Types:
a. Gear Actuator: For quarter-turn valves NPS 8 (DN 200) and larger.
b. Handwheel: For valves other than quarter-turn types.
c. Handlever: For quarter-turn valves NPS 6 (DN 150) and smaller except plug valves, **as directed**.
d. Wrench: For plug valves with square heads. Furnish the Owner with 1 wrench for every 5 **OR** 10, **as directed**, plug valves, for each size square plug-valve head.
e. 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.
5. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:
a. Gate Valves: With rising stem.
b. 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.
c. Butterfly Valves: With extended neck.
6. Valve-End Connections:
a. Flanged: With flanges according to ASME B16.1 for iron valves.
b. Grooved: With grooves according to AWWA C606.
c. Solder Joint: With sockets according to ASME B16.18.
d. Threaded: With threads according to ASME B1.20.1.
7. Valve Bypass and Drain Connections: MSS SP-45.

B. Bronze Angle Valves
1. Class 125, Bronze Angle Valves with Bronze Disc:
a. Description:
1) Standard: MSS SP-80, Type 1.
2) CWP Rating: 200 psig (1380 kPa).
3) Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
4) Ends: Threaded.
5) Stem and Disc: Bronze.
6) Packing: Asbestos free.
7) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.

2. Class 125, Bronze Angle Valves with Nonmetallic Disc:
   a. Description:
      1) Standard: MSS SP-80, Type 2.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
      4) Ends: Threaded.
      5) Stem: Bronze.
      6) Disc: PTFE or TFE.
      7) Packing: Asbestos free.
      8) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.
3. Class 150, Bronze Angle Valves with Bronze Disc:
   a. Description:
      1) Standard: MSS SP-80, Type 1.
      2) CWP Rating: 300 psig (2070 kPa).
      3) Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
      4) Ends: Threaded.
      5) Stem and Disc: Bronze.
      6) Packing: Asbestos free.
      7) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.
4. Class 150, Bronze Angle Valves with Nonmetallic Disc:
   a. Description:
      1) Standard: MSS SP-80, Type 2.
      2) CWP Rating: 300 psig (2070 kPa).
      3) Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
      4) Ends: Threaded.
      5) Stem: Bronze.
      6) Disc: PTFE or TFE.
      7) Packing: Asbestos free.
      8) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.

C. Brass Ball Valves
1. One-Piece, Reduced-Port, Brass Ball Valves with Brass Trim:
   a. Description:
      1) Standard: MSS SP-110.
      2) CWP Rating: 400 psig (2760 kPa).
      3) Body Design: One piece.
      4) Body Material: Forged brass.
      5) Ends: Threaded.
      6) Seats: PTFE or TFE.
      7) Stem: Brass.
      8) Ball: Chrome-plated brass.
      9) Port: Reduced.
2. Two-Piece, Full-Port, Brass Ball Valves with Brass Trim:
   a. Description:
      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig (1035 kPa).
      3) CWP Rating: 600 psig (4140 kPa).
      4) Body Design: Two piece.
      5) Body Material: Forged brass.
      6) Ends: Threaded.
      7) Seats: PTFE or TFE.
      8) Stem: Brass.
      9) Ball: Chrome-plated brass.
      10) Port: Full.
3. Two-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim:
   a. Description:

1) Standard: MSS SP-110.
2) SWP Rating: 150 psig (1035 kPa).
3) CWP Rating: 600 psig (4140 kPa).
4) Body Design: Two piece.
5) Body Material: Forged brass.
6) Ends: Threaded.
7) Seats: PTFE or TFE.
8) Stem: Stainless steel.
9) Ball: Stainless steel, vented.
10) Port: Full.

4. Two-Piece, Regular-Port, Brass Ball Valves with Brass Trim:
   a. Description:
      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig (1035 kPa).
      3) CWP Rating: 600 psig (4140 kPa).
      4) Body Design: Two piece.
      5) Body Material: Forged brass.
      6) Ends: Threaded.
      7) Seats: PTFE or TFE.
      8) Stem: Brass.
      9) Ball: Chrome-plated brass.
      10) Port: Regular.
5. Two-Piece, Regular-Port, Brass Ball Valves with Stainless-Steel Trim:
   a. Description:
      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig (1035 kPa).
      3) CWP Rating: 600 psig (4140 kPa).
      4) Body Design: Two piece.
      5) Body Material: Brass or bronze.
      6) Ends: Threaded.
      7) Seats: PTFE or TFE.
      8) Stem: Stainless steel.
      9) Ball: Stainless steel, vented.
      10) Port: Regular.
6. Three-Piece, Full-Port, Brass Ball Valves with Brass Trim:
   a. Description:
      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig (1035 kPa).
      3) CWP Rating: 600 psig (4140 kPa).
      4) Body Design: Three piece.
      5) Body Material: Forged brass.
      6) Ends: Threaded.
      7) Seats: PTFE or TFE.
      8) Stem: Brass.
      9) Ball: Chrome-plated brass.
      10) Port: Full.
7. Three-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim:
   a. Description:
      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig (1035 kPa).
      3) CWP Rating: 600 psig (4140 kPa).
      4) Body Design: Three piece.
      5) Body Material: Forged brass.
      6) Ends: Threaded.
      7) Seats: PTFE or TFE.

8) Stem: Stainless steel.
9) Ball: Stainless steel, vented.
10) Port: Full.

D. Bronze Ball Valves
1. One-Piece, Reduced-Port, Bronze Ball Valves with Bronze Trim:
a. Description:
1) Standard: MSS SP-110.
2) CWP Rating: 400 psig (2760 kPa).
3) Body Design: One piece.
4) Body Material: Bronze.
5) Ends: Threaded.
6) Seats: PTFE or TFE.
7) Stem: Bronze.
8) Ball: Chrome-plated brass.
9) Port: Reduced.
2. One-Piece, Reduced-Port, Bronze Ball Valves with Stainless-Steel Trim:
a. Description:
1) Standard: MSS SP-110.
2) CWP Rating: 600 psig (4140 kPa).
3) Body Design: One piece.
4) Body Material: Bronze.
5) Ends: Threaded.
6) Seats: PTFE or TFE.
7) Stem: Stainless steel.
8) Ball: Stainless steel, vented.
9) Port: Reduced.
3. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
a. Description:
1) Standard: MSS SP-110.
2) SWP Rating: 150 psig (1035 kPa).
3) CWP Rating: 600 psig (4140 kPa).
4) Body Design: Two piece.
5) Body Material: Bronze.
6) Ends: Threaded.
7) Seats: PTFE or TFE.
8) Stem: Bronze.
9) Ball: Chrome-plated brass.
10) Port: Full.
4. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
a. Description:
1) Standard: MSS SP-110.
2) SWP Rating: 150 psig (1035 kPa).
3) CWP Rating: 600 psig (4140 kPa).
4) Body Design: Two piece.
5) Body Material: Bronze.
6) Ends: Threaded.
7) Seats: PTFE or TFE.
8) Stem: Stainless steel.
9) Ball: Stainless steel, vented.
10) Port: Full.
5. Two-Piece, Regular-Port, Bronze Ball Valves with Bronze Trim:
a. Description:
1) Standard: MSS SP-110.
2) SWP Rating: 150 psig (1035 kPa).
3) CWP Rating: 600 psig (4140 kPa).

4) Body Design: Two piece.
5) Body Material: Bronze.
6) Ends: Threaded.
7) Seats: PTFE or TFE.
8) Stem: Bronze.
9) Ball: Chrome-plated brass.
10) Port: Regular.

6. Two-Piece, Regular-Port, Bronze Ball Valves with Stainless-Steel Trim:
   a. Description:
      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig (1035 kPa).
      3) CWP Rating: 600 psig (4140 kPa).
      4) Body Design: Two piece.
      5) Body Material: Bronze.
      6) Ends: Threaded.
      7) Seats: PTFE or TFE.
      8) Stem: Stainless steel.
      9) Ball: Stainless steel, vented.
      10) Port: Regular.
7. Three-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
   a. Description:
      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig (1035 kPa).
      3) CWP Rating: 600 psig (4140 kPa).
      4) Body Design: Three piece.
      5) Body Material: Bronze.
      6) Ends: Threaded.
      7) Seats: PTFE or TFE.
      8) Stem: Bronze.
      9) Ball: Chrome-plated brass.
      10) Port: Full.
8. Three-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
   a. Description:
      1) Standard: MSS SP-110.
      2) SWP Rating: 150 psig (1035 kPa).
      3) CWP Rating: 600 psig (4140 kPa).
      4) Body Design: Three piece.
      5) Body Material: Bronze.
      6) Ends: Threaded.
      7) Seats: PTFE or TFE.
      8) Stem: Stainless steel.
      9) Ball: Stainless steel, vented.
      10) Port: Full.

E. Iron Ball Valves
1. Class 125, Iron Ball Valves:
   a. Description:
      1) Standard: MSS SP-72.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Design: Split body.
      4) Body Material: ASTM A 126, gray iron.
      5) Ends: Flanged.
      6) Seats: PTFE or TFE.
      7) Stem: Stainless steel.
      8) Ball: Stainless steel.

9) Port: Full.

F. Iron, Single-Flange Butterfly Valves

1. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:
   a. Description:
      1) Standard: MSS SP-67, Type I.
      2) CWP Rating: 150 psig (1035 kPa).
      3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
      4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
      5) Seat: EPDM.
      6) Stem: One- or two-piece stainless steel.
      7) Disc: Aluminum bronze.
2. 150 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Aluminum-Bronze Disc:
   a. Description:
      1) Standard: MSS SP-67, Type I.
      2) CWP Rating: 150 psig (1035 kPa).
      3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
      4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
      5) Seat: NBR.
      6) Stem: One- or two-piece stainless steel.
      7) Disc: Aluminum bronze.
3. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Ductile-Iron Disc:
   a. Description:
      1) Standard: MSS SP-67, Type I.
      2) CWP Rating: 150 psig (1035 kPa).
      3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
      4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
      5) Seat: EPDM.
      6) Stem: One- or two-piece stainless steel.
      7) Disc: Nickel-plated or -coated, **as directed**, ductile iron.
4. 150 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Ductile-Iron Disc:
   a. Description:
      1) Standard: MSS SP-67, Type I.
      2) CWP Rating: 150 psig (1035 kPa).
      3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
      4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
      5) Seat: NBR.
      6) Stem: One- or two-piece stainless steel.
      7) Disc: Nickel-plated or -coated, **as directed**, ductile iron.
5. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Stainless-Steel Disc:
   a. Description:
      1) Standard: MSS SP-67, Type I.
      2) CWP Rating: 150 psig (1035 kPa).
      3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
      4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
      5) Seat: EPDM.
      6) Stem: One- or two-piece stainless steel.
      7) Disc: Stainless steel.
6. 150 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Stainless-Steel Disc:
   a. Description:
      1) Standard: MSS SP-67, Type I.

2) CWP Rating: 150 psig (1035 kPa).
3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
5) Seat: NBR.
6) Stem: One- or two-piece stainless steel.
7) Disc: Stainless steel.

7. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:
   a. Description:
      1) Standard: MSS SP-67, Type I.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
      4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
      5) Seat: EPDM.
      6) Stem: One- or two-piece stainless steel.
      7) Disc: Aluminum bronze.
8. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Aluminum-Bronze Disc:
   a. Description:
      1) Standard: MSS SP-67, Type I.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
      4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
      5) Seat: NBR.
      6) Stem: One- or two-piece stainless steel.
      7) Disc: Aluminum bronze.
9. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Ductile-Iron Disc:
   a. Description:
      1) Standard: MSS SP-67, Type I.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
      4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
      5) Seat: EPDM.
      6) Stem: One- or two-piece stainless steel.
      7) Disc: Nickel-plated or -coated, **as directed**, ductile iron.
10. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Ductile-Iron Disc:
   a. Description:
      1) Standard: MSS SP-67, Type I.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
      4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
      5) Seat: NBR.
      6) Stem: One- or two-piece stainless steel.
      7) Disc: Nickel-plated or -coated, **as directed**, ductile iron.
11. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Stainless-Steel Disc:
   a. Description:
      1) Standard: MSS SP-67, Type I.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
      4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
      5) Seat: EPDM.

6) Stem: One- or two-piece stainless steel.
7) Disc: Stainless steel.

12. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Stainless-Steel Disc:
    a. Description:
        1) Standard: MSS SP-67, Type I.
        2) CWP Rating: 200 psig (1380 kPa).
        3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
        4) Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
        5) Seat: NBR.
        6) Stem: One- or two-piece stainless steel.
        7) Disc: Stainless steel.

G. Iron, Grooved-End Butterfly Valves
1. 175 CWP, Iron, Grooved-End Butterfly Valves:
    a. Description:
        1) Standard: MSS SP-67, Type I.
        2) CWP Rating: 175 psig (1200 kPa).
        3) Body Material: Coated, ductile iron.
        4) Stem: Two-piece stainless steel.
        5) Disc: Coated, ductile iron.
        6) Seal: EPDM.
2. 300 CWP, Iron, Grooved-End Butterfly Valves:
    a. Description:
        1) Standard: MSS SP-67, Type I.
        2) NPS 8 (DN 50) and Smaller CWP Rating: 300 psig (2070 kPa).
        3) NPS 10 (DN 250) and Larger CWP Rating: 200 psig (1380 kPa).
        4) Body Material: Coated, ductile iron.
        5) Stem: Two-piece stainless steel.
        6) Disc: Coated, ductile iron.
        7) Seal: EPDM.

H. High-Performance Butterfly Valves
1. Class 150, Single-Flange, High-Performance Butterfly Valves:
    a. Description:
        1) Standard: MSS SP-68.
        2) CWP Rating: 285 psig (1965 kPa) at 100 deg F (38 deg C).
        3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
        4) Body Material: Carbon steel, cast iron, ductile iron, or stainless steel.
        5) Seat: Reinforced PTFE or metal.
        6) Stem: Stainless steel; offset from seat plane.
        7) Disc: Carbon steel.
        8) Service: Bidirectional.
2. Class 300, Single-Flange, High-Performance Butterfly Valves:
    a. Description:
        1) Standard: MSS SP-68.
        2) CWP Rating: 720 psig (4965 kPa) at 100 deg F (38 deg C).
        3) Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
        4) Body Material: Carbon steel, cast iron, or ductile iron.
        5) Seat: Reinforced PTFE or metal.
        6) Stem: Stainless steel; offset from seat plane.
        7) Disc: Carbon steel.
        8) Service: Bidirectional.

I. Bronze Lift Check Valves
   1. Class 125, Lift Check Valves with Bronze Disc:
      a. Description:
         1) Standard: MSS SP-80, Type 1.
         2) CWP Rating: 200 psig (1380 kPa).
         3) Body Design: Vertical flow.
         4) Body Material: ASTM B 61 or ASTM B 62, bronze.
         5) Ends: Threaded.
         6) Disc: Bronze.
   2. Class 125, Lift Check Valves with Nonmetallic Disc:
      a. Description:
         1) Standard: MSS SP-80, Type 2.
         2) CWP Rating: 200 psig (1380 kPa).
         3) Body Design: Vertical flow.
         4) Body Material: ASTM B 61 or ASTM B 62, bronze.
         5) Ends: Threaded.
         6) Disc: NBR, PTFE, or TFE.

J. Bronze Swing Check Valves
   1. Class 125, Bronze Swing Check Valves with Bronze Disc:
      a. Description:
         1) Standard: MSS SP-80, Type 3.
         2) CWP Rating: 200 psig (1380 kPa).
         3) Body Design: Horizontal flow.
         4) Body Material: ASTM B 62, bronze.
         5) Ends: Threaded.
         6) Disc: Bronze.
   2. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:
      a. Description:
         1) Standard: MSS SP-80, Type 4.
         2) CWP Rating: 200 psig (1380 kPa).
         3) Body Design: Horizontal flow.
         4) Body Material: ASTM B 62, bronze.
         5) Ends: Threaded.
         6) Disc: PTFE or TFE.
   3. Class 150, Bronze Swing Check Valves with Bronze Disc:
      a. Description:
         1) Standard: MSS SP-80, Type 3.
         2) CWP Rating: 300 psig (2070 kPa).
         3) Body Design: Horizontal flow.
         4) Body Material: ASTM B 62, bronze.
         5) Ends: Threaded.
         6) Disc: Bronze.
   4. Class 150, Bronze Swing Check Valves with Nonmetallic Disc:
      a. Description:
         1) Standard: MSS SP-80, Type 4.
         2) CWP Rating: 300 psig (2070 kPa).
         3) Body Design: Horizontal flow.
         4) Body Material: ASTM B 62, bronze.
         5) Ends: Threaded.
         6) Disc: PTFE or TFE.

K. Iron Swing Check Valves
   1. Class 125, Iron Swing Check Valves with Metal Seats:
      a. Description:

1) Standard: MSS SP-71, Type I.
2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
4) Body Design: Clear or full waterway.
5) Body Material: ASTM A 126, gray iron with bolted bonnet.
6) Ends: Flanged.
7) Trim: Bronze.
8) Gasket: Asbestos free.

2. Class 125, Iron Swing Check Valves with Nonmetallic-to-Metal Seats:
   a. Description:
      1) Standard: MSS SP-71, Type I.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
      4) Body Design: Clear or full waterway.
      5) Body Material: ASTM A 126, gray iron with bolted bonnet.
      6) Ends: Flanged.
      7) Trim: Composition.
      8) Seat Ring: Bronze.
      9) Disc Holder: Bronze.
      10) Disc: PTFE or TFE.
      11) Gasket: Asbestos free.
3. Class 250, Iron Swing Check Valves with Metal Seats:
   a. Description:
      1) Standard: MSS SP-71, Type I.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
      4) Body Design: Clear or full waterway.
      5) Body Material: ASTM A 126, gray iron with bolted bonnet.
      6) Ends: Flanged.
      7) Trim: Bronze.
      8) Gasket: Asbestos free.

L. Iron Swing Check Valves With Closure Control
1. Class 125, Iron Swing Check Valves with Lever- and Spring-Closure Control:
   a. Description:
      1) Standard: MSS SP-71, Type I.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
      4) Body Design: Clear or full waterway.
      5) Body Material: ASTM A 126, gray iron with bolted bonnet.
      6) Ends: Flanged.
      7) Trim: Bronze.
      8) Gasket: Asbestos free.
      9) Closure Control: Factory-installed, exterior lever and spring.
2. Class 125, Iron Swing Check Valves with Lever and Weight-Closure Control:
   a. Description:
      1) Standard: MSS SP-71, Type I.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
      4) Body Design: Clear or full waterway.
      5) Body Material: ASTM A 126, gray iron with bolted bonnet.
      6) Ends: Flanged.
      7) Trim: Bronze.
      8) Gasket: Asbestos free.
      9) Closure Control: Factory-installed, exterior lever and weight.

M. Iron, Grooved-End Swing Check Valves
1. 300 CWP, Iron, Grooved-End Swing Check Valves:
a. Description:
1) CWP Rating: 300 psig (2070 kPa).
2) Body Material: ASTM A 536, ductile iron.
3) Seal: EPDM.
4) Disc: Spring operated, ductile iron or stainless steel.

N. Iron, Center-Guided Check Valves
1. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
a. Description:
1) Standard: MSS SP-125.
2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
4) Body Material: ASTM A 126, gray iron.
5) Style: Compact wafer.
6) Seat: Bronze.
2. Class 125, Iron, Globe, Center-Guided Check Valves with Metal Seat:
a. Description:
1) Standard: MSS SP-125.
2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
4) Body Material: ASTM A 126, gray iron.
5) Style: Globe, spring loaded.
6) Ends: Flanged.
7) Seat: Bronze.
3. Class 150, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
a. Description:
1) Standard: MSS SP-125.
2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 300 psig (2070 kPa).
3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 250 psig (1725 kPa).
4) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
5) Style: Compact wafer.
6) Seat: Bronze.
4. Class 150, Iron, Globe, Center-Guided Check Valves with Metal Seat:
a. Description:
1) Standard: MSS SP-125.
2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 300 psig (2070 kPa).
3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 250 psig (1725 kPa).
4) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
5) Style: Globe, spring loaded.
6) Ends: Flanged.
7) Seat: Bronze.
5. Class 250, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
a. Description:
1) Standard: MSS SP-125.
2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
4) Body Material: ASTM A 126, gray iron.
5) Style: Compact wafer, spring loaded.
6) Seat: Bronze.
6. Class 250, Iron, Globe, Center-Guided Check Valves with Metal Seat:
a. Description:
1) Standard: MSS SP-125.
2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).

3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
4) Body Material: ASTM A 126, gray iron.
5) Style: Globe, spring loaded.
6) Ends: Flanged.
7) Seat: Bronze.

7. Class 300, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
   a. Description:
      1) Standard: MSS SP-125.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 400 psig (2760 kPa).
      4) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
      5) Style: Compact wafer, spring loaded.
      6) Seat: Bronze.
8. Class 300, Iron, Globe, Center-Guided Check Valves with Metal Seat:
   a. Description:
      1) Standard: MSS SP-125.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 400 psig (2760 kPa).
      4) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
      5) Style: Globe, spring loaded.
      6) Ends: Flanged.
      7) Seat: Bronze.
9. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
   a. Description:
      1) Standard: MSS SP-125.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
      4) Body Material: ASTM A 126, gray iron.
      5) Style: Compact wafer.
      6) Seat: EPDM **OR** BR, **as directed**.
10. Class 125, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
   a. Description:
      1) Standard: MSS SP-125.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
      4) Body Material: ASTM A 126, gray iron.
      5) Style: Globe, spring loaded.
      6) Ends: Flanged.
      7) Seat: EPDM **OR** NBR, **as directed**.
11. Class 150, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
   a. Description:
      1) Standard: MSS SP-125.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 300 psig (2070 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 250 psig (1725 kPa).
      4) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
      5) Style: Compact wafer.
      6) Seat: EPDM **OR** NBR, **as directed**.
12. Class 150, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
   a. Description:
      1) Standard: MSS SP-125.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 300 psig (2070 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 250 psig (1725 kPa).
      4) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
      5) Style: Globe, spring loaded.
      6) Ends: Flanged.
      7) Seat: EPDM **OR** NBR, **as directed**.

13. Class 250, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
    a. Description:
        1) Standard: MSS SP-125.
        2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
        3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
        4) Body Material: ASTM A 126, gray iron.
        5) Style: Compact wafer, spring loaded.
        6) Seat: EPDM **OR** NBR, **as directed**.
14. Class 250, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
    a. Description:
        1) Standard: MSS SP-125.
        2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
        3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
        4) Body Material: ASTM A 126, gray iron.
        5) Style: Globe, spring loaded.
        6) Ends: Flanged.
        7) Seat: EPDM **OR** NBR, **as directed**.
15. Class 300, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
    a. Description:
        1) Standard: MSS SP-125.
        2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
        3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 400 psig (2760 kPa).
        4) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
        5) Style: Compact wafer, spring loaded.
        6) Seat: EPDM **OR** NBR, **as directed**.
16. Class 300, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
    a. Description:
        1) Standard: MSS SP-125.
        2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
        3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 400 psig (2760 kPa).
        4) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
        5) Style: Globe, spring loaded.
        6) Ends: Flanged.
        7) Seat: EPDM **OR** NBR, **as directed**.

O. Iron, Plate-Type Check Valves
1. Class 125, Iron, Dual-Plate Check Valves with Metal Seat:
    a. Description:
        1) Standard: API 594.
        2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
        3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
        4) Body Design: Wafer, spring-loaded plates.
        5) Body Material: ASTM A 126, gray iron.
        6) Seat: Bronze.
2. Class 150, Iron, Dual-Plate Check Valves with Metal Seat:
    a. Description:
        1) Standard: API 594.
        2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 300 psig (2070 kPa).
        3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 250 psig (1725 kPa).
        4) Body Design: Wafer, spring-loaded plates.
        5) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
        6) Seat: Bronze.
3. Class 250, Iron, Dual-Plate Check Valves with Metal Seat:
    a. Description:
        1) Standard: API 594.

2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
4) Body Design: Wafer, spring-loaded plates.
5) Body Material: ASTM A 126, gray iron.
6) Seat: Bronze.

4. Class 300, Iron, Dual-Plate Check Valves with Metal Seat:
   a. Description:
      1) Standard: API 594.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 400 psig (2760 kPa).
      4) Body Design: Wafer, spring-loaded plates.
      5) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
      6) Seat: Bronze.
5. Class 125, Iron, Single-Plate Check Valves with Resilient Seat:
   a. Description:
      1) Standard: API 594.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
      4) Body Design: Wafer, spring-loaded plate.
      5) Body Material: ASTM A 126, gray iron.
      6) Seat: EPDM **OR** NBR, **as directed**.
6. Class 125, Iron, Dual-Plate Check Valves with Resilient Seat:
   a. Description:
      1) Standard: API 594.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
      4) Body Design: Wafer, spring-loaded plates.
      5) Body Material: ASTM A 126, gray iron.
      6) Seat: EPDM **OR** NBR, **as directed**.
7. Class 150, Iron, Dual-Plate Check Valves with Resilient Seat:
   a. Description:
      1) Standard: API 594.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 300 psig (2070 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 250 psig (1725 kPa).
      4) Body Design: Wafer, spring-loaded plates.
      5) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
      6) Seat: EPDM **OR** NBR, **as directed**.
8. Class 250, Iron, Wafer, Single-Plate Check Valves with Resilient Seat:
   a. Description:
      1) Standard: API 594.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
      4) Body Design: Wafer, spring-loaded plate.
      5) Body Material: ASTM A 126, gray iron.
      6) Seat: EPDM **OR** NBR, **as directed**.
9. Class 250, Iron, Dual-Plate Check Valves with Resilient Seat:
   a. Description:
      1) Standard: API 594.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
      4) Body Design: Wafer, spring-loaded plates.
      5) Body Material: ASTM A 126, gray iron.
      6) Seat: EPDM **OR** NBR, **as directed**.
10. Class 300, Iron, Dual-Plate Check Valves with Resilient Seat:
   a. Description:
      1) Standard: API 594.

2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 400 psig (2760 kPa).
4) Body Design: Wafer, spring-loaded plates.
5) Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
6) Seat: EPDM **OR** NBR, **as directed**.

P. Bronze Gate Valves
1. Class 125, NRS Bronze Gate Valves:
a. Description:
1) Standard: MSS SP-80, Type 1.
2) CWP Rating: 200 psig (1380 kPa).
3) Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
4) Ends: Threaded or solder joint, **as directed**.
5) Stem: Bronze.
6) Disc: Solid wedge; bronze.
7) Packing: Asbestos free.
8) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.
2. Class 125, RS Bronze Gate Valves:
a. Description:
1) Standard: MSS SP-80, Type 2.
2) CWP Rating: 200 psig (1380 kPa).
3) Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
4) Ends: Threaded or solder joint, **as directed**.
5) Stem: Bronze.
6) Disc: Solid wedge; bronze.
7) Packing: Asbestos free.
8) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.
3. Class 150, NRS Bronze Gate Valves:
a. Description:
1) Standard: MSS SP-80, Type 1.
2) CWP Rating: 300 psig (2070 kPa).
3) Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
4) Ends: Threaded.
5) Stem: Bronze.
6) Disc: Solid wedge; bronze.
7) Packing: Asbestos free.
8) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.
4. Class 150, RS Bronze Gate Valves:
a. Description:
1) Standard: MSS SP-80, Type 2.
2) CWP Rating: 300 psig (2070 kPa).
3) Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
4) Ends: Threaded.
5) Stem: Bronze.
6) Disc: Solid wedge; bronze.
7) Packing: Asbestos free.
8) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.

Q. Iron Gate Valves
1. Class 125, NRS, Iron Gate Valves:
a. Description:
1) Standard: MSS SP-70, Type I.
2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
4) Body Material: ASTM A 126, gray iron with bolted bonnet.

5) Ends: Flanged.
6) Trim: Bronze.
7) Disc: Solid wedge.
8) Packing and Gasket: Asbestos free.

2. Class 125, OS&Y, Iron Gate Valves:
   a. Description:
      1) Standard: MSS SP-70, Type I.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
      4) Body Material: ASTM A 126, gray iron with bolted bonnet.
      5) Ends: Flanged.
      6) Trim: Bronze.
      7) Disc: Solid wedge.
      8) Packing and Gasket: Asbestos free.
3. Class 250, NRS, Iron Gate Valves:
   a. Description:
      1) Standard: MSS SP-70, Type I.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
      4) Body Material: ASTM A 126, gray iron with bolted bonnet.
      5) Ends: Flanged.
      6) Trim: Bronze.
      7) Disc: Solid wedge.
      8) Packing and Gasket: Asbestos free.
4. Class 250, OS&Y, Iron Gate Valves:
   a. Description:
      1) Standard: MSS SP-70, Type I.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
      4) Body Material: ASTM A 126, gray iron with bolted bonnet.
      5) Ends: Flanged.
      6) Trim: Bronze.
      7) Disc: Solid wedge.
      8) Packing and Gasket: Asbestos free.

R. Bronze Globe Valves
1. Class 125, Bronze Globe Valves with Bronze Disc:
   a. Description:
      1) Standard: MSS SP-80, Type 1.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
      4) Ends: Threaded or solder joint, **as directed**.
      5) Stem and Disc: Bronze.
      6) Packing: Asbestos free.
      7) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.
2. Class 125, Bronze Globe Valves with Nonmetallic Disc:
   a. Description:
      1) Standard: MSS SP-80, Type 2.
      2) CWP Rating: 200 psig (1380 kPa).
      3) Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
      4) Ends: Threaded or solder joint, **as directed**.
      5) Stem: Bronze.
      6) Disc: PTFE or TFE.
      7) Packing: Asbestos free.
      8) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.
3. Class 150, Bronze Globe Valves with Nonmetallic Disc:

a. Description:
1) Standard: MSS SP-80, Type 2.
2) CWP Rating: 300 psig (2070 kPa).
3) Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
4) Ends: Threaded.
5) Stem: Bronze.
6) Disc: PTFE or TFE.
7) Packing: Asbestos free.
8) Handwheel: Malleable iron, bronze, or aluminum, **as directed**.

S. Iron Globe Valves
1. Class 125, Iron Globe Valves:
a. Description:
1) Standard: MSS SP-85, Type I.
2) CWP Rating: 200 psig (1380 kPa).
3) Body Material: ASTM A 126, gray iron with bolted bonnet.
4) Ends: Flanged.
5) Trim: Bronze.
6) Packing and Gasket: Asbestos free.
2. Class 250, Iron Globe Valves:
a. Description:
1) Standard: MSS SP-85, Type I.
2) CWP Rating: 500 psig (3450 kPa).
3) Body Material: ASTM A 126, gray iron with bolted bonnet.
4) Ends: Flanged.
5) Trim: Bronze.
6) Packing and Gasket: Asbestos free.

T. Lubricated Plug Valves
1. Class 125, Regular-Gland, Lubricated Plug Valves with Threaded Ends:
a. Description:
1) Standard: MSS SP-78, Type II.
2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
4) Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
5) Pattern: Regular or short **OR** Venturi, **as directed**.
6) Plug: Cast iron or bronze with sealant groove.
2. Class 125, Regular-Gland, Lubricated Plug Valves with Flanged Ends:
a. Description:
1) Standard: MSS SP-78, Type II.
2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
4) Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
5) Pattern: Regular or short **OR** Venturi, **as directed**.
6) Plug: Cast iron or bronze with sealant groove.
3. Class 125, Cylindrical, Lubricated Plug Valves with Threaded Ends:
a. Description:
1) Standard: MSS SP-78, Type IV.
2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
4) Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
5) Pattern: Regular or short **OR** Venturi, **as directed**.

6) Plug: Cast iron or bronze with sealant groove.

4. Class 125, Cylindrical, Lubricated Plug Valves with Flanged Ends:
   a. Description:
      1) Standard: MSS SP-78, Type IV.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
      4) Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
      5) Pattern: Regular or short **OR** Venturi, **as directed**.
      6) Plug: Cast iron or bronze with sealant groove.
5. Class 250, Regular-Gland, Lubricated Plug Valves with Threaded Ends:
   a. Description:
      1) Standard: MSS SP-78, Type II.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
      4) Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
      5) Pattern: Regular or short **OR** Venturi, **as directed**.
      6) Plug: Cast iron or bronze with sealant groove.
6. Class 250, Regular-Gland, Lubricated Plug Valves with Flanged Ends:
   a. Description:
      1) Standard: MSS SP-78, Type II.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
      4) Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
      5) Pattern: Regular or short **OR** Venturi, **as directed**.
      6) Plug: Cast iron or bronze with sealant groove.
7. Class 250, Cylindrical, Lubricated Plug Valves with Threaded Ends:
   a. Description:
      1) Standard: MSS SP-78, Type IV.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
      4) Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
      5) Pattern: Regular or short **OR** Venturi, **as directed**.
      6) Plug: Cast iron or bronze with sealant groove.
8. Class 250, Cylindrical, Lubricated Plug Valves with Flanged Ends:
   a. Description:
      1) Standard: MSS SP-78, Type IV.
      2) NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
      3) NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
      4) Body Material: ASTM A 48/A 48M or ASTM A 126, Grade 40 cast iron with lubrication-sealing system.
      5) Pattern: Regular or short **OR** Venturi, **as directed**.
      6) Plug: Cast iron or bronze with sealant groove.

U. Eccentric Plug Valves
1. 175 CWP, Eccentric Plug Valves with Resilient Seating.
   a. Description:
      1) Standard: MSS SP-108.
      2) CWP Rating: 175 psig (1200 kPa) minimum.
      3) Body and Plug: ASTM A 48/A 48M, gray iron; ASTM A 126, gray iron; or ASTM A 536, ductile iron.
      4) Bearings: Oil-impregnated bronze or stainless steel.
      5) Ends: Flanged.

6) Stem-Seal Packing: Asbestos free.
7) Plug, Resilient-Seating Material: Suitable for potable-water service unless otherwise indicated.

V. Chainwheels
1. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
a. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
b. Attachment: For connection to ball **OR** butterfly **OR** plug, **as directed**, valve stems.
c. Sprocket Rim with Chain Guides: Ductile iron **OR** Cast iron **OR** Aluminum **OR** Bronze, **as directed**, of type and size required for valve. Include zinc coating, **as directed**.
d. Chain: Hot-dip, galvanized steel **OR** Brass **OR** Stainless steel, **as directed**, of size required to fit sprocket rim.

1.3 EXECUTION

A. Valve Installation
1. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
2. Locate valves for easy access and provide separate support where necessary.
3. Install valves in horizontal piping with stem at or above center of pipe.
4. Install valves in position to allow full stem movement.
5. Install chainwheels on operators for ball **OR** butterfly **OR** gate **OR** globe **OR** plug, **as directed**, 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.
6. Install check valves for proper direction of flow and as follows:
a. Swing Check Valves: In horizontal position with hinge pin level.
b. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
c. Lift Check Valves: With stem upright and plumb.

B. Adjusting
1. 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.

C. General Requirements For Valve Applications
1. If valve applications are not indicated, use the following:
a. Shutoff Service: Ball, butterfly **OR** gate **OR** plug, **as directed**, valves.
b. Butterfly Valve Dead-End Service: Single-flange (lug) type.
c. Throttling Service except Steam: Globe **OR** angle **OR** ball **OR** butterfly, **as directed**, valves.
d. Throttling Service, Steam: Globe **OR** angle **OR** butterfly, **as directed**, valves.
e. Pump-Discharge Check Valves:
1) NPS 2 (DN 50) and Smaller: Bronze swing check valves with bronze **OR** nonmetallic, **as directed**, disc.
2) NPS 2-1/2 (DN 65) and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal **OR** resilient, **as directed**,-seat check valves.
2. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
3. Select valves, except wafer types, with the following end connections:
a. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
b. 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.

c. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
d. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
e. 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.
f. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.
g. For Grooved-End Copper Tubing and Steel Piping except Steam and Steam Condensate Piping: Valve ends may be grooved.

D. Chilled-Water Valve Schedule
1. Pipe NPS 2 (DN 50) and Smaller:
a. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
b. Bronze Angle Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
c. Ball Valves: One **OR** Two **OR** Three, **as directed**, piece, full **OR** regular **OR** reduced, **as directed**, port, brass **OR** bronze, **as directed**, with brass **OR** bronze **OR** stainless-steel, **as directed**, trim.
d. Bronze Swing Check Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
e. Bronze Gate Valves: Class 125 **OR** Class 150, **as directed**, NRS **OR** RS, **as directed**, bronze.
f. Bronze Globe Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
2. Pipe NPS 2-1/2 (DN 65) and Larger:
a. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
b. Iron Ball Valves, NPS 2-1/2 to NPS 10 (DN 65 to DN 250): Class 150.
c. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 200 CWP, EPDM **OR** NBR, **as directed**, seat, aluminum-bronze **OR** ductile-iron **OR** stainless-steel, **as directed**, disc.
d. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24 (DN 350 to DN 600): 150 CWP, EPDM **OR** NBR, **as directed**, seat, aluminum-bronze **OR** ductile-iron **OR** stainless-steel, **as directed**, disc.
e. Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 175 **OR** 300, **as directed**, CWP.
f. High-Performance Butterfly Valves: Class 150 **OR** Class 300, **as directed**, single flange.
g. Iron Swing Check Valves: Class 125 **OR** Class 250, **as directed**, metal **OR** nonmetallic-to-metal, **as directed**, seats.
h. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Class 125, lever and spring **OR** weight, **as directed**.
i. Iron, Grooved-End Check Valves, NPS 3 to NPS 12 (DN 80 to DN 300): 300 CWP.
j. Iron, Center-Guided Check Valves: Class 125 **OR** Class 150 **OR** Class 250 **OR** Class 300, **as directed**, compact-wafer **OR** globe, **as directed**, metal **OR** resilient, **as directed**, seat.
k. Iron, Plate-Type Check Valves: Class 125 **OR** Class 150 **OR** Class 250 **OR** Class 300, **as directed**; single **OR** dual, **as directed**, plate; metal **OR** resilient, **as directed**, seat.
l. Iron Gate Valves: Class 125 **OR** Class 250, **as directed**, NRS **OR** OS&Y, **as directed**.
m. Iron Globe Valves: Class 125 **OR** Class 250, **as directed**.
n. Lubricated Plug Valves: Class 125 **OR** Class 250, **as directed**, regular gland **OR** cylindrical, **as directed**, threaded **OR** flanged, **as directed**.
o. Eccentric Plug Valves: 175 CWP, resilient seating.

E. Condenser-Water Valve Schedule
1. Pipe NPS 2 (DN 50) and Smaller:
a. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.

b. Bronze Angle Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
c. Ball Valves: One **OR** Two **OR** Three, **as directed**, piece, full **OR** regular **OR** reduced, **as directed**, port, brass **OR** bronze, **as directed**, with brass **OR** bronze **OR** stainless-steel, **as directed**, trim.
d. Bronze Swing Check Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
e. Bronze Gate Valves: Class 125 **OR** Class 150, **as directed**, NRS **OR** RS, **as directed**.
f. Bronze Globe Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.

2. Pipe NPS 2-1/2 (DN 65) and Larger:
a. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
b. Iron Ball Valves, NPS 2-1/2 to NPS 10 (DN 65 to DN 250): Class 150.
c. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 200 CWP, EPDM **OR** NBR, **as directed**, seat, aluminum-bronze **OR** ductile-iron **OR** stainless-steel, **as directed**, disc.
d. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24 (DN 350 to DN 600): 150 CWP, EPDM **OR** NBR, **as directed**, seat, aluminum-bronze **OR** ductile-iron **OR** stainless-steel, **as directed**, disc.
e. Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 175 **OR** 300, **as directed**, CWP.
f. High-Performance Butterfly Valves: Class 150 **OR** Class 300, **as directed**, single flange.
g. Iron Swing Check Valves: Class 125 **OR** Class 250, **as directed**, metal **OR** nonmetallic-to-metal, **as directed**, seats.
h. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Class 125, lever and spring **OR** weight, **as directed**.
i. Iron, Grooved-End Check Valves, NPS 3 to NPS 12 (DN 80 to DN 300): 300 CWP.
j. Iron, Center-Guided Check Valves, NPS 2-1/2 to NPS 24 (DN 65 to DN 600): Class 125 **OR** Class 150 **OR** Class 250 **OR** Class 300, **as directed**, metal **OR** resilient, **as directed**, seat.
k. Iron, Plate-Type Check Valves: Class 125 **OR** Class 150 **OR** Class 250 **OR** Class 300, **as directed**; single **OR** dual, **as directed**, plate; metal **OR** resilient, **as directed**, seat.
l. Iron Gate Valves: Class 125 **OR** Class 250, **as directed**, NRS **OR** OS&Y, **as directed**.
m. Iron Globe Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Class 125 **OR** Class 250, **as directed**.
n. Lubricated Plug Valves: Class 125 **OR** Class 250, **as directed**, regular gland **OR** cylindrical, **as directed**, threaded **OR** flanged, **as directed**.

F. Heating-Water Valve Schedule
1. Pipe NPS 2 (DN 50) and Smaller:
a. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
b. Bronze Angle Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
c. Ball Valves: One **OR** Two **OR** Three, **as directed**, piece, full **OR** regular **OR** reduced, **as directed**, port, brass **OR** bronze, **as directed**, with brass **OR** bronze **OR** stainless-steel, **as directed**, trim.
d. Bronze Swing Check Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
e. Bronze Gate Valves: Class 125 **OR** Class 150, **as directed**, NRS **OR** RS, **as directed**.
f. Bronze Globe Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.

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

a. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
b. Iron Ball Valves, NPS 2-1/2 to NPS 10 (DN 65 to DN 250): Class 150.
c. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 200 CWP, EPDM **OR** NBR, **as directed**, seat, aluminum-bronze **OR** ductile-iron **OR** stainless-steel, **as directed**, disc.
d. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24 (DN 350 to DN 600): 150 CWP, EPDM **OR** NBR, **as directed**, seat, aluminum-bronze **OR** ductile-iron **OR** stainless-steel, **as directed**, disc.
e. Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 175 **OR** 300, **as directed**, CWP.
f. High-Performance Butterfly Valves: Class 150 **OR** Class 300, **as directed**, single flange.
g. Iron Swing Check Valves: Class 125 **OR** Class 250, **as directed**, metal **OR** nonmetallic-to-metal, **as directed**, seats.
h. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Class 125, lever and spring **OR** weight, **as directed**.
i. Iron, Grooved-End Check Valves, NPS 3 to NPS 12 (DN 80 to DN 300): 300 CWP.
j. Iron, Center-Guided Check Valves: Class 125 **OR** Class 150 **OR** Class 250 **OR** Class 300, **as directed**, compact-wafer **OR** globe, **as directed**, metal **OR** resilient, **as directed**, seat.
k. Iron, Plate-Type Check Valves: Class 125 **OR** Class 150 **OR** Class 250 **OR** Class 300, **as directed**; single **OR** dual, **as directed**, plate; metal **OR** resilient, **as directed**, seat.
l. Iron Gate Valves: Class 125 **OR** Class 250, **as directed**, NRS **OR** OS&Y, **as directed**.
m. Iron Globe Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Class 125 **OR** Class 250, **as directed**.

G. Low-Pressure Steam Valve Schedule (15 psig (104 kPa) Or Less)
1. Pipe NPS 2 (DN 50) and Smaller:
a. Bronze Angle Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
b. Ball Valves: One **OR** Two **OR** Three, **as directed**, piece, full **OR** regular **OR** reduced, **as directed**, port, brass **OR** bronze, **as directed**, with brass **OR** bronze **OR** stainless-steel, **as directed**, trim.
c. Bronze Swing Check Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
d. Bronze Gate Valves: Class 125 **OR** Class 150, **as directed**, NRS **OR** RS, **as directed**.
e. Bronze Globe Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
2. Pipe NPS 2-1/2 (DN 65) and Larger:
a. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
b. Iron Ball Valves, NPS 2-1/2 to NPS 10 (DN 65 to DN 250): Class 150.
c. High-Performance Butterfly Valves: Class 150 **OR** Class 300, **as directed**, single flange.
d. Iron Swing Check Valves: Class 125 **OR** Class 250, **as directed**, metal **OR** nonmetallic-to-metal, **as directed**, seats.
e. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Class 125, lever and spring **OR** weight, **as directed**.
f. Iron Gate Valves: Class 125 **OR** Class 250, **as directed**, NRS **OR** OS&Y, **as directed**.
g. Iron Globe Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Class 125 **OR** Class 250, **as directed**.

H. High-Pressure Steam Valve Schedule (More Than 15 psig (104 kPa))
1. Pipe NPS 2 (DN 50) and Smaller:
a. Bronze Angle Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.

b. Ball Valves: One **OR** Two **OR** Three, **as directed**, piece, full **OR** regular **OR** reduced, **as directed**, port, brass **OR** bronze, **as directed**, with brass **OR** bronze **OR** stainless-steel, **as directed**, trim.
c. Bronze Swing Check Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
d. Bronze Gate Valves: Class 125 **OR** Class 150, **as directed**, NRS **OR** RS, **as directed**, bronze.
e. Globe Valves: Class 125 **OR** 150, **as directed**, bronze, bronze **OR** nonmetallic, **as directed**, disc.

2. Pipe Sizes NPS 2-1/2 (DN 65) and Larger:
a. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
b. Ball Valves, NPS 2-1/2 to NPS 10 (DN 65 to DN 250): Class 150, iron.
c. High-Performance Butterfly Valves: Class 150 **OR** Class 300, **as directed**, single flange.
d. Iron Swing Check Valves: Class 125 **OR** Class 250, **as directed**, metal **OR** nonmetallic-to-metal, **as directed**, seats.
e. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Class 125, lever and spring **OR** weight, **as directed**.
f. Iron Gate Valves: Class 125 **OR** Class 250, **as directed**, NRS **OR** OS&Y, **as directed**.
g. Iron Globe Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Class 125 **OR** Class 250, **as directed**.

I. Steam-Condensate Valve Schedule
1. Pipe NPS 2 (DN 50) and Smaller:
a. Bronze Angle Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
b. Ball Valves: One **OR** Two **OR** Three, **as directed**, piece, full **OR** regular **OR** reduced, **as directed**, port, brass **OR** bronze, **as directed**, with brass **OR** bronze **OR** stainless-steel, **as directed**, trim.
c. Bronze Swing Check Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.
d. Bronze Gate Valves: Class 125 **OR** Class 150, **as directed**, NRS **OR** RS, **as directed**.
e. Bronze Globe Valves: Class 125 **OR** Class 150, **as directed**, bronze **OR** nonmetallic, **as directed**, disc.

2. Pipe NPS 2-1/2 (DN 65) and Larger:
a. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
b. Iron Ball Valves, NPS 2-1/2 to NPS 10 (DN 65 to DN 250): Class 150.
c. High-Performance Butterfly Valves: Class 150 **OR** Class 300, **as directed**, single flange.
d. Iron Swing Check Valves: Class 125 **OR** Class 250, **as directed**, metal **OR** nonmetallic-to-metal, **as directed**, seats.
e. Iron Swing Check Valves with Closure Control: Class 125, lever and spring **OR** weight, **as directed**.
f. Iron Gate Valves: Class 125 **OR** Class 250, **as directed**, NRS **OR** OS&Y, **as directed**.
g. Iron Globe Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Class 125 **OR** Class 250, **as directed**.
h. Lubricated Plug Valves: Class 125 **OR** Class 250, **as directed**, regular gland **OR** cylindrical, **as directed**, threaded **OR** flanged, **as directed**.

END OF SECTION 22 05 23 00b

SECTION 22 05 76 00 - SANITARY SEWERAGE

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for sanitary sewerage. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Pipe and fittings.
b. Nonpressure and pressure couplings.
c. Expansion joints and deflection fittings.
d. Backwater valves.
e. Cleanouts.
f. Encasement for piping.
g. Manholes.

C. Definitions
1. FRP: Fiberglass-reinforced plastic.

D. Submittals
1. Product Data: For the following:
a. Expansion joints and deflection fittings.
b. Backwater valves.
2. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.
3. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from sewer system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
4. Profile Drawings: Show system piping in elevation. Draw profiles to horizontal scale of not less than 1 inch equals 50 feet (1:500) and to vertical scale of not less than 1 inch equals 5 feet (1:50). Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.
5. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.
6. Field quality-control reports.

E. Delivery, Storage, And Handling
1. Do not store plastic manholes, pipe, and fittings in direct sunlight.
2. Protect pipe, pipe fittings, and seals from dirt and damage.
3. Handle manholes according to manufacturer's written rigging instructions.

F. Project Conditions
1. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
a. Notify the Owner no fewer than two days in advance of proposed interruption of service.
b. Do not proceed with interruption of service without the Owner written permission.

1.2 PRODUCTS

A. Hub-And-Spigot, Cast-Iron Soil Pipe And Fittings
1. Pipe and Fittings: ASTM A 74, Service class **OR** Service and Extra-Heavy classes **OR** Extra-Heavy class, **as directed**.
2. Gaskets: ASTM C 564, rubber.
3. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

B. Hubless Cast-Iron Soil Pipe And Fittings
1. Pipe and Fittings: ASTM A 888 or CISPI 301.
2. CISPI-Trademark, Shielded Couplings:
   a. Description: ASTM C 1277 and CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
3. Heavy-Duty, Shielded Couplings:
   a. Description: ASTM C 1277 and ASTM C 1540, with stainless-steel shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
4. Cast-Iron, Shielded Couplings:
   a. Description: ASTM C 1277 with ASTM A 48/A 48M, two-piece, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.
5. Unshielded Couplings:
   a. Description: ASTM C 1277 and ASTM C 1461, rigid, sleeve-type, reducing- or transition-type mechanical coupling, with integral, center pipe stop, molded from ASTM C 1440, TPE material; with corrosion-resistant-metal tension band and tightening mechanism on each end.

C. Ductile-Iron, Gravity Sewer Pipe And Fittings
1. Pipe: ASTM A 746, for push-on joints.
2. Standard Fittings: AWWA C110, ductile or gray iron, for push-on joints.
3. Compact Fittings: AWWA C153, ductile iron, for push-on joints.
4. Gaskets: AWWA C111, rubber.

D. Ductile-Iron, Pressure Pipe And Fittings
1. Push-on-Joint Piping:
   a. Pipe: AWWA C151.
   b. Standard Fittings: AWWA C110, ductile or gray iron.
   c. Compact Fittings: AWWA C153.
   d. Gaskets: AWWA C111, rubber, of shape matching pipe and fittings.
2. Mechanical-Joint Piping:
   a. Pipe: AWWA C151, with bolt holes in bell.
   b. Standard Fittings: AWWA C110, ductile or gray iron, with bolt holes in bell.
   c. Compact Fittings: AWWA C153, with bolt holes in bells.
   d. Glands: Cast or ductile iron; with bolt holes and high-strength, cast-iron or high-strength, low-alloy steel bolts and nuts.
   e. Gaskets: AWWA C111, rubber, of shape matching pipe, fittings, and glands.

E. ABS Pipe And Fittings
1. ABS Sewer Pipe and Fittings: ASTM D 2751, with bell-and-spigot ends for gasketed joints.
   a. NPS 3 to NPS 6 (DN 80 to DN 150): SDR 35.
   b. NPS 8 to NPS 12 (DN 200 to DN 300): SDR 42.
2. Gaskets: ASTM F 477, elastomeric seals.

F. PVC Pipe And Fittings

1. PVC Cellular-Core Sewer Piping:
   a. Pipe: ASTM F 891, Sewer and Drain Series, PS 50 minimum stiffness, PVC cellular-core pipe with plain ends for solvent-cemented joints.
   b. Fittings: ASTM D 3034, SDR 35, PVC socket-type fittings.
2. PVC Corrugated Sewer Piping:
   a. Pipe: ASTM F 949, PVC corrugated pipe with bell-and-spigot ends for gasketed joints.
   b. Fittings: ASTM F 949, PVC molded or fabricated, socket type.
   c. Gaskets: ASTM F 477, elastomeric seals.
3. PVC Profile Sewer Piping:
   a. Pipe: ASTM F 794, PVC profile, gravity sewer pipe with bell-and-spigot ends for gasketed joints.
   b. Fittings: ASTM D 3034, PVC with bell ends.
   c. Gaskets: ASTM F 477, elastomeric seals.
4. PVC Type PSM Sewer Piping:
   a. Pipe: ASTM D 3034, SDR 35, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
   b. Fittings: ASTM D 3034, PVC with bell ends.
   c. Gaskets: ASTM F 477, elastomeric seals.
5. PVC Gravity Sewer Piping:
   a. Pipe and Fittings: ASTM F 679, T-1 **OR** T-2, **as directed**, wall thickness, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F 477, elastomeric seals for gasketed joints.
6. PVC Pressure Piping:
   a. Pipe: AWWA C900, Class 100 **OR** Class 150 **OR** Class 200, **as directed**, PVC pipe with bell-and-spigot ends for gasketed joints.
   b. Fittings: AWWA C900, Class 100 **OR** Class 150 **OR** Class 200, **as directed**, PVC pipe with bell ends.
   c. Gaskets: ASTM F 477, elastomeric seals.
7. PVC Water-Service Piping:
   a. Pipe: ASTM D 1785, Schedule 40 **OR** Schedule 80, **as directed**, PVC, with plain ends for solvent-cemented joints.
   b. Fittings: ASTM D 2466, Schedule 40 **OR** ASTM D 2467, Schedule 80, **as directed**, PVC, socket type.

G. Fiberglass Pipe And Fittings
1. Fiberglass Sewer Pipe: ASTM D 3262, RTRP, for gasketed joints fabricated with Type 2, polyester **OR** Type 4, epoxy, **as directed**, resin.
   a. Liner: Reinforced thermoset **OR** Nonreinforced thermoset **OR** Thermoplastic **OR** No liner, **as directed**.
   b. Grade: Reinforced, surface layer matching pipe resin **OR** Nonreinforced, surface layer matching pipe resin **OR** No surface layer, **as directed**.
   c. Stiffness: 9 psig (62 kPa) **OR** 18 psig (124 kPa) **OR** 36 psig (248 kPa) **OR** 72 psig (496 kPa), **as directed**.
2. Fiberglass Nonpressure Fittings: ASTM D 3840, RTRF, for gasketed joints.
   a. Laminating Resin: Type 1, polyester **OR** Type 2, epoxy, **as directed**, resin.
   b. Reinforcement: Grade with finish compatible with resin.
3. Gaskets: ASTM F 477, elastomeric seals.

H. Concrete Pipe And Fittings
1. Nonreinforced-Concrete Sewer Pipe and Fittings: ASTM C 14 (ASTM C 14M), Class 1 **OR** Class 2 **OR** Class 3, **as directed**, with bell-and-spigot **OR** tongue-and-groove, **as directed**, ends for gasketed joints with ASTM C 443 (ASTM C 443M), rubber gaskets.
2. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76 (ASTM C 76M).
   a. Bell-and-spigot **OR** tongue-and-groove, **as directed**, ends for gasketed joints, with ASTM C 443 (ASTM C 443M), rubber gaskets.
   b. Class II, Wall A **OR** Wall B **OR** Wall C, **as directed**.

c. Class III, Wall A **OR** Wall B **OR** Wall C, **as directed**.
d. Class IV, Wall A **OR** Wall B **OR** Wall C, **as directed**.
e. Class V, Wall A **OR** Wall B, **as directed**.

I. Nonpressure-Type Transition Couplings
1. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.
2. Sleeve Materials:
   a. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
   b. For Concrete Pipes: ASTM C 443 (ASTM C 443M), rubber.
   c. For Fiberglass Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
   d. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
   e. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
3. Unshielded, Flexible Couplings:
   a. Description: Elastomeric sleeve, with stainless-steel shear ring, **as directed**, and corrosion-resistant-metal tension band and tightening mechanism on each end.
4. Shielded, Flexible Couplings:
   a. Description: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
5. Ring-Type, Flexible Couplings:
   a. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.
6. Nonpressure-Type, Rigid Couplings:
   a. Description: ASTM C 1461, sleeve-type, reducing- or transition-type mechanical coupling, molded from ASTM C 1440, TPE material; with corrosion-resistant-metal tension band and tightening mechanism on each end.

J. Pressure-Type Pipe Couplings
1. Tubular-Sleeve Couplings: AWWA C219, with center sleeve, gaskets, end rings, and bolt fasteners.
2. Metal, bolted, sleeve-type, reducing or transition coupling, for joining underground pressure piping. Include 150-psig (1035-kPa) **OR** 200-psig (1380-kPa), **as directed**, minimum pressure rating and ends of same sizes as piping to be joined.
3. Center-Sleeve Material: Manufacturer's standard **OR** Carbon steel **OR** Stainless steel **OR** Ductile iron **OR** Malleable iron, **as directed**.
4. Gasket Material: Natural or synthetic rubber.
5. Metal Component Finish: Corrosion-resistant coating or material.

K. Expansion Joints And Deflection Fittings
1. Ductile-Iron, Flexible Expansion Joints:
   a. Description: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for 250-psig (1725-kPa) minimum working pressure and for offset and expansion indicated.
2. Ductile-Iron Expansion Joints:
   a. Description: Three-piece assembly of telescoping sleeve with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Include rating for 250-psig (1725-kPa) minimum working pressure and for expansion indicated.
3. Ductile-Iron Deflection Fittings:

a. Description: Compound coupling fitting with ball joint, flexing section, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include rating for 250-psig (1725-kPa) minimum working pressure and for up to 15 degrees of deflection.

L. Backwater Valves
1. Cast-Iron Backwater Valves:
a. Description: ASME A112.14.1, gray-iron body and bolted cover, with bronze seat.
b. Horizontal type; with swing check valve and hub-and-spigot ends.
c. Combination horizontal and manual gate-valve type; with swing check valve, integral gate valve, and hub-and-spigot ends.
d. Terminal type; with bronze seat, swing check valve, and hub inlet.
2. PVC Backwater Valves:
a. Description: Horizontal type; with PVC body, PVC removable cover, and PVC swing check valve.

M. Cleanouts
1. Cast-Iron Cleanouts:
a. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
b. Top-Loading Classification(s): Light Duty **OR** Medium Duty **OR** Heavy Duty **OR** Extra-Heavy Duty, **as directed**.
c. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.
2. PVC Cleanouts:
a. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

N. Encasement For Piping
1. Standard: ASTM A 674 or AWWA C105.
2. Material: Linear low-density polyethylene film of 0.008-inch (0.20-mm) **OR** high-density, cross-laminated polyethylene film of 0.004-inch (0.10-mm), **as directed**, minimum thickness.
3. Form: Sheet **OR** Tube, **as directed**.
4. Color: Black **OR** Natural, **as directed**.

O. Manholes
1. Standard Precast Concrete Manholes:
a. Description: ASTM C 478 (ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for sealant joints.
b. Diameter: 48 inches (1200 mm) minimum unless otherwise indicated.
c. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
d. Base Section: 6-inch (150-mm) minimum thickness for floor slab and 4-inch (100-mm) minimum thickness for walls and base riser section; with separate base slab or base section with integral floor.
e. Riser Sections: 4-inch (100-mm) minimum thickness, of length to provide depth indicated.
f. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated; with top of cone of size that matches grade rings.
g. Joint Sealant: ASTM C 990 (ASTM C 990M), bitumen or butyl rubber.
h. Resilient Pipe Connectors: ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
i. Steps: Individual FRP steps or FRP ladder **OR** Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP **OR** ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP, **as directed**; wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor

steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches (1500 mm).

j. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.

OR

Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.

2. Designed Precast Concrete Manholes:
   a. Description: ASTM C 913; designed according to ASTM C 890 for A-16 (ASSHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for sealant joints.
   b. Ballast: Increase thickness of one or more precast concrete sections or add concrete to manhole as required to prevent flotation.
   c. Joint Sealant: ASTM C 990 (ASTM 990M), bitumen or butyl rubber.
   d. Resilient Pipe Connectors: ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
   e. Steps: Individual FRP steps or FRP ladder **OR** Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP **OR** ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP, **as directed**; wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches (1500 mm).
   f. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.

      OR

      Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.
3. Fiberglass Manholes:
   a. Description: ASTM D 3753.
   b. Diameter: 48 inches (1200 mm) minimum unless otherwise indicated.
   c. Ballast: Increase thickness of concrete base as required to prevent flotation.
   d. Base Section: Concrete, 6-inch (150-mm) minimum thickness.
   e. Resilient Pipe Connectors (if required): ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
   f. Steps: Individual FRP steps or FRP ladder, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches (1500 mm).
   g. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.

      OR

      Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.
4. Manhole Frames and Covers:

a. Description: Ferrous; 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser, with 4-inch- (100-mm-) minimum-width flange and 26-inch- (660-mm-) diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."
b. Material: ASTM A 536, Grade 60-40-18 ductile **OR** ASTM A 48/A 48M, Class 35 gray, **as directed**, iron unless otherwise indicated.

5. Manhole-Cover Inserts:
a. Description: Manufactured, plastic form, of size to fit between manhole frame and cover and designed to prevent stormwater inflow. Include handle for removal and gasket for gastight sealing.
b. Type: Solid **OR** Drainage with vent holes **OR** Valve, **as directed**.

P. Concrete
1. General: Cast-in-place concrete complying with ACI 318, ACI 350/350R (ACI 350M/350RM), and the following:
a. Cement: ASTM C 150, Type II.
b. Fine Aggregate: ASTM C 33, sand.
c. Coarse Aggregate: ASTM C 33, crushed gravel.
d. Water: Potable.
2. Portland Cement Design Mix: 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio.
a. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
b. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.
3. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
a. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
1) Invert Slope: 1 **OR** 2, **as directed**, percent through manhole.
b. Benches: Concrete, sloped to drain into channel.
1) Slope: 4 **OR** 8, **as directed**, percent.
4. Ballast and Pipe Supports: Portland cement design mix, 3000 psi (20.7 MPa) minimum, with 0.58 maximum water/cementitious materials ratio.
a. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
b. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

1.3 EXECUTION

A. Earthwork
1. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving".

B. Piping Installation
1. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
2. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.
3. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
4. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

5. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.
6. Install gravity-flow, nonpressure, drainage piping according to the following:
   a. Install piping pitched down in direction of flow, at minimum slope of 1 **OR** 2, **as directed**, percent unless otherwise indicated.
   b. Install piping NPS 6 (DN 150) and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
   c. Install piping with 36-inch (915-mm) **OR** 48-inch (1220-mm) **OR** 60-inch (1520-mm) **OR** 72-inch (1830-mm), **as directed**, minimum cover.
   d. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
   e. Install hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
   f. Install ductile-iron, gravity sewer piping according to ASTM A 746.
   g. Install ABS sewer piping according to ASTM D 2321 and ASTM F 1668.
   h. Install PVC cellular-core sewer piping according to ASTM D 2321 and ASTM F 1668.
   i. Install PVC corrugated sewer piping according to ASTM D 2321 and ASTM F 1668.
   j. Install PVC profile sewer piping according to ASTM D 2321 and ASTM F 1668.
   k. Install PVC Type PSM sewer piping according to ASTM D 2321 and ASTM F 1668.
   l. Install PVC gravity sewer piping according to ASTM D 2321 and ASTM F 1668.
   m. Install fiberglass sewer piping according to ASTM D 3839 and ASTM F 1668.
   n. Install nonreinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."
   o. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."
7. Install force-main, pressure piping according to the following:
   a. Install piping with restrained joints at tee fittings and at horizontal and vertical changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
   b. Install piping with 36-inch (915-mm) **OR** 48-inch (1220-mm) **OR** 60-inch (1520-mm) **OR** 72-inch (1830-mm), **as directed**, minimum cover.
   c. Install ductile-iron pressure piping according to AWWA C600 or AWWA M41.
   d. Install ductile-iron special fittings according to AWWA C600.
   e. Install PVC pressure piping according to AWWA M23 or to ASTM D 2774 and ASTM F 1668.
   f. Install PVC water-service piping according to ASTM D 2774 and ASTM F 1668.
8. If required to provide protection for metal piping, install corrosion-protection piping encasement over the following underground metal piping according to ASTM A 674 or AWWA C105:
   a. Hub-and-spigot, cast-iron soil pipe.
   b. Hubless cast-iron soil pipe and fittings.
   c. Ductile-iron pipe and fittings.
   d. Expansion joints and deflection fittings.
9. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

C. Pipe Joint Construction
1. Join gravity-flow, nonpressure, drainage piping according to the following:
   a. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
   b. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
   c. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

d. Join ductile-iron, gravity sewer piping according to AWWA C600 for push-on joints.
e. Join ABS sewer piping according to ASTM D 2321 and ASTM D 2751 for elastomeric-seal joints.
f. Join PVC cellular-core sewer piping according to ASTM D 2321 and ASTM F 891 for solvent-cemented joints.
g. Join PVC corrugated sewer piping according to ASTM D 2321.
h. Join PVC profile sewer piping according to ASTM D 2321 for elastomeric-seal joints or ASTM F 794 for gasketed joints.
i. Join PVC Type PSM sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
j. Join PVC gravity sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
k. Join fiberglass sewer piping according to ASTM D 4161 for elastomeric-seal joints.
l. Join nonreinforced-concrete sewer piping according to ASTM C 14 (ASTM C 14M) and ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.
m. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.
n. Join dissimilar pipe materials with nonpressure-type, flexible **OR** rigid, **as directed**, couplings.

2. Join force-main, pressure piping according to the following:
   a. Join ductile-iron pressure piping according to AWWA C600 or AWWA M41 for push-on joints.
   b. Join ductile-iron special fittings according to AWWA C600 or AWWA M41 for push-on joints.
   c. Join PVC pressure piping according to AWWA M23 for gasketed joints.
   d. Join PVC water-service piping according to ASTM D 2855.
   e. Join dissimilar pipe materials with pressure-type couplings.
3. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
   a. Use nonpressure flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
      1) Unshielded **OR** Shielded, **as directed**, flexible **OR** rigid, **as directed**, couplings for pipes of same or slightly different OD.
      2) Unshielded, increaser/reducer-pattern, flexible **OR** rigid, **as directed**, couplings for pipes with different OD.
      3) Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.
   b. Use pressure pipe couplings for force-main joints.

D. Manhole Installation
1. General: Install manholes complete with appurtenances and accessories indicated.
2. Install precast concrete manhole sections with sealants according to ASTM C 891.
3. Install FRP manholes according to manufacturer's written instructions.
4. Form continuous concrete channels and benches between inlets and outlet.
5. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches (76 mm) above finished surface elsewhere unless otherwise indicated.
6. Install manhole-cover inserts in frame and immediately below cover.

E. Concrete Placement
1. Place cast-in-place concrete according to ACI 318.

F. Backwater Valve Installation
1. Install horizontal-type backwater valves in piping manholes or pits.
2. Install combination horizontal and manual gate valves in piping and in manholes.
3. Install terminal-type backwater valves on end of piping and in manholes. Secure units to sidewalls.

G. Cleanout Installation
1. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts, and use cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
   a. Use Light-Duty, top-loading classification cleanouts in earth **OR** unpaved foot-traffic, **as directed**, areas.
   b. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
   c. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
   d. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.
2. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches (450 by 450 by 300 mm) deep. Set with tops 1 inch (25 mm) above surrounding grade.
3. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

H. Connections
1. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Division 22 Section "Sanitary Waste And Vent Piping".
2. Connect force-main piping to building's sanitary force mains specified in Division 22 Section "Sanitary Waste And Vent Piping". Terminate piping where indicated.
3. Make connections to existing piping and underground manholes.
   a. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch (150-mm) overlap with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
   b. Make branch connections from side into existing piping, NPS 4 to NPS 20 (DN 100 to DN 500). Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
   c. Make branch connections from side into existing piping, NPS 21 (DN 525) or larger, or to underground manholes by cutting opening into existing unit large enough to allow 3 inches (76 mm) of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in 6 inches (150 mm) of concrete for minimum length of 12 inches (300 mm) to provide additional support of collar from connection to undisturbed ground.
      1) Use concrete that will attain a minimum 28-day compressive strength of 3000 psi (20.7 MPa) unless otherwise indicated.
      2) Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
   d. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.
4. Connect to grease **OR** oil **OR** sand, **as directed**, interceptors specified in Division 22 Section "Sanitary Waste Interceptors".

I. Closing Abandoned Sanitary Sewer Systems
1. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
   a. Close open ends of piping with at least 8-inch- (203-mm-) thick, brick masonry bulkheads.
   b. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.
2. Abandoned Manholes: Excavate around manhole as required and use either procedure below:
   a. Remove manhole and close open ends of remaining piping.

b. Remove top of manhole down to at least 36 inches (915 mm) below final grade. Fill to within 12 inches (300 mm) of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.

3. Backfill to grade according to Division 31 Section "Earth Moving".

J. Identification

1. Materials and their installation are specified in Division 31 Section "Earth Moving". Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.
   a. Use warning tape **OR** detectable warning tape, **as directed**, over ferrous piping.
   b. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

K. Field Quality Control

1. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (600 mm) of backfill is in place, and again at completion of Project.
   a. Submit separate report for each system inspection.
   b. Defects requiring correction include the following:
      1) Alignment: Less than full diameter of inside of pipe is visible between structures.
      2) Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
      3) Damage: Crushed, broken, cracked, or otherwise damaged piping.
      4) Infiltration: Water leakage into piping.
      5) Exfiltration: Water leakage from or around piping.
   c. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
   d. Reinspect and repeat procedure until results are satisfactory.
2. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
   a. Do not enclose, cover, or put into service before inspection and approval.
   b. Test completed piping systems according to requirements of authorities having jurisdiction.
   c. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
   d. Submit separate report for each test.
   e. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
      1) Fill sewer piping with water. Test with pressure of at least 10-foot (3-m) head of water, and maintain such pressure without leakage for at least 15 minutes.
      2) Close openings in system and fill with water.
      3) Purge air and refill with water.
      4) Disconnect water supply.
      5) Test and inspect joints for leaks.

      OR

      Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
      6) Option: Test plastic gravity sewer piping according to ASTM F 1417.
      7) Option: Test concrete gravity sewer piping according to ASTM C 924 (ASTM C 924M).
   f. Force Main: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than 150 psig (1035 kPa).
      1) Ductile-Iron Piping: Test according to AWWA C600, "Hydraulic Testing" Section.
      2) PVC Piping: Test according to AWWA M23, "Testing and Maintenance" Chapter.
   g. Manholes: Perform hydraulic test according to ASTM C 969 (ASTM C 969M).
3. Leaks and loss in test pressure constitute defects that must be repaired.

4. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

L. Cleaning
1. Clean dirt and superfluous material from interior of piping. Flush with potable water.

END OF SECTION 22 05 76 00

SECTION 22 05 76 00a - STORM DRAINAGE PIPING SPECIALTIES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for storm drainage piping specialties. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Roof drains.
b. Miscellaneous storm drainage piping specialties.
c. Cleanouts.
d. Backwater valves.
e. Trench drains.
f. Channel drainage systems.
g. Through-penetration firestop assemblies.
h. Flashing materials.

C. Submittals
1. Product Data: For each type of product indicated.

D. Quality Assurance
1. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

1.2 PRODUCTS

A. Metal Roof Drains
1. Cast-Iron, Large-Sump, General-Purpose Roof Drains:
a. Standard: ASME A112.6.4, for general-purpose roof drains.
b. Body Material: Cast iron.
c. Dimension of Body: Nominal 14-inch (357-mm) diameter.
d. Combination Flashing Ring and Gravel Stop: Not required **OR** Required, **as directed**.
e. Flow-Control Weirs: Not required **OR** Required, **as directed**.
f. Outlet: Bottom **OR** Side, **as directed**.
g. Extension Collars: Not required **OR** Required, **as directed**.
h. Underdeck Clamp: Not required **OR** Required, **as directed**.
i. Expansion Joint: Not required **OR** Required, **as directed**.
j. Sump Receiver Plate: Not required **OR** Required, **as directed**.
k. Dome Material: Aluminum **OR** Cast iron **OR** PE **OR** Stainless steel, **as directed**.
l. Perforated Gravel Guard: Stainless steel **OR** Not required, **as directed**.
m. Vandal-Proof Dome: Not required **OR** Required, **as directed**.
n. Water Dam: Not required **OR** 2 inches (51 mm) high, **as directed**.
2. Cast-Iron, Medium-Sump, General-Purpose Roof Drains:
a. Standard: ASME A112.6.4, for general-purpose roof drains.
b. Body Material: Cast iron.
c. Dimension of Body: 8- to 12-inch (203- to 305-mm) diameter.
d. Combination Flashing Ring and Gravel Stop: Not required **OR** Required, **as directed**.
e. Flow-Control Weirs: Not required **OR** Required, **as directed**.
f. Outlet: Bottom **OR** Side, **as directed**.
g. Extension Collars: Not required **OR** Required, **as directed**.

h. Underdeck Clamp: Not required **OR** Required, **as directed**.
i. Expansion Joint: Not required **OR** Required, **as directed**.
j. Sump Receiver Plate: Not required **OR** Required, **as directed**.
k. Dome Material: Aluminum **OR** Cast iron **OR** Copper **OR** PE **OR** Stainless steel, **as directed**.
l. Wire Mesh: Stainless steel or brass over dome **OR** Not required, **as directed**.
m. Perforated Gravel Guard: Stainless steel **OR** Not required, **as directed**.
n. Vandal-Proof Dome: Not required **OR** Required, **as directed**.
o. Water Dam: Not required **OR** 2 inches (51 mm) high, **as directed**.

3. Copper, Medium-Sump, General-Purpose Roof Drains:
   a. Standard: ASME A112.6.4, for general-purpose roof drains.
   b. Body Material: Copper.
   c. Dimension of Body: 8- to 12-inch (203- to 305-mm) diameter.
   d. Combination Flashing Ring and Gravel Stop: Not required **OR** Required, **as directed**.
   e. Flow-Control Weirs: Not required **OR** Required, **as directed**.
   f. Outlet: Bottom **OR** Side, **as directed**.
   g. Extension Collars: Not required **OR** Required, **as directed**.
   h. Underdeck Clamp: Not required **OR** Required, **as directed**.
   i. Expansion Joint: Not required **OR** Required, **as directed**.
   j. Sump Receiver Plate: Not required **OR** Required, **as directed**.
   k. Dome Material: Aluminum **OR** Cast iron **OR** Copper **OR** PE **OR** Stainless steel, **as directed**.
   l. Wire Mesh: Stainless steel or brass over dome **OR** Not required, **as directed**.
   m. Perforated Gravel Guard: Stainless steel **OR** Not required, **as directed**.
   n. Vandal-Proof Dome: Not required **OR** Required, **as directed**.
   o. Water Dam: Not required **OR** 2 inches (51 mm) high, **as directed**.
4. Cast-Iron, Small-Sump, General-Purpose Roof Drains:
   a. Standard: ASME A112.6.4, for general-purpose roof drains.
   b. Body Material: Cast iron.
   c. Dimension of Body: Nominal 8-inch (203-mm) diameter.
   d. Combination Flashing Ring and Gravel Stop: Not required **OR** Required, **as directed**.
   e. Outlet: Bottom **OR** Side, **as directed**.
   f. Extension Collars: Not required **OR** Required, **as directed**.
   g. Underdeck Clamp: Not required **OR** Required, **as directed**.
   h. Expansion Joint: Not required **OR** Required, **as directed**.
   i. Sump Receiver Plate: Not required **OR** Required, **as directed**.
   j. Dome Material: Cast iron.
   k. Wire Mesh: Stainless steel or brass over dome **OR** Not required, **as directed**.
   l. Vandal-Proof Dome: Not required **OR** Required, **as directed**.
5. Copper, Small-Sump, General-Purpose Roof Drains:
   a. Standard: ASME A112.6.4, for general-purpose roof drains.
   b. Body Material: Copper.
   c. Dimension of Body: Nominal 8-inch (203-mm) diameter.
   d. Combination Flashing Ring and Gravel Stop: Not required **OR** Required, **as directed**.
   e. Outlet: Bottom **OR** Side, **as directed**.
   f. Extension Collars: Not required **OR** Required, **as directed**.
   g. Underdeck Clamp: Not required **OR** Required, **as directed**.
   h. Expansion Joint: Not required **OR** Required, **as directed**.
   i. Sump Receiver Plate: Not required **OR** Required, **as directed**.
   j. Dome Material: Cast iron.
   k. Wire Mesh: Stainless steel or brass over dome **OR** Not required, **as directed**.
   l. Vandal-Proof Dome: Not required **OR** Required, **as directed**.
6. Metal, Cornice and Gutter Roof Drains:
   a. Standard: ASME A112.6.4, for cornice and gutter roof drains.
   b. Body Material: Metal.

c. Dimension of Body: Nominal 6-inch (152-mm) diameter.
d. Outlet: Bottom **OR** Side **OR** 45-degree angle, **as directed**.
e. Dome Material: Bronze.
f. Vandal-Proof Dome: Not required **OR** Required, **as directed**.

7. Metal, Parapet Roof Drains:
   a. Standard: ASME A112.6.4, for parapet roof drains.
   b. Body Material: Cast iron.
   c. Outlet: Back **OR** Angle, **as directed**.
   d. Grate Material: Bronze **OR** Cast iron **OR** Nickel-bronze alloy, **as directd**.
   e. Vandal-Proof Grate: Not required **OR** Required, **as directed**.
8. Metal, Large-Sump, Promenade Roof Drains:
   a. Standard: ASME A112.6.4, for promenade roof drains.
   b. Body Material: Cast iron.
   c. Dimension of Body: Nominal 14-inch (357-mm) diameter.
   d. Dimension of Frame and Grate: Nominal 14 inches (357 mm) square.
   e. Outlet: Bottom.
   f. Grate Material: Bronze **OR** Cast iron **OR** Nickel-bronze alloy, **as directed**.
   g. Vandal-Proof Grate: Not required **OR** Required, **as directed**.
   h. Extension Collars: Not required **OR** Required, **as directed**.
   i. Underdeck Clamp: Not required **OR** Required, **as directed**.
   j. Expansion Joint: Not required **OR** Required, **as directed**.
   k. Sump Receiver Plate: Not required **OR** Required, **as directed**.
9. Metal, Medium-Sump, Promenade Roof Drains:
   a. Standard: ASME A112.6.4, for promenade roof drains.
   b. Body Material: Cast iron.
   c. Dimension of Body: 11- to 12-inch (280- to 305-mm) diameter.
   d. Dimension of Frame and Grate: Nominal 12 inches (305 mm) square.
   e. Outlet: Bottom.
   f. Grate Material: Bronze **OR** Cast iron **OR** Nickel-bronze alloy, **as directed**.
   g. Vandal-Proof Grate: Not required **OR** Required, **as directed**.
   h. Extension Collars: Not required **OR** Required, **as directed**.
   i. Underdeck Clamp: Not required **OR** Required, **as directed**.
   j. Expansion Joint: Not required **OR** Required, **as directed**.
   k. Sump Receiver Plate: Not required **OR** Required, **as directed**.
10. Metal, Small-Sump, Promenade Roof Drains:
    a. Standard: ASME A112.6.4, for promenade roof drains.
    b. Body Material: Cast iron.
    c. Dimension of Body: Nominal 8-inch (203-mm) diameter.
    d. Dimension of Frame and Grate: Nominal 8 inches (203 mm) square.
    e. Outlet: Bottom.
    f. Grate Material: Bronze **OR** Cast iron **OR** Nickel-bronze alloy, **as directed**.
    g. Vandal-Proof Grate: Not required **OR** Required, **as directed**.
    h. Extension Collars: Not required **OR** Required, **as directed**.
    i. Underdeck Clamp: Not required **OR** Required, **as directed**.
    j. Expansion Joint: Not required **OR** Required, **as directed**.
    k. Sump Receiver Plate: Not required **OR** Required, **as directed**.
11. Metal, Medium-Sump, Deck Roof Drains:
    a. Standard: ASME A112.6.4, for deck roof drains; ASME A112.6.3, for floor drains.
    b. Body Material: Metal.
    c. Flange: Anchor **OR** Anchor with weep holes **OR** Not required, **as directed**.
    d. Clamping Device: Not required **OR** Required, **as directed**.
    e. Integral Backwater Valve: Not required **OR** Required, **as directed**.
    f. Outlet: Bottom **OR** End **OR** Side, **as directed**.
    g. Grate Material: Cast iron.
    h. Grate Finish: Painted **OR** Not required, **as directed**.

i. Overall Dimension of Frame and Grate: Nominal 14 inches (357 mm) round **OR** square, **as directed**.
j. Top-Loading Classification: Extra-Heavy Duty **OR** Heavy Duty, **as directed**.
k. Vandal-Proof Frame and Grate: Not required **OR** Required, **as directed**.

12. Metal, Small-Sump, Deck Roof Drains:
a. Standard: ASME A112.6.4, for deck roof drains; ASME A112.6.3, for floor drains.
b. Body Material: Metal.
c. Flange: Anchor **OR** Anchor with weep holes **OR** Not required, **as directed**.
d. Clamping Device: Not required **OR** Required, **as directed**.
e. Integral Backwater Valve: Not required **OR** Required, **as directed**.
f. Outlet: Bottom **OR** End **OR** Side, **as directed**.
g. Grate Material: Cast iron.
h. Grate Finish: Painted **OR** Not required, **as directed**.
i. Overall Dimension of Frame and Grate: Nominal 8 inches (203 mm) round **OR** square, **as directed**.
j. Top-Loading Classification: Extra-Heavy Duty **OR** Heavy Duty **OR** Light Duty **OR** Medium Duty, **as directed**.
k. Vandal-Proof Frame and Grate: Not required **OR** Required, **as directed**.

B. Plastic Roof Drains
1. Plastic Roof Drains:
a. Standard: ASME A112.6.4, for plastic roof drains.
b. Body Material: ABS or PVC.
c. Sump Diameter: <**Insert nominal dimension**>.
d. Combination Flashing Ring and Gravel Stop: Not required **OR** Required, **as directed**.
e. Outlet: Bottom.
f. Extension Collars: Not required **OR** Required, **as directed**.
g. Underdeck Clamp: Not required **OR** Required, **as directed**.
h. Expansion Joint: Not required **OR** Required, **as directed**.
i. Sump Receiver Plate: Not required **OR** Required, **as directed**.
j. Dome Material: Aluminum **OR** Cast iron **OR** PE **OR** Stainless steel, **as directed**.
k. Vandal-Proof Dome: Not required **OR** Required, **as directed**.

C. Miscellaneous Storm Drainage Piping Specialties
1. Downspout Adaptors:
a. Description: Manufactured, gray-iron casting, for attaching to horizontal-outlet, parapet roof drain and to exterior, sheet metal downspout.
b. Size: Inlet size to match parapet drain outlet.
2. Downspout Boots:
a. Description: Manufactured, ASTM A 48/A 48M, gray-iron casting, with strap or ears for attaching to building; NPS 4 (DN 100) outlet; and shop-applied bituminous coating.
b. Size: Inlet size to match downspout and NPS 4 (DN 100) outlet.
3. Conductor Nozzles:
a. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.
b. Size: Same as connected conductor.

D. Cleanouts
1. Floor Cleanouts:
a. Standard: ASME A112.36.2M, for adjustable housing **OR** cast-iron soil pipe with cast-iron ferrule **OR** heavy-duty, adjustable housing **OR** threaded, adjustable housing, **as directed**, cleanouts.
b. Size: Same as connected branch.
c. Type: Adjustable housing **OR** Cast-iron soil pipe with cast-iron ferrule **OR** Heavy-duty, adjustable housing **OR** Threaded, adjustable housing, **as directed**.
d. Body or Ferrule Material: Cast iron **OR** Stainless steel, **as directed**.

e. Clamping Device: Not required **OR** Required, **as directed**.
f. Outlet Connection: Inside calk **OR** Spigot **OR** Threaded, **as directed**.
g. Closure: Brass plug with straight threads and gasket **OR** Brass plug with tapered threads **OR** Cast-iron plug **OR** Plastic plug, **as directed**.
h. Adjustable Housing Material: Cast iron **OR** Plastic, **as directed**, with threads **OR** set-screws or other device, **as directed**.
i. Frame and Cover Material and Finish: Nickel-bronze, copper alloy **OR** Painted cast iron **OR** Polished bronze **OR** Rough bronze **OR** Stainless steel, **as directed**.
j. Frame and Cover Shape: Round **OR** Square, **as directed**.
k. Top-Loading Classification: Extra-Heavy Duty **OR** Heavy Duty **OR** Light Duty **OR** Medium Duty, **as directed**.
l. Riser: ASTM A 74, Extra-Heavy **OR** Service, **as directed**, class, cast-iron drainage pipe fitting and riser to cleanout.

2. Test Tees:
   a. Standard: ASME A112.36.2M and ASTM A 74, ASTM A 888, or CISPI 301, for cleanout test tees.
   b. Size: Same as connected drainage piping.
   c. 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.
   d. Closure Plug: Countersunk or raised head, brass.
   e. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
3. Wall Cleanouts:
   a. Standard: ASME A112.36.2M, for cleanouts. Include wall access.
   b. Size: Same as connected drainage piping.
   c. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch **OR** Hubless, cast-iron soil-pipe test tee, **as directed**, as required to match connected piping.
   d. Closure: Countersunk **OR** Countersunk or raised-head **OR** Raised-head, **as directed**, drilled-and-threaded **OR** brass **OR** cast-iron, **as directed**, plug.
   e. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
   f. Wall Access: Round, deep, chrome-plated bronze **OR** flat, chrome-plated brass or stainless-steel, **as directed**, cover plate with screw.
   g. Wall Access: Round **OR** Square, **as directed**, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.
4. Plastic Floor Cleanouts:
   a. Size: Same as connected branch.
   b. Body Material: PVC.
   c. Closure Plug: PVC.
   d. Riser: Drainage pipe fitting and riser to cleanout of same material as drainage piping.

E. Backwater Valves
1. Cast-Iron, Horizontal Backwater Valves:
   a. Standard: ASME A112.14.1, for backwater valves.
   b. Size: Same as connected piping.
   c. Body Material: Cast iron.
   d. Cover: Cast iron with bolted or threaded access check valve.
   e. End Connections: Hub and spigot or hubless.
   f. Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed **OR** open for airflow unless subject to backflow condition, **as directed**.
   g. Extension: ASTM A 74, Service class; full-size, cast-iron soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.
2. Cast-Iron, Drain-Outlet Backwater Valves:
   a. Size: Same as floor drain outlet.
   b. Body Material: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
   c. Check Valve: Removable ball float.
   d. Inlet: Threaded.

e. Outlet: Threaded or spigot.

3. Plastic, Horizontal Backwater Valves:
   a. Standard: ASME A112.14.1, for backwater valves.
   b. Size: Same as connected piping.
   c. Body Material: ABS **OR** PVC, **as directed**.
   d. Cover: Same material as body with threaded access to check valve.
   e. Check Valve: Removable swing check.
   f. End Connections: Socket type.

F. Trench Drains
1. Trench Drains:
   a. Standard: ASME A112.6.3, for trench drains.
   b. Body Material: Cast iron.
   c. Flange: Anchor **OR** Anchor with weep holes **OR** Not required, **as directed**.
   d. Clamping Device: Not required **OR** Required, **as directed**.
   e. Outlet: Bottom **OR** End **OR** Side, **as directed**.
   f. Grate Material: Ductile iron or gray iron **OR** stainless steel, **as directed**.
   g. Grate Finish: Painted **OR** Not required, **as directed**.
   h. Dimensions of Frame and Grate: <**Insert dimensions**>.
   i. Top-Loading Classification: Extra-Heavy Duty **OR** Heavy Duty **OR** Light Duty **OR** Medium Duty, **as directed**.

G. Channel Drainage Systems
1. Narrow, Sloped-Invert, Polymer-Concrete, Channel Drainage Systems:
   a. Type: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
      1) Channel Sections: Narrow, interlocking-joint, sloped-invert, polymer-concrete modular units with end caps. Include rounded bottom, with built-in invert slope of 0.6 percent and with outlets in number, sizes, and locations indicated. Include extension sections necessary for required depth.
         a) Dimensions: 4-inch (102-mm) inside width. Include number of units required to form total lengths indicated.
         b) Frame: Galvanized steel or gray iron for grates **OR** Not required, **as directed**.
      2) Grates: Manufacturer's designation "heavy duty" **OR** “medium duty", **as directed**, with slots or perforations, and of width and thickness that fit recesses in channel sections.
         a) Material: Ductile iron **OR** Fiberglass **OR** Galvanized steel **OR** Gray iron **OR** Stainless steel, **as directed**.
         b) Locking Mechanism: Manufacturer's standard device for securing grates to channel sections **OR** Not required, **as directed**.
      3) Covers: Solid ductile or gray iron, of width and thickness that fit recesses in channel sections, and of lengths indicated.
      4) Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
      5) Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.
2. Narrow, Level-Invert, Polymer-Concrete, Channel Drainage Systems:
   a. Type: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
      1) Channel Sections: Narrow, interlocking-joint, precast, polymer-concrete modular units with end caps. Include rounded bottom, with level invert and with NPS 4 (DN 100) outlets in number and locations indicated.
         a) Dimensions: 5-inch (127-mm) inside width and 9-3/4-inch (248-mm) depth. Include number of units required to form total lengths indicated.

b) Frame: Galvanized steel or gray iron for grates **OR** Not required, **as directed**.

2) Grates: Manufacturer's designation "heavy duty" **OR** "medium duty", **as directed,** with slots or perforations, and of width and thickness that fit recesses in channel sections.

a) Material: Ductile iron **OR** Fiberglass **OR** Galvanized steel **OR** Gray iron **OR** Stainless steel, **as directed**.

b) Locking Mechanism: Manufacturer's standard device for securing grates to channel sections **OR** Not required, **as directed**.

3) Covers: Solid ductile or gray iron, of width and thickness that fit recesses in channel sections, and of lengths indicated.

4) Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.

5) Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

3. Wide, Level-Invert, Polymer-Concrete, Channel Drainage Systems:

a. Type: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.

1) Channel Sections: Wide, interlocking-joint, precast, polymer-concrete modular units with end caps. Include flat or rounded bottom, with level invert and with outlets in number, sizes, and locations indicated.

a) Dimensions: 8-inch (203-mm) inside width and 13-3/4-inch (350-mm) depth. Include number of units required to form total lengths indicated.

b) Frame: Galvanized steel or gray iron for grates **OR** Not required, **as directed**.

2) Grates: Manufacturer's designation "heavy duty" **OR** "medium duty", **as directed**, with slots or perforations, and of width and thickness that fit recesses in channel sections.

a) Material: Ductile iron **OR** Fiberglass **OR** Galvanized steel **OR** Gray iron **OR** Stainless steel, **as directed**.

b) Locking Mechanism: Manufacturer's standard device for securing grates to channel sections **OR** Not required, **as directed**.

3) Covers: Solid ductile or gray iron, of width and thickness that fit recesses in channel sections, and of lengths indicated.

4) Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.

5) Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

H. Through-Penetration Firestop Assemblies

1. Through-Penetration Firestop Assemblies:

a. Standard: ASTM E 814, for through-penetration firestop assemblies.

b. Certification and Listing: Intertek Testing Service NA for through-penetration firestop assemblies.

c. Size: Same as connected pipe.

d. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.

e. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.

f. Special Coating: Corrosion resistant on interior of fittings.

I. Flashing Materials

1. Copper Sheet: ASTM B 152/B 152M, 12 oz./sq. ft. (3.7 kg/sq. m or 0.41-mm thickness).

2. 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.
3. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil (1.01-mm) minimum thickness.
4. Fasteners: Metal compatible with material and substrate being fastened.
5. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
6. Solder: ASTM B 32, lead-free alloy.

1.3 EXECUTION

A. Installation
1. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 7 Sections.
   a. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
   b. Install expansion joints, if indicated, in roof drain outlets.
   c. Position roof drains for easy access and maintenance.
2. Install downspout adapters on outlet of back-outlet parapet roof drains and connect to sheet metal downspouts.
3. Install downspout boots at grade with top 6 inches (152 mm) **OR** 12 inches (305 mm) **OR** 18 inches (457 mm), **as directed**, above grade. Secure to building wall.
4. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.
5. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:
   a. 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.
   b. Locate cleanouts at each change in direction of piping greater than 45 degrees.
   c. 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.
   d. Locate cleanouts at base of each vertical soil and waste stack.
6. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
7. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
8. Install horizontal backwater valves in floor with cover flush with floor.
9. Install drain-outlet backwater valves in outlet of drains.
10. Install test tees in vertical conductors and near floor.
11. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.
12. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface unless otherwise indicated.
13. Assemble channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.
14. Install through-penetration firestop assemblies in plastic conductors at concrete floor penetrations.
15. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

B. Connections
1. Comply with requirements for piping specified in Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

C. Flashing Installation

1. 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:
   a. 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.
   b. Copper Sheets: Solder joints of copper sheets.
2. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
   a. 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.
   b. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around sleeve.
   c. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around specialty.
3. Set flashing on floors and roofs in solid coating of bituminous cement.
4. Secure flashing into sleeve and specialty clamping ring or device.
5. Fabricate and install flashing and pans, sumps, and other drainage shapes.

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

END OF SECTION 22 05 76 00a

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SECTION 22 07 19 00 - FIRE-SUPPRESSION SYSTEMS INSULATION

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for fire-suppression systems insulation. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Insulation Materials:
1) Calcium silicate.
2) Cellular glass.
3) Flexible elastomeric.
4) Mineral fiber.
5) Phenolic.
6) Polyisocyanurate.
7) Polyolefin.
8) Polystyrene.
b. Insulating cements.
c. Adhesives.
d. Mastics.
e. Lagging adhesives.
f. Sealants.
g. Factory-applied jackets.
h. Field-applied fabric-reinforcing mesh.
i. Field-applied cloths.
j. Field-applied jackets.
k. Tapes.
l. Securements.
m. Corner angles.

C. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:
a. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
3. Shop Drawings:
a. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
b. Detail attachment and covering of heat tracing inside insulation.
c. Detail insulation application at pipe expansion joints for each type of insulation.
d. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
e. Detail removable insulation at piping specialties and equipment connections.
f. Detail application of field-applied jackets.
g. Detail application at linkages of control devices.
h. Detail field application for fire-suppression water storage tanks.
4. Field quality-control reports.

D. Quality Assurance

1. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
   a. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   b. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

E. Delivery, Storage, And Handling
1. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.2 PRODUCTS

A. Insulation Materials
1. Comply with requirements in Part 1.3 schedule articles for where insulating materials shall be applied.
2. Products shall not contain asbestos, lead, mercury, or mercury compounds.
3. 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.
4. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
5. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
6. Calcium Silicate:
   a. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
   b. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.
7. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   a. Block Insulation: ASTM C 552, Type I.
   b. Special-Shaped Insulation: ASTM C 552, Type III.
   c. Board Insulation: ASTM C 552, Type IV.
   d. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
   e. Preformed Pipe Insulation with Factory-Applied ASJ **OR** ASJ-SSL, **as directed**: Comply with ASTM C 552, Type II, Class 2.
   f. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
8. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
9. 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 I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
10. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For equipment applications, provide insulation without factory-applied jacket **OR** with factory-applied ASJ **OR** with factory-applied FSK jacket, **as directed**. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
11. Mineral-Fiber, Preformed Pipe Insulation:
   a. 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, without factory-applied

jacket **OR** with factory-applied ASJ **OR** with factory-applied ASJ-SSL, **as directed**. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

b. Type II, 1200 deg F (649 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, without factory-applied jacket **OR** with factory-applied ASJ **OR** with factory-applied ASJ-SSL, **as directed**. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

12. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ **OR** FSK jacket, **as directed**, 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.

13. Phenolic:
    a. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.
    b. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
    c. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
    d. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.
        1) Preformed Pipe Insulation: None **OR** ASJ, **as directed**.
        2) Board for Equipment Applications: None **OR** ASJ, **as directed**.

14. Polyisocyanurate: Unfaced, preformed, rigid cellular polyisocyanurate material intended for use as thermal insulation.
    a. Comply with ASTM C 591, Type I or Type IV, except thermal conductivity (k-value) shall not exceed 0.19 Btu x in./h x sq. ft. x deg F (0.027 W/m x K) at 75 deg F (24 deg C) after 180 days of aging.
    b. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less for thickness up to 1-1/2 inches (38 mm) as tested by ASTM E 84.
    c. Fabricate shapes according to ASTM C 450 and ASTM C 585.
    d. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.
        1) Pipe Applications: None **OR** ASJ **OR** ASJ-SSL **OR** PVDC **OR** PVDC-SSL, **as directed**.
        2) Equipment Applications: None **OR** ASJ **OR** ASJ-SSL **OR** PVDC **OR** PVDC-SSL, **as directed**.

15. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.

16. Polystyrene: Rigid, extruded cellular polystyrene intended for use as thermal insulation. Comply with ASTM C 578, Type IV or Type XIII, except thermal conductivity (k-value) shall not exceed 0.26 Btu x in./h x sq. ft. x deg F (0.038 W/m x K) after 180 days of aging. Fabricate shapes according to ASTM C 450 and ASTM C 585.

B. Insulating Cements
1. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
2. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
3. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

C. Adhesives
1. 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.
2. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F (10 to 427 deg C).
    a. 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. Cellular-Glass, Phenolic, Polyisocyanurate, and Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F (minus 59 to plus 149 deg C).
   a. 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).
4. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
   a. 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).
5. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   a. 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).
6. Polystyrene Adhesive: Solvent- or water-based, synthetic resin adhesive with a service temperature range of minus 20 to plus 140 deg F (29 to plus 60 deg C).
7. 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.
   a. 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).
8. PVC Jacket Adhesive: Compatible with PVC jacket.
   a. 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).

D. Mastics
1. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
   a. For indoor applications, use mastics that have a VOC content of <**Insert value**> g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
   a. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
   b. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
   c. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
   d. Color: White.
3. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
   a. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.033 metric perm) at 30-mil (0.8-mm) dry film thickness.
   b. Service Temperature Range: Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C).
   c. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
   d. Color: White.
4. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
   a. Water-Vapor Permeance: ASTM F 1249, 3 perms (2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
   b. Service Temperature Range: Minus 20 to plus 200 deg F (Minus 29 to plus 93 deg C).
   c. Solids Content: 63 percent by volume and 73 percent by weight.
   d. Color: White.

E. Lagging Adhesives
1. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.
   a. For indoor applications, use lagging adhesives that have a VOC content of <**Insert value**> g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   b. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment and pipe insulation.
   c. Service Temperature Range: Minus 50 to plus 180 deg F (Minus 46 to plus 82 deg C).
   d. Color: White.

F. Sealants
1. Joint Sealants:
   a. Materials shall be compatible with insulation materials, jackets, and substrates.
   b. Permanently flexible, elastomeric sealant.
   c. Service Temperature Range: Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C).
   d. Color: White or gray.
   e. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. FSK and Metal Jacket Flashing Sealants:
   a. Materials shall be compatible with insulation materials, jackets, and substrates.
   b. Fire- and water-resistant, flexible, elastomeric sealant.
   c. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
   d. Color: Aluminum.
   e. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
   a. Materials shall be compatible with insulation materials, jackets, and substrates.
   b. Fire- and water-resistant, flexible, elastomeric sealant.
   c. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
   d. Color: White.
   e. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

G. Factory-Applied Jackets
1. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
   b. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
   c. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
   d. PVDC Jacket for Indoor Applications: 4-mil- (0.10-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms (0.013 metric perms) when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
   e. PVDC Jacket for Outdoor Applications: 6-mil- (0.15-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms (0.007 metric perms) when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
   f. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

H. Field-Applied Fabric-Reinforcing Mesh
1. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. (68 g/sq. m) with a thread count of 10 strands by 10 strands/sq. inch (4 strands by 4 strands/sq. mm) for covering pipe and pipe fittings.
2. Woven Glass-Fiber Fabric for Equipment Insulation: Approximately 6 oz./sq. yd. (203 g/sq. m) with a thread count of 5 strands by 5 strands/sq. inch (2 strands by 2 strands/sq. mm) for covering equipment.
3. Woven Polyester Fabric: Approximately 1 oz./sq. yd. (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. inch (4 strands by 4 strands/sq. mm), in a Leno weave.

I. Field-Applied Cloths
1. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd. (271 g/sq. m).

J. Field-Applied Jackets
1. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
2. 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.
   a. Adhesive: As recommended by jacket material manufacturer.
   b. Color: White **OR** Color-code jackets based on system. Color as selected by the Owner, **as directed**.
   c. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
      1) 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.
   d. Factory-fabricated tank heads and tank side panels.
3. Metal Jacket:
   a. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005, Temper H-14.
      1) Sheet and roll stock ready for shop or field sizing **OR** Factory cut and rolled to size, **as directed**.
      2) Finish and thickness are indicated in field-applied jacket schedules.
      3) Moisture Barrier for Indoor Applications: 1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper **OR** 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper **OR** 2.5-mil- (0.063-mm-) thick Polysurlyn, **as directed**.
      4) Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper **OR** 2.5-mil- (0.063-mm-) thick Polysurlyn, **as directed**.
      5) Factory-Fabricated Fitting Covers:
         a) Same material, finish, and thickness as jacket.
         b) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
         c) Tee covers.
         d) Flange and union covers.
         e) End caps.
         f) Beveled collars.
         g) Valve covers.
         h) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
   b. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
      1) Sheet and roll stock ready for shop or field sizing **OR** Factory cut and rolled to size, **as directed**.
      2) Material, finish, and thickness are indicated in field-applied jacket schedules.
      3) Moisture Barrier for Indoor Applications: 1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper **OR** 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper **OR** 2.5-mil- (0.063-mm-) thick Polysurlyn, **as directed**.
      4) Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper **OR** 2.5-mil- (0.063-mm-) thick Polysurlyn, **as directed**.
      5) Factory-Fabricated Fitting Covers:
         a) Same material, finish, and thickness as jacket.
         b) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
         c) Tee covers.
         d) Flange and union covers.
         e) End caps.
         f) Beveled collars.
         g) Valve covers.
         h) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

K. Tapes

1. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   a. Width: 3 inches (75 mm).
   b. Thickness: 11.5 mils (0.29 mm).
   c. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
   d. Elongation: 2 percent.
   e. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
   f. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
2. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   a. Width: 3 inches (75 mm).
   b. Thickness: 6.5 mils (0.16 mm).
   c. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
   d. Elongation: 2 percent.
   e. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
   f. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
3. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
   a. Width: 2 inches (50 mm).
   b. Thickness: 6 mils (0.15 mm).
   c. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
   d. Elongation: 500 percent.
   e. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.
4. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
   a. Width: 2 inches (50 mm).
   b. Thickness: 3.7 mils (0.093 mm).
   c. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
   d. Elongation: 5 percent.
   e. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.
5. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
   a. Width: 3 inches (75 mm).
   b. Film Thickness: 4 mils (0.10 mm).
   c. Adhesive Thickness: 1.5 mils (0.04 mm).
   d. Elongation at Break: 145 percent.
   e. Tensile Strength: 55 lbf/inch (10.1 N/mm) in width.
6. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
   a. Width: 3 inches (75 mm).
   b. Film Thickness: 6 mils (0.15 mm).
   c. Adhesive Thickness: 1.5 mils (0.04 mm).
   d. Elongation at Break: 145 percent.
   e. Tensile Strength: 55 lbf/inch (10.1 N/mm) in width.

L. Securements
1. Bands:
   a. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 **OR** Type 316, **as directed**; 0.015 inch (0.38 mm) thick, 1/2 inch (13 mm) **OR** 3/4 inch (19 mm), **as directed**, wide with wing seal **OR** closed seal, **as directed**.
   b. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 1/2 inch (13 mm) **OR** 3/4 inch (19 mm), **as directed**, wide with wing seal **OR** closed seal, **as directed**.
   c. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.
2. Insulation Pins and Hangers:
   a. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in

position indicated when self-locking washer is in place. Comply with the following requirements:

1) Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
2) Spindle: Copper- or zinc-coated, low carbon steel **OR** Aluminum **OR** Stainless steel, **as directed**, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
3) Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

b. 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:

1) Baseplate: Galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
2) Spindle: Copper- or zinc-coated, low carbon steel **OR** Aluminum **OR** Stainless steel, **as directed**, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
3) Adhesive-backed base with a peel-off protective cover.

c. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick, galvanized-steel **OR** aluminum **OR** stainless-steel, **as directed**, 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.

1) Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

3. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.
4. Wire: 0.080-inch (2.0-mm) nickel-copper alloy **OR** 0.062-inch (1.6-mm) soft-annealed, stainless steel **OR** 0.062-inch (1.6-mm) soft-annealed, galvanized steel, **as directed**.

1.3 EXECUTION

A. Preparation

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

   OR

   Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

   a. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils (0.127 mm) thick and an epoxy finish 5 mils (0.127 mm) thick if operating in a temperature range between 140 and 300 deg F (60 and 149 deg C). Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
   b. 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.
2. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
3. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

B. General Installation Requirements

1. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.

2. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.
3. 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.
4. Install insulation with longitudinal seams at top and bottom of horizontal runs.
5. Install multiple layers of insulation with longitudinal and end seams staggered.
6. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
7. Keep insulation materials dry during application and finishing.
8. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
9. Install insulation with least number of joints practical.
10. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
    a. Install insulation continuously through hangers and around anchor attachments.
    b. 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.
    c. 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.
    d. 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.
11. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
12. Install insulation with factory-applied jackets as follows:
    a. Draw jacket tight and smooth.
    b. 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.
    c. 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) **OR** 4 inches (100 mm), **as directed**, o.c.
        1) For below ambient services, apply vapor-barrier mastic over staples.
    d. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
    e. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
13. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
14. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
15. 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.
16. For above ambient services, do not install insulation to the following:
    a. Vibration-control devices.
    b. Testing agency labels and stamps.
    c. Nameplates and data plates.
    d. Manholes.
    e. Handholes.
    f. Cleanouts.

C. Penetrations

1. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   a. Seal penetrations with flashing sealant.
   b. 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.
   c. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
   d. Seal jacket to roof flashing with flashing sealant.
2. Insulation Installation at Below-Grade Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
3. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
   a. Seal penetrations with flashing sealant.
   b. 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.
   c. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
   d. Seal jacket to wall flashing with flashing sealant.
4. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
5. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
   a. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
6. Insulation Installation at Floor Penetrations:
   a. Pipe: Install insulation continuously through floor penetrations.
   b. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping".

D. Equipment, Tank, And Vessel Insulation Installation
1. Secure insulation with adhesive and anchor pins and speed washers.
   a. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 **OR** 50, **as directed**, percent coverage of tank and vessel surfaces.
   b. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
   c. Protect exposed corners with secured corner angles.
   d. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
      1) Do not weld anchor pins to ASME-labeled pressure vessels.
      2) Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
      3) On tanks and vessels, maximum anchor-pin spacing is 3 inches (75 mm) from insulation end joints, and 16 inches (400 mm) o.c. in both directions.
      4) Do not overcompress insulation during installation.
      5) Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
      6) Impale insulation over anchor pins and attach speed washers.
      7) 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.

e. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
f. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches (150 mm) from each end. Install wire or cable between two circumferential girdles 12 inches (300 mm) o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches (1200 mm) o.c. Use this network for securing insulation with tie wire or bands.
g. Stagger joints between insulation layers at least 3 inches (75 mm).
h. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
i. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
j. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

2. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
a. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
b. Seal longitudinal seams and end joints.

E. General Pipe Insulation Installation
1. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
2. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
a. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
b. 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.
c. 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.
d. 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.
e. 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.
f. 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.
g. 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.

h. 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.

i. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

3. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

4. Install removable insulation covers at locations indicated. Installation shall conform to the following:

a. 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.

b. 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.

c. 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.

d. 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.

e. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

F. Calcium Silicate Insulation Installation

1. Insulation Installation on Straight Pipes and Tubes:

a. Secure single-layer insulation with stainless-steel bands at 12-inch (300-mm) intervals and tighten bands without deforming insulation materials.

b. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with wire spaced at 12-inch (300-mm) intervals. Secure outer layer with stainless-steel bands at 12-inch (300-mm) intervals.

c. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch (25 mm). Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

2. Insulation Installation on Pipe Flanges:

a. Install preformed pipe insulation to outer diameter of pipe flange.

b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.

d. Finish flange insulation same as pipe insulation.

3. Insulation Installation on Pipe Fittings and Elbows:

a. Install preformed sections of same material as straight segments of pipe insulation when available.

b. When preformed insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
c. Finish fittings insulation same as pipe insulation.

4. Insulation Installation on Valves and Pipe Specialties:
a. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
b. Install insulation to flanges as specified for flange insulation application.
c. Finish valve and specialty insulation same as pipe insulation.

G. Cellular-Glass Insulation Installation
1. Insulation Installation on Straight Pipes and Tubes:
a. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
b. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and applicable insulation joint sealant.
c. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
d. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
2. Insulation Installation on Pipe Flanges:
a. Install preformed pipe insulation to outer diameter of pipe flange.
b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
d. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.
3. Insulation Installation on Pipe Fittings and Elbows:
a. Install preformed sections of same material as straight segments of pipe insulation when available.
b. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.
4. Insulation Installation on Valves and Pipe Specialties:
a. Install preformed sections of cellular-glass insulation to valve body.
b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
c. Install insulation to flanges as specified for flange insulation application.

H. Flexible Elastomeric Insulation Installation
1. 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.
2. Insulation Installation on Pipe Flanges:
a. Install pipe insulation to outer diameter of pipe flange.
b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
c. 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.
d. 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.
3. Insulation Installation on Pipe Fittings and Elbows:
a. Install mitered sections of pipe insulation.
b. 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.

4. Insulation Installation on Valves and Pipe Specialties:
   a. Install preformed valve covers manufactured of same material as pipe insulation when available.
   b. 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.
   c. Install insulation to flanges as specified for flange insulation application.
   d. 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.

I. Mineral-Fiber Insulation Installation
1. Insulation Installation on Straight Pipes and Tubes:
   a. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   b. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and applicable insulation joint sealant.
   c. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
   d. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
2. Insulation Installation on Pipe Flanges:
   a. Install preformed pipe insulation to outer diameter of pipe flange.
   b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
   d. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.
3. Insulation Installation on Pipe Fittings and Elbows:
   a. Install preformed sections of same material as straight segments of pipe insulation when available.
   b. 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.
4. Insulation Installation on Valves and Pipe Specialties:
   a. Install preformed sections of same material as straight segments of pipe insulation when available.
   b. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
   c. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   d. Install insulation to flanges as specified for flange insulation application.

J. Phenolic Insulation Installation
1. General Installation Requirements:
   a. Secure single-layer insulation with stainless-steel bands at 12-inch (300-mm) intervals and tighten bands without deforming insulation materials.
   b. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with 0.062-inch (1.6-mm) wire spaced at 12-inch (300-mm) intervals. Secure outer layer with stainless-steel bands at 12-inch (300-mm) intervals.
2. Insulation Installation on Straight Pipes and Tubes:
   a. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

b. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and applicable insulation joint sealant.
c. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
d. For insulation with factory-applied jackets with vapor retarders on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

3. Insulation Installation on Pipe Flanges:
   a. Install preformed pipe insulation to outer diameter of pipe flange.
   b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
4. Insulation Installation on Pipe Fittings and Elbows:
   a. Install preformed insulation sections of same material as straight segments of pipe insulation.
5. Insulation Installation on Valves and Pipe Specialties:
   a. Install preformed insulation sections of same material as straight segments of pipe insulation.
   b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   c. Install insulation to flanges as specified for flange insulation application.

K. Polyisocyanurate Insulation Installation
1. Insulation Installation on Straight Pipes and Tubes:
   a. Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.
   b. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
   c. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.
2. Insulation Installation on Pipe Flanges:
   a. Install preformed pipe insulation to outer diameter of pipe flange.
   b. Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch (38-mm) thickness.
   c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyisocyanurate block insulation of same thickness as pipe insulation.
3. Insulation Installation on Fittings and Elbows:
   a. Install preformed sections of same material as straight segments of pipe insulation.
4. Insulation Installation on Valves and Pipe Specialties:
   a. Install preformed sections of polyisocyanurate insulation to valve body.
   b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   c. Install insulation to flanges as specified for flange insulation application.

L. Polyolefin Insulation Installation
1. Insulation Installation on Straight Pipes and Tubes:
   a. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
2. Insulation Installation on Pipe Flanges:
   a. Install pipe insulation to outer diameter of pipe flange.

b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
d. 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.

3. Insulation Installation on Pipe Fittings and Elbows:
   a. Install mitered sections of polyolefin pipe insulation.
   b. 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.
4. Insulation Installation on Valves and Pipe Specialties:
   a. Install cut sections of polyolefin pipe and sheet insulation to valve body.
   b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   c. Install insulation to flanges as specified for flange insulation application.
   d. 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.

M. Polystyrene Insulation Installation
1. Insulation Installation on Straight Pipes and Tubes:
   a. Secure each layer of insulation with tape or bands and tighten bands without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.
   b. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
   c. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.
2. Insulation Installation on Pipe Flanges:
   a. Install preformed pipe insulation to outer diameter of pipe flange.
   b. Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch (38-mm) thickness.
   c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polystyrene block insulation of same thickness as pipe insulation.
3. Insulation Installation on Pipe Fittings and Elbows:
   a. Install preformed insulation sections of same material as straight segments of pipe insulation.
4. Insulation Installation on Valves and Pipe Specialties:
   a. Install preformed section of polystyrene insulation to valve body.
   b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   c. Install insulation to flanges as specified for flange insulation application.

N. Field-Applied Jacket Installation
1. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
   a. Draw jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.
   b. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of lagging adhesive.
   c. Completely encapsulate insulation with coating, leaving no exposed insulation.
2. Where FSK jackets are indicated, install as follows:
   a. Draw jacket material smooth and tight.
   b. Install lap or joint strips with same material as jacket.

c. Secure jacket to insulation with manufacturer's recommended adhesive.
d. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
e. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

3. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
   a. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
4. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.
5. Where PVDC jackets are indicated, install as follows:
   a. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
   b. Wrap factory-presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches (50 mm) over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
   c. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
   d. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches (850 mm) or less. The 33-1/2-inch- (850-mm-) circumference limit allows for 2-inch- (50-mm-) overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
   e. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

O. Finishes
1. Equipment and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 07.
   a. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
      1) Finish Coat Material: Interior, flat, latex-emulsion size.
2. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
3. Color: Final color as selected by the Owner. Vary first and second coats to allow visual inspection of the completed Work.
4. Do not field paint aluminum or stainless-steel jackets.

P. Field Quality Control
1. Perform tests and inspections.
2. Tests and Inspections:
   a. Inspect field-insulated equipment, randomly selected by the Owner, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
   b. Inspect pipe, fittings, strainers, and valves, randomly selected by the Owner, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of

inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

3. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

Q. Equipment Insulation Schedule
1. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
2. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.
3. Fire-suppression water storage tank insulation shall be one of the following:
   a. Cellular Glass: 2 inches (50 mm) thick.
   b. Flexible Elastomeric: 1 inch (25 mm) thick.
   c. Mineral-Fiber Board: 1 inch (25 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   d. Mineral-Fiber Pipe and Tank: 1 inch (25 mm) thick.
   e. Phenolic: 1 inch (25 mm) thick.
   f. Polyisocyanurate: 1 inch (25 mm) thick.
   g. Polyolefin: 1 inch (25 mm) thick.

R. Piping Insulation Schedule, General
1. 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.
2. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   a. Indoor fire-suppression piping.
   b. Underground piping.

S. Indoor Piping Insulation Schedule
1. Indoor Engine Coolant Piping for Remote Radiator of Engine-Driven Fire Pump:
   a. All Pipe Sizes: Insulation shall be one of the following:
      1) Calcium Silicate: 2 inches (50 mm) thick.
      2) Cellular Glass: 2 inches (50 mm) thick.
      3) Mineral-Fiber, Preformed Pipe, Type I or II: 2 inches (50 mm) thick.
2. Indoor Engine Exhaust Piping and Silencer, All Pipe Sizes: Calcium silicate, 4 inches (100 mm) thick.

T. Outdoor, Aboveground Piping Insulation Schedule
1. Outdoor Engine Coolant Piping for Remote Radiator of Engine-Driven Fire Pump:
   a. All Pipe Sizes: Insulation shall be one of the following:
      1) Calcium Silicate: 2 inches (50 mm) thick.
      2) Cellular Glass: 2 inches (50 mm) thick.
      3) Mineral-Fiber, Preformed Pipe, Type I or II: 2 inches (50 mm) thick.
2. Outdoor Engine Exhaust Piping and Silencer, All Pipe Sizes: Calcium silicate, 4 inches (100 mm) thick.
3. Outdoor Fire-Suppression Piping Filled with Water:
   a. All Pipe Sizes: Insulation shall be one of the following:
      1) Cellular Glass: 2 inches (50 mm) thick.
      2) Flexible Elastomeric: 2 inches (50 mm) thick.
      3) Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches (50 mm) thick.
      4) Phenolic: 2 inches (50 mm) thick.
      5) Polyisocyanurate: 2 inches (50 mm) thick.
      6) Polyolefin: 2 inches (50 mm) thick.
      7) Polystyrene: 2 inches (50 mm) thick.

U. Indoor, Field-Applied Jacket Schedule
1. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
2. If more than one material is listed, selection from materials listed is Contractor's option.
3. Piping, Concealed:
   a. None.
   b. Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
   c. Painted Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm), **as directed**, thick.
   d. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.
4. Piping, Exposed:
   a. None.
   b. PVC **OR** PVC, Color-Coded by System, **as directed**: 20 mils (0.5 mm) **OR** 30 mils (0.8 mm), **as directed**, thick.
   c. Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
   d. Painted Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm), **as directed**, thick.
   e. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.

V. Outdoor, Field-Applied Jacket Schedule
1. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
2. If more than one material is listed, selection from materials listed is Contractor's option.
3. Equipment, Concealed:
   a. None.
   b. PVC **OR** PVC, Color-Coded by System, **as directed**: 20 mils (0.5 mm) **OR** 30 mils (0.8 mm), **as directed**, thick.
   c. Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
   d. Painted Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm), **as directed**, thick.
   e. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.
4. Equipment, Exposed, up to 48 Inches (1200 mm) in Diameter or with Flat Surfaces up to 72 Inches (1800 mm):
   a. Aluminum **OR** Painted Aluminum, **as directed**, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**, with Z-Shaped Locking Seam, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
   b. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, **as directed**, with Z-Shaped Locking Seam, **as directed**: 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.

5. Equipment, Exposed, Larger Than 48 Inches (1200 mm) in Diameter or with Flat Surfaces Larger Than 72 Inches (1800 mm):
   a. Aluminum **OR** Painted Aluminum, **as directed**, Smooth **OR** Stucco Embossed, **as directed**, with 1-1/4-Inch- (32-mm-) Deep Corrugations **OR** 2-1/2-Inch- (65-mm-) Deep Corrugations **OR** 4-by-1-Inch (100-by-25-mm) Box Ribs, **as directed**: 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
   b. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth **OR** Stucco Embossed, **as directed**, with 1-1/4-Inch- (32-mm-) Deep Corrugations **OR** 2-1/2-Inch- (65-mm-) Deep Corrugations **OR** 4-by-1-Inch (100-by-25-mm) Box Ribs, **as directed**: 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.
6. Outdoor Exposed Piping:
   a. PVC: 20 mils (0.5 mm) **OR** 30 mils (0.8 mm) **OR** 40 mils (1.0 mm), **as directed**, thick.
   b. Aluminum **OR** Painted Aluminum, **as directed**, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**, with Z-Shaped Locking Seam, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
   c. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, ,**as directed** with Z-Shaped Locking Seam, **as directed**: 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.

END OF SECTION 22 07 19 00

SECTION 22 07 19 00a - PLUMBING INSULATION

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for plumbing insulation. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Insulation Materials:
1) Calcium silicate.
2) Cellular glass.
3) Flexible elastomeric.
4) Mineral fiber.
5) Phenolic.
6) Polyisocyanurate.
7) Polyolefin.
8) Polystyrene.
b. Insulating cements.
c. Adhesives.
d. Mastics.
e. Lagging adhesives.
f. Sealants.
g. Factory-applied jackets.
h. Field-applied fabric-reinforcing mesh.
i. Field-applied cloths.
j. Field-applied jackets.
k. Tapes.
l. Securements.
m. Corner angles.

C. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:
a. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
3. Shop Drawings:
a. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
b. Detail attachment and covering of heat tracing inside insulation.
c. Detail insulation application at pipe expansion joints for each type of insulation.
d. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
e. Detail removable insulation at piping specialties, equipment connections, and access panels.
f. Detail application of field-applied jackets.
g. Detail application at linkages of control devices.
h. Detail field application for each equipment type.
4. Field quality-control reports.

D. Quality Assurance

1. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
   a. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   b. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

E. Delivery, Storage, And Handling
1. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.2 PRODUCTS

A. Insulation Materials
1. Comply with requirements in Part 1.3 schedule articles for where insulating materials shall be applied.
2. Products shall not contain asbestos, lead, mercury, or mercury compounds.
3. 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.
4. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
5. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
6. Calcium Silicate:
   a. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
   b. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
   c. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.
7. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   a. Block Insulation: ASTM C 552, Type I.
   b. Special-Shaped Insulation: ASTM C 552, Type III.
   c. Board Insulation: ASTM C 552, Type IV.
   d. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
   e. Preformed Pipe Insulation with Factory-Applied ASJ **OR** ASJ-SSL, **as directed**: Comply with ASTM C 552, Type II, Class 2.
   f. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
8. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
9. 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 I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
10. High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type V, without factory-applied jacket.
11. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For equipment applications, provide insulation

without factory-applied jacket **OR** with factory-applied ASJ **OR** with factory-applied FSK jacket, **as directed**. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

12. High-Temperature, Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type III, without factory-applied jacket.
13. Mineral-Fiber, Preformed Pipe Insulation:
    a. 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, without factory-applied jacket **OR** with factory-applied ASJ **OR** with factory-applied ASJ-SSL, **as directed**. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
14. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ **OR** FSK jacket, **as directed**, 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.
15. Phenolic:
    a. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.
    b. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
    c. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
    d. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.
        1) Preformed Pipe Insulation: None **OR** ASJ, **as directed**.
        2) Board for Equipment Applications: None **OR** ASJ, **as directed**.
16. Polyisocyanurate: Unfaced, preformed, rigid cellular polyisocyanurate material intended for use as thermal insulation.
    a. Comply with ASTM C 591, Type I or Type IV, except thermal conductivity (k-value) shall not exceed 0.19 Btu x in./h x sq. ft. x deg F (0.027 W/m x K) at 75 deg F (24 deg C) after 180 days of aging.
    b. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less for thickness up to 1-1/2 inches (38 mm) as tested by ASTM E 84.
    c. Fabricate shapes according to ASTM C 450 and ASTM C 585.
    d. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.
        1) Pipe Applications: None **OR** ASJ **OR** ASJ-SSL **OR** PVDC **OR** PVDC-SSL, **as directed**.
        2) Equipment Applications: None **OR** ASJ **OR** ASJ-SSL **OR** PVDC **OR** PVDC-SSL, **as directed**.
17. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.
18. Polystyrene: Rigid, extruded cellular polystyrene intended for use as thermal insulation. Comply with ASTM C 578, Type IV or Type XIII, except thermal conductivity (k-value) shall not exceed 0.26 Btu x in./h x sq. ft. x deg F (0.038 W/m x K) after 180 days of aging. Fabricate shapes according to ASTM C 450 and ASTM C 585.

B. Insulating Cements
1. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
2. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
3. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

C. Adhesives
1. 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.
2. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F (10 to 427 deg C).

a. 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. Cellular-Glass, Phenolic, Polyisocyanurate, and Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F (minus 59 to plus 149 deg C).
   a. 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).
4. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
   a. 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).
5. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   a. 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).
6. Polystyrene Adhesive: Solvent- or water-based, synthetic resin adhesive with a service temperature range of minus 20 to plus 140 deg F (29 to plus 60 deg C).
7. 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.
   a. 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).
8. PVC Jacket Adhesive: Compatible with PVC jacket.
   a. 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).

D. Mastics
1. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
   a. For indoor applications, use mastics that have a VOC content of <**Insert value**> g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
   a. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
   b. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
   c. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
   d. Color: White.
3. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.
   a. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.03 metric perm) at 35-mil (0.9-mm) dry film thickness.
   b. Service Temperature Range: 0 to 180 deg F (Minus 18 to plus 82 deg C).
   c. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
   d. Color: White.
4. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
   a. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.033 metric perm) at 30-mil (0.8-mm) dry film thickness.
   b. Service Temperature Range: Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C).
   c. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
   d. Color: White.
5. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
   a. Water-Vapor Permeance: ASTM F 1249, 3 perms (2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
   b. Service Temperature Range: Minus 20 to plus 200 deg F (Minus 29 to plus 93 deg C).
   c. Solids Content: 63 percent by volume and 73 percent by weight.
   d. Color: White.

E. Lagging Adhesives

1. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.
    a. For indoor applications, use lagging adhesives that have a VOC content of <**Insert value**> g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
    b. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment and pipe insulation.
    c. Service Temperature Range: Minus 50 to plus 180 deg F (Minus 46 to plus 82 deg C).
    d. Color: White.

F. Sealants
1. Joint Sealants:
    a. Materials shall be compatible with insulation materials, jackets, and substrates.
    b. Permanently flexible, elastomeric sealant.
    c. Service Temperature Range: Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C).
    d. Color: White or gray.
    e. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. FSK and Metal Jacket Flashing Sealants:
    a. Materials shall be compatible with insulation materials, jackets, and substrates.
    b. Fire- and water-resistant, flexible, elastomeric sealant.
    c. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
    d. Color: Aluminum.
    e. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
    a. Materials shall be compatible with insulation materials, jackets, and substrates.
    b. Fire- and water-resistant, flexible, elastomeric sealant.
    c. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
    d. Color: White.
    e. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

G. Factory-Applied Jackets
1. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
    a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
    b. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
    c. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
    d. PVDC Jacket for Indoor Applications: 4-mil- (0.10-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms (0.013 metric perms) when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
    e. PVDC Jacket for Outdoor Applications: 6-mil- (0.15-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms (0.007 metric perms) when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
    f. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

H. Field-Applied Fabric-Reinforcing Mesh
1. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. (68 g/sq. m) with a thread count of 10 strands by 10 strands/sq. inch (4 strands by 4 strands/sq. mm) for covering pipe and pipe fittings.

2. Woven Glass-Fiber Fabric for Equipment Insulation: Approximately 6 oz./sq. yd. (203 g/sq. m) with a thread count of 5 strands by 5 strands/sq. inch (2 strands by 2 strands/sq. mm) for covering equipment.
3. Woven Polyester Fabric: Approximately 1 oz./sq. yd. (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. inch (4 strands by 4 strands/sq. mm), in a Leno weave, for equipment and pipe.

I. Field-Applied Cloths
1. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd. (271 g/sq. m).

J. Field-Applied Jackets
1. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
2. 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.
   a. Adhesive: As recommended by jacket material manufacturer.
   b. Color: White **OR** Color-code jackets based on system. Color as selected by the Owner, **as directed**.
   c. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
      1) 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.
   d. Factory-fabricated tank heads and tank side panels.
3. Metal Jacket:
   a. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005, Temper H-14.
      1) Sheet and roll stock ready for shop or field sizing **OR** Factory cut and rolled to size, **as directed**.
      2) Finish and thickness are indicated in field-applied jacket schedules.
      3) Moisture Barrier for Indoor Applications: 1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper **OR** 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper **OR** 2.5-mil- (0.063-mm-) thick Polysurlyn, **as directed**.
      4) Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper **OR** 2.5-mil- (0.063-mm-) thick Polysurlyn, **as directed**.
      5) Factory-Fabricated Fitting Covers:
         a) Same material, finish, and thickness as jacket.
         b) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
         c) Tee covers.
         d) Flange and union covers.
         e) End caps.
         f) Beveled collars.
         g) Valve covers.
         h) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
   b. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
      1) Sheet and roll stock ready for shop or field sizing **OR** Factory cut and rolled to size, **as directed**.
      2) Material, finish, and thickness are indicated in field-applied jacket schedules.
      3) Moisture Barrier for Indoor Applications: 1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper **OR** 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper **OR** 2.5-mil- (0.063-mm-) thick Polysurlyn, **as directed**.
      4) Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper **OR** 2.5-mil- (0.063-mm-) thick Polysurlyn, **as directed**.
      5) Factory-Fabricated Fitting Covers:

a) Same material, finish, and thickness as jacket.
b) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
c) Tee covers.
d) Flange and union covers.
e) End caps.
f) Beveled collars.
g) Valve covers.
h) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

4. Underground Direct-Buried Jacket: 125-mil- (3.2-mm-) thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

K. Tapes

1. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   a. Width: 3 inches (75 mm).
   b. Thickness: 11.5 mils (0.29 mm).
   c. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
   d. Elongation: 2 percent.
   e. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
   f. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
2. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   a. Width: 3 inches (75 mm).
   b. Thickness: 6.5 mils (0.16 mm).
   c. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
   d. Elongation: 2 percent.
   e. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
   f. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
3. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
   a. Width: 2 inches (50 mm).
   b. Thickness: 6 mils (0.15 mm).
   c. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
   d. Elongation: 500 percent.
   e. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.
4. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
   a. Width: 2 inches (50 mm).
   b. Thickness: 3.7 mils (0.093 mm).
   c. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
   d. Elongation: 5 percent.
   e. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.
5. PVDC Tape: White vapor-retarder PVDC tape with acrylic adhesive.
   a. Width: 3 inches (75 mm).
   b. Film Thickness: 4 mils (0.10 mm) **OR** 6 mils (0.15 mm), **as directed**.
   c. Adhesive Thickness: 1.5 mils (0.04 mm).
   d. Elongation at Break: 145 percent.
   e. Tensile Strength: 55 lbf/inch (10.1 N/mm) in width.

L. Securements

1. Bands:
   a. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 **OR** Type 316, **as directed**; 0.015 inch (0.38 mm) thick, 1/2 inch (13 mm) **OR** 3/4 inch (19 mm), **as directed**, wide with wing seal **OR** closed seal, **as directed**.

b. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 1/2 inch (13 mm) **OR** 3/4 inch (19 mm), **as directed**, wide with wing seal **OR** closed seal, **as directed**.

c. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

2. Insulation Pins and Hangers:

a. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) **OR** 0.135-inch- (3.5-mm-), **as directed**, diameter shank, length to suit depth of insulation indicated.

b. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) **OR** 0.135-inch- (3.5-mm-), **as directed**, diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.

c. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

1) Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.

2) Spindle: Copper- or zinc-coated, low carbon steel **OR** Aluminum **OR** Stainless steel, **as directed**, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.

3) Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

d. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

1) Baseplate: Perforated, nylon sheet, 0.030 inch (0.76 mm) thick by 1-1/2 inches (38 mm) in diameter.

2) Spindle: Nylon, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches (63 mm).

3) Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

e. 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:

1) Baseplate: Galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.

2) Spindle: Copper- or zinc-coated, low carbon steel **OR** Aluminum **OR** Stainless steel, **as directed**, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.

3) Adhesive-backed base with a peel-off protective cover.

f. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick, galvanized-steel **OR** aluminum **OR** stainless-steel, **as directed**, 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.

1) Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

g. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick nylon 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.

3. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.
4. Wire: 0.080-inch (2.0-mm) nickel-copper alloy **OR** 0.062-inch (1.6-mm) soft-annealed, stainless steel **OR** 0.062-inch (1.6-mm) soft-annealed, galvanized steel, **as directed**.

M. Corner Angles
1. PVC Corner Angles: 30 mils (0.8 mm) thick, minimum 1 by 1 inch (25 by 25 mm), PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.
2. Aluminum Corner Angles: 0.040 inch (1.0 mm) thick, minimum 1 by 1 inch (25 by 25 mm), aluminum according to ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005; Temper H-14.
3. Stainless-Steel Corner Angles: 0.024 inch (0.61 mm) thick, minimum 1 by 1 inch (25 by 25 mm), stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 **OR** Type 316, **as directed**.

1.3 EXECUTION

A. Preparation
1. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
   OR
   Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
   a. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils (0.127 mm) thick and an epoxy finish 5 mils (0.127 mm) thick if operating in a temperature range between 140 and 300 deg F (60 and 149 deg C). Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
   b. 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.
2. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
3. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

B. General Installation Requirements
1. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.
2. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.
3. 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.
4. Install insulation with longitudinal seams at top and bottom of horizontal runs.
5. Install multiple layers of insulation with longitudinal and end seams staggered.
6. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
7. Keep insulation materials dry during application and finishing.
8. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
9. Install insulation with least number of joints practical.
10. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
    a. Install insulation continuously through hangers and around anchor attachments.

b. 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.
c. 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.
d. 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.

11. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
12. Install insulation with factory-applied jackets as follows:
    a. Draw jacket tight and smooth.
    b. 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.
    c. 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) **OR** 4 inches (100 mm), **as directed**, o.c.
        1) For below ambient services, apply vapor-barrier mastic over staples.
    d. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
    e. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
13. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
14. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
15. 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.
16. For above ambient services, do not install insulation to the following:
    a. Vibration-control devices.
    b. Testing agency labels and stamps.
    c. Nameplates and data plates.
    d. Manholes.
    e. Handholes.
    f. Cleanouts.

C. Penetrations
1. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
    a. Seal penetrations with flashing sealant.
    b. 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.
    c. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
    d. Seal jacket to roof flashing with flashing sealant.
2. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
3. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
    a. Seal penetrations with flashing sealant.

b. 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.
c. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
d. Seal jacket to wall flashing with flashing sealant.

4. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
5. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
   a. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
6. Insulation Installation at Floor Penetrations:
   a. Pipe: Install insulation continuously through floor penetrations.
   b. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping".

D. Equipment, Tank, And Vessel Insulation Installation
1. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
   a. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 **OR** 50, **as directed**, percent coverage of tank and vessel surfaces.
   b. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
   c. Protect exposed corners with secured corner angles.
   d. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
      1) Do not weld anchor pins to ASME-labeled pressure vessels.
      2) Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
      3) On tanks and vessels, maximum anchor-pin spacing is 3 inches (75 mm) from insulation end joints, and 16 inches (400 mm) o.c. in both directions.
      4) Do not overcompress insulation during installation.
      5) Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
      6) Impale insulation over anchor pins and attach speed washers.
      7) 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.
   e. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
   f. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches (150 mm) from each end. Install wire or cable between two circumferential girdles 12 inches (300 mm) o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches (1200 mm) o.c. Use this network for securing insulation with tie wire or bands.
   g. Stagger joints between insulation layers at least 3 inches (75 mm).
   h. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.

i. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
j. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

2. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
   a. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
   b. Seal longitudinal seams and end joints.
3. Insulation Installation on Pumps:
   a. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch (150-mm) centers, starting at corners. Install 3/8-inch- (10-mm-) diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
   b. Fabricate boxes from galvanized steel **OR** aluminum **OR** stainless steel, **as directed**, at least 0.040 inch (1.0 mm) **OR** 0.050 inch (1.3 mm) **OR** 0.060 inch (1.6 mm), **as directed**, thick.
   c. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

E. General Pipe Insulation Installation
1. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
2. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   a. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
   b. 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.
   c. 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.
   d. 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.
   e. 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.
   f. 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.
   g. 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.

h. 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.

i. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

3. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

4. Install removable insulation covers at locations indicated. Installation shall conform to the following:

a. 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.

b. 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.

c. 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.

d. 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.

e. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

F. Calcium Silicate Insulation Installation

1. Insulation Installation on Domestic Water Boiler Breechings:

a. Secure single-layer insulation with stainless-steel bands at 12-inch (300-mm) intervals and tighten bands without deforming insulation material.

b. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with wire spaced at 12-inch (300-mm) intervals. Secure outer layer with stainless-steel bands at 12-inch (300-mm) intervals.

c. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch (25 mm). Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.

2. Insulation Installation on Straight Pipes and Tubes:

a. Secure single-layer insulation with stainless-steel bands at 12-inch (300-mm) intervals and tighten bands without deforming insulation materials.

b. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with wire spaced at 12-inch (300-mm) intervals. Secure outer layer with stainless-steel bands at 12-inch (300-mm) intervals.

c. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch (25 mm). Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

3. Insulation Installation on Pipe Flanges:

a. Install preformed pipe insulation to outer diameter of pipe flange.

b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
d. Finish flange insulation same as pipe insulation.

4. Insulation Installation on Pipe Fittings and Elbows:
   a. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
   b. When preformed insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
   c. Finish fittings insulation same as pipe insulation.
5. Insulation Installation on Valves and Pipe Specialties:
   a. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   b. Install insulation to flanges as specified for flange insulation application.
   c. Finish valve and specialty insulation same as pipe insulation.

G. Cellular-Glass Insulation Installation
1. Insulation Installation on Straight Pipes and Tubes:
   a. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   b. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   c. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
   d. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
2. Insulation Installation on Pipe Flanges:
   a. Install preformed pipe insulation to outer diameter of pipe flange.
   b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
   d. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.
3. Insulation Installation on Pipe Fittings and Elbows:
   a. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
   b. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.
4. Insulation Installation on Valves and Pipe Specialties:
   a. Install preformed sections of cellular-glass insulation to valve body.
   b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   c. Install insulation to flanges as specified for flange insulation application.

H. Flexible Elastomeric Insulation Installation
1. 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.
2. Insulation Installation on Pipe Flanges:
   a. Install pipe insulation to outer diameter of pipe flange.
   b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

c. 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.
d. 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.

3. Insulation Installation on Pipe Fittings and Elbows:
   a. Install mitered sections of pipe insulation.
   b. 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.
4. Insulation Installation on Valves and Pipe Specialties:
   a. Install preformed valve covers manufactured of same material as pipe insulation when available.
   b. 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.
   c. Install insulation to flanges as specified for flange insulation application.
   d. 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.

I. Mineral-Fiber Insulation Installation
1. Insulation Installation on Straight Pipes and Tubes:
   a. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   b. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   c. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
   d. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
2. Insulation Installation on Pipe Flanges:
   a. Install preformed pipe insulation to outer diameter of pipe flange.
   b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
   d. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.
3. Insulation Installation on Pipe Fittings and Elbows:
   a. Install preformed sections of same material as straight segments of pipe insulation when available.
   b. 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.
4. Insulation Installation on Valves and Pipe Specialties:
   a. Install preformed sections of same material as straight segments of pipe insulation when available.
   b. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
   c. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   d. Install insulation to flanges as specified for flange insulation application.

J. Phenolic Insulation Installation
1. General Installation Requirements:

a. Secure single-layer insulation with stainless-steel bands at 12-inch (300-mm) intervals and tighten bands without deforming insulation materials.
b. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with 0.062-inch (1.6-mm) wire spaced at 12-inch (300-mm) intervals. Secure outer layer with stainless-steel bands at 12-inch (300-mm) intervals.

2. Insulation Installation on Straight Pipes and Tubes:
   a. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   b. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   c. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
   d. For insulation with factory-applied jackets with vapor retarders on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
3. Insulation Installation on Pipe Flanges:
   a. Install preformed pipe insulation to outer diameter of pipe flange.
   b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
4. Insulation Installation on Pipe Fittings and Elbows:
   a. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
5. Insulation Installation on Valves and Pipe Specialties:
   a. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
   b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   c. Install insulation to flanges as specified for flange insulation application.

K. Polyisocyanurate Insulation Installation
1. Insulation Installation on Straight Pipes and Tubes:
   a. Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.
   b. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
   c. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.
2. Insulation Installation on Pipe Flanges:
   a. Install preformed pipe insulation to outer diameter of pipe flange.
   b. Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch (38-mm) thickness.
   c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyisocyanurate block insulation of same thickness as pipe insulation.
3. Insulation Installation on Fittings and Elbows:
   a. Install preformed sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
4. Insulation Installation on Valves and Pipe Specialties:
   a. Install preformed sections of polyisocyanurate insulation to valve body.

b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
c. Install insulation to flanges as specified for flange insulation application.

L. Polyolefin Insulation Installation
1. Insulation Installation on Straight Pipes and Tubes:
a. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
2. Insulation Installation on Pipe Flanges:
a. Install pipe insulation to outer diameter of pipe flange.
b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
d. 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.
3. Insulation Installation on Pipe Fittings and Elbows:
a. Install mitered sections of polyolefin pipe insulation.
b. 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.
4. Insulation Installation on Valves and Pipe Specialties:
a. Install cut sections of polyolefin pipe and sheet insulation to valve body.
b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
c. Install insulation to flanges as specified for flange insulation application.
d. 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.

M. Polystyrene Insulation Installation
1. Insulation Installation on Straight Pipes and Tubes:
a. Secure each layer of insulation with tape or bands and tighten bands without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.
b. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
c. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.
2. Insulation Installation on Pipe Flanges:
a. Install preformed pipe insulation to outer diameter of pipe flange.
b. Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch (38-mm) thickness.
c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polystyrene block insulation of same thickness as pipe insulation.
3. Insulation Installation on Pipe Fittings and Elbows:
a. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
4. Insulation Installation on Valves and Pipe Specialties:
a. Install preformed section of polystyrene insulation to valve body.
b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
c. Install insulation to flanges as specified for flange insulation application.

N. Field-Applied Jacket Installation
1. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
   a. Draw jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.
   b. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of lagging adhesive.
   c. Completely encapsulate insulation with coating, leaving no exposed insulation.
2. Where FSK jackets are indicated, install as follows:
   a. Draw jacket material smooth and tight.
   b. Install lap or joint strips with same material as jacket.
   c. Secure jacket to insulation with manufacturer's recommended adhesive.
   d. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
   e. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
3. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
   a. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
4. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.
5. Where PVDC jackets are indicated, install as follows:
   a. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
   b. Wrap factory-presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches (50 mm) over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
   c. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
   d. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches (850 mm) or less. The 33-1/2-inch- (850-mm-) circumference limit allows for 2-inch- (50-mm-) overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
   e. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

O. Finishes
1. Equipment and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 07.
   a. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
      1) Finish Coat Material: Interior, flat, latex-emulsion size.
2. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
3. Color: Final color as selected by the Owner. Vary first and second coats to allow visual inspection of the completed Work.
4. Do not field paint aluminum or stainless-steel jackets.

P. Field Quality Control
1. Perform tests and inspections.
2. Tests and Inspections:
   a. Inspect field-insulated equipment, randomly selected by the Owner, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
   b. Inspect pipe, fittings, strainers, and valves, randomly selected by the Owner, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
3. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

Q. Domestic Water Boiler Breeching Insulation Schedule
1. Round, exposed breeching and connector insulation shall be one of the following:
   a. Calcium Silicate: 4 inches (100 mm) thick.
   b. High-Temperature Mineral-Fiber Blanket: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
   c. High-Temperature Mineral-Fiber Board: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
2. Round, concealed breeching and connector insulation shall be one of the following:
   a. Calcium Silicate: 4 inches (100 mm) thick.
   b. High-Temperature Mineral-Fiber Blanket: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
   c. High-Temperature Mineral-Fiber Board: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
3. Rectangular, exposed breeching and connector insulation shall be one of the following:
   a. Calcium Silicate: 4 inches (100 mm) thick.
   b. High-Temperature Mineral-Fiber Blanket: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
   c. High-Temperature Mineral-Fiber Board: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
4. Rectangular, concealed breeching and connector insulation shall be one of the following:
   a. Calcium Silicate: 4 inches (100 mm) thick.
   b. High-Temperature Mineral-Fiber Blanket: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
   c. High-Temperature Mineral-Fiber Board: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.

R. Equipment Insulation Schedule
1. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
2. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.
3. Heat-exchanger (water-to-water for domestic water heating service) insulation shall be one of the following:
   a. Calcium Silicate: 3 inches (75 mm) thick.
   b. Cellular Glass: 3 inches (75 mm) thick.
   c. Mineral-Fiber Board: 2 inches (50 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   d. Mineral-Fiber Pipe and Tank: 2 inches (50 mm) thick.
4. Steam-to-hot-water converter insulation shall be one of the following:
   a. Calcium Silicate: 3 inches (75 mm) thick.

b. Cellular Glass: 3 inches (75 mm) thick.
c. Mineral-Fiber Board: 2 inches (50 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
d. Mineral-Fiber Pipe and Tank: 2 inches (50 mm) thick.

5. Domestic water pump insulation shall be one of the following:
   a. Cellular Glass: 2 inches (50 mm) thick.
   b. Mineral-Fiber Board: 1 inch (25 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   c. Phenolic: 1 inch (25 mm) thick.
   d. Polyisocyanurate: 1 inch (25 mm) thick.
6. Domestic chilled-water (potable) pump insulation shall be one of the following:
   a. Cellular Glass: 3 inches (75 mm) thick.
   b. Mineral-Fiber Board: 2 inches (50 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   c. Phenolic: 1 inch (25 mm) thick.
   d. Polyisocyanurate: 1-1/2 inches (38 mm) thick.
7. Domestic hot-water pump insulation shall be one of the following:
   a. Cellular Glass: 2 inches (50 mm) thick.
   b. Mineral-Fiber Board: 1 inch (25 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   c. Phenolic: 1 inch (25 mm) thick.
   d. Polyisocyanurate: 1 inch (25 mm) thick.
8. Domestic water, domestic chilled-water (potable), and domestic hot-water hydropneumatic tank insulation shall be one of the following:
   a. Cellular Glass: 1-1/2 inches (38 mm) thick.
   b. Flexible Elastomeric: 1 inch (25 mm) thick.
   c. Mineral-Fiber Board: 1 inch (25 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   d. Mineral-Fiber Pipe and Tank: 1 inch (25 mm) thick.
   e. Phenolic: 1 inch (25 mm) thick.
   f. Polyisocyanurate: 1 inch (25 mm) thick.
   g. Polyolefin: 1 inch (25 mm) thick.
9. Domestic hot-water storage tank insulation shall be one of the following, of thickness to provide an R-value of 12.5:
   a. Cellular glass.
   b. Mineral-Fiber Board: 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
   c. Mineral-fiber pipe and tank.
   d. Phenolic.
10. Domestic water storage tank insulation shall be one of the following:
    a. Cellular Glass: 2 inches (50 mm) thick.
    b. Flexible Elastomeric: 1 inch (25 mm) thick.
    c. Mineral-Fiber Board: 1 inch (25 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
    d. Mineral-Fiber Pipe and Tank: 1 inch (25 mm) thick.
    e. Phenolic: 1 inch (25 mm) thick.
    f. Polyisocyanurate: 1 inch (25 mm) thick.
    g. Polyolefin: 1 inch (25 mm) thick.
11. Domestic chilled-water (potable) storage tank insulation shall be one of the following:
    a. Cellular Glass: 2 inches (50 mm) thick.
    b. Flexible Elastomeric: 1 inch (25 mm) thick.
    c. Mineral-Fiber Board: 1 inch (25 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
    d. Mineral-Fiber Pipe and Tank: 1 inch (25 mm) thick.
    e. Phenolic: 1 inch (25 mm) thick.

f. Polyisocyanurate: 1 inch (25 mm) thick.
g. Polyolefin: 1 inch (25 mm) thick.

12. Piping system filter-housing insulation shall be one of the following:
    a. Cellular Glass: 3 inches (75 mm) thick.
    b. Mineral-Fiber Board: 2 inches (50 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) **OR** 3-lb/cu. ft. (48-kg/cu. m) **OR** 6-lb/cu. ft. (96-kg/cu. m), **as directed**, nominal density.
    c. Mineral-Fiber Pipe and Tank: 2 inches (50 mm) thick.

S. Piping Insulation Schedule, General
1. 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.
2. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
    a. Drainage piping located in crawl spaces.
    b. Underground piping.
    c. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

T. Indoor Piping Insulation Schedule
1. Domestic Cold Water:
    a. NPS 1 (DN 25) and Smaller: Insulation shall be one of the following:
        1) Cellular Glass: 1-1/2 inches (38 mm) thick.
        2) Flexible Elastomeric: 1/2 inch (13 mm) **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick.
        3) Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) **OR** 1 inch (25 mm), **as directed**, thick.
        4) Phenolic: 1 inch (25 mm) thick.
        5) Polyisocyanurate: 1 inch (25 mm) thick.
        6) Polyolefin: 1/2 inch (13 mm) **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick.
    b. NPS 1-1/4 (DN 32) and Larger: Insulation shall be one of the following:
        1) Cellular Glass: 1-1/2 inches (38 mm) thick.
        2) Flexible Elastomeric: 1 inch (25 mm) thick.
        3) Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
        4) Phenolic: 1 inch (25 mm) thick.
        5) Polyisocyanurate: 1 inch (25 mm) thick.
        6) Polyolefin: 1 inch (25 mm) thick.
2. Domestic Hot and Recirculated Hot Water:
    a. NPS 1-1/4 (DN 32) and Smaller: Insulation shall be one of the following:
        1) Cellular Glass: 1-1/2 inches (38 mm) thick.
        2) Flexible Elastomeric: 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick.
        3) Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) **OR** 1 inch (25 mm), **as directed**, thick.
        4) Phenolic: 1 inch (25 mm) thick.
        5) Polyisocyanurate: 1 inch (25 mm) thick.
        6) Polyolefin: 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick.
    b. NPS 1-1/2 (DN 40) and Larger: Insulation shall be one of the following:
        1) Cellular Glass: 1-1/2 inches (38 mm) thick.
        2) Flexible Elastomeric: 1 inch (25 mm) thick.
        3) Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
        4) Phenolic: 1 inch (25 mm) thick.
        5) Polyisocyanurate: 1 inch (25 mm) thick.
        6) Polyolefin: 1 inch (25 mm) thick.
3. Domestic Chilled Water (Potable):
    a. All Pipe Sizes: Insulation shall be one of the following:
        1) Cellular Glass: 1-1/2 inches (38 mm) thick.
        2) Flexible Elastomeric: 1 inch (25 mm) thick.

3) Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
4) Phenolic: 1 inch (25 mm) thick.
5) Polyisocyanurate: 1 inch (25 mm) thick.
6) Polyolefin: 1 inch (25 mm) thick.

4. Stormwater and Overflow:
   a. All Pipe Sizes: Insulation shall be one of the following:
      1) Cellular Glass: 1-1/2 inches (38 mm) thick.
      2) Flexible Elastomeric: 1 inch (25 mm) thick.
      3) Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
      4) Phenolic: 1 inch (25 mm) thick.
      5) Polyisocyanurate: 1 inch (25 mm) thick.
      6) Polyolefin: 1 inch (25 mm) thick.
5. Roof Drain and Overflow Drain Bodies:
   a. All Pipe Sizes: Insulation shall be one of the following:
      1) Cellular Glass: 1-1/2 inches (38 mm) thick.
      2) Flexible Elastomeric: 1 inch (25 mm) thick.
      3) Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
      4) Phenolic: 1 inch (25 mm) thick.
      5) Polyisocyanurate: 1 inch (25 mm) thick.
      6) Polyolefin: 1 inch (25 mm) thick.
6. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
   a. All Pipe Sizes: Insulation shall be one of the following:
      1) Flexible Elastomeric: 1/2 inch (13 mm) **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick.
      2) Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) **OR** 1 inch (25 mm) thick.
      3) Polyolefin: 1/2 inch (13 mm) **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm) thick.
7. Sanitary Waste Piping Where Heat Tracing Is Installed:
   a. All Pipe Sizes: Insulation shall be one of the following:
      1) Cellular Glass: 2 inches (50 mm) thick.
      2) Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inches (38 mm) thick.
      3) Phenolic: 1-1/2 inches (38 mm) thick.
      4) Polyisocyanurate: 1-1/2 inches (38 mm) thick.
8. Condensate and Equipment Drain Water below 60 Deg F (16 Deg C):
   a. All Pipe Sizes: Insulation shall be one of the following:
      1) Cellular Glass: 1-1/2 inches (38 mm) thick.
      2) Flexible Elastomeric: 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick.
      3) Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) **OR** 1 inch (25 mm), **as directed**, thick.
      4) Phenolic: 1 inch (25 mm) thick.
      5) Polyisocyanurate: 1 inch (25 mm) thick.
      6) Polyolefin: 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick.
9. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet (3 m) of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F (16 Deg C):
   a. All Pipe Sizes: Insulation shall be one of the following:
      1) Cellular Glass: 1-1/2 inches (38 mm) thick.
      2) Flexible Elastomeric: 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick.
      3) Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) **OR** 1 inch (25 mm), **as directed**, thick.
      4) Phenolic: 1 inch (25 mm) thick.
      5) Polyisocyanurate: 1 inch (25 mm) thick.
      6) Polyolefin: 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick.
10. Hot Service Drains:
   a. All Pipe Sizes: Insulation shall be one of the following:

1) Calcium Silicate: 1-1/2 inches (38 mm) thick.
2) Cellular Glass: 1-1/2 inches (38 mm) thick.
3) Mineral-Fiber, Preformed Pipe, Type I or II: 1 inch (25 mm) thick.

11. Hot Service Vents:
    a. All Pipe Sizes: Insulation shall be one of the following:
        1) Calcium Silicate: 1-1/2 inches (38 mm) thick.
        2) Cellular Glass: 1-1/2 inches (38 mm) thick.
        3) Mineral-Fiber, Preformed Pipe, Type I or II: 1 inch (25 mm) thick.

U. Outdoor, Aboveground Piping Insulation Schedule
1. Domestic Water Piping:
    a. All Pipe Sizes: Insulation shall be one of the following:
        1) Cellular Glass: 2 inches (50 mm) thick.
        2) Flexible Elastomeric: 2 inches (50 mm) thick.
        3) Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches (50 mm) thick.
        4) Phenolic: 2 inches (50 mm) thick.
        5) Polyisocyanurate: 2 inches (50 mm) thick.
        6) Polyolefin: 2 inches (50 mm) thick.
        7) Polystyrene: 2 inches (50 mm) thick.
2. Domestic Hot and Recirculated Hot Water:
    a. All Pipe Sizes: Insulation shall be one of the following:
        1) Cellular Glass: 2 inches (50 mm) thick.
        2) Flexible Elastomeric: 2 inches (50 mm) thick.
        3) Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches (50 mm) thick.
        4) Phenolic: 2 inches (50 mm) thick.
        5) Polyisocyanurate: 2 inches (50 mm) thick.
        6) Polyolefin: 2 inches (50 mm) thick.
3. Sanitary Waste Piping Where Heat Tracing Is Installed:
    a. All Pipe Sizes: Insulation shall be one of the following:
        1) Cellular Glass: 2 inches (50 mm) thick.
        2) Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches (50 mm) thick.
        3) Phenolic: 2 inches (50 mm) thick.
        4) Polyisocyanurate: 2 inches (50 mm) thick.
4. Hot Service Drains:
    a. All Pipe Sizes: Insulation shall be one of the following:
        1) Calcium Silicate: 1-1/2 inches (38 mm) thick.
        2) Cellular Glass: 1-1/2 inches (38 mm) thick.
        3) Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
5. Hot Service Vents:
    a. All Pipe Sizes: Insulation shall be one of the following:
        1) Calcium Silicate: 1-1/2 inches (38 mm) thick.
        2) Cellular Glass: 1-1/2 inches (38 mm) thick.
        3) Mineral-Fiber, Preformed Pipe Insulation, Type II: 1 inch (25 mm) thick.

V. Outdoor, Underground Piping Insulation Schedule
1. Loose-fill insulation, for belowground piping, is specified in Division 28.
2. Sanitary Waste Piping, All Sizes, Where Heat Tracing Is Installed: Cellular glass, 2 inches (50 mm) thick.
3. Chilled Water, All Sizes: Cellular glass, 2 inches (50 mm) thick.

W. Indoor, Field-Applied Jacket Schedule
1. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
2. If more than one material is listed, selection from materials listed is Contractor's option.
3. Equipment, Concealed:
    a. None.

b. PVC **OR** PVC, Color-Coded by System, **as directed**: 20 mils (0.5 mm) **OR** 30 mils (0.8 mm), **as directed**, thick.
c. Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
d. Painted Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm), **as directed**, thick.
e. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.

4. Equipment, Exposed, up to 48 Inches (1200 mm) in Diameter or with Flat Surfaces up to 72 Inches (1800 mm):
a. None.
b. PVC **OR** PVC, Color-Coded by System, **as directed**: 20 mils (0.5 mm) **OR** 30 mils (0.8 mm), **as directed**, thick.
c. Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
d. Painted Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm), **as directed**, thick.
e. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.

5. Equipment, Exposed, Larger Than 48 Inches (1200 mm) in Diameter or with Flat Surfaces Larger Than 72 Inches (1800 mm):
a. None.
b. Aluminum **OR** Painted Aluminum, **as directed**, Smooth **OR** Stucco Embossed, **as directed**, with 1-1/4-Inch- (32-mm-) Deep Corrugations **OR** 2-1/2-Inch- (65-mm-) Deep Corrugations **OR** 4-by-1-Inch (100-by-25-mm) Box Ribs, **as directed**: 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
c. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth **OR** Stucco Embossed, **as directed**, with 1-1/4-Inch- (32-mm-) Deep Corrugations **OR** 2-1/2-Inch- (65-mm-) Deep Corrugations **OR** 4-by-1-Inch (100-by-25-mm) Box Ribs, **as directed**: 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.

6. Piping, Concealed:
a. None.
b. PVC **OR** PVC, Color-Coded by System, **as directed**: 20 mils (0.5 mm) **OR** 30 mils (0.8 mm), **as directed**, thick.
c. Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
d. Painted Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm), **as directed**, thick.
e. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.

7. Piping, Exposed:
a. None.
b. PVC **OR** PVC, Color-Coded by System, **as directed**: 20 mils (0.5 mm) **OR** 30 mils (0.8 mm), **as directed**, thick.

c. Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
d. Aluminum **OR** Painted Aluminum, **as directed**, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm), **as directed**, thick.
e. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.

X. Outdoor, Field-Applied Jacket Schedule
1. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
2. If more than one material is listed, selection from materials listed is Contractor's option.
3. Equipment, Concealed:
a. None.
b. PVC **OR** PVC, Color-Coded by System, **as directed**: 20 mils (0.5 mm) **OR** 30 mils (0.8 mm), **as directed**, thick.
c. Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
d. Aluminum **OR** Painted Aluminum, **as directed**, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm), **as directed**, thick.
e. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, **as directed**, 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.
4. Equipment, Exposed, up to 48 Inches (1200 mm) in Diameter or with Flat Surfaces up to 72 Inches (1800 mm):
a. Aluminum **OR** Painted Aluminum, **as directed**, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**, with Z-Shaped Locking Seam, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
b. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, **as directed**, with Z-Shaped Locking Seam, **as directed**: 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.
5. Equipment, Exposed, Larger Than 48 Inches (1200 mm) in Diameter or with Flat Surfaces Larger Than 72 Inches (1800 mm):
a. Aluminum **OR** Painted Aluminum, **as directed**, Smooth **OR** Stucco Embossed, **as directed** with 1-1/4-Inch- (32-mm-) Deep Corrugations **OR** 2-1/2-Inch- (65-mm-) Deep Corrugations **OR** 4-by-1-Inch (100-by-25-mm) Box Ribs, **as directed**: 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.
b. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth **OR** Stucco Embossed, **as directed**, with 1-1/4-Inch- (32-mm-) Deep Corrugations **OR** 2-1/2-Inch- (65-mm-) Deep Corrugations **OR** 4-by-1-Inch (100-by-25-mm) Box Ribs, **as directed**: 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.
6. Piping, Concealed:
a. None.
b. PVC **OR** PVC, Color-Coded by System, **as directed**: 20 mils (0.5 mm) **OR** 30 mils (0.8 mm), **as directed**, thick.
c. Aluminum, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.

d. Aluminum **OR** Painted Aluminum, **as directed**, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm), **as directed**, thick.

e. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, **as directed**: 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.

7. Piping, Exposed:

a. PVC: 20 mils (0.5 mm) **OR** 30 mils (0.8 mm) **OR** 40 mils (1.0 mm), **as directed**, thick.

b. Aluminum **OR** Painted Aluminum, **as directed**, Smooth **OR** Corrugated **OR** Stucco Embossed, **as directed**, with Z-Shaped Locking Seam, **as directed**: 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm) **OR** 0.032 inch (0.81 mm) **OR** 0.040 inch (1.0 mm), **as directed**, thick.

c. Stainless Steel, Type 304 **OR** Type 316, **as directed**, Smooth 2B Finish **OR** Corrugated **OR** Stucco Embossed, ,**as directed,** with Z-Shaped Locking Seam, **as directed**: 0.010 inch (0.25 mm) **OR** 0.016 inch (0.41 mm) **OR** 0.020 inch (0.51 mm) **OR** 0.024 inch (0.61 mm), **as directed**, thick.

Y. Underground, Field-Installed Insulation Jacket

1. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 22 07 19 00a

SECTION 22 11 16 00 - DOMESTIC WATER PIPING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for domestic water piping. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
b. Encasement for piping.
c. Specialty valves.
d. Flexible connectors.
e. Water meters furnished by utility company for installation by Contractor.
OR
Water meters.
f. Escutcheons.
g. Sleeves and sleeve seals.
h. Wall penetration systems.

C. Performance Requirements
1. Seismic Performance: Domestic water piping and support and installation shall withstand effects of earthquake motions determined according to ASCE/SEI 7.

D. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:
a. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.
3. Field quality-control reports.

E. Quality Assurance
1. Piping materials shall bear label, stamp, or other markings of specified testing agency.
2. Comply with NSF 14 for plastic, potable domestic water piping and components. Include marking "NSF-pw" on piping, **as directed**.
3. Comply with NSF 61 for potable domestic water piping and components.

F. Project Conditions
1. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
a. Notify the Owner no fewer than two days in advance of proposed interruption of water service.
b. Do not proceed with interruption of water service without the Owner's written permission.

1.2 PRODUCTS

A. Piping Materials

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

B. Copper Tube And Fittings
1. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) water tube, drawn temper.
   a. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
   b. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
   c. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
   d. 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.
   e. Copper Pressure-Seal-Joint Fittings:
      1) NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
      2) NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.
   f. Copper Push-on-Joint Fittings:
      1) Description: Cast-copper fitting complying with ASME B16.18 or wrought-copper fitting complying with ASME B 16.22; with stainless-steel teeth and EPDM-rubber O-ring seal in each end instead of solder-joint ends.
   g. Copper-Tube Extruded-Tee Connections:
      1) Description: Tee formed in copper tube according to ASTM F 2014.
   h. Grooved-Joint Copper-Tube Appurtenances:
      1) Copper Grooved-End Fittings: ASTM B 75 (ASTM B 75M) copper tube or ASTM B 584 bronze castings.
      2) Grooved-End-Tube Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, EPDM-rubber gaskets suitable for hot and cold water, and bolts and nuts.
2. Soft Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) and ASTM B 88, Type L (ASTM B 88M, Type B) water tube, annealed temper.
   a. Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
   b. Copper Pressure-Seal-Joint Fittings:
      1) NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
      2) NPS 3 and NPS 4 (DN 80 and DN 100): Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.

C. Ductile-Iron Pipe And Fittings
1. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   a. Standard-Pattern, Mechanical-Joint Fittings: AWWA C110, ductile or gray iron.
   b. Compact-Pattern, Mechanical-Joint Fittings: AWWA C153, ductile iron.
      1) Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
2. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   a. Standard-Pattern, Push-on-Joint Fittings: AWWA C110, ductile or gray iron.
      1) Gaskets: AWWA C111, rubber.
   b. Compact-Pattern, Push-on-Joint Fittings: AWWA C153, ductile iron.
      1) Gaskets: AWWA C111, rubber.
3. Plain-End, Ductile-Iron Pipe: AWWA C151.
   a. Grooved-Joint, Ductile-Iron-Pipe Appurtenances:
      1) Grooved-End, Ductile-Iron Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.

2) Grooved-End, Ductile-Iron-Pipe Couplings: AWWA C606 for ductile-iron-pipe dimensions. Include ferrous housing sections, EPDM-rubber gaskets suitable for hot and cold water, and bolts and nuts.

D. Galvanized-Steel Pipe And Fittings
1. Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B, Standard Weight. Include ends matching joining method.
a. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Standard Weight, seamless steel pipe with threaded ends.
b. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
c. 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.
d. Flanges: ASME B16.1, Class 125, cast iron.
e. Grooved-Joint, Galvanized-Steel-Pipe Appurtenances:
1) Galvanized, Grooved-End Fittings for Galvanized-Steel Piping: ASTM A 47/A 47M, malleable-iron casting; ASTM A 106/A 106M, steel pipe; or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
2) Grooved-End-Pipe Couplings for Galvanized-Steel Piping: AWWA C606 for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gaskets suitable for hot and cold water, and bolts and nuts.

E. CPVC Piping
1. CPVC Pipe: ASTM F 441/F 441M, Schedule 40 and Schedule 80.
a. CPVC Socket Fittings: ASTM F 438 for Schedule 40 and ASTM F 439 for Schedule 80.
b. CPVC Threaded Fittings: ASTM F 437, Schedule 80.
2. CPVC Piping System: ASTM D 2846/D 2846M, SDR 11, pipe and socket fittings.
3. CPVC Tubing System: ASTM D 2846/D 2846M, SDR 11, tube and socket fittings.

F. PEX Tube And Fittings
1. PEX Distribution System: ASTM F 877, SDR 9 tubing.
a. Fittings for PEX Tube: ASTM F 1807, metal-insert type with copper or stainless-steel crimp rings and matching PEX tube dimensions.
b. Manifold: Multiple-outlet, plastic or corrosion-resistant-metal assembly complying with ASTM F 877; with plastic or corrosion-resistant-metal valve for each outlet.

G. PVC Pipe And Fittings
1. PVC Pipe: ASTM D 1785, Schedule 40 and Schedule 80.
a. PVC Socket Fittings: ASTM D 2466 for Schedule 40 and ASTM D 2467 for Schedule 80.
b. PVC Schedule 80 Threaded Fittings: ASTM D 2464.

H. Piping Joining Materials
1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; full-face or ring type unless otherwise indicated.
2. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
3. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
4. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
5. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.
a. Use CPVC solvent cement that has a VOC content of 490 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).
6. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

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).

7. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

I. Encasement For Piping
1. Standard: ASTM A 674 or AWWA C105.
2. Form: Sheet **OR** Tube, **as directed**.
3. Material: LLDPE film of 0.008-inch (0.20-mm) **OR** LLDPE film of 0.008-inch (0.20-mm) minimum thickness or high-density, cross-laminated PE film of 0.004-inch (0.10-mm) **OR** High-density, cross-laminated PE film of 0.004-inch (0.10-mm), **as directed**, minimum thickness.
4. Color: Black **OR** Natural, **as directed**.

J. Specialty Valves
1. Comply with requirements in Division 22 Section "General-duty Valves For Plumbing Piping" for general-duty metal valves.
2. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.
3. CPVC Union Ball Valves:
   a. Description:
      1) Standard: MSS SP-122.
      2) Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, at 73 deg F (23 deg C).
      3) Body Material: CPVC.
      4) Body Design: Union type.
      5) End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket **OR** threaded, **as directed**.
      6) End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable, socket **OR** threaded **OR** flanged, **as directed**.
      7) Ball: CPVC; full port.
      8) Seals: PTFE or EPDM-rubber O-rings.
      9) Handle: Tee shaped.
4. PVC Union Ball Valves:
   a. Description:
      1) Standard: MSS SP-122.
      2) Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, at 73 deg F (23 deg C).
      3) Body Material: PVC.
      4) Body Design: Union type.
      5) End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket **OR** threaded, **as directed**.
      6) End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable, socket **OR** threaded **OR** flanged, **as directed**.
      7) Ball: PVC; full port.
      8) Seals: PTFE or EPDM-rubber O-rings.
      9) Handle: Tee shaped.
5. CPVC Non-Union Ball Valves:
   a. Description:
      1) Standard: MSS SP-122.
      2) Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, at 73 deg F (23 deg C).
      3) Body Material: CPVC.
      4) Body Design: Non-union type.

5) End Connections: Socket or threaded.
6) Ball: CPVC; full or reduced port.
7) Seals: PTFE or EPDM-rubber O-rings.
8) Handle: Tee shaped.

6. PVC Non-Union Ball Valves:
   a. Description:
      1) Standard: MSS SP-122.
      2) Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, at 73 deg F (23 deg C).
      3) Body Material: PVC.
      4) Body Design: Non-union type.
      5) End Connections: Socket or threaded.
      6) Ball: PVC; full or reduced port.
      7) Seals: PTFE or EPDM-rubber O-rings.
      8) Handle: Tee shaped.
7. CPVC Butterfly Valves:
   a. Description:
      1) Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, at 73 deg F (23 deg C).
      2) Body Material: CPVC.
      3) Body Design: Lug or wafer type.
      4) Seat: EPDM rubber.
      5) Seals: PTFE or EPDM-rubber O-rings.
      6) Disc: CPVC.
      7) Stem: Stainless steel.
      8) Handle: Lever.
8. PVC Butterfly Valves:
   a. Description:
      1) Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, at 73 deg F (23 deg C).
      2) Body Material: PVC.
      3) Body Design: Lug or wafer type.
      4) Seat: EPDM rubber.
      5) Seals: PTFE or EPDM-rubber O-rings.
      6) Disc: PVC.
      7) Stem: Stainless steel.
      8) Handle: Lever.
9. CPVC Ball Check Valves:
   a. Description:
      1) Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, at 73 deg F (23 deg C).
      2) Body Material: CPVC.
      3) Body Design: Union-type ball check.
      4) End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket **OR** threaded, **as directed**.
      5) End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable, socket **OR** threaded **OR** flanged, **as directed**.
      6) Ball: CPVC.
      7) Seals: EPDM- or FKM-rubber O-rings.
10. PVC Ball Check Valves:
   a. Description:
      1) Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, at 73 deg F (23 deg C).
      2) Body Material: PVC.
      3) Body Design: Union-type ball check.

4) End Connections for Valves NPS 2 (DN 50) and Smaller: Detachable, socket **OR** threaded, **as directed**.
5) End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Detachable, socket **OR** threaded **OR** flanged, **as directed**.
6) Ball: PVC.
7) Seals: EPDM- or FKM-rubber O-rings.

11. CPVC Gate Valves:
    a. Description:
        1) Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, at 73 deg F (23 deg C).
        2) Body Material: CPVC.
        3) Body Design: Nonrising stem.
        4) End Connections for Valves NPS 2 (DN 50) and Smaller: Socket **OR** Threaded, **as directed**.
        5) End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Socket **OR** Threaded **OR** Flanged, **as directed**.
        6) Gate and Stem: Plastic.
        7) Seals: EPDM rubber.
        8) Handle: Wheel.
12. PVC Gate Valves:
    a. Description:
        1) Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, at 73 deg F (23 deg C).
        2) Body Material: PVC.
        3) Body Design: Nonrising stem.
        4) End Connections for Valves NPS 2 (DN 50) and Smaller: Socket **OR** Threaded, **as directed**.
        5) End Connections for Valves NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Socket **OR** Threaded **OR** Flanged, **as directed**.
        6) Gate and Stem: Plastic.
        7) Seals: EPDM rubber.
        8) Handle: Wheel.

K. Transition Fittings
1. General Requirements:
    a. Same size as pipes to be joined.
    b. Pressure rating at least equal to pipes to be joined.
    c. End connections compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Sleeve-Type Transition Coupling: AWWA C219.
4. Plastic-to-Metal Transition Fittings:
    a. Description: CPVC **OR** PVC, **as directed**, one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert and one solvent-cement-socket threaded, **as directed**, end.
5. Plastic-to-Metal Transition Unions:
    a. Description: CPVC **OR** PVC, **as directed**, four-part union. Include brass or stainless-steel, **as directed**, threaded end, solvent-cement-joint or threaded, **as directed**, plastic end, rubber O-ring, and union nut.

L. Dielectric Fittings
1. 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.
2. Dielectric Unions:

a. Description:
1) Pressure Rating: 150 psig (1035 kPa) **OR** 250 psig (1725 kPa), **as directed**, at 180 deg F (82 deg C).
2) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:
a. Description:
1) Factory-fabricated, bolted, companion-flange assembly.
2) Pressure Rating: 150 psig (1035 kPa) **OR** 175 psig (1200 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
3) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

4. Dielectric-Flange Kits:
a. Description:
1) Nonconducting materials for field assembly of companion flanges.
2) Pressure Rating: 150 psig (1035 kPa).
3) Gasket: Neoprene or phenolic.
4) Bolt Sleeves: Phenolic or polyethylene.
5) Washers: Phenolic with steel backing washers.

5. Dielectric Couplings:
a. Description:
1) Galvanized-steel coupling.
2) Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
3) End Connections: Female threaded.
4) Lining: Inert and noncorrosive, thermoplastic.

6. Dielectric Nipples:
a. Description:
1) Electroplated steel nipple complying with ASTM F 1545.
2) Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
3) End Connections: Male threaded or grooved.
4) Lining: Inert and noncorrosive, propylene.

M. Flexible Connectors
1. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
a. Working-Pressure Rating: Minimum 200 psig (1380 kPa) **OR** 250 psig (1725 kPa), **as directed**.
b. End Connections NPS 2 (DN 50) and Smaller: Threaded copper pipe or plain-end copper tube.
c. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged copper alloy.

2. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
a. Working-Pressure Rating: Minimum 200 psig (1380 kPa) **OR** 250 psig (1725 kPa), **as directed**.
b. End Connections NPS 2 (DN 50) and Smaller: Threaded steel-pipe nipple.
c. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged steel nipple.

N. Water Meters
1. Displacement-Type Water Meters:
a. Description:
1) Standard: AWWA C700.
2) Pressure Rating: 150-psig (1035-kPa) working pressure.
3) Body Design: Nutating disc; totalization meter.
4) Registration: In gallons (liters) or cubic feet (cubic meters) as required by utility.
5) Case: Bronze.
6) End Connections: Threaded.

2. Turbine-Type Water Meters:

a. Description:
   1) Standard: AWWA C701.
   2) Pressure Rating: 150-psig (1035-kPa) working pressure.
   3) Body Design: Turbine; totalization meter.
   4) Registration: In gallons (liters) or cubic feet (cubic meters) as required by utility company.
   5) Case: Bronze.
   6) End Connections for Meters NPS 2 (DN 50) and Smaller: Threaded.
   7) End Connections for Meters NPS 2-1/2 (DN 65) and Larger: Flanged.

3. Compound-Type Water Meters:
   a. Description:
      1) Standard: AWWA C702.
      2) Pressure Rating: 150-psig (1035-kPa) working pressure.
      3) Body Design: With integral mainline and bypass meters; totalization meter.
      4) Registration: In gallons (liters) or cubic feet (cubic meters) as required by utility company.
      5) Case: Bronze.
      6) Pipe Connections: Flanged.
4. Fire-Service-Type Water Meters:
   a. Description:
      1) Standard: AWWA C703 and UL listing.
      2) Pressure Rating: 175-psig (1200-kPa) working pressure.
      3) Body Design:
         a) Proportional, Detector-Type Water Meters: With meter on bypass.
            i. Bypass Meter: AWWA C701, turbine **OR** AWWA C702, compound, **as directed**, type with bronze case; size not less than one-half nominal size of main-line meter.
         b) Turbine-Type Water Meters: With strainer, and with meter on bypass.
            i. Strainer: Full size, matching water meter.
            ii. Bypass Meter: AWWA C701, turbine type with bronze case; not less than NPS 2 (DN 50).
      4) Registration: In gallons (liters) or cubic feet (cubic meters) as required by utility company.
      5) Case: Bronze.
      6) Pipe Connections for Meters NPS 2 (DN 50) and Smaller: Threaded.
      7) Pipe Connections for Meters NPS 2-1/2 (DN 65) and Larger: Flanged.
5. Remote Registration System: Direct-reading type complying with AWWA C706; modified with signal transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

   OR

   Remote Registration System: Encoder type complying with AWWA C707; modified with signal transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

O. Escutcheons
   1. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.
   2. One Piece, Cast Brass: Polished, chrome-plated **OR** rough-brass, **as directed**, finish with setscrews.
   3. One Piece, Deep Pattern: Deep-drawn, box-shaped brass with chrome-plated finish.
   4. One Piece, Stamped Steel: Chrome-plated finish with setscrew **OR** spring clips, **as directed**.
   5. Split Casting, Cast Brass: Polished, chrome-plated **OR** rough-brass, **as directed**, finish with concealed hinge and setscrew.
   6. Split Plate, Stamped Steel: Chrome-plated finish with concealed **OR** exposed-rivet, **as directed**, hinge, setscrew **OR** spring clips, **as directed**.
   7. One-Piece Floor Plates: Cast-iron flange with holes for fasteners, **as directed**.

8. Split-Casting Floor Plates: Cast brass with concealed hinge.

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

Q. Sleeve Seals
1. Description: Modular sealing element unit, designed for field assembly, used to fill annular space between pipe and sleeve.
   a. Sealing Elements: EPDM-rubber **OR** NBR, **as directed**, interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   b. Pressure Plates: Carbon steel **OR** Plastic **OR** Stainless steel, **as directed**.
   c. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, **OR** Stainless steel, **as directed**, of length required to secure pressure plates to sealing elements.

R. Wall Penetration Systems
1. Description: Wall-sleeve assembly, consisting of housing and gland, gaskets, and pipe sleeve.
   a. Carrier-Pipe Deflection: Up to 5 percent without leakage.
   b. Housing: Ductile-iron casting with hub, waterstop, anchor ring, and locking devices. Include gland, bolts, and nuts.
   c. Housing-to-Sleeve Gasket: EPDM rubber **OR** NBR, **as directed**.
   d. Housing-to-Carrier-Pipe Gasket: AWWA C111, EPDM rubber **OR** NBR, **as directed**.
   e. Pipe Sleeve: AWWA C151, ductile-iron pipe **OR** ASTM A 53/A 53M, Schedule 40, zinc-coated steel pipe, **as directed**.

S. Grout
1. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
2. Characteristics: Nonshrink; recommended for interior and exterior applications.
3. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

1.3 EXECUTION

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

B. Piping Installation
1. 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.
2. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

3. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
4. Install underground copper tube and ductile-iron pipe in PE encasement according to ASTM A 674 or AWWA C105.
5. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 22 Section "Meters And Gages For Plumbing Piping" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.
6. Install shutoff valve immediately upstream of each dielectric fitting.
7. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for pressure-reducing valves.
8. Install domestic water piping level with 0.25 percent slope downward toward drain **OR** without pitch, **as directed**, and plumb.
9. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
10. Install seismic restraints on piping. Comply with requirements in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment" for seismic-restraint devices.
11. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
12. 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.
13. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
14. Install piping adjacent to equipment and specialties to allow service and maintenance.
15. Install piping to permit valve servicing.
16. 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.
17. Install piping free of sags and bends.
18. Install fittings for changes in direction and branch connections.
19. Install PEX piping with loop at each change of direction of more than 90 degrees.
20. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
21. Install pressure gages on suction and discharge piping from each plumbing pump and packaged booster pump. Comply with requirements in Division 22 Section "Meters And Gages For Plumbing Piping" for pressure gages.
22. Install thermostats in hot-water circulation piping. Comply with requirements in Division 22 Section "Domestic Water Pumps" for thermostats.
23. Install thermometers on inlet **OR** inlet and outlet, **as directed**, piping from each water heater. Comply with requirements in Division 22 Section "Meters And Gages For Plumbing Piping" for thermometers.

C. Joint Construction
1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
3. 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:
   a. Apply appropriate tape or thread compound to external pipe threads.
   b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
4. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

5. 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."
6. Pressure-Sealed Joints: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.
7. Copper-Tubing, Push-on Joints: Clean end of tube. Measure insertion depth with manufacturer's depth gage. Join copper tube and push-on-joint fittings by inserting tube to measured depth.
8. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
9. Copper-Tubing Grooved Joints: Roll groove end of tube. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for roll-grooved joints.
10. Ductile-Iron-Piping Grooved Joints: Cut groove end of pipe. Assemble coupling with housing, gasket, lubricant, and bolts. Join ductile-iron pipe and grooved-end fittings according to AWWA C606 for ductile-iron-pipe, cut-grooved joints.
11. Steel-Piping Grooved Joints: Cut **OR** Roll, **as directed**, groove end of pipe. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
12. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
13. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
    a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
    b. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
    c. PVC Piping: Join according to ASTM D 2855.
14. PEX Piping Joints: Join according to ASTM F 1807.
15. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

D. Valve Installation
1. General-Duty Valves: Comply with requirements in Division 22 Section "General-duty Valves For Plumbing Piping" for valve installations.
2. 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.
3. 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 22 Section "Domestic Water Piping Specialties".
    a. Hose-End Drain Valves: At low points in water mains, risers, and branches.
    b. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.
4. 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 22 Section "Domestic Water Piping Specialties" for balancing valves.
5. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for calibrated balancing valves.

E. Transition Fitting Installation
1. Install transition couplings at joints of dissimilar piping.
2. Transition Fittings in Underground Domestic Water Piping:

a. NPS 1-1/2 (DN 40) and Smaller: Fitting-type coupling.
b. NPS 2 (DN 50) and Larger: Sleeve-type coupling.

3. Transition Fittings in Aboveground Domestic Water Piping NPS 2 (DN 50) and Smaller: Plastic-to-metal transition fittings **OR** unions, **as directed**.

F. Dielectric Fitting Installation
1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric couplings **OR** nipples **OR** unions, **as directed**.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges **OR** flange kits **OR** nipples, **as directed**.
4. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

G. Flexible Connector Installation
1. Install flexible connectors in suction and discharge piping connections to each domestic water pump and in suction and discharge manifold connections to each domestic water booster pump, **as directed**.
2. Install bronze-hose flexible connectors in copper domestic water tubing.
3. Install stainless-steel-hose flexible connectors in steel domestic water piping.

H. Water Meter Installation
1. Rough-in domestic water piping for water meter installation, and install water meters, **as directed**, according to utility company's requirements.
2. Water meters will be furnished and installed by utility company.
OR
Install water meters according to AWWA M6 and utility company's requirements.
3. Install displacement-type water meters with shutoff valve on water-meter inlet. Install valve on water-meter outlet and valved bypass around meter unless prohibited by authorities having jurisdiction.
OR
Install turbine-type water meters with shutoff valve on water-meter inlet. Install valve on water-meter outlet and valved bypass around meter unless prohibited by authorities having jurisdiction.
OR
Install compound-type water meters with shutoff valves on water-meter inlet and outlet and on valved bypass around meter. Support meters, valves, and piping on brick or concrete piers.
OR
Install fire-service water meters with shutoff valves on water-meter inlet and outlet and on full-size valved bypass around meter. Support meter, valves, and piping on brick or concrete piers.
4. Install remote registration system according to standards of utility company and of authorities having jurisdiction.

I. Hanger And Support Installation
1. Comply with requirements in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment" for seismic-restraint devices.
2. Comply with requirements in Division 22 Section "Hangers And Supports For Plumbing Piping And Equipment" for pipe hanger and support products and installation.
   a. Vertical Piping: MSS Type 8 or 42, clamps.
   b. Individual, Straight, Horizontal Piping Runs:
      1) 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
      2) Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
      3) Longer Than 100 Feet (30 m) If Indicated: MSS Type 49, spring cushion rolls.
   c. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   d. Base of Vertical Piping: MSS Type 52, spring hangers.
3. Support vertical piping and tubing at base and at each floor.

4. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch (10 mm).
5. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 3/4 (DN 20) and Smaller: 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
   b. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
   c. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
   d. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
   e. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
   f. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.
   g. NPS 8 (DN 200): 10 feet (3 m) with 3/4-inch (19-mm) rod.
6. Install supports for vertical copper tubing every 10 feet (3 m).
7. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 1-1/4 (DN 32) and Smaller: 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
   b. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
   c. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
   d. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
   e. NPS 3 and NPS 3-1/2 (DN 80 and DN 90): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
   f. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.
   g. NPS 6 (DN 150): 12 feet (3.7 m) with 3/4-inch (19-mm) rod.
   h. NPS 8 to NPS 12 (DN 200 to DN 300): 12 feet (3.7 m) with 7/8-inch (22-mm) rod.
8. Install supports for vertical steel piping every 15 feet (4.5 m).
9. Install vinyl-coated hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 1 (DN 25) and Smaller: 36 inches (900 mm) with 3/8-inch (10-mm) rod.
   b. NPS 1-1/4 to NPS 2 (DN 32 to DN 50): 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
   c. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
   d. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
   e. NPS 6 (DN 150): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.
   f. NPS 8 (DN 200): 48 inches (1200 mm) with 7/8-inch (22-mm) rod.
10. Install supports for vertical CPVC piping every 60 inches (1500 mm) for NPS 1 (DN 25) and smaller, and every 72 inches (1800 mm) for NPS 1-1/4 (DN 32) and larger.
11. Install vinyl-coated hangers for PEX piping with the following maximum horizontal spacing and minimum rod diameters:
    a. NPS 1 (DN 25) and Smaller: 32 inches (815 mm) with 3/8-inch (10-mm) rod.
12. Install hangers for vertical PEX piping every 48 inches (1200 mm).
13. Install vinyl-coated hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
    a. NPS 2 (DN 50) and Smaller: 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
    b. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
    c. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
    d. NPS 6 (DN 150): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.
    e. NPS 8 (DN 200): 48 inches (1200 mm) with 7/8-inch (22-mm) rod.
14. Install supports for vertical PVC piping every 48 inches (1200 mm).
15. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

J. Connections
   1. Drawings indicate general arrangement of piping, fittings, and specialties.
   2. Install piping adjacent to equipment and machines to allow service and maintenance.

3. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
4. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
   a. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
   b. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
   c. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 Section(s) "Plumbing Fixtures" OR "Healthcare Plumbing Fixtures" OR "Emergency Plumbing Fixtures" OR "Security Plumbing Fixtures", **as directed**, for connection sizes.
   d. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 (DN 65) and larger.

K. Escutcheon Installation
1. Install escutcheons for penetrations of walls, ceilings, and floors.
2. Escutcheons for New Piping:
   a. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
   b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** stamped steel with set screw **OR** stamped steel with set screw or spring clips **OR** stamped steel with spring clips, **as directed**.
   c. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** One piece or split casting, cast brass with polished chrome-plated finish **OR** Split casting, cast brass with polished chrome-plated finish **OR** One piece, stamped steel with set screw **OR** One piece or split plate, stamped steel with set screw **OR** Split plate, stamped steel with set screw, **as directed**.
   d. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish **OR** cast brass with rough-brass finish **OR** stamped steel with set screw **OR** stamped steel with spring clips **OR** stamped steel with set screw or spring clips, **as directed**.
   e. Bare Piping in Equipment Rooms: One piece, cast brass **OR** stamped steel with set screw **OR** stamped steel with spring clips **OR** stamped steel with set screw or spring clips, **as directed**.
   f. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.
3. Escutcheons for Existing Piping:
   a. Chrome-Plated Piping: Split casting, cast brass with chrome-plated finish.
   b. Insulated Piping: Split plate, stamped steel with concealed **OR** exposed-rivet, **as directed**, hinge and spring clips.
   c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and spring clips, **as directed**.
   d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and set screw, **as directed**.
   e. Bare Piping in Unfinished Service Spaces: Split casting, cast brass with polished chrome-plated finish **OR** casting, cast brass with rough-brass finish **OR** plate, stamped steel with concealed hinge and set screw or spring clips **OR** plate, stamped steel with concealed or exposed-rivet hinge and set screw or spring clips **OR** plate, stamped steel with exposed-rivet hinge and set screw or spring clips, **as directed**.
   f. Bare Piping in Equipment Rooms: Split casting, cast brass **OR** plate, stamped steel with set screw or spring clips, **as directed**.
   g. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.

L. Sleeve Installation

1. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.
2. Sleeves are not required for core-drilled holes.
3. Permanent sleeves are not required for holes formed by removable PE sleeves.
4. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.
5. Install sleeves in new partitions, slabs, and walls as they are built.
6. 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 in Division 07 Section "Joint Sealants" for joint sealants.
7. 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 in Division 07 Section "Joint Sealants" for joint sealants.
8. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals **OR** wall penetration systems, **as directed**, specified in this Section.
9. Seal space outside of sleeves in concrete slabs and walls with grout.
10. 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.
11. Install sleeve materials according to the following applications:
    a. Sleeves for Piping Passing through Concrete Floor Slabs: Molded PE **OR** Molded PVC **OR** Steel pipe, **as directed**.
    b. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Steel pipe **OR** Stack sleeve fittings, **as directed**.
        1) Extend sleeves 2 inches (50 mm) above finished floor level.
        2) 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 in Division 07 Section "Sheet Metal Flashing And Trim" for flashing.
    c. Sleeves for Piping Passing through Gypsum-Board Partitions:
        1) PVC pipe **OR** Steel pipe, **as directed**, sleeves for pipes smaller than NPS 6 (DN 150).
        2) Galvanized-steel sheet sleeves for pipes NPS 6 (DN 150) and larger.
        3) Exception: Sleeves are not required for water supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.
    d. Sleeves for Piping Passing through Concrete Roof Slabs: Molded PE **OR** Molded PVC **OR** Steel pipe, **as directed**.
    e. Sleeves for Piping Passing through Exterior Concrete Walls:
        1) Steel pipe sleeves for pipes smaller than NPS 6 (DN 150).
        2) Cast-iron wall pipe sleeves for pipes NPS 6 (DN 150) and larger.
        3) 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.
        4) Do not use sleeves when wall penetration systems are used.
    f. Sleeves for Piping Passing through Interior Concrete Walls:
        1) PVC pipe **OR** Steel pipe, **as directed**, sleeves for pipes smaller than NPS 6 (DN 150).
        2) Galvanized-steel sheet sleeves for pipes NPS 6 (DN 150) and larger.
12. 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" for firestop materials and installations.

M. Sleeve Seal Installation
1. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.
2. 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.

N. Wall Penetration System Installation
1. Install wall penetration systems in new, exterior concrete walls.
2. Assemble wall penetration system components with sleeve pipe. Install so that end of sleeve pipe and face of housing are flush with wall. Adjust locking devices to secure sleeve pipe in housing.

O. Identification
1. Identify system components. Comply with requirements in Division 22 Section "Identification For Plumbing Piping And Equipment" for identification materials and installation.
2. Label pressure piping with system operating pressure.

P. Field Quality Control
1. Perform tests and inspections.
2. Piping Inspections:
   a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
   b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
      1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
      2) Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
   c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
   d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
3. Piping Tests:
   a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
   b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
   c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   d. Cap and subject piping to static water pressure of 50 psig (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.
   e. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
   f. Prepare reports for tests and for corrective action required.
4. Domestic water piping will be considered defective if it does not pass tests and inspections.
5. Prepare test and inspection reports.

Q. Adjusting
1. Perform the following adjustments before operation:
   a. Close drain valves, hydrants, and hose bibbs.
   b. Open shutoff valves to fully open position.
   c. Open throttling valves to proper setting.
   d. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

1) Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
2) Adjust calibrated balancing valves to flows indicated.

e. Remove plugs used during testing of piping and for temporary sealing of piping during installation.

f. Remove and clean strainer screens. Close drain valves and replace drain plugs.

g. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.

h. Check plumbing specialties and verify proper settings, adjustments, and operation.

R. Cleaning

1. Clean and disinfect potable and non-potable, **as directed**, domestic water piping as follows:
   a. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   b. 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:
      1) Flush piping system with clean, potable water until dirty water does not appear at outlets.
      2) Fill and isolate system according to either of the following:
         a) 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.
         b) 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.
      3) Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
      4) Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
2. Clean non-potable domestic water piping as follows:
   a. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   b. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
      1) Flush piping system with clean, potable water until dirty water does not appear at outlets.
      2) Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
3. Prepare and submit reports of purging and disinfecting activities.
4. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

S. Piping Schedule

1. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
2. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
3. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
4. Under-building-slab, domestic water, building service piping, NPS 3 (DN 80) and smaller, shall be one of the following:
   a. Soft copper tube, ASTM B 88, Type K (ASTM B 88M, Type A) **OR** ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**; wrought-copper solder-joint fittings; and brazed **OR** copper pressure-seal fittings; and pressure-sealed, **as directed**, joints.
   b. PVC, Schedule 40 pipe; PVC, Schedule 40 **OR** Schedule 80 pipe; PVC, Schedule 80, **as directed**, socket fittings; and solvent-cemented joints.
5. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 (DN 100 to DN 200) and larger, shall be one of the following:

a. Soft copper tube, ASTM B 88, Type K (ASTM B 88M, Type A) **OR** ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**; wrought-copper solder-joint fittings; and brazed joints.
b. Mechanical-joint, ductile-iron pipe; standard-pattern **OR** compact-pattern, **as directed**, mechanical-joint fittings; and mechanical joints.
c. Push-on-joint, ductile-iron pipe; standard-pattern **OR** compact-pattern, **as directed**, push-on-joint fittings; and gasketed joints.
d. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
e. PVC, Schedule 40 pipe; PVC, Schedule 40 **OR** Schedule 80 pipe; PVC, Schedule 80, **as directed**, socket fittings; and solvent-cemented joints.

6. Under-building slab, combined domestic water, building-service, and fire-service-main piping, NPS 6 to NPS 12 (DN 150 to DN 300), shall be one of the following:
   a. Mechanical-joint, ductile-iron pipe; standard-pattern **OR** compact-pattern, **as directed**, mechanical-joint fittings; and mechanical joints.
   b. Push-on-joint, ductile-iron pipe; standard-pattern **OR** compact-pattern, **as directed**, push-on-joint fittings; and gasketed joints.
   c. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
7. Under-building-slab, domestic water piping, NPS 2 (DN 50) and smaller, shall be one of the following:
   a. Hard **OR** Soft, **as directed**, copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); wrought-copper solder-joint fittings; and brazed **OR** copper pressure-seal-joint fittings; and pressure-sealed, **as directed**, joints.
   b. PVC, Schedule 40 pipe; PVC, Schedule 40 **OR** Schedule 80 pipe; PVC, Schedule 80, **as directed**, socket fittings; and solvent-cemented joints.
8. Aboveground domestic water piping, NPS 2 (DN 50) and smaller, shall be one of the following:
   a. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
   b. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**; cast-copper **OR** wrought-copper, **as directed**, solder-joint fittings; and brazed **OR** soldered, **as directed**, joints.
   c. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B, **as directed**; copper pressure-seal-joint fittings; and pressure-sealed joints.
   d. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B) **OR**, **as directed**; copper push-on-joint fittings; and push-on joints.
   e. CPVC, Schedule 40 pipe; CPVC, Schedule 40 **OR** Schedule 80 pipe; CPVC, Schedule 80, **as directed**, socket fittings; and solvent-cemented joints.
   f. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
   g. CPVC Tubing System: CPVC tube; CPVC socket fittings; and solvent-cemented joints. NPS 1-1/2 (DN 40) and NPS 2 (DN 50) CPVC pipe with CPVC socket fittings may be used instead of tubing.
   h. PEX Tube, NPS 1 (DN 25) and smaller; fittings for PEX tube; and crimped joints.
   i. PVC, Schedule 40 pipe; PVC, Schedule 40 **OR** Schedule 80 pipe; PVC, Schedule 80, **as directed**, socket fittings; and solvent-cemented joints.
9. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be one of the following:
   a. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**; cast-copper **OR** wrought-copper, **as directed**, solder-joint fittings; and brazed **OR** soldered, **as directed**, joints.
   b. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**; copper pressure-seal-joint fittings; and pressure-sealed joints.
   c. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B, **as directed**; grooved-joint copper-tube appurtenances; and grooved joints.

d. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
e. Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
f. CPVC, Schedule 40 pipe; CPVC, Schedule 40 **OR** Schedule 80 pipe; CPVC, Schedule 80, **as directed**, socket fittings; and solvent-cemented joints.
g. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
h. PVC, Schedule 40 pipe; PVC, Schedule 40 **OR** Schedule 80 pipe; PVC, Schedule 80, **as directed**, socket fittings; and solvent-cemented joints.

10. Aboveground domestic water piping, NPS 5 to NPS 8 (DN 125 to DN 200), shall be one of the following:
    a. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**; cast-copper **OR** wrought-copper, **as directed**, solder-joint fittings; and brazed **OR** soldered, **as directed**, joints.
    b. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**; grooved-joint copper-tube appurtenances; and grooved joints.
    c. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
    d. Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
    e. CPVC, Schedule 40 pipe; CPVC, Schedule 40 **OR** Schedule 80 pipe; CPVC, Schedule 80, **as directed**, socket fittings; and solvent-cemented joints.
    f. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
    g. PVC, Schedule 40 pipe; PVC, Schedule 40 **OR** Schedule 80 pipe; PVC, Schedule 80, **as directed**, socket fittings; and solvent-cemented joints.
11. Aboveground, combined domestic-water-service and fire-service-main piping, NPS 6 to NPS 12 (DN 150 to DN300), shall be one of the following:
    a. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
    b. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
    c. Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.

T. Valve Schedule
1. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
    a. 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.
    b. 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.
    c. Hot-Water Circulation Piping, Balancing Duty: Calibrated **OR** Memory-stop, **as directed**, balancing valves.
    d. Drain Duty: Hose-end drain valves.
2. Use check valves to maintain correct direction of domestic water flow to and from equipment.
3. Iron grooved-end valves may be used with grooved-end piping.
4. CPVC and PVC valves matching piping materials may be used.

END OF SECTION 22 11 16 00

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SECTION 22 11 16 00a - SANITARY WASTE AND VENT PIPING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for sanitary waste and vent piping. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following for soil, waste, and vent piping inside the building:
   a. Pipe, tube, and fittings.
   b. Special pipe fittings.
   c. Encasement for underground metal piping.

C. Performance Requirements
1. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
   a. Soil, Waste, and Vent Piping: 10-foot head of water (30 kPa).
   b. Sanitary Sewer, Force-Main Piping: 50 psig (345 kPa) **OR** 100 psig (690 kPa) **OR** 150 psig (1035 kPa), **as directed**.
2. Seismic Performance: Soil, waste, and vent piping and support and installation shall be capable of withstanding the effects of seismic events determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures."

D. Submittals
1. Product Data: For pipe, tube, fittings, and couplings.
2. LEED Submittal:
   a. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.
3. Shop Drawings:
   a. Design Calculations: Signed and sealed by a qualified professional engineer for selecting seismic restraints.
   b. Sovent Drainage System: Include plans, elevations, sections, and details.
4. Field quality-control inspection and test reports.

E. Quality Assurance
1. Piping materials shall bear label, stamp, or other markings of specified testing agency.

1.2 PRODUCTS

A. Piping Materials
1. Refer to Part 1.3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

B. Hub-And-Spigot, Cast-Iron Soil Pipe And Fittings
1. Pipe and Fittings: ASTM A 74, Service and Extra-Heavy class(es).
2. Gaskets: ASTM C 564, rubber.
3. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

C. Hubless Cast-Iron Soil Pipe And Fittings
1. Pipe and Fittings: ASTM A 888 or CISPI 301.

2. Sovent Stack Fittings: ASME B16.45 or ASSE 1043, hubless, cast-iron aerator and deaerator drainage fittings.
3. 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. Heavy-Duty, Shielded, Cast-Iron Couplings: ASTM A 48/A 48M, two-piece, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve.
4. Rigid, Unshielded Couplings: ASTM C 1461, sleeve-type, reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Steel Pipe And Fittings
1. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade A or B, Standard Weight or Schedule 40, galvanized. Include ends matching joining method.
2. Drainage Fittings: ASME B16.12, galvanized, **as directed**, threaded, cast-iron drainage pattern.
3. 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, **as directed**, standard pattern.
   d. Cast-Iron Flanges: ASME B16.1, Class 125.
   e. Cast-Iron, Flanged Fittings: ASME B16.1, Class 125, galvanized, **as directed**.
4. Grooved-Joint Systems:
   a. Grooved-End, Steel-Piping Fittings: ASTM A 47/A 47M, galvanized, **as directed**, malleable-iron casting; ASTM A 106, galvanized-steel pipe; or ASTM A 536, galvanized, **as directed**, ductile-iron casting; with dimensions matching steel pipe.
   b. Grooved-End, Steel-Piping Couplings: AWWA C606, for steel-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

E. Stainless-Steel Pipe And Fittings
1. Pipe and Fittings: ASME A112.3.1, drainage pattern with socket and spigot ends.
2. Gaskets: Lip seals shaped to fit socket groove, with plastic backup ring.
   a. Material: EPDM, unless NBR is indicated.

F. Ductile-Iron Pipe And Fittings
1. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end, unless grooved or flanged ends are indicated.
   a. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
   b. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
2. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end, unless grooved or flanged ends are indicated.
   a. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
   b. Gaskets: AWWA C111, rubber.
3. Grooved-Joint Systems:
   a. Grooved-End, Ductile-Iron Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.

b. Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

4. Flanges: ASME 16.1, Class 125, cast iron.

G. Copper Tube And Fittings

1. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
   a. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
2. Hard Copper Tube: ASTM B 88, Types L and M (ASTM B 88M, Types B and C), water tube, drawn temper.
   a. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
   b. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
   c. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
3. Soft Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B), water tube, annealed temper.
   a. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.

H. Special Pipe Fittings

1. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.
   a. Sleeve Materials:
      1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
      2) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
2. Shielded Nonpressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
3. Rigid, Unshielded, Nonpressure Pipe Couplings: ASTM C 1461, sleeve-type reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.
4. Pressure Pipe Couplings: AWWA C219 metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
   a. Center-Sleeve Material: Manufacturer's standard **OR** Carbon steel **OR** Stainless steel **OR** Ductile iron **OR** Malleable iron, **as directed**.
   b. Gasket Material: Natural or synthetic rubber.
   c. Metal Component Finish: Corrosion-resistant coating or material.
5. Flexible Ball Joints: Ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include gasketed ball-joint section and ductile-iron gland, rubber gasket, and steel bolts.
6. Expansion Joints: Two or three-piece, ductile-iron assembly consisting of telescoping sleeve(s) with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
7. Wall-Penetration Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

I. Encasement For Underground Metal Piping

1. Description: ASTM A 674 or AWWA C105, high-density, crosslaminated PE film of 0.004-inch (0.10-mm) **OR** LLDPE film of 0.008-inch (0.20-mm), **as directed**, minimum thickness.
2. Form: Sheet **OR** Tube, **as directed**.
3. Color: Black **OR** Natural, **as directed**.

1.3 EXECUTION

A. Excavation
1. Refer to Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

B. Piping Applications
1. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.
2. Aboveground, soil and waste piping NPS 4 (DN 100) and smaller shall be any of the following:
   a. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   b. Hubless cast-iron soil pipe and fittings and sovent stack fittings, **as directed**; standard, shielded, stainless-steel **OR** heavy-duty shielded, stainless-steel **OR** rigid, unshielded, **as directed**, couplings; and hubless-coupling joints.
   c. Steel pipe, drainage fittings, and threaded joints.
   d. Stainless-steel pipe and fittings, gaskets, and gasketed joints.
   e. Copper DWV tube, copper drainage fittings, and soldered joints.
   f. Dissimilar Pipe-Material Couplings: Flexible, **OR** Shielded, **OR** Rigid, unshielded, **as directed**, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
3. Aboveground, soil and waste piping NPS 5 (DN 125) and larger shall be any of the following:
   a. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   b. Hubless cast-iron soil pipe and fittings and sovent stack fittings, **as directed**; standard, **OR** heavy-duty, **as directed**, shielded, stainless-steel couplings; and hubless-coupling joints.
   c. Steel pipe, drainage fittings, and threaded joints.
   d. Solid-wall **OR** Cellular-core, **as directed**, PVC pipe, PVC socket fittings, and solvent-cemented joints.
   e. Dissimilar Pipe-Material Couplings: Flexible, **OR** Shielded, **as directed**, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
4. Aboveground, vent piping NPS 4 (DN 100) and smaller shall be any of the following:
   a. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   b. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel **OR** heavy-duty shielded, stainless-steel **OR** rigid, unshielded, **as directed**, couplings; and hubless-coupling joints.
   c. Steel pipe, drainage fittings, and threaded joints.
   d. Stainless-steel pipe and fittings gaskets, and gasketed joints.
   e. Copper DWV tube, copper drainage fittings, and soldered joints.
      1) Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2 (DN 65 and DN 90): Hard copper tube, Type M (Type C); copper pressure fittings; and soldered joints.
   f. Dissimilar Pipe-Material Couplings: Flexible, **OR** Shielded, **OR** Rigid, unshielded, **as directed**, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
5. Aboveground, vent piping NPS 5 (DN 125) and larger shall be any of the following:
   a. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   b. Hubless cast-iron soil pipe and fittings; standard, **OR** heavy-duty, **as directed**, shielded, stainless-steel couplings; and hubless-coupling joints.
   c. Steel pipe, drainage fittings, and threaded joints.
   d. Dissimilar Pipe-Material Couplings: Flexible, **OR** Shielded, **as directed**, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
6. Underground, soil, waste, and vent piping NPS 4 (DN 100) and smaller shall be any of the following:
   a. Extra-Heavy **OR** Service, **as directed**, class, cast-iron soil piping; gaskets; and gasketed **OR** calking materials; and calked, **as directed**, joints.
   b. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel **OR** heavy-duty shielded, stainless-steel **OR** heavy-duty shielded, cast-iron **OR** rigid, unshielded, **as directed**, couplings; and hubless-coupling joints.

c. Stainless-steel pipe and fittings, gaskets, and gasketed joints.
d. Dissimilar Pipe-Material Couplings: Flexible, **OR** Shielded, **OR** Rigid, unshielded, **as directed**, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

7. Underground, soil and waste piping NPS 5 (DN 125) and larger shall be any of the following:
   a. Extra-Heavy **OR** Service, **as directed**, class, cast-iron soil piping; gaskets; and gasketed **OR** calking materials; and calked, **as directed**, joints.
   b. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel **OR** heavy-duty shielded, stainless-steel **OR** heavy-duty shielded, cast-iron, **as directed**, couplings; and hubless-coupling joints.
   c. Dissimilar Pipe-Material Couplings: Flexible, **OR** Shielded, **as directed**, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
8. Aboveground sanitary-sewage force mains NPS 1-1/2 and NPS 2 (DN 40 and DN 50) shall be any of the following:
   a. Hard copper tube, Type L (Type B) **OR** Type M (Type C), **as directed**; copper pressure fittings; and soldered joints.
   b. Steel pipe, pressure fittings, and threaded joints.
9. Aboveground sanitary-sewage force mains NPS 2-1/2 to NPS 6 (DN 65 to DN 150) shall be any of the following:
   a. Hard copper tube, Type L (Type B) **OR** Type M (Type C), **as directed**; copper pressure fittings; and soldered joints.
   b. Steel pipe, pressure fittings, and threaded joints.
   c. Grooved-end steel pipe, grooved-joint system fittings and couplings, and grooved joints.
10. Underground sanitary-sewage force mains NPS 4 (DN 100) and smaller shall be any of the following:
    a. Hard **OR** Soft, **as directed**, copper tube, Type L (Type B); copper **OR** wrought-copper, **as directed**, pressure fittings; and soldered joints.
    b. Steel pipe, pressure fittings, and threaded joints.
       1) Include grooved-joint system fittings and couplings and grooved joints where indicated.
    c. Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile-iron fittings; glands, gaskets, and bolts; and mechanical joints.
       1) Include grooved-joint system fittings and couplings and grooved joints where indicated.
    d. Push-on-joint, ductile-iron pipe; push-on-joint ductile-iron fittings; gaskets; and gasketed joints.
       1) Include grooved-joint system fittings and couplings and grooved joints where indicated.
    e. Pressure pipe couplings, if dissimilar pipe materials or piping with small difference in OD must be joined.
11. Underground sanitary-sewage force mains NPS 5 (DN 125) and larger shall be any of the following:
    a. Steel pipe, pressure fittings, and threaded joints.
    b. Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile-iron fittings; glands, gaskets, and bolts; and mechanical-joint joints.
    c. Push-on-joint, ductile-iron pipe; push-on-joint, ductile-iron fittings; gaskets; and gasketed joints.
    d. Pressure pipe couplings, if dissimilar pipe materials or piping with small difference in OD must be joined.

C. Piping Installation
1. Sanitary sewer piping outside the building is specified in Division 2 Section "Sanitary Sewerage."
2. Basic piping installation requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."
3. Install seismic restraints on piping. Seismic-restraint devices are specified in Division 15 Section "Mechanical Vibration and Seismic Controls."

4. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
5. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.
6. Install underground, steel, force-main piping. Install encasement on piping according to ASTM A 674 or AWWA C105, **as directed**.
7. Install underground, ductile-iron, force-main piping according to AWWA C600. Install buried piping inside the building between wall and floor penetrations and connection to sanitary sewer piping outside the building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
   a. Install encasement on piping according to ASTM A 674 or AWWA C105.
8. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."
   a. Install encasement on piping according to ASTM A 674 or AWWA C105.
9. Install underground, ductile-iron, special pipe fittings according to AWWA C600.
   a. Install encasement on piping according to ASTM A 674 or AWWA C105.
10. 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 15 Section "Basic Mechanical Materials and Methods."

    OR

    Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.
11. 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."
    a. Install encasement on underground piping according to ASTM A 674 or AWWA C105.
12. 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.
13. 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.
14. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
    a. 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.
    b. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
    c. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
15. Install engineered soil and waste drainage and vent piping systems as follows:
    a. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
    b. Sovent Drainage System: Comply with ASSE 1043 and sovent fitting manufacturer's written installation instructions.
    c. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.
16. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
17. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

D. Joint Construction

1. Basic piping joint construction requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."
2. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
3. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
4. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
5. 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.
6. Grooved Joints: Assemble joint with keyed coupling, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

E. Valve Installation
1. General valve installation requirements are specified in Division 15 Section "Valves."
2. Shutoff Valves: Install shutoff valve on each sewage pump discharge.
   a. Install gate or full-port ball valve for piping NPS 2 (DN 50) and smaller.
   b. Install gate valve for piping NPS 2-1/2 (DN 65) and larger.
3. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.
4. Backwater Valves: Install backwater valves in piping subject to sewage backflow.
   a. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated.
   b. Floor Drains: Drain outlet backwater valves, unless drain has integral backwater valve.
   c. Install backwater valves in accessible locations.
   d. Backwater valve are specified in Division 15 Section "Plumbing Specialties."

F. Hanger And Support Installation
1. Seismic-restraint devices are specified in Division 15 Section "Mechanical Vibration Controls and Seismic Restraints."
2. Pipe hangers and supports are specified in Division 15 Section "Hangers and Supports." Install the following:
   a. Vertical Piping: MSS Type 8 or Type 42, clamps.
   b. Install individual, straight, horizontal piping runs according to the following:
      1) 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
      2) Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
      3) Longer Than 100 Feet (30 m), if Indicated: MSS Type 49, spring cushion rolls.
   c. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   d. Base of Vertical Piping: MSS Type 52, spring hangers.
3. Install supports according to Division 15 Section "Hangers and Supports."
4. Support vertical piping and tubing at base and at each floor.
5. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.
6. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
   b. NPS 3 (DN 80): 60 inches (1500 mm) with 1/2-inch (13-mm) rod.
   c. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1500 mm) with 5/8-inch (16-mm) rod.
   d. NPS 6 (DN 150): 60 inches (1500 mm) with 3/4-inch (19-mm) rod.
   e. NPS 8 to NPS 12 (DN 200 to DN 300): 60 inches (1500 mm) with 7/8-inch (22-mm) rod.
7. Install supports for vertical cast-iron soil piping every 15 feet (4.5 m).
8. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 1-1/4 (DN 32): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.

b. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
c. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
d. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
e. NPS 3 (DN 80): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
f. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.
g. NPS 6 (DN 150): 12 feet (3.7 m) with 3/4-inch (19-mm) rod.
h. NPS 8 to NPS 12 (DN 200 to DN 300): 12 feet (3.7 m) with 7/8-inch (22-mm) rod.

9. Install supports for vertical steel piping every 15 feet (4.5 m).
10. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:
    a. NPS 2 (DN 50): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
    b. NPS 3 (DN 80): 96 inches (2400 mm) with 1/2-inch (13-mm) rod.
    c. NPS 4 (DN 100): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
    d. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.
11. Install supports for vertical stainless-steel piping every 10 feet (3 m).
12. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
    a. NPS 1-1/4 (DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
    b. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
    c. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
    d. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
    e. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.
    f. NPS 8 (DN 200): 10 feet (3 m) with 3/4-inch (19-mm) rod.
13. Install supports for vertical copper tubing every 10 feet (3 m).
14. Install hangers for ABS and PVC piping with the following maximum horizontal spacing and minimum rod diameters:
    a. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
    b. NPS 3 (DN 80): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
    c. NPS 4 and 5 (DN 100 and 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
    d. NPS 6 (DN 150): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.
    e. NPS 8 to NPS 12 (DN 200 to DN 300): 48 inches (1200 mm) with 7/8-inch (22-mm) rod.
15. Install supports for vertical ABS and PVC piping every 48 inches (1200 mm).
16. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

G. Connections
1. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
3. Connect drainage and vent piping to the following:
    a. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
    b. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
    c. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
    d. 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.
4. Connect force-main piping to the following:
    a. Sanitary Sewer: To exterior force main or sanitary manhole.
    b. Sewage Pumps: To sewage pump discharge.

H. Field Quality Control
1. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   b. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
2. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
3. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
4. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   a. 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.
   b. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   c. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
   d. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg (250 Pa). Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
   e. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   f. Prepare reports for tests and required corrective action.
5. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   a. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   b. 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.
   c. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   d. Prepare reports for tests and required corrective action.

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

END OF SECTION 22 11 16 00a

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SECTION 22 11 16 00b - STORM DRAINAGE PIPING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for storm drainage piping. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following storm drainage piping inside the building:
a. Pipe, tube, and fittings.
b. Special pipe fittings.
c. Encasement for underground metal piping.

C. Performance Requirements
1. Components and installation shall be capable of withstanding the following minimum working-pressure, unless otherwise indicated:
a. Storm Drainage Piping: 10-foot head of water (30 kPa).
b. Storm Drainage, Force-Main Piping: 50 psig (345 kPa) **OR** 100 psig (690 kPa) **OR** 150 psig (1035 kPa), **as directed**.
2. Seismic Performance: Soil, waste, and vent piping and support and installation shall be capable of withstanding the effects of seismic events determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures."

D. Submittals
1. Product Data: For pipe, tube, fittings, and couplings.
2. LEED Submittal:
a. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.
3. Shop Drawings:
a. Design Calculations: Signed and sealed by a qualified professional engineer for selecting seismic restraints.
b. Controlled-Flow Storm Drainage System: Include calculations, plans, and details.
4. Field quality-control inspection and test reports.

E. Quality Assurance
1. Piping materials shall bear label, stamp, or other markings of specified testing agency.

1.2 PRODUCTS

A. Piping Materials
1. Refer to Part 1.3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

B. Hub-And-Spigot, Cast-Iron Soil Pipe And Fittings
1. Pipe and Fittings: ASTM A 74, Service and Extra-Heavy class(es).
2. Gaskets: ASTM C 564, rubber.
3. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

C. Hubless Cast-Iron Soil Pipe And Fittings
1. Pipe and Fittings: ASTM A 888 or CISPI 301.

2. 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. Heavy-Duty, Shielded, Cast-Iron Couplings: ASTM A 48/A 48M, two-piece, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve.
3. Rigid, Unshielded Couplings: ASTM C 1461, sleeve-type, reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Steel Pipe And Fittings
1. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade A or B, Standard Weight or Schedule 40, galvanized. Include ends matching joining method.
2. Drainage Fittings: ASME B16.12, galvanized, **as directed**, threaded, cast-iron drainage pattern.
3. 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, **as directed**, standard pattern.
   d. Cast-Iron Flanges: ASME B16.1, Class 125.
   e. Cast-Iron, Flanged Fittings: ASME B16.1, Class 125, galvanized, **as directed**.
4. Grooved-Joint Systems:
   a. Grooved-End, Steel-Piping Fittings: ASTM A 47/A 47M, galvanized, **as directed**, malleable-iron casting; ASTM A 106, galvanized-steel pipe; or ASTM A 536, galvanized, **as directed**, ductile-iron casting; with dimensions matching steel pipe.
   b. Grooved-End, Steel-Piping Couplings: AWWA C606, for steel-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

E. Ductile-Iron Pipe And Fittings
1. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end, unless grooved or flanged ends are indicated.
   a. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
   b. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
2. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end, unless grooved or flanged ends are indicated.
   a. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
   b. Gaskets: AWWA C111, rubber.
3. Grooved-Joint Systems:
   a. Grooved-End, Ductile-Iron Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.
   b. Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.
4. Flanges: ASME 16.1, Class 125, cast iron.

F. Copper Tube And Fittings
1. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.

a. Copper Drainage Fittings: ASME B16.23, cast-copper or ASME B16.29, wrought-copper, solder-joint fittings.

2. Hard Copper Tube: ASTM B 88, Types L and M (ASTM B 88M, Types B and C), water tube, drawn temper.
   a. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
   b. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
   c. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
3. Soft Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B), water tube, annealed temper.
   a. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.

G. Special Pipe Fittings
1. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.
   a. Sleeve Materials:
      1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
      2) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
2. Shielded Nonpressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
3. Rigid, Unshielded, Nonpressure Pipe Couplings: ASTM C 1461, sleeve-type reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.
4. Pressure Pipe Couplings: AWWA C219 metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
   a. Center-Sleeve Material: Manufacturer's standard **OR** Carbon steel **OR** Stainless steel **OR** Ductile iron **OR** Malleable iron, **as directed**.
   b. Gasket Material: Natural or synthetic rubber.
   c. Metal Component Finish: Corrosion-resistant coating or material.
5. Flexible Ball Joints: Ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include gasketed ball-joint section and ductile-iron gland, rubber gasket, and steel bolts.
6. Expansion Joints: Two or three-piece, ductile-iron assembly consisting of telescoping sleeve(s) with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
7. Wall-Penetration Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

H. Encasement For Underground Metal Piping
1. Description: ASTM A 674 or AWWA C105, high-density, crosslaminated PE film of 0.004-inch (0.10-mm) **OR** LLDPE film of 0.008-inch (0.20-mm), **as directed**, minimum thickness.
2. Form: Sheet **OR** Tube, **as directed**.
3. Color: Black **OR** Natural, **as directed**.

1.3 EXECUTION

A. Excavation
1. Refer to Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

B. Piping Applications
1. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.
2. Aboveground storm drainage piping NPS 6 (DN 150) and smaller shall be any of the following:
   a. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   b. Hubless cast-iron soil pipe and fittings; standard, **OR** heavy-duty, **as directed**, shielded, stainless-steel couplings; and coupled joints.
   c. Steel pipe, drainage fittings, and threaded joints.
   d. Copper DWV tube, copper drainage fittings, and soldered joints.
   e. Dissimilar Pipe-Material Couplings: Flexible, **OR** Shielded, **OR** Rigid, unshielded, **as directed**, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
3. Aboveground, storm drainage piping NPS 8 (DN 200) and larger shall be any of the following:
   a. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   b. Hubless cast-iron soil pipe and fittings; standard, **OR** heavy-duty, **as directed**, shielded, stainless-steel couplings; and coupled joints.
   c. Steel pipe, drainage fittings, and threaded joints.
   d. Dissimilar Pipe-Material Couplings: Flexible, **OR** Shielded, **as directed**, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
4. Underground storm drainage piping NPS 6 (DN 150) and smaller shall be any of the following:
   a. Extra-heavy **OR** Service, **as directed**, class, cast-iron soil pipe and fittings; gaskets; and gasketed **OR** calking materials; and calked, **as directed**, joints.
   b. Hubless cast-iron soil pipe and fittings; standard, **OR** heavy-duty, **as directed**, shielded, stainless-steel couplings; and coupled joints.
   c. Steel pipe, drainage fittings, and threaded joints.
   d. Dissimilar Pipe-Material Couplings: Flexible, **OR** Shielded, **OR** Rigid, unshielded, **as directed**, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
5. Underground, storm drainage piping NPS 8 (DN 200) and larger shall be any of the following:
   a. Extra-Heavy **OR** Service, **as directed**, class, cast-iron soil pipe and fittings; gaskets; and gasketed **OR** calking materials; and calked, **as directed**, joints.
   b. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel **OR** heavy-duty shielded, stainless-steel **OR** heavy-duty shielded, cast-iron, **as directed**, couplings; and coupled joints.
   c. Dissimilar Pipe-Material Couplings: Flexible, **OR** Shielded, **as directed**, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.
6. Aboveground storm drainage force mains NPS 1-1/2 and NPS 2 (DN 40 and DN 50) shall be any of the following:
   a. Hard copper tube, Type L (Type B) **OR** Type M (Type C), **as directed**,; copper pressure fittings; and soldered joints.
   b. Steel pipe, pressure fittings, and threaded joints.
7. Aboveground storm drainage force mains NPS 2-1/2 and NPS 6 (DN 65 and DN 150) shall be any of the following:
   a. Hard copper tube, Type L (Type B); copper pressure fittings; and soldered joints.
   b. Steel pipe, pressure fittings, and threaded joints.
   c. Grooved-end steel pipe, grooved-joint system fittings and couplings, and grooved joints.
8. Underground storm drainage force mains NPS 4 (DN 100) and smaller shall be any of the following:
   a. Hard **OR** Soft, **as directed**, copper tube, Type L (Type B); copper **OR** wrought-copper, **as directed**, pressure fittings; and soldered joints.
   b. Steel pipe, pressure fittings, and threaded joints.
      1) Include grooved-joint system fittings and couplings and grooved joints where indicated.
   c. Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile-iron fittings; glands, gaskets, and bolts; and mechanical joints.

1) Include grooved-joint system fittings and couplings and grooved joints where indicated.

d. Push-on-joint, ductile-iron pipe; push-on-joint, ductile-iron fittings; gaskets; and gasketed joints.

1) Include grooved-joint system fittings and couplings and grooved joints where indicated.

e. Pressure pipe couplings if dissimilar pipe materials or piping with small difference in OD must be joined.

9. Underground storm drainage force mains NPS 5 (DN 125) and larger shall be any of the following:

a. Steel pipe, pressure fittings, and threaded joints.

b. Mechanical-joint, ductile-iron pipe; mechanical-joint, ductile-iron fittings; glands, gaskets, and bolts; and mechanical-joint joints.

c. Push-on-joint, ductile-iron pipe; push-on-joint, ductile-iron fittings; gaskets; and gasketed joints.

d. Pressure pipe couplings if dissimilar pipe materials or piping with small difference in OD must be joined.

C. Piping Installation

1. Storm sewer and drainage piping outside the building are specified in Division 2 Section "Storm Drainage."
2. Basic piping installation requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."
3. Install seismic restraints on piping. Seismic-restraint devices are specified in Division 15 Section "Mechanical Vibration and Seismic Controls."
4. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers. Cleanouts are specified in Division 15 Section "Plumbing Specialties."
5. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.
6. Install underground, steel, force-main piping. Install encasement on piping according to ASTM A 674 or AWWA C105, **as directed**.
7. Install underground, ductile-iron, force-main piping according to AWWA C600. Install buried piping inside building between wall and floor penetrations and connection to storm sewer piping outside building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.

   a. Install encasement on piping according to ASTM A 674 or AWWA C105.
8. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."

   a. Install encasement on piping according to ASTM A 674 or AWWA C105.
9. Install underground, ductile-iron, special pipe fittings according to AWWA C600.

   a. Install encasement on piping according to ASTM A 674 or AWWA C105.
10. 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 15 Section "Basic Mechanical Materials and Methods."

    OR

    Install wall-penetration fitting system at each service pipe penetration through foundation wall. Make installation watertight.
11. 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."

    a. Install encasement on underground piping according to ASTM A 674 or AWWA C105.
12. 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.
13. 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.

14. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:
    a. 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.
    b. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.
15. Install force mains at elevations indicated.
16. Install engineered controlled-flow storm drainage piping in locations indicated.
17. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
18. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

D. Joint Construction
1. Basic piping joint construction requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."
2. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
3. Hub-and-Spigot, Cast-Iron Soil Piping Calked Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
4. Hubless Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
5. 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.
6. Grooved Joints: Cut groove ends of pipe and assemble grooved ends of pipes, grooved-end fittings, and grooved-end-piping couplings according to AWWA C606.

E. Valve Installation
1. General valve installation requirements are specified in Division 15 Section "Valves."
2. Shutoff Valves: Install shutoff valve on each sump pump discharge.
    a. Install gate or full-port ball valve for piping NPS 2 (DN 50) and smaller.
    b. Install gate valve for piping NPS 2-1/2 (DN 65) and larger.
3. Check Valves: Install swing check valve, between pump and shutoff valve, on each sump pump discharge.
4. Backwater Valves: Install backwater valves in piping subject to backflow.
    a. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated.
    b. Install backwater valves in accessible locations.
    c. Backwater valve are specified in Division 15 Section "Plumbing Specialties."

F. Hanger And Support Installation
1. Seismic-restraint devices are specified in Division 15 Section "Mechanical Vibration Controls and Seismic Restraints."
2. Pipe hangers and supports are specified in Division 15 Section "Hangers and Supports." Install the following:
    a. Vertical Piping: MSS Type 8 or Type 42, clamps.
    b. Individual, Straight, Horizontal Piping Runs: According to the following:
        1) 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
        2) Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
        3) Longer Than 100 Feet (30 m), if Indicated: MSS Type 49, spring cushion rolls.
    c. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
    d. Base of Vertical Piping: MSS Type 52, spring hangers.
3. Install supports according to Division 15 Section "Hangers and Supports."
4. Support vertical piping and tubing at base and at each floor.

5. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.
6. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
   b. NPS 3 (DN 80): 60 inches (1500 mm) with 1/2-inch (13-mm) rod.
   c. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1500 mm) with 5/8-inch (16-mm) rod.
   d. NPS 6 (DN 150): 60 inches (1500 mm) with 3/4-inch (19-mm) rod.
   e. NPS 8 to NPS 12 (DN 200 to DN 300): 60 inches (1500 mm) with 7/8-inch (22-mm) rod.
   f. 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).
7. Install supports for vertical cast-iron soil piping every 15 feet (4.5 m).
8. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 1-1/4 (DN 32): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
   b. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
   c. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
   d. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
   e. NPS 3 (DN 80): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
   f. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.
   g. NPS 6 (DN 150): 12 feet (3.7 m) with 3/4-inch (19-mm) rod.
   h. NPS 8 to NPS 12 (DN 200 to DN 300): 12 feet (3.7 m) with 7/8-inch (22-mm) rod.
9. Install supports for vertical steel piping every 15 feet (4.5 m).
10. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
    a. NPS 1-1/4 (DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
    b. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
    c. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
    d. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
    e. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.
    f. NPS 8 (DN 200): 10 feet (3 m) with 3/4-inch (19-mm) rod.
11. Install supports for vertical copper tubing every 10 feet (3 m).
12. Install hangers for ABS and PVC piping with the following maximum horizontal spacing and minimum rod diameters:
    a. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
    b. NPS 3 (DN 80): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
    c. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
    d. NPS 6 (DN 150): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.
    e. NPS 8 to NPS 12 (DN 200 to DN 300): 48 inches (1200 mm) with 7/8-inch (22-mm) rod.
13. Install supports for vertical ABS and PVC piping every 48 inches (1200 mm).
14. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

G. Connections
1. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
3. Connect storm drainage piping to roof drains and storm drainage specialties.
4. Connect force-main piping to the following:
   a. Storm Sewer: To exterior force main or storm manhole.
   b. Sump Pumps: To sump pump discharge.

H. Field Quality Control

1. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
   b. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
2. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
3. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
4. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   a. 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.
   b. 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.
   c. Test Procedure: Test storm drainage piping, except outside leaders, **as directed**, 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 to completion of inspection, water level must not drop. Inspect joints for leaks.
   d. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   e. Prepare reports for tests and required corrective action.
5. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   a. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   b. 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.
   c. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   d. Prepare reports for tests and required corrective action.

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

END OF SECTION 22 11 16 00b

SECTION 22 11 16 00c - HYDRONIC PIPING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for hydronic piping. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
a. Hot-water heating piping.
b. Chilled-water piping.
c. Dual-temperature heating and cooling water piping.
d. Condenser-water piping.
e. Glycol cooling-water piping.
f. Makeup-water piping.
g. Condensate-drain piping.
h. Blowdown-drain piping.
i. Air-vent piping.
j. Safety-valve-inlet and -outlet piping.

C. Definitions
1. PTFE: Polytetrafluoroethylene.
2. RTRF: Reinforced thermosetting resin (fiberglass) fittings.
3. RTRP: Reinforced thermosetting resin (fiberglass) pipe.

D. Performance Requirements
1. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:
a. Hot-Water Heating Piping: **psig (kPa),** as directed by the Owner at 200 deg F (93 deg C).
b. Chilled-Water Piping: **psig (kPa),** as directed by the Owner at 200 deg F (93 deg C).
c. Dual-Temperature Heating and Cooling Water Piping: **psig (kPa),** ethylene at 200 deg F (93 deg C).
d. Condenser-Water Piping: **psig (kPa),** as directed by the Owner at 150 deg F (66 deg C).
e. Glycol Cooling-Water Piping: **psig (kPa),** as directed by the Owner at 150 deg F (66 deg C).
f. Makeup-Water Piping: 80 psig (552 kPa) at 150 deg F (66 deg C).
g. Condensate-Drain Piping: 150 deg F (66 deg C).
h. Blowdown-Drain Piping: 200 deg F (93 deg C).
i. Air-Vent Piping: 200 deg F (93 deg C).
j. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

E. Submittals
1. Product Data: For each type of the following:
a. Plastic pipe and fittings with solvent cement.
b. RTRP and RTRF with adhesive.
c. Pressure-seal fittings.
d. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
e. Air control devices.

f. Chemical treatment.
g. Hydronic specialties.

2. LEED Submittal:
   a. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.
3. Shop Drawings: Detail, at 1/4 (1:50) 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.
4. Welding certificates.
5. Qualification Data: For Installer.
6. Field quality-control test reports.
7. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.
8. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

F. Quality Assurance
1. Installer Qualifications:
   a. Installers of Pressure-Sealed Joints: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
   b. Fiberglass Pipe and Fitting Installers: Installers of RTRF and RTRP shall be certified by the manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.
2. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
3. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
   a. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   b. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
4. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1.2 PRODUCTS

A. Copper Tube And Fittings
1. Drawn-Temper Copper Tubing: ASTM B 88, Type L (ASTM B 88M, Type B) **OR** ASTM B 88, Type M (ASTM B 88M, Type C), **as directed**.
2. Annealed-Temper Copper Tubing: ASTM B 88, Type K (ASTM B 88M, Type A).
3. DWV Copper Tubing: ASTM B 306, Type DWV.
4. Wrought-Copper Fittings: ASME B16.22.
   a. Grooved-End Copper Fittings: ASTM B 75 (ASTM B 75M), copper tube or ASTM B 584, bronze casting.
   b. Grooved-End-Tube Couplings: Rigid pattern, unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, prelubricated, **as directed**, EPDM gasket rated for minimum 230 deg F (110 deg C) for use with housing, and steel bolts and nuts.
5. Copper or Bronze Pressure-Seal Fittings:
   a. Housing: Copper.
   b. O-Rings and Pipe Stops: EPDM.

c. Tools: Manufacturer's special tools.
d. Minimum 200-psig (1379-kPa) working-pressure rating at 250 deg F (121 deg C).
6. Copper, Mechanically Formed Tee Option: For forming T-branch on copper water tube.
7. Wrought-Copper Unions: ASME B16.22.

B. Steel Pipe And Fittings
1. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 1.3 "Piping Applications" Article.
2. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 1.3 "Piping Applications" Article.
3. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 1.3 "Piping Applications" Article.
4. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 1.3 "Piping Applications" Article.
5. 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 1.3 "Piping Applications" Article.
6. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
7. 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:
a. Material Group: 1.1.
b. End Connections: Butt welding.
c. Facings: Raised face.
8. Grooved Mechanical-Joint Fittings and Couplings:
a. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
b. Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
9. Steel Pressure-Seal Fittings:
a. Housing: Steel.
b. O-Rings and Pipe Stop: EPDM.
c. Tools: Manufacturer's special tool.
d. Minimum 300-psig (2070-kPa) working-pressure rating at 230 deg F (110 deg C).
10. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

C. Plastic Pipe And Fittings
1. CPVC Plastic Pipe: ASTM F 441/F 441M, Schedules 40 and 80, plain ends as indicated in Part 1.3 "Piping Applications" Article.
2. CPVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM F 438 for Schedule 40 pipe; ASTM F 439 for Schedule 80 pipe.
3. PVC Plastic Pipe: ASTM D 1785, Schedules 40 and 80, plain ends as indicated in Part 1.3 "Piping Applications" Article.
4. PVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM D 2466 for Schedule 40 pipe; ASTM D 2467 for Schedule 80 pipe.

D. Fiberglass Pipe And Fittings
1. RTRP: ASTM D 2996, filament-wound pipe with tapered bell and spigot ends for adhesive joints.
2. RTRF: Compression or spray-up/contact molded of same material, pressure class, and joining method as pipe.
3. Flanges: ASTM D 4024. Full-face gaskets suitable for the service, minimum 1/8-inch (3.2-mm) thick, 60-70 durometer. ASTM A 307, Grade B, hex head bolts with washers.

E. Joining Materials
1. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   a. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
      1) Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      2) Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
3. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
4. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
5. 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.
6. 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.
7. Solvent Cements for Joining Plastic Piping:
   a. CPVC Piping: ASTM F 493.
      1) Use CPVC solvent cement that has a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
      2) 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).
   b. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
      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) 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).
8. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.
   a. Use fiberglass adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
9. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

F. Transition Fittings
1. Plastic-to-Metal Transition Fittings:
   a. CPVC **OR** PVC, **as directed**, one-piece fitting with one threaded brass or copper insert and one Schedule 80 solvent-cement-joint end.
2. Plastic-to-Metal Transition Unions:
   a. MSS SP-107, CPVC **OR** PVC, **as directed**, union. Include brass or copper end, Schedule 80 solvent-cement-joint end, rubber gasket, and threaded union.

G. Dielectric Fittings
1. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
2. Insulating Material: Suitable for system fluid, pressure, and temperature.
3. Dielectric Unions:
   a. Factory-fabricated union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).
4. Dielectric Flanges:
   a. Factory-fabricated companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.
5. Dielectric-Flange Kits:
   a. Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

b. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig (1035- or 2070-kPa) minimum working pressure where required to suit system pressures.

6. Dielectric Couplings:
   a. 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).
7. Dielectric Nipples:
   a. 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).

H. Valves
1. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 22 Section(s) "General-duty Valves For Plumbing Piping" OR Division 23 Section(s) "General-duty Valves For Hvac Piping".
2. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section "Instrumentation And Control For Hvac".
3. Plastic Ball Valves:
   a. Body: One-, two-, or three-piece CPVC or PVC to match piping.
   b. Ball: Full-port CPVC or PVC to match piping.
   c. Seats: PTFE.
   d. Seals: EPDM.
   e. End Connections: Socket, union, or flanged.
   f. Handle Style: Tee shape.
   g. CWP Rating: Equal to piping service.
   h. Maximum Operating Temperature: Equal to piping service.
   i. Comply with MSS SP-122.
4. Plastic Butterfly Valves:
   a. Body: PVC or CPVC to match piping wafer type for installation between flanges.
   b. Disc: EPDM-coated steel.
   c. Seats: PTFE.
   d. Handle Style: Locking lever.
   e. CWP Rating: Equal to piping service.
   f. Maximum Operating Temperature: Equal to piping service.
5. Plastic Check Valves:
   a. Body: One-, two-, or three-piece PVC or CPVC to match piping.
   b. Ends: Socket or flanged.
   c. Seats: PTFE.
   d. Check Style: Swing or ball type.
   e. CWP Rating: Equal to piping service.
   f. Maximum Operating Temperature: Equal to piping service.
6. Bronze, Calibrated-Orifice, Balancing Valves:
   a. Body: Bronze, ball or plug type with calibrated orifice or venturi.
   b. Ball: Brass or stainless steel.
   c. Plug: Resin.
   d. Seat: PTFE.
   e. End Connections: Threaded or socket.
   f. Pressure Gage Connections: Integral seals for portable differential pressure meter.
   g. Handle Style: Lever, with memory stop to retain set position.
   h. CWP Rating: Minimum 125 psig (860 kPa).
   i. Maximum Operating Temperature: 250 deg F (121 deg C).
7. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:
   a. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
   b. Ball: Brass or stainless steel.
   c. Stem Seals: EPDM O-rings.
   d. Disc: Glass and carbon-filled PTFE.
   e. Seat: PTFE.

f. End Connections: Flanged or grooved.
g. Pressure Gage Connections: Integral seals for portable differential pressure meter.
h. Handle Style: Lever, with memory stop to retain set position.
i. CWP Rating: Minimum 125 psig (860 kPa).
j. Maximum Operating Temperature: 250 deg F (121 deg C).

8. Diaphragm-Operated, Pressure-Reducing Valves:
   a. Body: Bronze or brass.
   b. Disc: Glass and carbon-filled PTFE.
   c. Seat: Brass.
   d. Stem Seals: EPDM O-rings.
   e. Diaphragm: EPT.
   f. Low inlet-pressure check valve.
   g. Inlet Strainer: removable without system shutdown.
   h. Valve Seat and Stem: Noncorrosive.
   i. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.
9. Diaphragm-Operated Safety Valves:
   a. Body: Bronze or brass.
   b. Disc: Glass and carbon-filled PTFE.
   c. Seat: Brass.
   d. Stem Seals: EPDM O-rings.
   e. Diaphragm: EPT.
   f. Wetted, Internal Work Parts: Brass and rubber.
   g. Inlet Strainer: removable without system shutdown.
   h. Valve Seat and Stem: Noncorrosive.
   i. 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.
10. Automatic Flow-Control Valves:
   a. Body: Brass or ferrous metal.
   b. Piston and Spring Assembly: Stainless steel **OR** Corrosion resistant, **as directed**, tamper proof, self cleaning, and removable.
   c. Combination Assemblies: Include bonze or brass-alloy ball valve.
   d. Identification Tag: Marked with zone identification, valve number, and flow rate.
   e. Size: Same as pipe in which installed.
   f. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
   g. Minimum CWP Rating: 175 psig (1207 kPa) **OR** 300 psig (2070 kPa), **as directed**.
   h. Maximum Operating Temperature: 200 deg F (93 deg C) **OR** 250 deg F (121 deg C), **as directed**.

I. Air Control Devices
1. Manual Air Vents:
   a. Body: Bronze.
   b. Internal Parts: Nonferrous.
   c. Operator: Screwdriver or thumbscrew.
   d. Inlet Connection: NPS 1/2 (DN 15).
   e. Discharge Connection: NPS 1/8 (DN 6).
   f. CWP Rating: 150 psig (1035 kPa).
   g. Maximum Operating Temperature: 225 deg F (107 deg C).
2. Automatic Air Vents:
   a. Body: Bronze or cast iron.
   b. Internal Parts: Nonferrous.
   c. Operator: Noncorrosive metal float.
   d. Inlet Connection: NPS 1/2 (DN 15).

e. Discharge Connection: NPS 1/4 (DN 8).
f. CWP Rating: 150 psig (1035 kPa).
g. Maximum Operating Temperature: 240 deg F (116 deg C).

3. Expansion Tanks:
   a. Tank: Welded steel, rated for 125-psig (860-kPa) working pressure and 375 deg F (191 deg C) maximum operating temperature, with taps in bottom of tank for tank fitting and taps in end of tank for gage glass. Tanks shall be factory tested with taps fabricated and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   b. Air-Control Tank Fitting: Cast-iron body, copper-plated tube, brass vent tube plug, and stainless-steel ball check, 100-gal. (379-L) unit only; sized for compression-tank diameter. Provide tank fittings for 125-psig (860-kPa) working pressure and 250 deg F (121 deg C) maximum operating temperature.
   c. Tank Drain Fitting: Brass body, nonferrous internal parts; 125-psig (860-kPa) working pressure and 240 deg F (116 deg C) maximum operating temperature; constructed to admit air to compression tank, drain water, and close off system.
   d. Gage Glass: Full height with dual manual shutoff valves, 3/4-inch- (20-mm-) diameter gage glass, and slotted-metal glass guard.
4. Diaphragm-Type **OR** Bladder-Type, **as directed**, Expansion Tanks:
   a. 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.
   b. Diaphragm **OR** Bladder, **as directed**: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
   c. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.
5. Tangential-Type Air Separators:
   a. 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.
   b. Air Collector Tube: Perforated stainless steel, constructed to direct released air into expansion tank.
   c. Tangential Inlet and Outlet Connections: Threaded for NPS 2 (DN 50) and smaller; flanged connections for NPS 2-1/2 (DN 65) and larger.
   d. Blowdown Connection: Threaded.
   e. Size: Match system flow capacity.
6. In-Line Air Separators:
   a. Tank: One-piece cast iron with an integral weir constructed to decelerate system flow to maximize air separation.
   b. Maximum Working Pressure: Up to 175 psig (1207 kPa).
   c. Maximum Operating Temperature: Up to 300 deg F (149 deg C).
7. Air Purgers:
   a. Body: Cast iron with internal baffles that slow the water velocity to separate the air from solution and divert it to the vent for quick removal.
   b. Maximum Working Pressure: 150 psig (1035 kPa).
   c. Maximum Operating Temperature: 250 deg F (121 deg C).

J. Chemical Treatment
1. 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.
   a. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.
2. Ethylene and Propylene Glycol: Industrial grade with corrosion inhibitors and environmental-stabilizer additives for mixing with water in systems indicated to contain antifreeze or glycol solutions.

K. Hydronic Piping Specialties
1. Y-Pattern Strainers:

a. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
b. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
c. Strainer Screen: 40 **OR** 60, **as directed**,-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
d. CWP Rating: 125 psig (860 kPa).

2. Basket Strainers:
   a. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
   b. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
   c. Strainer Screen: 40 **OR** 60, **as directed**,-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
   d. CWP Rating: 125 psig (860 kPa).
3. T-Pattern Strainers:
   a. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
   b. End Connections: Grooved ends.
   c. Strainer Screen: 40 **OR** 60, **as directed**,-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
   d. CWP Rating: 750 psig (5170 kPa).
4. Stainless-Steel Bellow, Flexible Connectors:
   a. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
   b. End Connections: Threaded or flanged to match equipment connected.
   c. Performance: Capable of 3/4-inch (20-mm) misalignment.
   d. CWP Rating: 150 psig (1035 kPa).
   e. Maximum Operating Temperature: 250 deg F (121 deg C).
5. Spherical, Rubber, Flexible Connectors:
   a. Body: Fiber-reinforced rubber body.
   b. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
   c. Performance: Capable of misalignment.
   d. CWP Rating: 150 psig (1035 kPa).
   e. Maximum Operating Temperature: 250 deg F (121 deg C).
6. Expansion fittings are specified in Division 22 Section(s) "Expansion Fittings And Loops For Plumbing Piping" OR Division 23 Section(s) "Expansion Fittings And Loops For Hvac Piping".

1.3 EXECUTION

1. Hot-water heating piping, aboveground, NPS 2 (DN 50) and smaller, shall be any of the following:
   a. Type L (B) **OR** M (C), **as directed**, drawn-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed **OR** pressure-seal, **as directed**, joints.
   b. Schedule 40 **OR** 30 **OR** 20, **as directed**, steel pipe; Class 125, cast-iron **OR** 150, malleable-iron **OR** 250, cast-iron **OR** 300, malleable-iron, **as directed**, fittings; cast-iron flanges and flange fittings; and threaded joints.
   c. Schedule 5 steel pipe; steel, pressure-seal couplings and fittings; and pressure-seal joints.
   d. Schedule 40 **OR** 80, **as directed**, CPVC plastic pipe and fittings and solvent-welded joints.
2. Hot-water heating piping, aboveground, NPS 2-1/2 (DN 65) and larger, shall be any of the following:
   a. Type L (B) **OR** M (C), **as directed**, drawn-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed, **as directed**, joints.
   b. Schedule 40 **OR** 30 **OR** 20, **as directed**, steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
   c. Schedule 40 **OR** 30 **OR** 20, **as directed**, steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.

d. Schedule 40 **OR** 80, **as directed**, CPVC plastic pipe and fittings and solvent-welded joints.
e. RTRP and RTRF with adhesive or flanged joints.

3. Hot-water heating piping installed belowground and within slabs shall be either of the following:
   a. Type K (A), annealed-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed, **as directed**, joints. Use the fewest possible joints.
   b. RTRP and RTRF with adhesive or flanged joints.
4. Chilled-water piping, aboveground, NPS 2 (DN 50) and smaller, shall be any of the following:
   a. Type L (B) **OR** M (C), **as directed**, drawn-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed **OR** pressure-seal, **as directed**, joints.
   b. Schedule 40 **OR** 30 **OR** 20, **as directed**, steel pipe; Class 125, cast-iron **OR** 150, malleable-iron **OR** 250, cast-iron **OR** 300, malleable-iron, **as directed**, fittings; cast-iron flanges and flange fittings; and threaded joints.
   c. Schedule 5 steel pipe; steel, pressure-seal couplings and fittings; and pressure-seal joints.
   d. Schedule 40 **OR** 80, **as directed**, CPVC plastic pipe and fittings and solvent-welded joints.
5. Chilled-water piping, aboveground, NPS 2-1/2 (DN 65) and larger, shall be any of the following:
   a. Type L (B) **OR** M (C), **as directed**, drawn-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed, **as directed**, joints.
   b. Schedule 40 **OR** 30 **OR** 20, **as directed**, steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
   c. Schedule 40 **OR** 30 **OR** 20, **as directed**, steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.
   d. Schedule 40 **OR** 80, **as directed**, CPVC plastic pipe and fittings and solvent-welded joints.
   e. RTRP and RTRF with adhesive or flanged joints.
6. Chilled-water piping installed belowground and within slabs shall be either of the following:
   a. Type K (A), annealed-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed, **as directed**, joints. Use the fewest possible joints.
   b. RTRP and RTRF with adhesive or flanged joints.
7. Dual-temperature heating and cooling water piping, aboveground, NPS 2 (DN 50) and smaller, shall be any of the following:
   a. Type L (B) **OR** M (C), **as directed**, drawn-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed **OR** pressure-seal, **as directed**, joints.
   b. Schedule 40 **OR** 30 **OR** 20, **as directed**, steel pipe; Class 125, cast-iron **OR** 150, malleable-iron **OR** 250, cast-iron **OR** 300, malleable-iron, **as directed**, fittings; cast-iron flanges and flange fittings; and threaded joints.
   c. Schedule 5 steel pipe; steel, pressure-seal couplings and fittings; and pressure-seal joints.
   d. Schedule 40 **OR** 80, **as directed**, CPVC plastic pipe and fittings and solvent-welded joints.
8. Dual-temperature heating and cooling water piping, aboveground, NPS 2-1/2 (DN 65) and larger, shall be any of the following:
   a. Type L (B) **OR** M (C), **as directed**, drawn-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed, **as directed**, joints.
   b. Schedule 40 **OR** 30 **OR** 20, **as directed**, steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
   c. Schedule 40 **OR** 30 **OR** 20, **as directed**, steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.
   d. Schedule 40 **OR** 80, **as directed**, CPVC plastic pipe and fittings and solvent-welded joints.
   e. RTRP and RTRF with adhesive or flanged joints.
9. Dual-temperature heating and cooling water piping installed belowground and within slabs shall be either of the following:
   a. Type K (A), annealed-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed, **as directed**, joints. Use the fewest possible joints.
   b. RTRP and RTRF with adhesive or flanged joints.
10. Condenser-water piping, aboveground, NPS 2 (DN 50) and smaller, shall be any of the following:
    a. Type L (B) **OR** M (C), **as directed**, drawn-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed **OR** pressure-seal, **as directed**, joints.

b. Schedule 80 **OR** 40 **OR** 30 **OR** 20, **as directed**, steel pipe; Class 125, cast-iron **OR** 150, malleable-iron **OR** 250, cast-iron **OR** 300, malleable-iron, **as directed**, fittings; cast-iron flanges and flange fittings; and threaded joints.
c. Schedule 5 steel pipe; steel, pressure-seal couplings and fittings; and pressure-seal joints.
d. Schedule 40 **OR** 80, **as directed**, CPVC plastic pipe and fittings and solvent-welded joints.

11. Condenser-water piping, aboveground, NPS 2-1/2 (DN 65) and larger, shall be any of the following:
    a. Type L (B) **OR** M (C), **as directed**,, drawn-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed, **as directed**, joints.
    b. Schedule 80 **OR** 40 **OR** 30 **OR** 20, **as directed**, steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
    c. Schedule 80 **OR** 40 **OR** 30 **OR** 20, **as directed**, steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.
    d. Schedule 40 **OR** 80, **as directed**, CPVC plastic pipe and fittings and solvent-welded joints.
    e. RTRP and RTRF with adhesive or flanged joints.
12. Condenser-water piping installed belowground and within slabs shall be either of the following:
    a. Type K (A), annealed-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed, **as directed**, joints. Use the fewest possible joints.
    b. RTRP and RTRF with adhesive or flanged joints.
13. Glycol cooling-water piping, aboveground, NPS 2 (DN 50) and smaller, shall be any of the following:
    a. Type L (B) **OR** M (C), **as directed**, drawn-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed **OR** pressure-seal, **as directed**, joints.
    b. Schedule 40 **OR** 30 **OR** 20, **as directed**, steel pipe; Class 125, cast-iron **OR** 150, malleable-iron **OR** 250, cast-iron **OR** 300, malleable-iron, **as directed**, fittings; cast-iron flanges and flange fittings; and threaded joints.
    c. Schedule 5 steel pipe; steel, pressure-seal couplings and fittings; and pressure-seal joints.
    d. Schedule 40 **OR** 80, **as directed**, CPVC plastic pipe and fittings and solvent-welded joints.
14. Glycol cooling-water piping, aboveground, NPS 2-1/2 (DN 65) and larger, shall be any of the following:
    a. Type L (B) **OR** M (C), **as directed**, drawn-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed, **as directed**, joints.
    b. Schedule 40 **OR** 30 **OR** 20, **as directed**, steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
    c. Schedule 40 **OR** 30 **OR** 20, **as directed**, steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.
    d. Schedule 40 **OR** 80, **as directed**, CPVC plastic pipe and fittings and solvent-welded joints.
    e. RTRP and RTRF with adhesive or flanged joints.
15. Glycol cooling-water piping installed belowground and within slabs shall be either of the following:
    a. Type K (A), annealed-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed, **as directed**, joints. Use the fewest possible joints.
    b. RTRP and RTRF with adhesive or flanged joints.
16. Makeup-water piping installed aboveground shall be either of the following:
    a. Type L (B) **OR** M (C), **as directed**, drawn-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed, **as directed**, joints.
    b. Schedule 40 **OR** 80, **as directed**, CPVC plastic pipe and fittings, and solvent-welded joints.
17. Makeup-Water Piping Installed Belowground and within Slabs: Type K (A), annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.
18. Condensate-Drain Piping: Type M (C) **OR** DWV, **as directed**, drawn-temper copper tubing, wrought-copper fittings, and soldered joints or Schedule 40 PVC plastic pipe and fittings and solvent-welded joints, **as directed**.

    OR

    Condensate-Drain Piping: Schedule 40 PVC plastic pipe and fittings and solvent-welded joints.

19. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.
20. Air-Vent Piping:
    a. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.
    b. Outlet: Type K (A), annealed-temper copper tubing with soldered or flared joints.
21. 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.

B. Valve Applications
1. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.
2. Install throttling-duty **OR** calibrated-orifice, balancing, **as directed**, valves at each branch connection to return main.
3. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.
4. Install check valves at each pump discharge and elsewhere as required to control flow direction.
5. 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.
6. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

C. Piping Installations
1. 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.
2. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
3. 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.
4. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
5. Install piping to permit valve servicing.
6. Install piping at indicated slopes.
7. Install piping free of sags and bends.
8. Install fittings for changes in direction and branch connections.
9. Install piping to allow application of insulation.
10. Select system components with pressure rating equal to or greater than system operating pressure.
11. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
12. 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.
13. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
14. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
15. Install branch connections to mains using mechanically formed, **as directed**, 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.
16. Install valves according to Division 22 Section(s) "General-duty Valves For Plumbing Piping" OR Division 23 Section(s) "General-duty Valves For Hvac Piping".
17. Install unions in piping, NPS 2 (DN 50) and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

18. Install flanges in piping, NPS 2-1/2 (DN 65) and larger, at final connections of equipment and elsewhere as indicated.
19. 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).
20. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 22 Section(s) "Expansion Fittings And Loops For Plumbing Piping" OR Division 23 Section(s) "Expansion Fittings And Loops For Hvac Piping".
21. Identify piping as specified in Division 22 Section(s) "Identification For Plumbing Piping And Equipment" OR Division 23 Section(s) "Identification For Hvac Piping And Equipment".

D. Hangers And Supports
1. Hanger, support, and anchor devices are specified in Division 22 Section(s) "Hangers And Supports For Plumbing Piping And Equipment" OR Division 23 Section(s) "Hangers And Supports For Hvac Piping And Equipment". Comply with the following requirements for maximum spacing of supports.
2. Seismic restraints are specified in Division 21 Section(s) "Vibration And Seismic Controls For Fire-suppression Piping And Equipment" OR Division 22 Section(s) "Vibration And Seismic Controls For Plumbing Piping And Equipment" OR Division 23 Section(s) "Vibration And Seismic Controls For Hvac Piping And Equipment".
3. Install the following pipe attachments:
   a. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet (6 m) long.
   b. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet (6 m) or longer.
   c. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6 m) or longer, supported on a trapeze.
   d. Spring hangers to support vertical runs.
   e. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
   f. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.
4. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
   a. NPS 3/4 (DN 20): Maximum span, 7 feet (2.1 m); minimum rod size, 3/8 inch (10 mm).
   b. NPS 1 (DN 25): Maximum span, 7 feet (2.1 m); minimum rod size, 3/8 inch (10 mm).
   c. NPS 1-1/4 (DN 32): Maximum span, 7 feet (2.1 m); minimum rod size, 3/8 inch (10 mm).
   d. NPS 1-1/2 (DN 40): Maximum span, 9 feet (2.7 m); minimum rod size, 3/8 inch (10 mm).
   e. NPS 2 (DN 50): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (10 mm).
   f. NPS 2-1/2 (DN 65): Maximum span, 11 feet (3.4 m); minimum rod size, 1/2 inch (12 mm).
   g. NPS 3 (DN 80): Maximum span, 12 feet (3.7 m); minimum rod size, 1/2 inch (12 mm).
   h. NPS 3-1/2 (DN 90): Maximum span, 13 feet (4 m); minimum rod size, 1/2 inch (12 mm).
   i. NPS 4 (DN 100): Maximum span, 14 feet (4.3 m); minimum rod size, 5/8 inch (16 mm).
   j. NPS 5 (DN 125): Maximum span, 16 feet (4.9 m); minimum rod size, 5/8 inch (16 mm).
   k. NPS 6 (DN 150): Maximum span, 17 feet (5.2 m); minimum rod size, 3/4 inch (20 mm).
   l. NPS 8 (DN 200): Maximum span, 19 feet (5.8 m); minimum rod size, 3/4 inch (20 mm).
   m. NPS 10 (DN 250): Maximum span, 22 feet (6.7 m); minimum rod size, 7/8 inch (20 mm).
   n. NPS 12 (DN 300): Maximum span, 23 feet (7 m); minimum rod size, 7/8 inch (20 mm).
   o. NPS 14 (DN 350): Maximum span, 25 feet (7.6 m); minimum rod size, 1 inch (24 mm).
   p. NPS 16 (DN 400): Maximum span, 27 feet (8.2 m); minimum rod size, 1 inch (24 mm).
   q. NPS 18 (DN 450): Maximum span, 28 feet (8.5 m); minimum rod size, 1 inch (24 mm).
   r. NPS 20 (DN 500): Maximum span, 30 feet (9.1 m); minimum rod size, 1-1/4 inches (30 mm).
5. Install hangers for drawn-temper copper tubing with the following maximum spacing and minimum rod sizes:
   a. NPS 3/4 (DN 20): Maximum span, 5 feet (1.5 m); minimum rod size, 3/8 inch (10 mm).

b. NPS 1 (DN 25): Maximum span, 6 feet (1.8 m); minimum rod size, 3/8 inch (10 mm).
c. NPS 1-1/4 (DN 32): Maximum span, 7 feet (2.1 m); minimum rod size, 3/8 inch (10 mm).
d. NPS 1-1/2 (DN 40): Maximum span, 8 feet (2.4 m); minimum rod size, 3/8 inch (10 mm).
e. NPS 2 (DN 50): Maximum span, 8 feet (2.4 m); minimum rod size, 3/8 inch (10 mm).
f. NPS 2-1/2 (DN 65): Maximum span, 9 feet (2.7 m); minimum rod size, 1/2 inch (12 mm).
g. NPS 3 (DN 80): Maximum span, 10 feet (3 m); minimum rod size, 1/2 inch (12 mm).

6. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
7. Fiberglass Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
8. Support vertical runs at roof, at each floor, and at 10-foot (3-m) intervals between floors.

E. Pipe Joint Construction
1. Join pipe and fittings according to the following requirements and Division 21 specifying piping systems.
2. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
3. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
4. 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.
5. 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.
6. 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:
   a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
7. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1.1 "Quality Assurance" Article.
8. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
9. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   b. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
   c. PVC Pressure Piping: Join ASTM D 1785 schedule number, 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.
   d. PVC Nonpressure Piping: Join according to ASTM D 2855.
10. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.
11. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.
12. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.
13. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

F. Hydronic Specialties Installation

1. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
   OR
   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.
2. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.
3. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 (DN 50) and larger.
   OR
   Install tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.
4. 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.
5. Install expansion tanks above the air separator. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.
   a. Install tank fittings that are shipped loose.
   b. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.

   OR
   Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system Project requirements.

G. Terminal Equipment Connections
1. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
2. Install control valves in accessible locations close to connected equipment.
3. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
4. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Division 22 Section(s) "Meters And Gages For Plumbing Piping" OR Division 23 Section(s) "Meters And Gages For Hvac Piping".

H. Chemical Treatment
1. 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:
   a. pH: 9.0 to 10.5.
   b. "P" Alkalinity: 100 to 500 ppm.
   c. Boron: 100 to 200 ppm.
   d. Chemical Oxygen Demand: Maximum 100 ppm. Modify this value if closed system contains glycol.
   e. Corrosion Inhibitor:
      1) Sodium Nitrate: 1000 to 1500 ppm.
      2) Molybdate: 200 to 300 ppm.
      3) Chromate: 200 to 300 ppm.
      4) Sodium Nitrate Plus Molybdate: 100 to 200 ppm each.
      5) Chromate Plus Molybdate: 50 to 100 ppm each.
   f. Soluble Copper: Maximum 0.20 ppm.
   g. Tolyiriazole Copper and Yellow Metal Corrosion Inhibitor: Minimum 10 ppm.
   h. Total Suspended Solids: Maximum 10 ppm.

i. Ammonia: Maximum 20 ppm.
j. Free Caustic Alkalinity: Maximum 20 ppm.
k. Microbiological Limits:
1) Total Aerobic Plate Count: Maximum 1000 organisms/ml.
2) Total Anaerobic Plate Count: Maximum 100 organisms/ml.
3) Nitrate Reducers: 100 organisms/ml.
4) Sulfate Reducers: Maximum 0 organisms/ml.
5) Iron Bacteria: Maximum 0 organisms/ml.

2. 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.
3. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.
4. Fill systems indicated to have antifreeze or glycol solutions with the following concentrations:
a. Hot-Water Heating Piping: Minimum percent ethylene, as directed by the Owner **OR** propylene, **as directed**, glycol.
b. Chilled-Water Piping: Minimum percent ethylene, as directed by the Owner **OR** propylene, **as directed**, glycol.
c. Dual-Temperature Heating and Cooling Water Piping: Minimum percent, as directed by the Owner ethylene **OR** propylene, **as directed**, glycol.
d. Glycol Cooling-Water Piping: Minimum percent ethylene, as directed by the Owner. **OR** propylene, **as directed**, glycol.

I. Field Quality Control
1. Prepare hydronic piping according to ASME B31.9 and as follows:
a. Leave joints, including welds, uninsulated and exposed for examination during test.
b. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
c. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
d. 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.
e. 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.
2. Perform the following tests on hydronic piping:
a. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
b. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
c. Isolate expansion tanks and determine that hydronic system is full of water.
d. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
e. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
f. Prepare written report of testing.
3. Perform the following before operating the system:
a. Open manual valves fully.
b. Inspect pumps for proper rotation.
c. Set makeup pressure-reducing valves for required system pressure.
d. 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).

e. Set temperature controls so all coils are calling for full flow.
f. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
g. Verify lubrication of motors and bearings.

END OF SECTION 22 11 16 00c

SECTION 22 11 16 00d - STEAM AND CONDENSATE PIPING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for steam and condensate piping. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following for LP and HP steam and condensate piping:
a. Pipe and fittings.
b. Strainers.
c. Flash tanks.
d. Safety valves.
e. Pressure-reducing valves.
f. Steam traps.
g. Thermostatic air vents and vacuum breakers.
h. Steam and condensate meters.

C. Definitions
1. HP Systems: High-pressure piping operating at more than 15 psig (104 kPa) as required by ASME B31.1.
2. LP Systems: Low-pressure piping operating at 15 psig (104 kPa) or less as required by ASME B31.9.
3. RTRF: Reinforced thermosetting resin (fiberglass) fittings.
4. RTRP: Reinforced thermosetting resin (fiberglass) pipe.

D. Performance Requirements
1. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures:
a. HP Steam Piping: <**Insert psig (kPa)**.>
b. LP Steam Piping: <**Insert psig (kPa).**>
c. Condensate Piping: <**Insert psig (kPa)**> at 250 deg F (121 deg C).
d. Makeup-Water Piping: 80 psig (552 kPa) at 150 deg F (66 deg C).
e. Blowdown-Drain Piping: Equal to pressure of the piping system to which it is attached.
f. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.
g. Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

E. Submittals
1. Product Data: For each type of the following:
a. RTRP and RTRF with adhesive.
b. Pressure-reducing and safety valve.
c. Steam trap.
d. Air vent and vacuum breaker.
e. Flash tank.
f. Meter.
2. Shop Drawings: Detail, 1/4 inch equals 1 foot (1:50) scale, flash tank assemblies and fabrication of pipe anchors, hangers, pipe, multiple pipes, alignment guides, and expansion joints and loops and their attachment to the building structure. Detail locations of anchors, alignment guides, and expansion joints and loops.

3. Welding certificates.
4. Field quality-control test reports.
5. Operation and Maintenance Data: For valves, safety valves, pressure-reducing valves, steam traps, air vents, vacuum breakers, and meters to include in emergency, operation, and maintenance manuals.

F. Quality Assurance
1. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code - Steel."
2. Pipe Welding: Qualify processes and operators according to the following:
   a. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   b. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
3. ASME Compliance: Comply with ASME B31.1, "Power Piping" **AND/OR** ASME B31.9, "Building Services Piping", **as directed**, for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp flash tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1.2 PRODUCTS

A. Copper Tube And Fittings
1. Drawn-Temper Copper Tubing: ASTM B 88, Type L (ASTM B 88M, Type B) **OR** ASTM B 88, Type M (ASTM B 88M, Type C), **as directed**.
2. Annealed-Temper Copper Tubing: ASTM B 88, Type K (ASTM B 88M, Type A).
3. Wrought-Copper Fittings and Unions: ASME B16.22.

B. Steel Pipe And Fittings
1. Steel Pipe: ASTM A 53/A 53M, black steel, plain ends, Type, Grade, and Schedule as indicated in Part 3 piping applications articles.
2. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125, 150, and 300 as indicated in Part 3 piping applications articles.
3. Malleable-Iron Threaded Fittings: ASME B16.3; Classes 150 and 300 as indicated in Part 3 piping applications articles.
4. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 piping applications articles.
5. Cast-Iron Threaded Flanges and Flanged Fittings: ASME B16.1, Classes 125 and 250 as indicated in Part 3 piping applications articles; raised ground face, and bolt holes spot faced.
6. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
7. Wrought-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   a. Material Group: 1.1.
   b. End Connections: Butt welding.
   c. Facings: Raised face.
8. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, black steel of same Type, Grade, and Schedule as pipe in which installed.
9. Stainless-Steel Bellows, Flexible Connectors:
   a. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforced, protective jacket.
   b. End Connections: Threaded or flanged to match equipment connected.
   c. Performance: Capable of 3/4-inch (20-mm) misalignment.
   d. CWP Rating: 150-psig (1035-kPa).
   e. Maximum Operating Temperature: 250 deg F (121 deg C).

C. Fiberglass Pipe And Fittings

1. RTRP: ASTM D 2996 filament-wound pipe with tapered bell and spigot ends for adhesive joints.
2. RTRF: Compression or spray-up/contact molded fittings of same material, pressure class, and joining method as pipe.
3. Flanges: ASTM D 4024 full-face gaskets suitable for the service, minimum 1/8 inch (3.2 mm) thick, 60-70 durometer. ASTM A 307, Grade B, hex head bolts with washers.
4. Bonding Adhesive for Fiberglass Piping: As recommended by fiberglass piping manufacturer.

D. Joining Materials
1. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   a. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
      1) Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      2) Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
3. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
4. 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.
5. Welding Filler Metals: Comply with AWS D10.12 (AWS D10.12M) for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
6. Welding Materials: Comply with Section II, Part C, of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

E. Dielectric Fittings
1. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
2. Insulating Material: Suitable for system fluid, pressure, and temperature.
3. Dielectric Unions:
   a. Factory-fabricated union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).
4. Dielectric Flanges:
   a. Factory-fabricated companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.
5. Dielectric-Flange Kits:
   a. Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
   b. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.

F. Valves
1. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section "General-duty Valves For Hvac Piping".
2. Stop-Check Valves:
   a. Body and Bonnet: Malleable iron.
   b. End Connections: Flanged.
   c. Disc: Cylindrical with removable liner and machined seat.
   d. Stem: Brass alloy.
   e. Operator: Outside screw and yoke with cast-iron handwheel.
   f. Packing: Polytetrafluoroethylene-impregnated packing with two-piece packing gland assembly.
   g. Pressure Class: 250.

G. Strainers
1. Y-Pattern Strainers:

a. Body: ASTM A 126, Class B cast iron, with bolted cover and bottom drain connection.
b. End Connections: Threaded ends for strainers NPS 2 (DN 50) and smaller; flanged ends for strainers NPS 2-1/2 (DN 65) and larger.
c. Strainer Screen: Stainless-steel, 20 mesh strainer, and perforated stainless-steel basket with 50 percent free area.
d. Tapped blowoff plug.
e. CWP Rating: 250-psig (1725-kPa) working steam pressure.

2. Basket Strainers:
a. Body: ASTM A 126, Class B cast iron, with bolted cover and bottom drain connection.
b. End Connections: Threaded ends for strainers NPS 2 (DN 50) and smaller; flanged ends for strainers NPS 2-1/2 (DN 65) and larger.
c. Strainer Screen: Stainless-steel, 20 mesh strainer, and perforated stainless-steel basket with 50 percent free area.
d. CWP Rating: 250-psig (1725-kPa) working steam pressure.

H. Flash Tanks
1. Shop or factory fabricated of welded steel according to ASME Boiler and Pressure Vessel Code, for 150-psig (1035-kPa) rating; and bearing ASME label. Fabricate with tappings for low-pressure steam and condensate outlets, high-pressure condensate inlet, air vent, safety valve, and legs.

I. Safety Valves
1. Bronze **OR** Brass, **as directed**, Safety Valves:
a. Disc Material: Forged copper alloy.
b. End Connections: Threaded inlet and outlet.
c. Spring: Fully enclosed steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
d. Pressure Class: 250.
e. Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.
f. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

2. Cast-Iron Safety Valves:
a. Disc Material: Forged copper alloy with bronze nozzle.
b. End Connections: Raised-face flanged inlet and threaded or flanged outlet connections.
c. Spring: Fully enclosed cadmium-plated steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
d. Pressure Class: 250.
e. Drip-Pan Elbow: Cast iron and having threaded inlet, outlet, and drain, with threads complying with ASME B1.20.1.
f. Exhaust Head: Cast iron and having threaded inlet and drain, with threads complying with ASME B1.20.1.
g. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

J. Pressure-Reducing Valves
1. Size, Capacity, and Pressure Rating: Factory set for inlet and outlet pressures indicated.
2. Description: Pilot-actuated, diaphragm type, with adjustable pressure range and positive shutoff.
3. Body: Cast iron.
4. End Connections: Threaded connections for valves NPS 2 (DN 50) and smaller and flanged connections for valves NPS 2-1/2 (DN 65) and larger.
5. Trim: Hardened stainless steel.
6. Head and Seat: Replaceable, main head stem guide fitted with flushing and pressure-arresting device cover over pilot diaphragm.
7. Gaskets: Non-asbestos materials.

K. Steam Traps
1. Thermostatic Traps:
   a. Body: Bronze angle-pattern body with integral union tailpiece and screw-in cap.
   b. Trap Type: Balanced-pressure.
   c. Bellows: Stainless steel or monel.
   d. Head and Seat: Replaceable, hardened stainless steel.
   e. Pressure Class: 125.
2. Thermodynamic Traps:
   a. Body: Stainless steel with screw-in cap.
   b. End Connections: Threaded.
   c. Disc and Seat: Stainless steel.
   d. Maximum Operating Pressure: 600 psig (4140 kPa).
3. Float and Thermostatic Traps:
   a. Body and Bolted Cap: ASTM A 126, cast iron.
   b. End Connections: Threaded.
   c. Float Mechanism: Replaceable, stainless steel.
   d. Head and Seat: Hardened stainless steel.
   e. Trap Type: Balanced pressure.
   f. Thermostatic Bellows: Stainless steel or monel.
   g. Thermostatic air vent capable of withstanding 45 deg F (25 deg C) of superheat and resisting water hammer without sustaining damage.
   h. Vacuum Breaker: Thermostatic with phosphor bronze bellows, and stainless steel cage, valve, and seat.
   i. Maximum Operating Pressure: 125 psig (860 kPa).
4. Inverted Bucket Traps:
   a. Body and Cap: Cast iron.
   b. End Connections: Threaded.
   c. Head and Seat: Stainless steel.
   d. Valve Retainer, Lever, and Guide Pin Assembly: Stainless steel.
   e. Bucket: Brass or stainless steel.
   f. Strainer: Integral stainless-steel inlet strainer within the trap body.
   g. Air Vent: Stainless-steel thermostatic vent.
   h. Pressure Rating: 250 psig (1725 kPa).

L. Thermostatic Air Vents And Vacuum Breakers
1. Thermostatic Air Vents:
   a. Body: Cast iron, bronze or stainless steel.
   b. End Connections: Threaded.
   c. Float, Valve, and Seat: Stainless steel.
   d. Thermostatic Element: Phosphor bronze bellows in a stainless-steel cage.
   e. Pressure Rating: 125 psig (861 kPa) **OR** 300 psig (2068 kPa), **as directed**.
   f. Maximum Temperature Rating: 350 deg F (177 deg C).
2. Vacuum Breakers:
   a. Body: Cast iron, bronze, or stainless steel.
   b. End Connections: Threaded.
   c. Sealing Ball, Retainer, Spring, and Screen: Stainless steel.
   d. O-ring Seal: EPR.
   e. Pressure Rating: 125 psig (861 kPa) **OR** 300 psig (2068 kPa), **as directed**.
   f. Maximum Temperature Rating: 350 deg F (177 deg C).

M. Steam Meters
1. Meters shall have a microprocessor to display totalizer flow, flow rate, temperature, pressure, time, and date; alarms for high and low flow rate and temperature.
   a. Computer shall have 4 to 20-mA or 2 to 10 volt output for temperature, pressure, and contact closure for flow increments.
   b. Independent timers to store four peak flow rates and total flow.

c. Interface compatible with central workstation described in Division 23 Section "Instrumentation And Control For Hvac".
d. Microprocessor Enclosure: NEMA 250, Type 4.

2. Sensor:
   a. Venturi, of stainless-steel **OR** carbon-steel, **as directed**, construction, for insertion in pipeline between flanges. At least 10:1 turndown with plus or minus 1 percent accuracy over full-flow range.
   b. Vortex type with stainless-steel wetted parts and wafer **OR** flange, **as directed**, connections; and with a piezoelectric sensor removable and serviceable without shutting down the process. At least 10:1 turndown with plus or minus 1 percent accuracy over full-flow range.
   c. Spring-loaded, variable-area flowmeter type; density compensated with stainless-steel wetted parts and wafer **OR** flange, **as directed**, connections. At least 10:1 turndown with plus or minus 2 percent accuracy over full-flow range.

N. Condensate Meters
1. Body: Cast iron, bronze, or brass.
2. Turbine: Copper, brass, or stainless steel.
3. Connections: Threaded for NPS 2 (DN 50) and smaller and flanged for NPS 2-1/2 (DN 65).
4. Totalizer: Meters shall have a microprocessor to display flow, flow rate, time, and date; alarms for high and low flow rate, pressure, and temperature.
   a. Computer shall have 4- to 20-mA or 2- to 10-volt output for temperature, pressure, and contact closure for flow increments.
   b. Independent timers to store four peak flow rates and total flow.
   c. Interface compatible with central workstation specified in Division 23 Section "Instrumentation And Control For Hvac".
   d. Microprocessor Enclosure: NEMA 250, Type 4.
5. Pressure Rating: Atmospheric.
6. Maximum Temperature Rating: 250 deg F (121 deg C).

1.3 EXECUTION

A. LP Steam Piping Applications
1. LP Steam Piping, NPS 2 (DN 50) and Smaller: Schedule 40 **OR** 80, **as directed**, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
2. LP Steam Piping, NPS 2-1/2 through NPS 12 (DN 65 through DN 300): Schedule 40 **OR** 80, **as directed**, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
3. LP Steam Piping, NPS 14 through NPS 18 (DN 350 through DN 450): Schedule 30, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
4. LP Steam Piping, NPS 20 (DN 500) and Larger: Schedule 20, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
5. Condensate piping above grade, NPS 2 (DN 50) and smaller, shall be either of the following, **as directed**:
   a. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
   b. RTRP and RTRF with adhesive or flanged joints.
6. Condensate piping above grade, NPS 2-1/2 (DN 65) and larger, shall be either of the following, **as directed**:
   a. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
   b. RTRP and RTRF with adhesive or flanged joints.
7. Condensate piping below grade, NPS 2 (DN 50) and smaller, shall be either of the following, **as directed**:

a. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
b. RTRP and RTRF with adhesive or flanged joints.

8. Condensate piping below grade, NPS 2-1/2 (DN 65) and larger, shall be either of the following, **as directed**:
   a. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
   b. RTRP and RTRF with adhesive or flanged joints.

B. HP Steam Piping Applications
1. HP Steam Piping, NPS 2 (DN 50) and Smaller: Schedule 40 **OR** 80, **as directed**, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
2. HP Steam Piping, NPS 2-1/2 through NPS 12 (DN 65 through DN 300): Schedule 40 **OR** 80, **as directed**, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
3. HP Steam Piping, NPS 14 through NPS 18 (DN 350 through DN 450): Schedule 30, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
4. HP Steam Piping, NPS 20 (DN 500) and Larger: Schedule 20, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
5. Condensate piping above grade, NPS 2 (DN 50) and smaller, shall be either of the following, **as directed**:
   a. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
   b. RTRP and RTRF with adhesive or flanged joints.
6. Condensate piping above grade, NPS 2-1/2 (DN 65) and larger, shall be either of the following, **as directed**:
   a. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
   b. RTRP and RTRF with adhesive or flanged joints.
7. Condensate piping below grade, NPS 2 (DN 50) and smaller, shall be either of the following, **as directed**:
   a. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
   b. RTRP and RTRF with adhesive or flanged joints.
8. Condensate piping below grade, NPS 2-1/2 (DN 65) and larger, shall be either of the following, **as directed**:
   a. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
   b. RTRP and RTRF with adhesive or flanged joints.

C. Ancillary Piping Applications
1. Makeup-water piping installed above grade shall be either of the following, **as directed**:
   a. Drawn-temper copper tubing, wrought-copper fittings, and soldered **OR** brazed, **as directed**, joints.
   b. Schedule 40 **OR** 80, **as directed**, CPVC plastic pipe and fittings, and solvent welded joints.
2. Makeup-Water Piping Installed below Grade and within Slabs: Annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.
3. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.
4. Air-Vent Piping:
   a. Inlet: Same as service where installed.
   b. Outlet: Type K (A) annealed-temper copper tubing with soldered or flared joints.
5. Vacuum-Breaker Piping: Outlet, same as service where installed.
6. Safety-Valve-Inlet and -Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

D. Valve Applications

1. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.
2. Install safety valves on pressure-reducing stations and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

E. Piping Installation
1. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Use indicated piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
2. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
3. 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.
4. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
5. Install piping to permit valve servicing.
6. Install piping free of sags and bends.
7. Install fittings for changes in direction and branch connections.
8. Install piping to allow application of insulation.
9. Select system components with pressure rating equal to or greater than system operating pressure.
10. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
11. Install drains, consisting of a tee fitting, NPS 3/4 (DN 20) full port-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.
12. Install steam supply piping at a minimum uniform grade of 0.2 percent downward in direction of steam flow.
13. Install condensate return piping at a minimum uniform grade of 0.4 percent downward in direction of condensate flow.
14. Reduce pipe sizes using eccentric reducer fitting installed with level side down.
15. Install branch connections to mains using mechanically formed, **as directed**, tee fittings in main pipe, with the branch connected to top of main pipe.
16. Install valves according to Division 23 Section "General-duty Valves For Hvac Piping".
17. Install unions in piping, NPS 2 (DN 50) and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
18. Install flanges in piping, NPS 2-1/2 (DN 65) and larger, at final connections of equipment and elsewhere as indicated.
19. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 (DN 20) nipple and full port 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).
20. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 23 Section "Expansion Fittings And Loops For Hvac Piping".
21. Identify piping as specified in Division 23 Section "Identification For Hvac Piping And Equipment".
22. Install drip legs at low points and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, and control valves.
    a. On straight runs with no natural drainage points, install drip legs at intervals not exceeding 300 feet (90 m).
    b. Size drip legs same size as main. In steam mains NPS 6 (DN 150) and larger, drip leg size can be reduced, but to no less than NPS 4 (DN 100).
23. Flash Tank:

a. Pitch condensate piping down toward flash tank.
b. If more than one condensate pipe discharges into flash tank, install a check valve in each line.
c. Install thermostatic air vent at tank top.
d. Install safety valve at tank top.
e. Install full-port ball valve, and swing check valve on condensate outlet.
f. Install inverted bucket or float and thermostatic trap at low-pressure condensate outlet, sized for three times the calculated heat load.
g. Install pressure gage on low-pressure steam outlet according to Division 23 Section "Meters And Gages For Hvac Piping".

F. Steam-Trap Installation
1. Install steam traps in accessible locations as close as possible to connected equipment.
2. Install full-port ball valve, strainer, and union upstream from trap; install union, check valve, and full-port ball valve downstream from trap unless otherwise indicated.

G. Pressure-Reducing Valve Installation
1. Install pressure-reducing valves in accessible location for maintenance and inspection.
2. Install bypass piping around pressure-reducing valves, with globe valve equal in size to area of pressure-reducing valve seat ring, unless otherwise indicated.
3. Install gate valves on both sides of pressure-reducing valves.
4. Install unions or flanges on both sides of pressure-reducing valves having threaded- or flanged-end connections respectively.
5. Install pressure gages on low-pressure side of pressure-reducing valves after the bypass connection according to Division 23 Section "Meters And Gages For Hvac Piping".
6. Install strainers upstream for pressure-reducing valve.
7. Install safety valve downstream from pressure-reducing valve station.

H. Steam Or Condensate Meter Installation
1. Install meters with lengths of straight pipe upstream and downstream according to steam meter manufacturer's instructions.
2. Provide data acquisition wiring. Refer to Division 23 Section "Instrumentation And Control For Hvac".

I. Safety Valve Installation
1. Install safety valves according to ASME B31.1, "Power Piping" **OR** ASME B31.9, "Building Services Piping," **as directed**
2. Pipe safety-valve discharge without valves to atmosphere outside the building.
3. Install drip-pan elbow fitting adjacent to safety valve and pipe drain connection to nearest floor drain.
4. Install exhaust head with drain to waste, on vents equal to or larger than NPS 2-1/2 (DN 65).

J. Hangers And Supports
1. Install hangers and supports according to Division 23 Section "Hangers And Supports For Hvac Piping And Equipment". Comply with requirements below for maximum spacing.
2. Seismic restraints are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment".
3. Install the following pipe attachments:
   a. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet (6 m) long.
   b. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet (6 m) or longer.
   c. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6 m) or longer, supported on a trapeze.
   d. Spring hangers to support vertical runs.
4. Install hangers with the following maximum spacing and minimum rod sizes:
   a. NPS 3/4 (DN 20): Maximum span, 9 feet (2.7 m); minimum rod size, 1/4 inch (6.4 mm).

b. NPS 1 (DN 25): Maximum span, 9 feet (2.7 m); minimum rod size, 1/4 inch (6.4 mm).
c. NPS 1-1/2 (DN 40): Maximum span, 12 feet (3.7 m); minimum rod size, 3/8 inch (10 mm).
d. NPS 2 (DN 50): Maximum span, 13 feet (4 m); minimum rod size, 3/8 inch (10 mm).
e. NPS 2-1/2 (DN 65): Maximum span, 14 feet (4.3 m); minimum rod size, 3/8 inch (10 mm).
f. NPS 3 (DN 80): Maximum span, 15 feet (4.6 m); minimum rod size, 3/8 inch (10 mm).
g. NPS 4 (DN 100): Maximum span, 17 feet (5.2 m); minimum rod size, 1/2 inch (13 mm).
h. NPS 6 (DN 150): Maximum span, 21 feet (6.4 m); minimum rod size, 1/2 inch (13 mm).
i. NPS 8 (DN 200): Maximum span, 24 feet (7.3 m); minimum rod size, 5/8 inch (16 mm).
j. NPS 10 (DN 250): Maximum span, 26 feet (8 m); minimum rod size, 3/4 inch (19 mm).
k. NPS 12 (DN 300): Maximum span, 30 feet (9.1 m); minimum rod size, 7/8 inch (22 mm).
l. NPS 14 (DN 350): Maximum span, 32 feet (9.8 m); minimum rod size, 1 inch (25 mm).
m. NPS 16 (DN 400): Maximum span, 35 feet (10.7 m); minimum rod size, 1 inch (25 mm).
n. NPS 18 (DN 450): Maximum span, 37 feet (11.3 m); minimum rod size, 1-1/4 inches (32 mm).
o. NPS 20 (DN 500): Maximum span, 39 feet (11.9 m); minimum rod size, 1-1/4 inches (32 mm).

5. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
   a. NPS 1/2 (DN 15): Maximum span, 4 feet (1.2 m); minimum rod size, 1/4 inch (6.4 mm).
   b. NPS 3/4 (DN 20): Maximum span, 5 feet (1.5 m); minimum rod size, 1/4 inch (6.4 mm).
   c. NPS 1 (DN 25): Maximum span, 6 feet (1.8 m); minimum rod size, 1/4 inch (6.4 mm).
   d. NPS 1-1/2 (DN 40): Maximum span, 8 feet (2.4 m); minimum rod size, 3/8 inch (10 mm).
   e. NPS 2 (DN 50): Maximum span, 8 feet (2.4 m); minimum rod size, 3/8 inch (10 mm).
   f. NPS 2-1/2 (DN 65): Maximum span, 9 feet (2.7 m); minimum rod size, 3/8 inch (10 mm).
   g. NPS 3 (DN 80): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (10 mm).
6. Support vertical runs at roof, at each floor, and at 10-foot (3-m) intervals between floors.
7. Fiberglass Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.

K. Pipe Joint Construction
1. Join pipe and fittings according to the following requirements and Division 21 specifying piping systems.
2. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
3. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
4. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube ends. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
5. 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.
6. 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:
   a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
7. Welded Joints: Construct joints according to AWS D10.12 (AWS D10.12M), using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
8. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
9. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

L. Terminal Equipment Connections

1. Size for supply and return piping connections shall be the same as or larger than equipment connections.
2. Install traps and control valves in accessible locations close to connected equipment.
3. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
4. Install vacuum breakers downstream from control valve, close to coil inlet connection.
5. Install a drip leg at coil outlet.

M. Field Quality Control
1. Prepare steam and condensate piping according to ASME B31.1, "Power Piping" **AND/OR** ASME B31.9, "Building Services Piping," **as directed,** and as follows:
   a. Leave joints, including welds, uninsulated and exposed for examination during test.
   b. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
   c. Flush system with clean water. Clean strainers.
   d. 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.
2. Perform the following tests on steam and condensate piping:
   a. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
   b. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength.
   c. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
3. Prepare written report of testing.

END OF SECTION 22 11 16 00d

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SECTION 22 11 16 00e - REFRIGERANT PIPING

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for refrigerant piping. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes refrigerant piping used for air-conditioning applications.

C. Performance Requirements
1. Line Test Pressure for Refrigerant R-22:
   a. Suction Lines for Air-Conditioning Applications: 185 psig (1276 kPa).
   b. Suction Lines for Heat-Pump Applications: 325 psig (2241 kPa).
   c. Hot-Gas and Liquid Lines: 325 psig (2241 kPa).
2. Line Test Pressure for Refrigerant R-134a:
   a. Suction Lines for Air-Conditioning Applications: 115 psig (793 kPa).
   b. Suction Lines for Heat-Pump Applications: 225 psig (1551 kPa).
   c. Hot-Gas and Liquid Lines: 225 psig (1551 kPa).
3. Line Test Pressure for Refrigerant R-407C:
   a. Suction Lines for Air-Conditioning Applications: 230 psig (1586 kPa).
   b. Suction Lines for Heat-Pump Applications: 380 psig (2620 kPa).
   c. Hot-Gas and Liquid Lines: 380 psig (2620 kPa).
4. Line Test Pressure for Refrigerant R-410A:
   a. Suction Lines for Air-Conditioning Applications: 300 psig (2068 kPa).
   b. Suction Lines for Heat-Pump Applications: 535 psig (3689 kPa).
   c. Hot-Gas and Liquid Lines: 535 psig (3689 kPa).

D. Submittals
1. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:
   a. Thermostatic expansion valves.
   b. Solenoid valves.
   c. Hot-gas bypass valves.
   d. Filter dryers.
   e. Strainers.
   f. Pressure-regulating valves.
2. 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.
   a. Shop Drawing Scale: 1/4 inch equals 1 foot (1:50).
   b. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
3. Welding certificates.
4. Field quality-control test reports.
5. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

E. Quality Assurance
1. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
2. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
3. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

F. Product Storage And Handling
1. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.2 PRODUCTS

A. Copper Tube And Fittings
1. Copper Tube: ASTM B 88, Type K or L (ASTM B 88M, Type A or B) **OR** ASTM B 280, Type ACR, **as directed**.
2. Wrought-Copper Fittings: ASME B16.22.
3. Wrought-Copper Unions: ASME B16.22.
4. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
5. Brazing Filler Metals: AWS A5.8.
6. Flexible Connectors:
   a. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
   b. End Connections: Socket ends.
   c. Offset Performance: Capable of minimum 3/4-inch (20-mm) misalignment in minimum 7-inch- (180-mm-) long assembly.
   d. Pressure Rating: Factory test at minimum 500 psig (3450 kPa).
   e. Maximum Operating Temperature: 250 deg F (121 deg C).

B. Steel Pipe And Fittings
1. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; Type, Grade, and wall thickness as selected in Part 3 piping applications articles.
2. Wrought-Steel Fittings: ASTM A 234/A 234M, for welded joints.
3. Steel Flanges and Flanged Fittings: ASME B16.5, steel, including bolts, nuts, and gaskets, bevel-welded end connection, and raised face.
4. 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.
5. Flanged Unions:
   a. Body: Forged-steel flanges for NPS 1 to NPS 1-1/2 (DN 25 to DN 40) and ductile iron for NPS 2 to NPS 3 (DN 50 to DN 80). Apply rust-resistant finish at factory.
   b. Gasket: Fiber asbestos free.
   c. Fasteners: Four plated-steel bolts, with silicon bronze nuts. Apply rust-resistant finish at factory.
   d. End Connections: Brass tailpiece adapters for solder-end connections to copper tubing.
   e. Offset Performance: Capable of minimum 3/4-inch (20-mm) misalignment in minimum 7-inch- (180-mm-) long assembly.
   f. Pressure Rating: Factory test at minimum 400 psig (2760 kPa).
   g. Maximum Operating Temperature: 330 deg F (165 deg C).
6. Flexible Connectors:
   a. Body: Stainless-steel bellows with woven, flexible, stainless-steel-wire-reinforced protective jacket
   b. End Connections:
      1) NPS 2 (DN 50) and Smaller: With threaded-end connections.
      2) NPS 2-1/2 (DN 65) and Larger: With flanged-end connections.

c. Offset Performance: Capable of minimum 3/4-inch (20-mm) misalignment in minimum 7-inch- (180-mm-) long assembly.
d. Pressure Rating: Factory test at minimum 500 psig (3450 kPa).
e. Maximum Operating Temperature: 250 deg F (121 deg C).

C. Valves And Specialties
1. Diaphragm Packless Valves:
a. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
b. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
c. Operator: Rising stem and hand wheel.
d. Seat: Nylon.
e. End Connections: Socket, union, or flanged.
f. Working Pressure Rating: 500 psig (3450 kPa).
g. Maximum Operating Temperature: 275 deg F (135 deg C).
2. Packed-Angle Valves:
a. Body and Bonnet: Forged brass or cast bronze.
b. Packing: Molded stem, back seating, and replaceable under pressure.
c. Operator: Rising stem.
d. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
e. Seal Cap: Forged-brass or valox hex cap.
f. End Connections: Socket, union, threaded, or flanged.
g. Working Pressure Rating: 500 psig (3450 kPa).
h. Maximum Operating Temperature: 275 deg F (135 deg C).
3. Check Valves:
a. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
b. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
c. Piston: Removable polytetrafluoroethylene seat.
d. Closing Spring: Stainless steel.
e. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
f. End Connections: Socket, union, threaded, or flanged.
g. Maximum Opening Pressure: 0.50 psig (3.4 kPa).
h. Working Pressure Rating: 500 psig (3450 kPa).
i. Maximum Operating Temperature: 275 deg F (135 deg C).
4. Service Valves:
a. Body: Forged brass with brass cap including key end to remove core.
b. Core: Removable ball-type check valve with stainless-steel spring.
c. Seat: Polytetrafluoroethylene.
d. End Connections: Copper spring.
e. Working Pressure Rating: 500 psig (3450 kPa).
5. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.
a. Body and Bonnet: Plated steel.
b. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
c. Seat: Polytetrafluoroethylene.
d. End Connections: Threaded.
e. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch (16-GRC) conduit adapter, and 24 **OR** 115 **OR** 208, **as directed**,-V ac coil.
f. Working Pressure Rating: 400 psig (2760 kPa).
g. Maximum Operating Temperature: 240 deg F (116 deg C).
h. Manual operator.
6. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
a. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
b. Piston, Closing Spring, and Seat Insert: Stainless steel.
c. Seat Disc: Polytetrafluoroethylene.
d. End Connections: Threaded.

e. Working Pressure Rating: 400 psig (2760 kPa).
f. Maximum Operating Temperature: 240 deg F (116 deg C).

7. Thermostatic Expansion Valves: Comply with ARI 750.
   a. Body, Bonnet, and Seal Cap: Forged brass or steel.
   b. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
   c. Packing and Gaskets: Non-asbestos.
   d. Capillary and Bulb: Copper tubing filled with refrigerant charge.
   e. Suction Temperature: 40 deg F (4.4 deg C).
   f. Superheat: Adjustable **OR** Nonadjustable, **as directed**.
   g. Reverse-flow option (for heat-pump applications).
   h. End Connections: Socket, flare, or threaded union.
   i. Working Pressure Rating: 700 psig (4820 kPa) **OR** 450 psig (3100 kPa), **as directed**.
8. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.
   a. Body, Bonnet, and Seal Cap: Ductile iron or steel.
   b. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
   c. Packing and Gaskets: Non-asbestos.
   d. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
   e. Seat: Polytetrafluoroethylene.
   f. Equalizer: Internal **OR** External, **as directed**.
   g. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch (16-GRC) conduit adapter, and 24 **OR** 115 **OR** 208, **as directed**,-V ac coil.
   h. End Connections: Socket.
   i. Set Pressure: as directed by the Owner.
   j. Throttling Range: Maximum 5 psig (34 kPa).
   k. Working Pressure Rating: 500 psig (3450 kPa).
   l. Maximum Operating Temperature: 240 deg F (116 deg C).
9. Straight-Type Strainers:
   a. Body: Welded steel with corrosion-resistant coating.
   b. Screen: 100-mesh stainless steel.
   c. End Connections: Socket or flare.
   d. Working Pressure Rating: 500 psig (3450 kPa).
   e. Maximum Operating Temperature: 275 deg F (135 deg C).
10. Angle-Type Strainers:
   a. Body: Forged brass or cast bronze.
   b. Drain Plug: Brass hex plug.
   c. Screen: 100-mesh monel.
   d. End Connections: Socket or flare.
   e. Working Pressure Rating: 500 psig (3450 kPa).
   f. Maximum Operating Temperature: 275 deg F (135 deg C).
11. Moisture/Liquid Indicators:
   a. Body: Forged brass.
   b. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
   c. Indicator: Color coded to show moisture content in ppm.
   d. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
   e. End Connections: Socket or flare.
   f. Working Pressure Rating: 500 psig (3450 kPa).
   g. Maximum Operating Temperature: 240 deg F (116 deg C).
12. Replaceable-Core Filter Dryers: Comply with ARI 730.
   a. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
   b. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
   c. Desiccant Media: Activated alumina **OR** charcoal, **as directed**.
   d. Designed for reverse flow (for heat-pump applications).
   e. End Connections: Socket.

f. Access Ports: NPS 1/4 (DN 8) connections at entering and leaving sides for pressure differential measurement.
g. Maximum Pressure Loss: 2 psig (14 kPa).
h. Rated Flow: as directed by the Owner.
i. Working Pressure Rating: 500 psig (3450 kPa).
j. Maximum Operating Temperature: 240 deg F (116 deg C).

13. Permanent Filter Dryers: Comply with ARI 730.
    a. Body and Cover: Painted-steel shell.
    b. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
    c. Desiccant Media: Activated alumina **OR** charcoal, **as directed**.
    d. Designed for reverse flow (for heat-pump applications).
    e. End Connections: Socket.
    f. Access Ports: NPS 1/4 (DN 8) connections at entering and leaving sides for pressure differential measurement.
    g. Maximum Pressure Loss: 2 psig (14 kPa).
    h. Rated Flow: as directed by the Owner.
    i. Working Pressure Rating: 500 psig (3450 kPa).
    j. Maximum Operating Temperature: 240 deg F (116 deg C).
14. Mufflers:
    a. Body: Welded steel with corrosion-resistant coating.
    b. End Connections: Socket or flare.
    c. Working Pressure Rating: 500 psig (3450 kPa).
    d. Maximum Operating Temperature: 275 deg F (135 deg C).
15. Receivers: Comply with ARI 495.
    a. Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
    b. Comply with UL 207; listed and labeled by an NRTL.
    c. Body: Welded steel with corrosion-resistant coating.
    d. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
    e. End Connections: Socket or threaded.
    f. Working Pressure Rating: 500 psig (3450 kPa).
    g. Maximum Operating Temperature: 275 deg F (135 deg C).
16. Liquid Accumulators: Comply with ARI 495.
    a. Body: Welded steel with corrosion-resistant coating.
    b. End Connections: Socket or threaded.
    c. Working Pressure Rating: 500 psig (3450 kPa).
    d. Maximum Operating Temperature: 275 deg F (135 deg C).

D. Refrigerants
1. ASHRAE 34, R-22: Monochlorodifluoromethane.
2. ASHRAE 34, R-134a: Tetrafluoroethane.
3. ASHRAE 34, R-407C: Difluoromethane/Pentafluoroethane/1,1,1,2-Tetrafluoroethane.
4. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

1.3 EXECUTION

A. Piping Applications For Refrigerant R-22
1. Suction Lines NPS 1-1/2 (DN 40) and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.
   OR
   Suction Lines NPS 4 (DN 100) and Smaller **OR** NPS 2 to NPS 4 (DN 50 to DN 100), **as directed**, for Conventional Air-Conditioning Applications: Copper, Type ACR **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.

2. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications, **as directed**: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.
   OR
   Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications, **as directed**: Copper, Type ACR **OR** K (A) **OR** L (B, **as directed**, drawn-temper tubing and wrought-copper fittings with soldered joints.
   OR
   Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications, **as directed**:
   a. NPS 1-1/2 (DN 40) and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.
      OR
      NPS 1-1/2 (DN 40) and Smaller: Copper, Type ACR **OR** L (B), **as directed,** drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.
   b. NPS 2 to NPS 3 (DN 50 to DN 80): Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.
   c. NPS 4 (DN 100): Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with soldered joints.
3. Safety-Relief-Valve Discharge Piping: Schedule 40, black-steel and wrought-steel fittings with welded joints.
   OR
   Safety-Relief-Valve Discharge Piping: Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with soldered joints.
   OR
   Safety-Relief-Valve Discharge Piping:
   a. NPS 1-1/2 (DN 40) and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.
      OR
      NPS 1-1/2 (DN 40) and Smaller: Copper, Type ACR **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with brazed joints.
   b. NPS 2 to NPS 3 (DN 50 to DN 80): Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.
   c. NPS 4 (DN 100): Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with soldered joints.

B. Piping Applications For Refrigerant R-134a
1. Suction Lines NPS 1-1/2 (DN 40) and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed,** joints.
   OR
   Suction Lines NPS 4 (DN 100) and Smaller **OR** NPS 2 to NPS 4 (DN 50 to DN 100), **as directed**, for Conventional Air-Conditioning Applications: Copper, Type ACR **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed,** joints.
2. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications, **as directed**: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed,** joints.
   OR
   Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications, **as directed**: Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with soldered joints.
   OR
   Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications, **as directed**:
   a. NPS 1-1/2 (DN 40) and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed,** joints.
      OR

NPS 1-1/2 (DN 40) and Smaller: Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.

b. NPS 4 (DN 100): Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.

3. Safety-Relief-Valve Discharge Piping: Schedule 40, black-steel and wrought-steel fittings with welded joints.

OR

Safety-Relief-Valve Discharge Piping: Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with soldered joints.

OR

Safety-Relief-Valve Discharge Piping:

a. NPS 1-1/2 (DN 40) and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.

OR

NPS 1-1/2 (DN 40) and Smaller: Copper, Type ACR **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.

b. NPS 4 (DN 100): Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.

C. Piping Applications For Refrigerant R-407c

1. Suction Lines NPS 1-1/2 (DN 40) and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings

OR

Suction Lines NPS 4 (DN 100) and Smaller **OR** NPS 2 to NPS 4 (DN 50 to DN 100), **as directed**, for Conventional Air-Conditioning Applications: Copper, Type ACR **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.

2. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications, **as directed**: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.

OR

Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications, **as directed**: Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with soldered joints.

OR

Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications, **as directed**:

a. NPS 1 (DN 25) and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.

OR

NPS 1 (DN 25) and Smaller: Copper, Type ACR **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.

b. NPS 1-1/4 to NPS 2 (DN 32 to DN 50): Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.

c. NPS 4 (DN 100): Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with soldered joints.

3. Safety-Relief-Valve Discharge Piping: Schedule 40, black-steel and wrought-steel fittings with welded joints.

OR

Safety-Relief-Valve Discharge Piping: Copper, Type ACR **OR** K (A) **OR** L (B**)**, **as directed**, drawn-temper tubing and wrought-copper fittings with soldered joints.

OR

Safety-Relief-Valve Discharge Piping:

a. NPS 1 (DN 25) and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed **OR** soldered joints.

OR

NPS 1 (DN 25) and Smaller: Copper, Type ACR **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.

b. NPS 1-1/4 to NPS 2 (DN 32 to DN 50): Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.

c. NPS 4 (DN 100): Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with soldered joints.

D. Piping Applications For Refrigerant R-410a

1. Suction Lines NPS 1-1/2 (DN 40) and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.

OR

Suction Lines NPS 3-1/2 (DN 90) and Smaller **OR** NPS 2 to NPS 3-1/2 (DN 50 to DN 90), **as directed**, for Conventional Air-Conditioning Applications: Copper, Type ACR **OR** L (B), **as directed,** drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.

OR

Suction Lines NPS 4 (DN 100) and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with soldered joints.

2. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications, **as directed**: Copper, Type ACR **OR** L (B), **as directed**, annealed- or drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.

OR

Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications, **as directed** Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.

OR

Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications, **as directed**: Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.

OR

Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications, **as directed**: Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.

OR

Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications, **as directed**:

a. NPS 5/8 (DN 18) and Smaller: Copper, Type ACR **OR** L (B), **as directed**, annealed- or drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.

b. NPS 3/4 to NPS 1 (DN 20 to DN 25) and Smaller: Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.

c. NPS 1-1/4 (DN 32) and Smaller: Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.

d. NPS 1-1/2 to NPS 2 (DN 40 to DN 50): Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.

OR

Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications, **as directed**, NPS 2 to NPS 4 (DN 50 to DN 100): Schedule 40, black-steel and wrought-steel fittings with welded joints.

3. Safety-Relief-Valve Discharge Piping: Copper, Type ACR **OR** L (B), **as directed**, annealed- or drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.

OR

Safety-Relief-Valve Discharge Piping: Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.

OR
Safety-Relief-Valve Discharge Piping: Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.
OR
Safety-Relief-Valve Discharge Piping: Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.
OR
Safety-Relief-Valve Discharge Piping:
a. NPS 5/8 (DN 18) and Smaller: Copper, Type ACR **OR** L (B), **as directed**, annealed- or drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.
b. NPS 3/4 to NPS 1 (DN 20 to DN 25) and Smaller: Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with brazed **OR** soldered, **as directed**, joints.
c. NPS 1-1/4 (DN 32) and Smaller: Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.
d. NPS 1-1/2 to NPS 2 (DN 40 to DN 50): Copper, Type ACR **OR** K (A) **OR** L (B), **as directed**, drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.

OR
Safety-Relief-Valve Discharge Piping NPS 2 to NPS 4 (DN 50 to DN 100): Schedule 40, black-steel and wrought-steel fittings with welded joints.

E. Valve And Specialty Applications
1. Install diaphragm packless **OR** packed-angle, **as directed**, valves in suction and discharge lines of compressor.
2. 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.
3. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
4. Except as otherwise indicated, install diaphragm packless **OR** packed-angle, **as directed**, valves on inlet and outlet side of filter dryers.
5. Install a full-sized, three-valve bypass around filter dryers.
6. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.
7. Install thermostatic expansion valves as close as possible to distributors on evaporators.
   a. Install valve so diaphragm case is warmer than bulb.
   b. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
   c. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
8. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.
9. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
10. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
    a. Solenoid valves.
    b. Thermostatic expansion valves.
    c. Hot-gas bypass valves.
    d. Compressor.
11. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor, **as directed**.
12. Install receivers sized to accommodate pump-down charge.
13. Install flexible connectors at compressors.

F. Piping Installation

1. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
2. Install refrigerant piping according to ASHRAE 15.
3. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
4. 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.
5. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
6. Install piping adjacent to machines to allow service and maintenance.
7. Install piping free of sags and bends.
8. Install fittings for changes in direction and branch connections.
9. Select system components with pressure rating equal to or greater than system operating pressure.
10. Refer to Division 23 Section(s) "Instrumentation And Control For Hvac" AND "Sequence Of Operations For Hvac Controls" for solenoid valve controllers, control wiring, and sequence of operation.
11. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
12. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 08 Section "Access Doors And Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.
13. Install refrigerant piping in protective conduit where installed belowground.
14. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
15. Slope refrigerant piping as follows:
    a. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
    b. Install horizontal suction lines with a uniform slope downward to compressor.
    c. Install traps and double risers to entrain oil in vertical runs.
    d. Liquid lines may be installed level.
16. 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.
17. Before installation of steel refrigerant piping, clean pipe and fittings using the following procedures:
    a. Shot blast the interior of piping.
    b. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through tubing by means of a wire or electrician's tape.
    c. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
    d. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
    e. Finally, draw a clean, dry, lintless cloth through the tube or pipe.
    f. Safety-relief-valve discharge piping is not required to be cleaned but is required to be open to allow unrestricted flow.
18. Install pipe sleeves at penetrations in exterior walls and floor assemblies.
19. Seal penetrations through fire and smoke barriers according to Division 07 Section "Penetration Firestopping".
20. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

21. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.
22. Seal pipe penetrations through exterior walls according to Division 07 Section "Joint Sealants" for materials and methods.
23. Identify refrigerant piping and valves according to Division 23 Section "Identification For Hvac Piping And Equipment".

G. Pipe Joint Construction
1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
3. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
4. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
5. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
   a. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
   b. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.
6. Threaded Joints: Thread steel 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:
   a. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
   b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
7. Steel pipe can be threaded, but threaded joints must be seal brazed or seal welded.
8. Welded Joints: Construct joints according to AWS D10.12/D10.12M.
9. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

H. Hangers And Supports
1. Hanger, support, and anchor products are specified in Division 23 Section "Hangers And Supports For Hvac Piping And Equipment".
2. Install the following pipe attachments:
   a. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet (6 m) long.
   b. Roller hangers and spring hangers for individual horizontal runs 20 feet (6 m) or longer.
   c. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6 m) or longer, supported on a trapeze.
   d. Spring hangers to support vertical runs.
   e. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
3. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
   a. NPS 1/2 (DN 15): Maximum span, 60 inches (1500 mm); minimum rod size, 1/4 inch (6.4 mm).
   b. NPS 5/8 (DN 18): Maximum span, 60 inches (1500 mm); minimum rod size, 1/4 inch (6.4 mm).
   c. NPS 1 (DN 25): Maximum span, 72 inches (1800 mm); minimum rod size, 1/4 inch (6.4 mm).
   d. NPS 1-1/4 (DN 32): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
   e. NPS 1-1/2 (DN 40): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
   f. NPS 2 (DN 50): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
   g. NPS 2-1/2 (DN 65): Maximum span, 108 inches (2700 mm); minimum rod size, 3/8 inch (9.5 mm).

h. NPS 3 (DN 80): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (9.5 mm).
i. NPS 4 (DN 100): Maximum span, 12 feet (3.7 m); minimum rod size, 1/2 inch (13 mm).

4. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
   a. NPS 2 (DN 50): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (9.5 mm).
   b. NPS 2-1/2 (DN 65): Maximum span, 11 feet (3.4 m); minimum rod size, 3/8 inch (9.5 mm).
   c. NPS 3 (DN 80): Maximum span, 12 feet (3.7 m); minimum rod size, 3/8 inch (9.5 mm).
   d. NPS 4 (DN 100): Maximum span, 14 feet (4.3 m); minimum rod size, 1/2 inch (13 mm).
5. Support multifloor vertical runs at least at each floor.

I. Field Quality Control
1. Perform tests and inspections and prepare test reports.
2. Tests and Inspections:
   a. Comply with ASME B31.5, Chapter VI.
   b. 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.
   c. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
      1) Fill system with nitrogen to the required test pressure.
      2) System shall maintain test pressure at the manifold gage throughout duration of test.
      3) Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
      4) Remake leaking joints using new materials, and retest until satisfactory results are achieved.

J. System Charging
1. Charge system using the following procedures:
   a. Install core in filter dryers after leak test but before evacuation.
   b. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers (67 Pa). If vacuum holds for 12 hours, system is ready for charging.
   c. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig (14 kPa).
   d. Charge system with a new filter-dryer core in charging line.

K. Adjusting
1. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
2. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
3. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
4. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
   a. Open shutoff valves in condenser water circuit.
   b. Verify that compressor oil level is correct.
   c. Open compressor suction and discharge valves.
   d. Open refrigerant valves except bypass valves that are used for other purposes.
   e. Check open compressor-motor alignment and verify lubrication for motors and bearings.
5. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 22 11 16 00e

SECTION 22 11 16 00f - GENERAL-SERVICE COMPRESSED-AIR PIPING

1.1 GENERAL

A. Description Of Work:
1. This specification covers the furnishing and installation of materials for general-service compressed-air piping. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes piping and related specialties for general-service compressed-air systems operating at 200 psig (1380 kPa) or less.

C. Definitions
1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CR: Chlorosulfonated polyethylene synthetic rubber.
3. EPDM: Ethylene-propylene-diene terpolymer rubber.
4. HDPE: High-density polyethylene plastic.
5. NBR: Acrylonitrile-butadiene rubber.
6. PE: Polyethylene plastic.
7. PVC: Polyvinyl chloride plastic.
8. High-Pressure Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures between 150 and 200 psig (1035 and 1380 kPa).
9. Low-Pressure Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures of 150 psig (1035 kPa) or less.

D. Performance Requirements
1. Seismic Performance: Compressed-air piping and support and installation shall withstand effects of seismic events determined according to SEI/ASCE 7, "Minimum Design Loads for Buildings and Other Structures.".

E. Submittals
1. Product Data: For the following:
   a. Plastic pipes, fittings, and valves.
   b. Dielectric fittings.
   c. Flexible pipe connectors.
   d. Safety valves.
   e. Pressure regulators. Include rated capacities and operating characteristics.
   f. Automatic drain valves.
   g. Filters. Include rated capacities and operating characteristics.
   h. Lubricators. Include rated capacities and operating characteristics.
   i. Quick couplings.
   j. Hose assemblies.
2. Brazing **OR** Welding, **as directed**, certificates.
3. Field quality-control test reports.
4. Operation and maintenance data.

F. Quality Assurance
1. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or to AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."
2. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

3. ASME Compliance:
   a. Comply with ASME B31.1, "Power Piping," for high-pressure compressed-air piping.
   b. Comply with ASME B31.9, "Building Services Piping," for low-pressure compressed-air piping.

G. Project Conditions
1. Interruption of Existing Compressed-Air Service: Do not interrupt compressed-air service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary compressed-air service according to requirements indicated:
   a. Notify the Owner no fewer than two days in advance of proposed interruption of compressed-air service.
   b. Do not proceed with interruption of compressed-air service without the Owner's written permission.

1.2 PRODUCTS

A. Pipes, Tubes, And Fittings
1. Schedule 40, Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B, black or hot-dip zinc coated with ends threaded according to ASME B1.20.1.
   a. Steel 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 Fittings: ASME B16.3, Class 150 or 300, threaded.
   c. Malleable-Iron Unions: ASME B16.39, Class 150 or 300, threaded.
   d. Steel Flanges: ASME B16.5, Class 150 or 300, carbon steel, threaded.
   e. Wrought-Steel Butt-Welding Fittings: ASME B16.9, Schedule 40.
   f. Steel Flanges: ASME B16.5, Class 150 or 300, carbon steel.
   g. Grooved-End Fittings and Couplings:
      1) Grooved-End Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron casting; with grooves according to AWWA C606 and dimensions matching steel pipe.
      2) Couplings: AWWA C606 or UL 213, for steel-pipe dimensions and rated for 300-psig (2070-kPa) minimum working pressure. Include ferrous housing sections, gasket suitable for compressed air, and bolts and nuts. Provide EDPM gaskets for oil-free compressed air. Provide NBR gaskets if compressed air contains oil or oil vapor.
2. Schedule 5, Steel Pipe: ASTM A 135, carbon steel with plain ends and zinc-plated finish.
   a. Pressure-Seal Fittings: Listed and labeled by a qualified testing agency and FMG-approved, carbon-steel, pressure-seal housing with O-ring end seals suitable for compressed-air piping and rated for 300-psig (2070-kPa) minimum working pressure. Provide EDPM seals for oil-free compressed air. Provide NBR seals if compressed air contains oil or oil vapor.
3. Copper Tube: ASTM B 88, Type K or L (ASTM B 88M, Type A or B) and ASTM B 88, Type M (ASTM B 88M, Type C) seamless, drawn-temper, water tube.
   a. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, wrought copper with dimensions for brazed joints.
   b. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150 or 300.
   c. Copper Unions: ASME B16.22 or MSS SP-123.
   d. Press-Type Fittings, NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
   e. Press-Type Fittings, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.
   f. Extruded-Tee Outlets: Procedure for making branch outlets in copper tube according to ASTM F 2014.

g. Grooved-End Fittings and Couplings:
   1) Grooved-End Fittings: ASTM B 75 (ASTM B 75M), copper tube or ASTM B 584, bronze castings.
   2) Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, gasket suitable for compressed air, and bolts and nuts. Provide EDPM gasket for oil-free compressed air. Provide NBR gasket if compressed air contains oil or oil vapor.

4. Transition Couplings for Metal Piping: Metal coupling or other manufactured fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
5. PVC Pipe: ASTM D 1785, Schedule 40.
   a. PVC Fittings: ASTM D 2466, Schedule 40, socket type.
6. Blue ABS Piping System: Made of ASTM D 3965, ABS-resin modified to provide shatter-resistant pipe for compressed-air service. Pipe and fittings are light blue and sizes are in millimeters.
   a. Transition Fittings, 20 to 63 mm: Composite union with ABS socket end, CR O-ring, and malleable-iron union nut and threaded end; with construction similar to MSS SP-107, transition union.
   b. Transition Fittings, 90 to 110 mm: Flange assembly with ABS flange, CR gasket, and metal flange of material matching piping to be connected.
   c. Valves, 20 to 63 mm: ABS union ball valve with socket ends.
   d. Valves, 90 to 110 mm: ABS butterfly valve with lever handle.
7. Green ABS Piping System: Made of ASTM D 3965, ABS-resin modified to provide shatter-resistant pipe for compressed-air service. Pipe and fittings are dark green with SDR of 9.0 and same OD as ASTM A 53/A 53M, steel pipe.
   a. Transition Fittings, NPS 1/2 to NPS 2 (DN 15 to DN 50): Composite union with ABS socket end, CR O-ring, ABS union nut, and brass solder-joint end; with construction similar to MSS SP-107, transition union.
   b. Transition Fittings, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): ABS flange, CR gasket, and metal flange of material matching piping to be connected.
   c. Valves, NPS 1/2 to NPS 2 (DN 15 to DN 50): Union ball valve with socket ends.
   d. Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Union ball valve with flanged ends. Include safety exhaust feature in Part 3 "Valve Applications" Article if required.
8. HDPE Piping System: Made of ASTM D 1248, HDPE resin to provide shatter-resistant pipe for compressed-air service. Pipe and fittings are dark blue with pipe dimensions about the same OD as ASTM D 3035, PE pipe.
   a. Transition Fittings, NPS 1/2 to NPS 2 (DN 15 to DN 50): HDPE adapter with one socket end and one end with threaded brass insert.
   b. Transition Fittings, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): HDPE flange, CR gasket, and metal flange of material matching piping to be connected.
   c. Valves, NPS 1/2 to NPS 3 (DN 15 to DN 80): HDPE union ball valve with socket ends.

B. Joining Materials
1. Pipe-Flange Gasket Materials: Suitable for compressed-air piping system contents.
   a. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
      1) Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      2) Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
3. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
4. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
5. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated.
6. 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.
7. Solvent Cements for Joining Plastic Piping:

a. ABS Piping: ASTM D 2235.
b. PVC Piping: ASTM D 2564. Include primer complying with ASTM F 656.

C. Valves
1. Metal Ball, Butterfly, Check, Gate, and Globe Valves: Comply with requirements in Division 22 Section "General-duty Valves For Plumbing Piping".

D. Dielectric Fittings
1. General Requirements for Dielectric Fittings: Combination fitting of copper alloy and ferrous materials with insulating material; suitable for system fluid, pressure, and temperature. Include threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
2. Dielectric Unions: Factory-fabricated union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).
3. 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.
4. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
   a. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig (1035- or 2070-kPa) minimum working pressure where required to suit system pressures.

E. Flexible Pipe Connectors
1. Bronze-Hose Flexible Pipe Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
   a. Working-Pressure Rating: 200 psig (1380 kPa) **OR** 250 psig (1725 kPa), **as directed**, minimum.
   b. End Connections, NPS 2 (DN 50) and Smaller: Threaded copper pipe or plain-end copper tube.
   c. End Connections, NPS 2-1/2 (DN 65) and Larger: Flanged copper alloy.
2. Stainless-Steel-Hose Flexible Pipe Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
   a. Working-Pressure Rating: 200 psig (1380 kPa) **OR** 250 psig (1725 kPa), **as directed**, minimum.
   b. End Connections, NPS 2 (DN 50) and Smaller: Threaded steel pipe nipple.
   c. End Connections, NPS 2-1/2 (DN 65) and Larger: Flanged steel nipple.

F. Sleeves
1. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
2. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   a. Underdeck Clamp: Clamping ring with set screws.

G. Escutcheons
1. General Requirements: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and tube and OD that completely covers opening.
2. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.
3. One-Piece, Cast-Brass Escutcheons: With set screw.
   a. Finish: Polished chrome-plated **OR** Rough brass, **as directed**.
4. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.
   a. Finish: Polished chrome-plated **OR** Rough brass, **as directed**.
5. One-Piece, Stamped-Steel Escutcheons: With set screw **OR** spring clips, **as directed**, and chrome-plated finish.

6. Split-Plate, Stamped-Steel Escutcheons: With concealed **OR** exposed-rivet, **as directed**, hinge, set screw **OR** spring clips, **as directed**, and chrome-plated finish.
7. One-Piece, Floor-Plate Escutcheons: Cast iron.
8. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

H. Specialties
1. Safety Valves: ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," construction; National Board certified, labeled, and factory sealed; constructed of bronze body with poppet-type safety valve for compressed-air service.
   a. Pressure Settings: Higher than discharge pressure and same or lower than receiver pressure rating.
2. Air-Main Pressure Regulators: Bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 250-psig (1725-kPa) inlet pressure, unless otherwise indicated.
   a. Type: Pilot operated.
3. Air-Line Pressure Regulators: Diaphragm **OR** Pilot, **as directed**, operated, bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 200-psig (1380-kPa) minimum inlet pressure, unless otherwise indicated.
   OR
   Air-Line Pressure Regulators: Diaphragm operated, aluminum alloy or plastic body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 200-psig (1380-kPa) minimum inlet pressure, unless otherwise indicated.
4. Automatic Drain Valves: Stainless-steel body and internal parts, rated for 200-psig (1380-kPa) minimum working pressure, capable of automatic discharge of collected condensate. Include mounting bracket if wall mounting is indicated, **as directed**.
5. Coalescing Filters: Coalescing type with activated carbon capable of removing water and oil aerosols; with color-change dye to indicate when carbon is saturated and warning light to indicate when selected maximum pressure drop has been exceeded. Include mounting bracket if wall mounting is indicated, **as directed**.
6. Mechanical Filters: Two-stage, mechanical-separation-type, air-line filters. Equip with deflector plates, resin-impregnated-ribbon-type filters with edge filtration, and drain cock. Include mounting bracket if wall mounting is indicated, **as directed**.
7. Air-Line Lubricators: With drip chamber and sight dome for observing oil drop entering air stream; with oil-feed adjustment screw and quick-release collar for easy bowl removal. Include mounting bracket if wall mounting is indicated, **as directed**.
   a. Provide with automatic feed device for supplying oil to lubricator.

I. Quick Couplings
1. General Requirements for Quick Couplings: Assembly with locking-mechanism feature for quick connection and disconnection of compressed-air hose.
2. Automatic-Shutoff Quick Couplings: Straight-through brass body with O-ring or gasket seal and stainless-steel or nickel-plated-steel operating parts.
   a. Socket End: With one-way valve and threaded inlet for connection to piping or threaded hose fitting.
   b. Plug End: Flow-sensor-bleeder, check-valve **OR** Straight-through, **as directed**, type with barbed outlet for attaching hose.
3. Valveless Quick Couplings: Straight-through brass body with stainless-steel or nickel-plated-steel operating parts.
   a. Socket End: With O-ring or gasket seal, without valve, and with barbed inlet for attaching hose.
   b. Plug End: With barbed outlet for attaching hose.

J. Hose Assemblies
1. Description: Compatible hose, clamps, couplings, and splicers suitable for compressed-air service, of nominal diameter indicated, and rated for 300-psig (2070-kPa) minimum working pressure, unless otherwise indicated.

a. Hose: Reinforced single **OR** double, **as directed**,-wire-braid, CR-covered hose for compressed-air service.
b. Hose Clamps: Stainless-steel clamps or bands.
c. Hose Couplings: Two-piece, straight-through, threaded brass or stainless-steel O-ring or gasket-seal swivel coupling with barbed ends for connecting two sections of hose.
d. Hose Splicers: One-piece, straight-through brass or stainless-steel fitting with barbed ends for connecting two sections of hose.

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

1.3 EXECUTION

A. Piping Applications
1. Compressed-Air Piping between Air Compressors and Receivers: Use one of the following piping materials for each size range:
a. NPS 2 (DN 50) and Smaller: Schedule 40, black **OR** galvanized, **as directed**,-steel pipe; threaded, malleable-iron fittings; and threaded joints.
b. NPS 2 (DN 50) and Smaller: Schedule 5, galvanized-steel pipe; pressure-seal fittings; and pressure-sealed joints.
c. NPS 2 (DN 50) and Smaller: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.
d. NPS 2 (DN 50) and Smaller: Type K or L (Type A or B), copper tube; wrought-copper fittings; and brazed joints.
e. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Schedule 40, black **OR** galvanized, **as directed**,-steel pipe; threaded, malleable-iron fittings; and threaded joints.
f. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Schedule 40, black **OR** galvanized, **as directed**,-steel pipe; grooved-end fittings; couplings; and grooved joints.
g. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.
h. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Type K or L (Type A or B), copper tube; wrought-copper fittings; and brazed joints.
i. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Type K or L (Type A or B), copper tube; grooved-end copper fittings; couplings; and grooved joints.
j. NPS 5 (DN 125) and Larger: Schedule 40, black **OR** galvanized, **as directed**,-steel pipe; threaded, malleable-iron fittings; and threaded joints.
k. NPS 5 (DN 125) and Larger: Schedule 40, black **OR** galvanized, **as directed**,-steel pipe; grooved-end fittings; couplings; and grooved joints.
l. NPS 5 (DN 125) and Larger: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.
m. NPS 5 (DN 125) and Larger: Grooved-end, Type K or L (ASTM B 88M Type A or B), copper tube; grooved-end copper fittings; couplings; and grooved joints.
2. Low-Pressure Compressed-Air Distribution Piping: Use one of the following piping materials for each size range:
a. NPS 2 (DN 50) and Smaller: Schedule 40, black **OR** galvanized, **as directed**,-steel pipe; threaded, malleable-iron fittings; and threaded joints.
b. NPS 2 (DN 50) and Smaller: Schedule 5, galvanized-steel pipe; pressure-seal fittings; and pressure-sealed joints.
c. NPS 2 (DN 50) and Smaller: Type K or L (Type A or B), copper tube; wrought-copper fittings; and brazed **OR** soldered, **as directed**, joints.

d. NPS 2 (DN 50) and Smaller: Type K or L (Type A or B), copper tube; press-type fittings; and pressure-sealed joints.
e. NPS 2 (DN 50) and Smaller: 63-mm and smaller, blue ABS pipe and fittings; transition fittings; valves; and solvent-cemented joints.
f. NPS 2 (DN 50) and Smaller: Green ABS pipe and fittings, transition fittings, and valves; and solvent-cemented joints.
g. NPS 2 (DN 50) and Smaller: HDPE pipe, fittings, and valves; and heat-fusion joints.
h. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Schedule 40, black **OR** galvanized, **as directed**,-steel pipe; threaded, malleable-iron fittings; and threaded joints.
i. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Schedule 40, black **OR** galvanized, **as directed**,-steel pipe; grooved-end fittings; couplings; and grooved joints.
j. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Type K or L (Type A or B), copper tube; wrought-copper fittings; and brazed **OR** soldered, **as directed**, joints.
k. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Type K or L (Type A or B), copper tube; grooved-end copper fittings; couplings; and grooved joints.
l. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Type K or L (Type A or B), copper tube; press-type fittings; and pressure-sealed joints.
m. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): 90- and 110-mm, blue ABS pipe and fittings; transition fittings; and solvent-cemented joints. Include butterfly valves and flanged joints.
n. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): NPS 3 and NPS 4 (DN 80 and DN 100), green ABS pipe and fittings; transition fittings; and solvent-cemented joints. Include ball valves and flanged joints.
o. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): NPS 3 and NPS 4 (DN 80 and DN 100), HDPE pipe and fittings; valves; and heat-fusion joints.
p. NPS 5 and NPS 6 (DN 125 and DN 150): Schedule 40, black **OR** galvanized, **as directed**,-steel pipe; threaded, malleable-iron fittings; and threaded joints.
q. NPS 5 (DN 125) and Larger: Schedule 40, black **OR** galvanized, **as directed**,-steel pipe; grooved-end fittings; couplings; and grooved joints.
r. NPS 5 to NPS 8 (DN 125 to DN 200): Type K or L (Type A or B), copper tube; grooved-end copper fittings; couplings; and grooved joints.

3. High-Pressure Compressed-Air Distribution Piping: Use one of the following piping materials for each size range:
   a. NPS 2 (DN 50) and Smaller: Schedule 40, black **OR** galvanized, **as directed**,-steel pipe; threaded, malleable-iron fittings; and threaded joints.
   b. NPS 2 (DN 50) and Smaller: Schedule 5, galvanized-steel pipe; pressure-seal fittings; and pressure-sealed joints.
   c. NPS 2 (DN 50) and Smaller: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.
   d. NPS 2 (DN 50) and Smaller: Type K or L (Type A or B), copper tube; wrought-copper fittings; and brazed **OR** soldered, **as directed**, joints.
   e. NPS 2-1/2 to NPS 6 (DN 65 to DN 150): Schedule 40, black **OR** galvanized, **as directed**,-steel pipe; threaded, malleable-iron fittings; and threaded joints.
   f. NPS 2-1/2 to NPS 6 (DN 65 to DN 150): Schedule 40, black **OR** galvanized, **as directed**,-steel pipe; grooved-end fittings; couplings; and grooved joints.
   g. NPS 2-1/2 to NPS 6 (DN 65 to DN 150): Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.
   h. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Type K or L (Type A or B), copper tube; wrought-copper fittings; and brazed **OR** soldered, **as directed**, joints.
   i. NPS 2-1/2 to NPS 6 (DN 65 to DN 150): Type K or L (Type A or B), copper tube; wrought-copper fittings; and brazed joints.
   j. NPS 2-1/2 to NPS 6 (DN 65 to DN 150): Type K or L (Type A or B), copper tube; grooved-end copper fittings; couplings; and grooved joints.
   k. NPS 8 (DN 200) and Larger: Schedule 40, black **OR** galvanized, **as directed**,-steel pipe; grooved-end fittings; couplings; and grooved joints.
   l. NPS 8 (DN 200) and Larger: Schedule 40, black-steel pipe; wrought-steel fittings; and welded joints.

m. NPS 8 (DN 200): Type K or L (Type A or B), copper tube; grooved-end copper fittings; couplings; and grooved joints.

4. Drain Piping: Use one of the following piping materials:
   a. NPS 2 (DN 50) and Smaller: Type M (Type C) copper tube; wrought-copper fittings; and brazed or soldered joints.
   b. NPS 2 (DN 50) and Smaller: PVC pipe and fittings; and solvent-cemented joints.

B. Valve Applications
1. General-Duty Valves: Comply with requirements in Division 22 Section "General-duty Valves For Plumbing Piping" for metal general-duty valves. Use metal valves, unless otherwise indicated.
   a. Metal General-Duty Valves: Use valve types specified in "Valve Applications" Article in Division 22 Section "General-duty Valves For Plumbing Piping" according to the following:
      1) Low-Pressure Compressed Air: Valve types specified for low-pressure compressed air.
      2) High-Pressure Compressed Air: Valve types specified for medium-pressure compressed air.
      3) Equipment Isolation NPS 2 (DN 50) and Smaller: Safety-exhaust, copper-alloy ball valve with exhaust vent and pressure rating at least as great as piping system operating pressure.
      4) Grooved-end valves may be used with grooved-end piping and grooved joints.
   b. Plastic General-Duty Valves: Provide valves, made by piping manufacturer, that are compatible with piping. Do not use plastic valves between air compressors and receivers.
      1) Blue ABS Piping System: Ball and butterfly valves.
      2) Green ABS Piping System: Ball valves.
      3) HDPE Piping System: Ball valves.

C. Piping Installation
1. Drawing plans, schematics, and diagrams indicate general location and arrangement of compressed-air piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
2. Install piping concealed from view and protected from physical contact by building occupants, unless otherwise indicated and except in equipment rooms and service areas.
3. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.
4. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and to coordinate with other services occupying that space.
5. Install piping adjacent to equipment and machines to allow service and maintenance.
6. Install air and drain piping with 1 percent slope downward in direction of flow.
7. Install nipples, flanges, unions, transition and special fittings, and valves with pressure ratings same as or higher than system pressure rating, unless otherwise indicated.
8. Equipment and Specialty Flanged Connections:
   a. Use steel companion flange with gasket for connection to steel pipe.
   b. Use cast-copper-alloy companion flange with gasket and brazed **OR** soldered, **as directed**, joint for connection to copper tube. Do not use soldered joints for connection to air compressors or to equipment or machines producing shock or vibration.
9. Flanged joints may be used instead of specified joint for any piping or tubing system.
10. Extended-tee outlets with brazed branch connection may be used for copper tubing, within extruded-tee connection diameter to run tube diameter ratio for tube type, according to Extruded Tee Connections Sizes and Wall Thickness for Copper Tube (Inches) Table in ASTM F 2014.
11. Install eccentric reducers where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
12. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.

13. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver. Comply with requirements in Division 22 Section "Meters And Gages For Plumbing Piping".
14. Install piping to permit valve servicing.
15. Install piping free of sags and bends.
16. Install fittings for changes in direction and branch connections.
17. Install seismic restraints on piping. Seismic-restraint devices are specified in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment".

D. Joint Construction
1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
3. 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:
   a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
4. Welded Joints for Steel Piping: Join according to AWS D10.12/D10.12M.
5. Brazed Joints for Copper Tubing: Join according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
6. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Join according to ASTM B 828 or CDA's "Copper Tube Handbook."
7. Extruded-Tee Outlets for Copper Tubing: Form branches according to ASTM F 2014, with tools recommended by procedure manufacturer, and using operators qualified according to Part 1 "Quality Assurance" Article.
8. Flanged Joints: Use asbestos-free, nonmetallic gasket suitable for compressed air. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.
9. Grooved Joints: Assemble couplings with housing, gasket, lubricant, and bolts. Join according to AWWA C606 for grooved joints. Do not apply lubricant to prelubricated gaskets.
10. Heat-Fusion Joints for PE Piping: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657 for socket-fusion joints.
11. Pressure-Sealed Joints: Join with tools recommended by fitting manufacturer, using operators qualified according to Part 1 "Quality Assurance" Article.
12. Solvent-Cemented Joints for ABS Piping: Clean and dry joining surfaces. Join according to the following:
    a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
    b. Join according to ASME B31.9 for solvent-cemented joints and to ASTM D 2235 Appendix.
13. Solvent-Cemented Joints for PVC Piping: Clean and dry joining surfaces. Join according to the following:
    a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
    b. Apply primer and join according to ASME B31.9 for solvent-cemented joints and to ASTM D 2672.
14. Dissimilar Metal Piping Material Joints: Use dielectric fittings.

E. Valve Installation
1. General-Duty Valves: Comply with requirements in Division 22 Section "General-duty Valves For Plumbing Piping".
2. Install shutoff valves and unions or flanged joints at compressed-air piping to air compressors.
3. Install shutoff valve at inlet to each automatic drain valve, filter, lubricator, and pressure regulator.
4. Install check valves to maintain correct direction of compressed-air flow to and from compressed-air piping specialties and equipment.

F. Dielectric Fitting Installation
1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. NPS 2 (DN 50) and Smaller: Use dielectric unions.
3. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges.
4. NPS 5 (DN 125)and Larger: Use dielectric flange kits.

G. Flexible Pipe Connector Installation
1. Install flexible pipe connectors in discharge piping and in inlet air piping from remote air-inlet filter, **as directed**, of each air compressor.
2. Install bronze-hose flexible pipe connectors in copper compressed-air tubing.
3. Install stainless-steel-hose flexible pipe connectors in steel compressed-air piping.

H. Specialty Installation
1. Install safety valves on receivers in quantity and size to relieve at least the capacity of connected air compressors.
2. Install air-main pressure regulators in compressed-air piping at or near air compressors.
3. Install air-line pressure regulators in branch piping to equipment and tools, **as directed**.
4. Install automatic drain valves on aftercoolers, receivers, and dryers. Discharge condensate onto nearest floor drain.
5. Install coalescing filters in compressed-air piping at or near air compressors and upstream from mechanical filters. Mount on wall at locations indicated, **as directed**.
6. Install mechanical filters in compressed-air piping at or near air compressors and downstream from coalescing filters. Mount on wall at locations indicated, **as directed**.
7. Install air-line lubricators in branch piping to machine tools. Mount on wall at locations indicated, **as directed**.
8. Install quick couplings at piping terminals for hose connections.
9. Install hose assemblies at hose connections.

I. Connections
1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment and machine.
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 and machine.

J. Sleeve Installation
1. Sleeves are not required for core-drilled holes.
2. Permanent sleeves are not required for holes formed by removable PE sleeves.
3. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs using galvanized-steel pipe **OR** galvanized-steel sheet **OR** stack sleeve fittings **OR** PVC pipe, **as directed**.
   OR
   Install sleeves for pipes passing through concrete and masonry walls, gypsum board partitions, and concrete floor and roof slabs.
   a. Wall Penetrations: Cut sleeves to length for mounting flush with both surfaces.
   b. Floor Penetrations: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
4. Install sleeves in new walls and slabs as new walls and slabs are constructed.
5. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
   a. PVC **OR** Steel, **as directed**, Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
   b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum board partitions.
   c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to

2 inches (50 mm) above finished floor level. Comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim" for flashing.

1) Seal space outside of sleeve fittings with grout.

6. 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. Escutcheon Installation

1. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   a. 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 **OR** stamped steel with set screw **OR** stamped steel with set screw or spring clips **OR** stamped steel with spring clips, **as directed**.
      3) Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** One piece or split-casting, cast brass with polished chrome-plated finish **OR** Split casting, cast brass with polished chrome-plated finish **OR** One piece, stamped steel with set screw **OR** One piece or split plate, stamped steel with set screw **OR** Split plate, stamped steel with set screw, **as directed**.
      4) Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish **OR** cast brass with rough-brass finish **OR** stamped steel with set screw **OR** stamped steel with spring clips **OR** stamped steel with set screw or spring clips, **as directed**.
      5) Bare Piping in Equipment Rooms: One piece, cast brass **OR** stamped steel with set screw **OR** stamped steel with spring clips **OR** stamped steel with set screw or spring clips, **as directed**.
      6) Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.
   b. Existing Piping:
      1) Chrome-Plated Piping: Split-casting, cast brass with chrome-plated finish.
      2) Insulated Piping: Split-plate, stamped steel with concealed **OR** exposed-rivet, **as directed**, hinge and spring clips.
      3) Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and spring clips, **as directed**.
      4) Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and set screw, **as directed**.
      5) Bare Piping in Unfinished Service Spaces: Split casting, cast brass with polished chrome-plated finish **OR** casting, cast brass with rough-brass finish **OR** plate, stamped steel with concealed hinge and set screw or spring clips **OR** plate, stamped steel with concealed or exposed-rivet hinge and set screw or spring clips **OR** plate, stamped steel with exposed-rivet hinge and set screw or spring clips, **as directed**.
      6) Bare Piping in Equipment Rooms: Split casting, cast brass **OR** plate, stamped steel with set screw or spring clips, **as directed**.
      7) Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.

L. Hanger And Support Installation

1. Comply with requirements in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment" for seismic-restraint devices.
2. Comply with requirements in Division 22 Section "Hangers And Supports For Plumbing Piping And Equipment" for pipe hanger and support devices.
3. Vertical Piping: MSS Type 8 or 42, clamps.
4. Individual, Straight, Horizontal Piping Runs:
   a. 100 Feet (30 m) or Less: MSS Type 1, adjustable, steel clevis hangers.

b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.

5. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
6. Base of Vertical Piping: MSS Type 52, spring hangers.
7. Support horizontal piping within 12 inches (300 mm) of each fitting and coupling.
8. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.
9. Install hangers for Schedule 40, steel piping with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 1/4 to NPS 1/2 (DN 8 to DN 15): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
   b. NPS 3/4 to NPS 1-1/4 (DN 20 to DN 32): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
   c. NPS 1-1/2 (DN 40): 12 feet (3.7 m) with 3/8-inch (10-mm) rod.
   d. NPS 2 (DN 50): 13 feet (4 m) with 3/8-inch (10-mm) rod.
   e. NPS 2-1/2 (DN 65): 14 feet (4.3 m) with 1/2-inch (13-mm) rod.
   f. NPS 3 (DN 80): 15 feet (4.6 m) with 1/2-inch (13-mm) rod.
   g. NPS 3-1/2 (DN 90): 16 feet (4.9 m) with 1/2-inch (13-mm) rod.
   h. NPS 4 (DN 100): 17 feet (5.2 m) with 5/8-inch (16-mm) rod.
   i. NPS 5 (DN 125): 19 feet (5.8 m) with 5/8-inch (16-mm) rod.
   j. NPS 6 (DN 150): 21 feet (6.4 m) with 3/4-inch (19-mm) rod.
   k. NPS 8 (DN 200): 24 feet (7.3 m) with 3/4-inch (19-mm) rod.
   l. NPS 10 (DN 250): 26 feet (7.9 m) with 7/8-inch (22-mm) rod.
   m. NPS 12 (DN 300): 30 feet (9.1 m) with 7/8-inch (22-mm) rod.
10. Install supports for vertical, Schedule 40, steel piping every 15 feet (4.6 m).
11. Install hangers for Schedule 5, steel piping with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 1/2 (DN 15): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
   b. NPS 3/4 (DN 20): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
   c. NPS 1 (DN 25): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
   d. NPS 1-1/4 (DN 32): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
   e. NPS 1-1/2 (DN 40): 10 feet (3 m) with 3/8-inch (10-mm) rod.
   f. NPS 2 (DN 50): 11 feet (3.4 m) with 3/8-inch (10-mm) rod.
12. Install supports for vertical, Schedule 5, steel piping every 10 feet (3 m).
13. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 1/4 (DN 8): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
   b. NPS 3/8 and NPS 1/2 (DN 10 and DN 15): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
   c. NPS 3/4 (DN 20): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
   d. NPS 1 (DN 25): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
   e. NPS 1-1/4 (DN 32): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
   f. NPS 1-1/2 (DN 40): 10 feet (3 m) with 3/8-inch (10-mm) rod.
   g. NPS 2 (DN 50): 11 feet (3.4 m) with 3/8-inch (10-mm) rod.
   h. NPS 2-1/2 (DN 65): 13 feet (4 m) with 1/2-inch (13-mm) rod.
   i. NPS 3 (DN 80): 14 feet (4.3 m) with 1/2-inch (13-mm) rod.
   j. NPS 3-1/2 (DN 90): 15 feet (4.6 m) with 1/2-inch (13-mm) rod.
   k. NPS 4 (DN 100): 16 feet (4.9 m) with 1/2-inch (13-mm) rod.
   l. NPS 5 (DN 125): 18 feet (5.5 m) with 1/2-inch (13-mm) rod.
   m. NPS 6 (DN 150): 20 feet (6 m) with 5/8-inch (16-mm) rod.
   n. NPS 8 (DN 200): 23 feet (7 m) with 3/4-inch (19-mm) rod.
14. Install supports for vertical copper tubing every 10 feet (3 m).
15. Install vinyl-coated hangers for ABS piping with the following maximum horizontal spacing and minimum rod diameters:
   a. All Sizes: Install continuous support for piping with compressed air at normal operating temperature above 100 deg F (38 deg C).
   b. NPS 3/8 and NPS 1/2 (DN 10 and DN 15): 30 inches (760 mm) with 3/8-inch (10-mm) rod.

c. NPS 3/4 (DN 20): 38 inches (975 mm) with 3/8-inch (10-mm) rod.
d. NPS 1 (DN 25): 40 inches (1015 mm) with 3/8-inch (10-mm) rod.
e. NPS 1-1/4 (DN 32): 45 inches (1140 mm) with 3/8-inch (10-mm) rod.
f. NPS 1-1/2 (DN 40): 52 inches (1330 mm) with 3/8-inch (10-mm) rod.
g. NPS 2 (DN 50): 58 inches (1470 mm) with 3/8-inch (10-mm) rod.
h. NPS 3 (DN 80): 68 inches (1730 mm) with 1/2-inch (13-mm) rod.
i. NPS 4 (DN 100): 76 inches (1900 mm) with 1/2-inch (13-mm) rod.

16. Install supports for vertical ABS piping every 48 inches (1220 mm).
17. Install vinyl-coated hangers for HDPE piping with the following maximum horizontal spacing and minimum rod diameters:
    a. All Sizes: Install continuous support for piping with compressed air at normal operating temperature above 100 deg F (38 deg C).
    b. NPS 1/2 (DN 15): 30 inches (760 mm) with 3/8-inch (10-mm) rod.
    c. NPS 3/4 (DN 20): 35 inches (890 mm) with 3/8-inch (10-mm) rod.
    d. NPS 1 (DN 25): 40 inches (1015 mm) with 3/8-inch (10-mm) rod.
    e. NPS 1-1/4 (DN 32): 43 inches (1090 mm) with 3/8-inch (10-mm) rod.
    f. NPS 1-1/2 (DN 40): 49 inches (1245 mm) with 3/8-inch (10-mm) rod.
    g. NPS 2 (DN 50): 55 inches (1400 mm) with 3/8-inch (10-mm) rod.
    h. NPS 3 and NPS 4 (DN 80 and DN 100): 96 inches (2440 mm) with 1/2-inch (13-mm) rod.
18. Install supports for vertical HDPE piping every 48 inches (1220 mm).

M. Labeling And Identification
1. Install identifying labels and devices for general-service compressed-air piping, valves, and specialties. Comply with requirements in Division 22 Section "Identification For Plumbing Piping And Equipment".

N. Field Quality Control
1. Perform field tests and inspections.
2. Tests and Inspections:
    a. Piping Leak Tests for Metal Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen to pressure of 50 psig (345 kPa) above system operating pressure, but not less than 150 psig (1035 kPa). Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
    b. Piping Leak Tests for ABS Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen, at temperature of 110 deg F (43 deg C) or less, to pressure of 40 psig (275 kPa) above system operating pressure, but not less than 80 psig (550 kPa) **OR** 100 psig (690 kPa), **as directed**, or more than 120 psig (825 kPa). Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
    c. Piping Leak Tests for HDPE Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen, at temperature of 100 deg F (38 deg C) or less, to pressure of 40 psig (275 kPa) above system operating pressure, but not less than 100 psig (690 kPa) **OR** 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, or more than 180 psig (1240 kPa). Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
    d. Repair leaks and retest until no leaks exist.
    e. Inspect filters, lubricators, and pressure regulators for proper operation.
3. Prepare test reports.

END OF SECTION 22 11 16 00f

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SECTION 22 11 16 00g - COMPRESSED-AIR PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for compressed-air piping for laboratory and healthcare facilities. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Compressed-air piping and specialties for nonmedical laboratory facilities, designated "laboratory air," operating at 50 psig (345 kPa) **OR** 100 psig (690 kPa) **OR** 125 psig (860 kPa), **as directed**.
b. Medical air piping and specialties, designated "medical air," operating at 50 to 55 psig (345 to 380 kPa).
c. Dental air piping and specialties, designated "dental air," operating at 80 to 100 psig (550 to 690 kPa).
d. Gas-powered-tool air piping and specialties, designated "instrument air," operating at 175 psig (1200 kPa).
e. Healthcare laboratory air piping and specialties, designated "medical laboratory air," operating at 100 psig (690 kPa).

C. Definitions
1. D.I.S.S.: Diameter-index safety system.
2. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
3. Medical Compressed-Air Piping Systems: Include medical air, dental air, instrument air, and medical laboratory air piping systems.

D. Submittals
1. Product Data: For the following:
a. Compressed-air tubes and fittings.
b. Compressed-air valves and valve boxes.
c. Medical compressed-air service connections.
d. Medical compressed-air pressure control panels.
e. Medical compressed-air manifolds.
f. Medical compressed-air alarm system components.
2. Shop Drawings: Diagram power, signal, and control wiring.
3. Piping Material Certification: Signed by Installer certifying that medical compressed-air piping materials comply with NFPA 99 requirements.
4. Brazing certificates.
5. Field quality-control test reports.
6. Operation and maintenance data.

E. Quality Assurance
1. Installer Qualifications:
a. Medical Compressed-Air Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010.
b. Pressure-Seal Joining Procedure for Copper Tubing: Qualify operators according to training provided by Viega; Plumbing and Heating Systems.

2. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization **OR** is an NRTL, **as directed**, and that is acceptable to authorities having jurisdiction.
   a. Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.
3. Source Limitations: Obtain compressed-air service connections of same type and from same manufacturer as service connections provided for in Division 22 Section "Gas Piping For Laboratory And Healthcare Facilities".
4. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."
5. 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.
6. ASME Compliance:
   a. Comply with ASME B31.1, "Power Piping," for laboratory compressed-air piping operating at more than 150 psig (1035 kPa).
   b. Comply with ASME B31.9, "Building Services Piping," for laboratory compressed-air piping operating at 150 psig (1035 kPa) or less.
7. Comply with NFPA 99, "Health Care Facilities," for medical compressed-air system materials and installation in healthcare facilities.

F. Project Conditions
1. Interruption of Existing Laboratory and Medical Compressed-Air Service(s): Do not interrupt laboratory or medical compressed-air service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
   a. Notify the Owner no fewer than two days in advance of proposed interruption of laboratory and medical compressed-air service(s).
   b. Do not proceed with interruption of laboratory and medical compressed-air service(s) without the Owner's written permission.

1.2 PRODUCTS

A. Pipes, Tubes, And Fittings
1. Copper Medical Gas Tube: ASTM B 819, Type K **OR** Type L, **as directed**, seamless, drawn temper, that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube and in blue for Type L tube.
   a. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.
   b. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.
   c. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.
   d. Press-Type Fittings:
      1) NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
      2) NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.
2. Memory-Metal Couplings: Cryogenic compression fitting made of ASTM F 2063, nickel-titanium, shape-memory alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.

3. Copper Water Tube: ASTM B 88, Type M (ASTM B 88M, Type C), seamless, drawn temper.
   a. Copper Fittings: ASME B16.18, cast-copper or ASME B16.22, wrought-copper, solder-joint pressure type.
   b. Press-Type Fittings:
      1) NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
      2) NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.
4. PVC Pipe: ASTM D 1785, Schedule 40.
   a. PVC Fittings: ASTM D 2466, Schedule 40, socket type.

B. Joining Materials
1. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
2. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
3. Threaded-Joint Tape: PTFE.
4. Solvent Cement for Joining PVC Piping: ASTM D 2564. Include primer complying with ASTM F 656.

C. Valves
1. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
2. Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
   a. Pressure Rating: 300 psig (2070 kPa) minimum.
   b. Ball: Full-port, chrome-plated brass.
   c. Seats: PTFE or TFE.
   d. Handle: Lever type with locking device, **as directed**.
   e. Stem: Blowout proof with PTFE or TFE seal.
   f. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
3. Check Valves: In-line pattern, bronze.
   a. Pressure Rating: 300 psig (2070 kPa) minimum.
   b. Operation: Spring loaded.
   c. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
4. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
   a. Pressure Rating: 300 psig (2070 kPa) minimum.
   b. Ball: Full-port, chrome-plated brass.
   c. Seats: PTFE or TFE.
   d. Handle: Lever type with locking device, **as directed**.
   e. Stem: Blowout proof with PTFE or TFE seal.
   f. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
   g. Pressure Gage: Manufacturer installed on one copper-tube extension.
5. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.
   a. Interior Finish: Factory-applied white enamel.
   b. Cover Plate: Aluminum or extruded-anodized aluminum **OR** Satin-chrome finish steel **OR** Stainless steel with NAAMM AMP 503, No. 4 finish, **as directed**, with frangible or removable windows.
   c. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

   OR

   Zone Valve Boxes: Formed or extruded aluminum with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.

a. Interior Finish: Factory-applied white enamel.
b. Cover Plate: Aluminum or extruded-anodized aluminum **OR** Stainless steel with NAAMM AMP 503, No. 4 finish, **as directed**, with frangible or removable windows.
c. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

6. Safety Valves: Bronze-body, ASME-construction, poppet, pressure-relief type with settings to match system requirements.
7. Pressure Regulators: Bronze body and trim; spring-loaded, diaphragm-operated relieving type; manual pressure-setting adjustment; rated for 250-psig (1725-kPa) minimum inlet pressure; and capable of controlling delivered air pressure within 0.5 psig for each 10-psig (5.0 kPa for each 100-kPa) inlet pressure.
8. Automatic Drain Valves: Stainless-steel body and internal parts, rated for 200-psig (1380-kPa) minimum working pressure, capable of automatic discharge of collected condensate. Include mounting bracket where wall mounting is indicated, **as directed**.

D. Medical Compressed-Air Service Connections

1. Connection Devices: For specific medical compressed-air pressure and service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.
   a. Roughing-in Assembly:
      1) Steel outlet box for recessed mounting and concealed piping.
      2) Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed.
      3) Double seals that will prevent air leakage.
      4) ASTM B 819, NPS 3/8 (DN 10) copper outlet tube brazed to valve with service marking and tube-end dust cap.
   b. Finishing Assembly:
      1) Brass housing with primary check valve.
      2) Double seals that will prevent air leakage.
      3) Cover plate with gas-service label.
   c. Quick-Coupler Service Connections: Pressure outlet with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.
   d. D.I.S.S. Service Connections: Pressure outlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.
      1) Medical Air Service Connections: CGA V-5, D.I.S.S. No. 1160.
      2) Instrument Air Service Connections: CGA V-5, D.I.S.S. No. 1160.
   e. Cover Plates: One piece, stainless steel, with NAAMM AMP 503, No. 4 finish **OR** metal, with chrome-plated finish **OR** anodized aluminum, **as directed**, and permanent, color-coded, identifying label matching corresponding service.

E. Medical Compressed-Air Pressure Control Panels

1. Description: Steel box and support brackets for recessed roughing in with stainless-steel or anodized-aluminum cover plate with printed operating instructions. Include manifold assembly consisting of inlet supply valve, inlet supply pressure gage, line-pressure control regulator, outlet supply pressure gage, D.I.S.S. service connection, and piping outlet for remote service connection.
   a. Minimum Working Pressure: 200 psig (1380 kPa).
   b. Line-Pressure Control Regulator: Self-relieving diaphragm type with precision manual adjustment.
   c. Pressure Gages: 0- to 300-psig (0- to 2070-kPa) range.

d. Service Connection: CGA V-5, D.I.S.S. No. 1160, instrument air outlet.
e. Before final assembly, provide temporary dust shield and U-tube for testing.
f. Label cover plate "Air Pressure Control."

F. Medical Compressed-Air Manifolds
1. General Requirements for Medical Compressed-Air Manifolds: Comply with NFPA 99, Ch. 5, "Manifolds for Gas Cylinders without Reserve Supply."
2. Central Control Panel Unit: Weatherproof cabinet, supply and delivery pressure gages, electrical alarm system connections and transformer, indicator lights or devices, manifold connection, pressure changeover switch, line-pressure regulator, shutoff valves, and safety valve.
3. Manifold and Headers: Duplex, nonferrous-metal header for number of cylinders indicated, divided into two equal banks. Units include design for 2000-psig (13.8-MPa) minimum inlet pressure. Include cylinder bank headers with inlet (pigtail) connections complying with CGA V-1, individual inlet check valves, shutoff valve, pressure regulator, check valve, and pressure gage.
4. Compressed-Air Cylinders: Will be furnished by the Owner **OR** Number and type of compressed-air cylinders required for complete manifold systems, **as directed**.
5. Operation: Automatic, pressure-switch-activated changeover from one cylinder bank to the other when first bank becomes exhausted, without line-pressure fluctuation or resetting of regulators and without supply interruption by shutoff of either cylinder bank header.
6. Mounting: Wall with mounting brackets for manifold control cabinet and headers **OR** Floor with support legs for manifold control cabinet, **as directed**.
7. Label manifold control unit with permanent label identifying compressed air and system operating pressure.
8. Medical Air Manifolds: For 4 cylinders and 1250-cu. ft./h (9.85-L/s) **OR** 8 cylinders and 2500-cu. ft./h (19.7-L/s), **as directed**, capacity at 55-psig (380-kPa) line pressure.
9. Instrument Air Manifolds: For 8 cylinders and 2000-cu. ft./h (15.7-L/s) **OR** 12 cylinders and 3000-cu. ft./h (23.6-L/s), **as directed**, capacity at 200-psig (1380-kPa) minimum line pressure.

G. Medical Compressed-Air-Piping Alarm Systems
1. Panels for medical compressed-air piping systems may be combined in single panels with medical vacuum and medical gas piping systems.
2. Components: Designed for continuous service and to operate on power supplied from 120 **OR** 240 **OR** 277, **as directed**,-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.
3. Dew Point Monitors: Continuous line monitoring, having panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, factory- or field-installed valved bypass, and visual and cancelable audio signal for dryer site and master alarm panels. Alarm signals when pressure dew point rises above 39 deg F (4 deg C) at 55 psig (380 kPa).
   a. Operation: Chilled-mirror method **OR** Chilled-mirror method or hygrometer moisture analyzer with sensor probe **OR** Hygrometer moisture analyzer with sensor probe, **as directed**.
4. Pressure Switches or Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
   a. Low-Pressure Operating Range: 0- to 100-psig (0- to 690-kPa).
   b. High-Pressure Operating Range: Up to 250-psig (1725-kPa).
5. Carbon Monoxide Monitors: Panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, and factory- or field-installed valved bypass. Alarm signals when carbon monoxide level rises above 10 ppm.
6. General Requirements for Medical Compressed-Air Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
   a. Mounting: Exposed, surface **OR** Recessed, **as directed**, installation.
   b. Enclosures: Fabricated from minimum 0.047-inch- (1.2-mm-) thick steel or minimum 0.05-inch- (1.27-mm-) thick aluminum, with knockouts for electrical and piping connections.
7. Master Alarm Panels: Separate trouble alarm signals, pressure gages, and indicators for medical compressed-air piping systems.

a. Include alarm signals when the following conditions exist:
   1) Medical Air: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa), backup air compressor is in operation, pressure drop across filter assembly increases more than 2 psig (13.8 kPa), dew point rises above 39 deg F (4 deg C) at 55 psig (380 kPa), carbon monoxide level rises above 10 ppm, and high water level is reached in receiver for liquid-ring, medical air compressor systems.
   2) Dental Air: Pressure drops below 65 psig (450 kPa) or rises above 110 psig (760 kPa), backup air compressor is in operation, pressure drop across filter assembly increases more than 2 psig (13.8 kPa), dew point rises above 50 deg F (10 deg C) at 125 psig (860 kPa), and carbon monoxide level rises above 10 ppm.
   3) Instrument Air: Pressure drops below 165 psig (1140 kPa) or rises above 185 psig (1275 kPa).
   4) Medical Laboratory Air: Pressure drops below 90 psig (630 kPa) or rises above 110 psig (760 kPa).

8. Anesthetizing-Area Alarm Panels: Separate trouble alarm signals, pressure gages, and indicators for medical compressed-air piping systems.
   a. Include alarm signals when the following conditions exist:
      1) Medical Air: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).
      2) Instrument Air: Pressure drops below 165 psig (1140 kPa) or rises above 185 psig (1275 kPa).
9. Area Alarm Panels: Separate trouble alarm signals, pressure gages, and indicators for medical compressed-air piping systems.
   a. Include alarm signals when the following condition exists:
      1) Medical Air: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).
10. Dental-Area Alarm Panels: Separate trouble alarm signals, pressure gages, and indicators for medical compressed-air piping systems.
   a. Include alarm signals when the following conditions exist:
      1) Dental Air: Pressure drops below 65 psig (450 kPa) or rises above 110 psig (760 kPa), backup air compressor is in operation, pressure drop across filter assembly increases more than 2 psig (13.8 kPa), dew point rises above 50 deg F (10 deg C) at 125 psig (860 kPa), and carbon monoxide level rises above 10 ppm.
      2) Instrument Air: Pressure drops below 165 psig (1140 kPa) or rises above 185 psig (1275 kPa).
11. Medical Laboratory Area Alarm Panels: Separate trouble alarm signals, pressure gages,; and indicators for medical compressed-air piping systems.
   a. Include alarm signals when the following condition exists:
      1) Medical Laboratory Air: Pressure drops below 90 psig (630 kPa) or rises above 110 psig (760 kPa).

H. Computer Interface Cabinet
   1. Description: Wall-mounting, welded-steel control cabinet with gasketed door, mounting brackets, grounding device, and white-enamel finish for connection of medical compressed-air- piping-system alarms to facility computer. Include factory-installed signal circuit boards, power transformer, circuit breaker, wiring terminal board, and internal wiring capable of interfacing 20, **as directed**, alarm signals.

I. Compressed-Air-Cylinder Storage Racks
   1. Wall Storage Racks: Fabricate racks with chain restraints for upright cylinders as indicated or provide equivalent manufactured wall racks.
   2. Freestanding Storage Racks: Fabricate racks as indicated or provide equivalent manufactured storage racks.

J. Flexible Pipe Connectors
1. Description: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
a. Working-Pressure Rating: 200 psig (1380 kPa) **OR** 250 psig (1725 kPa), **as directed**, minimum.
b. End Connections: Threaded copper pipe or plain-end copper tube.

K. Sleeves
1. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
2. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
a. Underdeck Clamp: Clamping ring with set screws.

L. Escutcheons
1. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and tube and OD that completely covers opening.
2. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.
3. One-Piece, Cast-Brass Escutcheons: With set screw.
a. Finish: Polished chrome-plated **OR** Rough brass, **as directed**.
4. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.
a. Finish: Polished chrome-plated **OR** Rough brass, **as directed**.
5. One-Piece, Stamped-Steel Escutcheons: With set screw **OR** spring clips, **as directed**, and chrome-plated finish.
6. Split-Plate, Stamped-Steel Escutcheons: With concealed **OR** exposed-rivet, **as directed**, hinge, set screw **OR** spring clips, **as directed**, and chrome-plated finish.
7. One-Piece, Floor-Plate Escutcheons: Cast iron.
8. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

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

N. Nitrogen
1. Description: Comply with USP 28 - NF 23 for oil-free dry nitrogen.

1.3 EXECUTION

A. Piping Applications
1. Connect new tubing to existing tubing with memory-metal couplings.
2. Laboratory Air Piping: Use one of the following piping materials for each size range:
a. NPS 4 (DN 100) and Smaller: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
b. NPS 4 (DN 100) and Smaller: Type L, copper medical gas tube; press-type fittings; and pressure-sealed joints.
c. NPS 5 to NPS 8 (DN 125 to DN 200): Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
3. Medical Air Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

4. Dental Air Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
5. Instrument Air Piping:
   a. NPS 3 (DN 80) and Smaller: Use Type K **OR** Type L, **as directed**, copper medical gas tube; wrought-copper fittings; and brazed joints.
   b. NPS 3-1/2 (DN 90) and Larger: Use Type K, copper medical gas tube; wrought-copper fittings; and brazed joints.
6. Medical Laboratory Air Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
7. Drain Piping: Use one of the following piping materials:
   a. Copper water tube, cast- or wrought-copper fittings, and soldered **OR** press-type fittings, and pressure-sealed, **as directed**, joints.
   b. PVC pipe, PVC fittings, and solvent-cemented joints.

B. Piping Installation
1. Drawing plans, schematics, and diagrams indicate general location and arrangement of compressed-air piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
2. Comply with ASSE Standard #6010 for installation of compressed-air piping.
3. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
4. 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.
5. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
6. Install piping adjacent to equipment and specialties to allow service and maintenance.
7. Install air and drain piping with 1 percent slope downward in direction of flow.
8. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications below unless otherwise indicated.
9. Install eccentric reducers, if available, where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
10. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.
11. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver. Comply with requirements in Division 22 Section "Meters And Gages For Plumbing Piping".
12. Install piping to permit valve servicing.
13. Install piping free of sags and bends.
14. Install fittings for changes in direction and branch connections.
15. Install medical compressed-air piping to medical compressed-air service connections specified in this Section, to medical compressed-air service connections in equipment specified in Division 22 Section "Gas Piping For Laboratory And Healthcare Facilities", and to equipment specified in other Sections requiring medical compressed-air service.
16. Install seismic restraints on compressed-air piping. Seismic-restraint devices are specified in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment".
17. Install compressed-air service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
18. Connect compressed-air piping to air compressors and to compressed-air outlets and equipment requiring compressed-air service.
19. Install unions in copper compressed-air tubing adjacent to each valve and at final connection to each piece of equipment, machine, and specialty.

C. Valve Installation
1. Install shutoff valve at each connection to and from compressed-air equipment and specialties.
2. Install check valves to maintain correct direction of compressed-air flow from compressed-air equipment.
3. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
4. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.
5. Install safety valves on compressed-air receivers where required by NFPA 99 and where recommended by specialty manufacturers.
6. Install pressure regulators on compressed-air piping where reduced pressure is required.
7. Install automatic drain valves on equipment, specialties, and piping with drain connection. Run drain piping to floor drain so contents spill over or into it.
8. Install flexible pipe connectors in discharge piping and in inlet air piping from remote air-inlet filter, **as directed**, of each air compressor.

D. Joint Construction
1. Ream ends of PVC pipes and remove burrs.
2. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
3. Threaded Joints: Apply appropriate tape to external pipe threads.
4. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free dry nitrogen during brazing.
5. Soldered Joints: Apply ASTM B 813, water-flushable flux to tube end. Join copper tube and fittings according to ASTM B 828.
6. Pressure-Sealed Joints: Join copper tube and press-type fittings with tools recommended by fitting manufacturer.
7. Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of memory-metal coupling joints.
8. Solvent-Cemented Joints: Clean and dry joining surfaces. Join PVC pipe and fittings according to the following:
   a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   b. Apply primer and join according to ASME B31.9 for solvent-cemented joints, and ASTM D 2672.

E. Compressed-Air Service Component Installation
1. Install compressed-air pressure control panel in walls. Attach to substrate.
2. Install compressed-air manifolds on concrete base, **as directed**, anchored to substrate.
3. Install compressed-air cylinders and connect to manifold piping.
4. Install compressed-air manifolds with seismic restraints as indicated.
5. Install compressed-air-cylinder wall storage racks attached to substrate.

F. Medical Compressed-Air-Piping Alarm System Installation
1. Alarm panels for medical compressed-air piping systems may be combined in single panels with medical vacuum piping systems and medical gas piping systems.
2. Install alarm system components for medical compressed-air-piping according to and in locations required by NFPA 99.
3. Install area and master alarm panels for medical compressed-air piping system where indicated.
4. Install computer interface cabinet with connection to medical compressed-air-piping alarm system and to facility computer.

G. Sleeve Installation
1. Sleeves are not required for core-drilled holes.
2. Permanent sleeves are not required for holes formed by removable PE sleeves.

3. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs using galvanized-steel pipe **OR** galvanized-steel sheet **OR** stack sleeve fittings **OR** PVC pipe, **as directed**.
   a. Wall Penetrations: Cut sleeves to length for mounting flush with both surfaces.
   b. Floor Penetrations: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

   OR

   Install sleeves in new walls and slabs as new walls and slabs are constructed.
4. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
   a. PVC **OR** Steel, **as directed**, Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
   b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger penetrating gypsum board partitions.
   c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim" for flashing.
      1) Seal space outside of sleeve fittings with grout.
5. 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".

H. Escutcheon Installation
1. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   a. 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 **OR** stamped steel with set screw **OR** stamped steel with set screw or spring clips **OR** stamped steel with spring clips, **as directed**.
      3) Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** One piece or split casting, cast brass with polished chrome-plated finish **OR** Split casting, cast brass with polished chrome-plated finish **OR** One piece, stamped steel with set screw **OR** One piece or split plate, stamped steel with set screw **OR** Split plate, stamped steel with set screw, **as directed**.
      4) Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish **OR** cast brass with rough-brass finish **OR** stamped steel with set screw **OR** stamped steel with spring clips **OR** stamped steel with set screw or spring clips, **as directed**.
      5) Bare Piping in Equipment Rooms: One piece, cast brass **OR** stamped steel with set screw **OR** stamped steel with spring clips **OR** stamped steel with set screw or spring clips, **as directed**.
      6) Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.
   b. Existing Piping:
      1) Chrome-Plated Piping: Split casting, cast brass with chrome-plated finish.
      2) Insulated Piping: Split plate, stamped steel with concealed **OR** exposed-rivet, **as directed**, hinge and spring clips.
      3) Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and spring clips, **as directed**.

4) Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and set screw, **as directed**.
5) Bare Piping in Unfinished Service Spaces: Split casting, cast brass with polished chrome-plated finish **OR** casting, cast brass with rough-brass finish **OR** plate, stamped steel with concealed hinge and set screw or spring clips **OR** plate, stamped steel with concealed or exposed-rivet hinge and set screw or spring clips **OR** plate, stamped steel with exposed-rivet hinge and set screw or spring clips, **as directed**.
6) Bare Piping in Equipment Rooms: Split casting, cast brass **OR** plate, stamped steel with set screw or spring clips, **as directed**.
7) Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.

I. Hanger And Support Installation
1. Comply with requirements in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment" for seismic-restraint devices.
2. Comply with requirements in Division 22 Section "Hangers And Supports For Plumbing Piping And Equipment" for pipe hanger and support devices.
3. Vertical Piping: MSS Type 8 or 42, clamps.
4. 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.
5. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Division 22 Section "Hangers And Supports For Plumbing Piping And Equipment" for trapeze hangers.
6. Base of Vertical Piping: MSS Type 52, spring hangers.
7. Support horizontal piping within 12 inches (300 mm) of each fitting and coupling.
8. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.
9. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 1/4 (DN 8): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
   b. NPS 3/8 and NPS 1/2 (DN 10 and DN 15): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
   c. NPS 3/4 (DN 20): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
   d. NPS 1 (DN 25): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
   e. NPS 1-1/4 (DN 32): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
   f. NPS 1-1/2 (DN 40): 10 feet (3 m) with 3/8-inch (10-mm) rod.
   g. NPS 2 (DN 50): 11 feet (3.4 m) with 3/8-inch (10-mm) rod.
   h. NPS 2-1/2 (DN 65): 13 feet (4 m) with 1/2-inch (13-mm) rod.
   i. NPS 3 (DN 80): 14 feet (4.3 m) with 1/2-inch (13-mm) rod.
   j. NPS 3-1/2 (DN 90): 15 feet (4.6 m) with 1/2-inch (13-mm) rod.
   k. NPS 4 (DN 100): 16 feet (4.9 m) with 1/2-inch (13-mm) rod.
   l. NPS 5 (DN 125): 18 feet (5.5 m) with 1/2-inch (13-mm) rod.
   m. NPS 6 (DN 150): 20 feet (6 m) with 5/8-inch (16-mm) rod.
   n. NPS 8 (DN 200): 23 feet (7 m) with 3/4-inch (19-mm) rod.
10. Install supports for vertical copper tubing every 10 feet (3 m).

J. Labeling And Identification
1. Install identifying labels and devices for nonmedical laboratory compressed-air piping, valves, and specialties. Comply with requirements in Division 22 Section "Identification For Plumbing Piping And Equipment".
2. Install identifying labels and devices for medical compressed-air piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
   a. Medical Air: Black letters on yellow background.

b. Dental Air: Black letters on yellow-and-white diagonal stripe background.
c. Instrument Air: White letters on red background.
d. Medical Laboratory Air: Black letters on yellow-and-white checkerboard background.

K. Field Quality Control For Compressed-Air Piping In Nonmedical Laboratory Facilities
1. Perform tests and inspections of compressed-air piping in nonmedical laboratory facilities and prepare test reports.
2. Tests and Inspections:
a. Piping Leak Tests for Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry nitrogen to pressure of 50 psig (345 kPa) above system operating pressure, but not less than 150 psig (1035 kPa). Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
b. Repair leaks and retest until no leaks exist.
c. Inspect filters and pressure regulators for proper operation.

L. Field Quality Control For Medical Compressed-Air Piping In Healthcare Facilities
1. Perform tests and inspections of medical compressed-air piping systems in healthcare facilities and prepare test reports.
2. Tests and Inspections:
a. Medical Compressed-Air Testing Coordination: Perform tests, inspections, verifications, and certification of medical compressed-air piping systems concurrently with tests, inspections, and certification of medical vacuum piping and medical gas piping systems.
b. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
1) Initial blowdown.
2) Initial pressure test.
3) Cross-connection test.
4) Piping purge test.
5) Standing pressure test for positive-pressure medical compressed-air piping.
6) Repair leaks and retest until no leaks exist.
c. System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical compressed-air piping systems and perform the following tests and inspections:
1) Standing pressure test.
2) Individual-pressurization **OR** Individual-pressurization or pressure-differential **OR** Pressure-differential, **as directed**, cross-connection test.
3) Valve test.
4) Master and area alarm tests.
5) Piping purge test.
6) Piping particulate test.
7) Piping purity test.
8) Final tie-in test.
9) Operational pressure test.
10) Medical air purity test.
11) Verify correct labeling of equipment and components.
d. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
1) Inspections performed.
2) Procedures, materials, and gases used.
3) Test methods used.
4) Results of tests.
3. Remove and replace components that do not pass tests and inspections and retest as specified above.

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SECTION 22 11 16 00h - VACUUM PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for vacuum piping for laboratory and healthcare facilities. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Laboratory low-vacuum piping and specialties, designated "laboratory low vacuum" operating at 12 inches mercury (40.6 kPa vacuum) **OR** 20 inches mercury (67.7 kPa vacuum), **as directed**.
b. Laboratory high-vacuum piping and specialties, designated "laboratory high vacuum" operating at 24 inches mercury (81.3 kPa vacuum) **OR** 29 inches mercury (98.2 kPa vacuum), **as directed**.
c. Medical surgical vacuum piping and specialties, designated "medical vacuum" operating at 15 inches mercury (380 mm mercury or 50.7 kPa vacuum) **OR** 20 inches mercury (510 mm mercury or 67.7 kPa vacuum) **OR** 30 inches mercury (760 mm mercury or 101.4 kPa vacuum), **as directed**.
d. Waste anesthetic gas disposal piping and specialties, designated "WAGD evacuation" operating at 14 inches mercury (355 mm mercury or 47.2 kPa vacuum) **OR** 15 inches mercury (380 mm mercury or 50.7 kPa vacuum), **as directed**.
e. Dental vacuum piping and specialties, designated "dental vacuum" operating at 10 inches mercury (255 mm mercury or 33.8 kPa vacuum) **OR** 12 inches mercury (305 mm mercury or 40.6 kPa vacuum), **as directed**.
f. Oral-evacuation piping and specialties, designated "HVE" operating at 5 inches mercury (127 mm mercury or 16.9 kPa vacuum) **OR** 8 inches mercury (203 mm mercury or 27.0 kPa vacuum), **as directed**.
g. Healthcare laboratory vacuum piping and specialties, designated "medical laboratory vacuum" operating at 12 inches mercury (40.6 kPa vacuum) **OR** 20 inches mercury (67.7 kPa vacuum) **OR** 24 inches mercury (81.3 kPa vacuum), **as directed**.

C. Definitions
1. D.I.S.S.: Diameter-index safety system.
2. HVE: High-volume (oral) evacuation.
3. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
4. WAGD: Waste anesthetic gas disposal.
5. Medical vacuum piping systems include medical vacuum, WAGD evacuation, dental vacuum, HVE, and medical laboratory vacuum piping systems.

D. Submittals
1. Product Data: For the following:
a. Vacuum pipes **OR** tubes, **as directed**, and fittings.
b. Vacuum valves and valve boxes.
c. Medical vacuum service connections and vacuum-bottle brackets.
2. LEED Submittal:
a. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.
3. Shop Drawings: Diagram power, signal, and control wiring.

4. Piping Material Certification: Signed by Installer certifying that medical vacuum piping materials comply with NFPA 99 requirements.
5. Qualification Data: For Installer and testing agency.
6. Brazing certificates.
7. Field quality-control test reports.
8. Operation and maintenance data.

E. Quality Assurance
1. Installer Qualifications:
   a. Medical Vacuum Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010.
   b. Extruded-Tee Outlet Procedure: Qualify operators according to training provided by T-DRILL Industries Inc., for making branch outlets.
   c. Pressure-Seal Joining Procedure for Copper Tubing: Qualify operators according to training provided by Viega; Plumbing and Heating Systems.
2. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL, and that is acceptable to authorities having jurisdiction.
   a. Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.
3. Source Limitations: Obtain vacuum service connections of same type and from same manufacture as service connections provided for in Division 22 Section "Gas Piping For Laboratory And Healthcare Facilities".
4. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."
5. 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.
6. Comply with ASME B31.9, "Building Services Piping," for vacuum piping in laboratory facilities.
7. NFPA Compliance: Comply with NFPA 99, "Health Care Facilities," for medical vacuum system materials and installation in healthcare facilities.

F. Project Conditions
1. Interruption of Existing Laboratory or Medical Vacuum Service(s): Do not interrupt laboratory or medical vacuum service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
   a. Notify the Owner no fewer than two days in advance of proposed interruption of laboratory or medical vacuum service(s).
   b. Do not proceed with interruption of laboratory or medical vacuum service(s) without the Owner's written permission.

1.2 PRODUCTS

A. Pipes, Tubes, And Fittings
1. Copper Medical Gas Tube: ASTM B 819, Type L, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in blue.
   a. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.

b. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.
c. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.
d. Press-Type Fittings:
1) NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
2) NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.

2. Copper Water Tube: ASTM B 88, Type M (ASTM B 88M, Type C), seamless, drawn temper.
a. Cast-Copper Fittings: ASME B16.18, solder-joint pressure type.
b. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type.
c. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150.
d. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.
e. Press-Type Fittings:
1) NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
2) NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.

3. Extruded-Tee Outlets: ASTM F 2014 procedure for making branch outlets in copper tube.
4. Memory-Metal Couplings: Cryogenic compression fitting made of ASTM F 2063, nickel-titanium, shape-memory alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.
5. PVC Pipe: ASTM D 1785, Schedule 40 and Schedule 80.
a. PVC Pressure Fittings: ASTM D 2466, Schedule 40 and ASTM D 2467, Schedule 80; socket type.

B. Joining Materials
1. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
2. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
3. Threaded-Joint Tape: PTFE.
4. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness, full-face type.
5. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.
6. Solvent Cement for Joining PVC Piping: ASTM D 2564. Include primer complying with ASTM F 656.
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).

C. Valves
1. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
a. Exception: Factory cleaning and bagging are not required for valves for WAGD service.
2. Copper-Alloy Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
a. Pressure Rating: 300 psig (2070 kPa) minimum.
b. Ball: Full-port, chrome-plated brass.
c. Seats: PTFE or TFE.
d. Handle: Lever type with locking device, **as directed**.
e. Stem: Blowout proof with PTFE or TFE seal.
f. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
3. Bronze Check Valves: In-line pattern.
a. Pressure Rating: 300 psig (2070 kPa) minimum.
b. Operation: Spring loaded.

c. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

4. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
   a. Pressure Rating: 300 psig (2070 kPa) minimum.
   b. Ball: Full-port, chrome-plated brass.
   c. Seats: PTFE or TFE.
   d. Handle: Lever type with locking device, **as directed**.
   e. Stem: Blowout proof with PTFE or TFE seal.
   f. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
   g. Vacuum Gage: Manufacturer installed on one copper-tube extension.
5. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with vacuum gages and in sizes required to permit manual operation of valves.
   a. Interior Finish: Factory-applied white enamel.
   b. Cover Plate: Aluminum or extruded-anodized aluminum **OR** Satin-chrome finish steel **OR** Stainless steel with NAAMM AMP 503, No. 4 finish, **as directed**, with frangible or removable windows.
   c. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.
6. Zone Valve Boxes: Formed or extruded aluminum with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with vacuum gages and in sizes required to permit manual operation of valves.
   a. Interior Finish: Factory-applied white enamel.
   b. Cover Plate: Aluminum or extruded-anodized aluminum **OR** Stainless steel with NAAMM AMP 503, No. 4 finish, **as directed**, with frangible or removable windows.
   c. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.
7. PVC Ball Valves: MSS SP-122, with union ends and 150-psig (1035-kPa) minimum working-pressure rating and suitable for vacuum service.
8. PVC Butterfly Valves: Lug type with lever handle and 150-psig (1035-kPa) minimum working-pressure rating and suitable for vacuum service.
9. PVC Check Valves: Ball-, in-line-, piston-, or swing-check design with flanged or union ends and 70-psig (480-kPa) **OR** 100-psig (690-kPa), **as directed**, minimum working-pressure rating and suitable for vacuum service.
10. Safety Valves: Bronze-body, ASME-construction, pressure-relief type with settings to match system requirements.
11. Automatic Drain Valves: Stainless-steel body and internal parts, rated for 200-psig (1380-kPa) minimum working pressure, capable of automatic discharge of collected condensate. Include mounting bracket where wall mounting is indicated.

D. Medical Vacuum Service Connections
1. Connection Devices: For specific medical vacuum service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.
   a. Roughing-in Assembly:
      1) Steel outlet box for recessed mounting and concealed piping.
      2) Brass-body inlet block.
      3) Seals that will prevent vacuum leakage.
      4) ASTM B 819, NPS 3/8 (DN 10) copper outlet tube brazed to valve with service marking and tube-end dust cap.
   b. Finishing Assembly:
      1) Brass housing with primary check valve.
      2) Seals that will prevent vacuum leakage.
      3) Cover plate with gas-service label.

c. Quick-Coupler Service Connections: Suction inlets for medical vacuum **OR** medical vacuum and WAGD evacuation **OR** WAGD evacuation, **as directed**, service outlets with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.

d. D.I.S.S. Service Connections: Suction inlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.

1) Medical Vacuum Service Connections: CGA V-5, D.I.S.S. No. 1220.

2) WAGD Evacuation Service Connections: CGA V-5, D.I.S.S. No. 2220.

e. Vacuum Bottle Brackets: One piece, with pattern and finish matching corresponding service cover plate.

f. Cover Plates: One piece, stainless steel, with NAAMM AMP 503, No. 4 finish **OR** metal, with chrome-plated finish **OR** anodized aluminum, **as directed**, and permanent, color-coded, identifying label matching corresponding service.

E. Medical Vacuum Piping Alarm Systems

1. Panels for medical vacuum piping systems may be combined in single panels with medical compressed-air and medical gas piping systems.

2. Components: Designed for continuous service and to operate on power supplied from 120-V **OR** 240-V **OR** 277-V, **as directed**, ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.

3. Vacuum Switches or Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.

a. Vacuum Operating Range: 0- to 30-in. Hg (0- to 101-kPa vacuum).

4. General Requirements for Medical Vacuum Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.

a. Mounting: Exposed, surface **OR** Recessed, **as directed**, installation.

b. Enclosures: Fabricated from minimum 0.047-inch- (1.2-mm-) thick steel or minimum 0.05-inch- (1.27-mm-) thick aluminum, with knockouts for electrical and piping connections.

5. Master Alarm Panels: With separate trouble alarm signals, vacuum gages, and indicators for medical vacuum piping systems.

a. Include alarm signals when the following conditions exist:

1) Medical Vacuum: Vacuum drops below 12-in. Hg (40 kPa vacuum) and backup vacuum pump is in operation.

2) WAGD Evacuation: Vacuum drops below 12-in. Hg (40 kPa vacuum).

3) Dental Vacuum: Vacuum drops below 6-in. Hg (20 kPa vacuum) and backup vacuum producer is in operation.

4) HVE: 4-in. Hg (13 kPa vacuum) and backup vacuum producer is in operation.

5) Medical Laboratory Vacuum: Vacuum drops below 10-in. Hg (34 kPa vacuum).

6. Anesthetizing-Area Alarm Panels: Separate trouble alarm signals; vacuum gages; and indicators for medical vacuum piping systems.

a. Include alarm signals when the following conditions exist:

1) Medical Vacuum: Vacuum drops below 12-in. Hg (40 kPa vacuum).

2) WAGD Evacuation: Vacuum drops below 12-in. Hg (40 kPa vacuum).

7. Area Alarm Panels: Separate trouble alarm signals; vacuum gages; and indicators for medical vacuum piping systems.

a. Include alarm signals when the following condition exists:

1) Medical Vacuum: Vacuum drops below 12-in. Hg (40 kPa vacuum).

8. Dental Area Alarm Panels: Separate trouble alarm signals; vacuum gages; and indicators for medical vacuum piping systems.

a. Include alarm signals when the following conditions exist:

1) Dental Vacuum: Vacuum drops below 6-in. Hg (20 kPa vacuum) and backup vacuum producer is in operation.

2) HVE: 4-in. Hg (13 kPa vacuum) and backup vacuum producer is in operation.

9. Medical Laboratory Area Alarm Panels: Separate trouble alarm signals; vacuum gages; and indicators for medical vacuum piping systems.
   a. Include alarm signals when the following condition exists:
      1) Medical Vacuum: Vacuum drops below 12-in. Hg (40 kPa vacuum).

F. Computer Interface Cabinet
1. Description: Wall-mounting, welded-steel, control cabinet with gasketed door, mounting brackets, grounding device, and white-enamel finish for connection of medical vacuum piping system alarms to facility computer. Include factory-installed signal circuit boards, power transformer, circuit breaker, wiring terminal board, and internal wiring capable of interfacing 20 alarm signals.

G. Flexible Pipe Connectors
1. Description: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
   a. Working-Pressure Rating: 200 psig (1380 kPa) **OR** 250 psig (1725 kPa), **as directed**, minimum.
   b. End Connections: Threaded copper pipe or plain-end copper tube.

H. Sleeves
1. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
2. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   a. Underdeck Clamp: Clamping ring with set screws.

I. Escutcheons
1. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and tube and OD that completely covers opening.
2. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.
3. One-Piece, Cast-Brass Escutcheons: With set screw.
   a. Finish: Polished chrome-plated **OR** Rough brass **OR** Polished chrome-plated and rough brass, **as directed**.
4. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.
   a. Finish: Polished chrome-plated **OR** Rough brass **OR** Polished chrome-plated and rough brass, **as directed**.
5. One-Piece, Stamped-Steel Escutcheons: With set screw **OR** spring clips, **as directed**, and chrome-plated finish.
6. Split-Plate, Stamped-Steel Escutcheons: With concealed **OR** exposed-rivet, **as directed**, hinge, set screw **OR** spring clips, **as directed**, and chrome-plated finish.
7. One-Piece, Floor-Plate Escutcheons: Cast iron.
8. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

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

K. Nitrogen
1. Description: Comply with USP 28 - NF 23 for oil-free dry nitrogen.

1.3 EXECUTION

A. Preparation
1. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:
   a. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."
   b. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb (0.453 kg) of chemical to 3 gal. (11.3 L) of water.
      1) Scrub to ensure complete cleaning.
      2) Rinse with clean, hot water to remove cleaning solution.

B. Piping Applications
1. Connect new copper tubing to existing tubing with memory-metal couplings.
2. Nonhealthcare Laboratory Low Vacuum Piping: Use one of the following piping materials for each size range:
   a. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed **OR** soldered, **as directed**, joints.
   b. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; press-type fittings; and pressure-sealed joints.
   c. NPS 5 to NPS 8 (DN 125 to DN 200): Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed **OR** soldered, **as directed**, joints.
3. Nonhealthcare Laboratory High Vacuum Piping: Use one of the following piping materials for each size range:
   a. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed **OR** soldered, **as directed**, joints.
   b. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; press-type fittings; and pressure-sealed joints.
   c. NPS 5 to NPS 8 (DN 125 to DN 200): Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed **OR** soldered, **as directed**, joints.
4. Medical Vacuum Piping: Use one of the following piping materials for each size range:
   a. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed joints.
   b. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; press-type fittings; and pressure-sealed joints.
   c. NPS 5 to NPS 8 (DN 125 to DN 200): Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed joints.
5. WAGD Evacuation Piping: Use one of the following piping materials for each size range:
   a. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed joints.
   b. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; press-type fittings; and pressure-sealed joints.
   c. NPS 5 to NPS 8 (DN 125 to DN 200): Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed joints.
6. Dental Vacuum Piping: Use one of the following piping materials for each size range:
   a. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed **OR** soldered, **as directed**, joints.
   b. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; press-type fittings; and pressure-sealed joints.
   c. NPS 5 to NPS 8 (DN 125 to DN 200): Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed **OR** soldered, **as directed**, joints.
7. HVE Piping: Use one of the following piping materials for each size range:

a. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed **OR** soldered, **as directed**, joints.
b. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; press-type fittings; and pressure-sealed joints.
c. NPS 4 (DN 100) and Smaller: Schedule 40 PVC pipe, Schedule 40 PVC fittings **OR** Schedule 80 PVC pipe, Schedule 80 PVC fittings, **as directed**, and solvent-cemented joints.
d. NPS 5 to NPS 8 (DN 125 to DN 200): Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed **OR** soldered, **as directed**, joints.
e. NPS 5 to NPS 8 (DN 125 to DN 200): Schedule 40 PVC pipe, Schedule 40 PVC fittings **OR** Schedule 80 PVC pipe, Schedule 80 PVC fittings, **as directed**, and solvent-cemented joints.

8. Medical Laboratory Vacuum Piping: Use one of the following piping materials for each size range:
   a. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed joints.
   b. NPS 4 (DN 100) and Smaller: Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; press-type fittings; and pressure-sealed joints.
   c. NPS 5 to NPS 8 (DN 125 to DN 200): Type L, copper medical gas **OR** M (C) copper water, **as directed**, tube; wrought-copper fittings; and brazed joints.
9. Drain Piping: Use one of the following piping materials:
   a. Copper water tube, cast- or wrought-copper fittings, and soldered **OR** press-type fittings, and pressure-sealed, **as directed**, joints.
   b. PVC pipe, PVC fittings, and solvent-cemented joints.

C. Piping Installation
1. Drawing plans, schematics, and diagrams indicate general location and arrangement of vacuum piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
2. Comply with ASSE Standard #6010 for installation of vacuum piping.
3. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
4. 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.
5. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
6. Install piping adjacent to equipment and specialties to allow service and maintenance.
7. Install vacuum and drain piping with 1 percent slope downward in direction of flow.
8. Install nipples, unions, and special fittings, and valves with pressure ratings same as or higher than piping pressure rating used in applications below unless otherwise indicated.
9. Install eccentric reducers, if available, where vacuum piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
10. Provide drain leg and drain trap at end of each main and branch and at low points.
11. Install thermometer and vacuum gage on inlet piping to each vacuum producer and on each receiver and separator, **as directed**. Comply with requirements in Division 22 Section "Meters And Gages For Plumbing Piping".
12. Install piping to permit valve servicing.
13. Install piping free of sags and bends.
14. Install fittings for changes in direction and for branch connections. Extruded-tee branch outlets in copper tubing may be made where specified.
15. Install medical vacuum piping to medical vacuum service connections specified in this Section and to equipment specified in other Sections requiring medical vacuum service.

16. Install seismic restraints on vacuum piping. Seismic-restraint devices are specified in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment".
17. Install medical vacuum service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
18. Install medical vacuum bottle bracket adjacent to each wall-mounted medical vacuum service connection suction inlet.
19. Connect vacuum piping to vacuum producers and to equipment requiring vacuum service.
20. Install unions, in copper vacuum tubing adjacent to each valve and at final connection to each piece of equipment, machine, and specialty.
21. Install unions, in PVC vacuum piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment, machine, and specialty.
22. Install flanges, in PVC vacuum piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment, machine, and specialty.

D. Valve Applications
1. Valves for Copper Vacuum Tubing: Use copper alloy ball and bronze check types.
2. Valves for PVC Vacuum Piping:
   a. NPS 4 (DN 100) and Smaller: Use copper alloy ball and bronze **OR** PVC ball, butterfly, and, **as directed**, check types.
   b. NPS 5 (DN 125) and Larger: Use PVC butterfly and check types.

E. Valve Installation
1. Install shutoff valve at each connection to and from vacuum equipment and specialties.
2. Install check valves to maintain correct direction of vacuum flow to vacuum-producing equipment.
3. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
4. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.
5. Install safety valves on vacuum receivers, where required by NFPA 99, and where recommended by specialty manufacturers.
6. Install automatic drain valves on equipment, specialties, and piping with drain connection. Run drain piping to floor drain, so contents spill over or into it.
7. Install flexible pipe connectors in suction inlet piping to each vacuum producer.

F. Joint Construction
1. Ream ends of pipes and tubes and remove burrs.
2. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
3. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
4. Threaded Joints: Apply appropriate tape to external pipe threads.
5. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free dry nitrogen during brazing.
6. Soldered Joints: Apply ASTM B 813, water-flushable flux to tube end. Join copper tube and fittings according to ASTM B 828.
7. Extruded-Tee Outlets: Form branches in copper tube according to ASTM F 2014, with tools recommended by procedure manufacture.
8. Flanged Joints:
   a. Copper Tubing: Install flange on copper tubes. Use pipe-flange gasket between flanges. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.
   b. PVC Piping: Install PVC flange on PVC pipes. Use pipe-flange gasket between flanges. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.
9. Pressure-Sealed Joints: Join copper tube and copper and copper-alloy fittings with tools recommended by fitting manufacturer.
10. Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of memory-metal coupling joints.
11. Solvent-Cemented Joints: Clean and dry joining surfaces. Join PVC pipe and fittings according to the following:

a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
b. Apply primer and join according to ASME B31.9 for solvent-cemented joints and to ASTM D 2672.

G. Medical Vacuum Piping Alarm System Installation
1. Panels for medical vacuum piping systems may be combined in single panels with medical compressed-air piping systems and medical gas piping systems.
2. Install medical vacuum piping system alarm system components in locations required by and according to NFPA 99.
3. Install medical vacuum piping system area and master alarm panels where indicated.
4. Install computer interface cabinet with connection to medical vacuum piping alarm system and to facility computer.

H. Sleeve Installation
1. Sleeves are not required for core-drilled holes.
2. Permanent sleeves are not required for holes formed by removable PE sleeves.
3. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs using galvanized-steel pipe **OR** galvanized-steel sheet **OR** stack sleeve fittings **OR** PVC pipe, **as directed**.
   a. Wall Penetrations: Cut sleeves to length for mounting flush with both surfaces.
   b. Floor Penetrations: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

   OR

   Install sleeves in new walls and slabs as new walls and slabs are constructed.
4. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
   a. PVC **OR** Steel, **as directed**, Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
   b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum board partitions.
   c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim" for flashing.
      1) Seal space outside of sleeve fittings with grout.
5. 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".

I. Escutcheon Installation
1. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   a. 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 **OR** stamped steel with set screw **OR** stamped steel with set screw or spring clips **OR** stamped steel with spring clips, **as directed**.
      3) Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** One piece or split casting, cast brass with polished chrome-plated finish **OR** Split casting, cast brass with polished chrome-plated finish **OR** One-piece, stamped steel with set screw **OR** One piece or split plate, stamped steel with set screw **OR** Split plate, stamped steel with set screw, **as directed**.

4) Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish **OR** cast brass with rough-brass finish **OR** stamped steel with set screw **OR** stamped steel with spring clips **OR** stamped steel with set screw or spring clips, **as directed**.
5) Bare Piping in Equipment Rooms: One piece, cast brass **OR** stamped steel with set screw **OR** stamped steel with spring clips **OR** stamped steel with set screw or spring clips, **as directed**.
6) Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

b. Existing Piping:
1) Chrome-Plated Piping: Split casting, cast brass with chrome-plated finish.
2) Insulated Piping: Split plate, stamped steel with concealed **OR** exposed-rivet, **as directed**, hinge and spring clips.
3) Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and spring clips, **as directed**.
4) Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and set screw, **as directed**.
5) Bare Piping in Unfinished Service Spaces: Split casting, cast brass with polished chrome-plated finish **OR** casting, cast brass with rough-brass finish **OR** plate, stamped steel with concealed hinge and set screw or spring clips **OR** plate, stamped steel with concealed or exposed-rivet hinge and set screw or spring clips **OR** plate, stamped steel with exposed-rivet hinge and set screw or spring clips, **as directed**.
6) Bare Piping in Equipment Rooms: Split casting, cast brass **OR** plate, stamped steel with set screw or spring clips, **as directed**.
7) Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.

J. Hanger And Support Installation
1. Comply with requirements in Division 22 Section "Hangers And Supports For Plumbing Piping And Equipment" for pipe hanger and support devices.
2. Vertical Piping: MSS Type 8 or 42, clamps.
3. 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.
4. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Division 22 Section "Hangers And Supports For Plumbing Piping And Equipment" for trapeze hangers.
5. Base of Vertical Piping: MSS Type 52, spring hangers.
6. Support horizontal piping within 12 inches (300 mm) of each fitting and coupling.
7. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.
8. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 1/4 (DN 8): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
   b. NPS 3/8 and NPS 1/2 (DN 10 and DN 15): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
   c. NPS 3/4 (DN 20): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
   d. NPS 1 (DN 25): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
   e. NPS 1-1/4 (DN 32): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
   f. NPS 1-1/2 (DN 40): 10 feet (3 m) with 3/8-inch (10-mm) rod.
   g. NPS 2 (DN 50): 11 feet (3.4 m) with 3/8-inch (10-mm) rod.
   h. NPS 2-1/2 (DN 65): 13 feet (4 m) with 1/2-inch (13-mm) rod.
   i. NPS 3 (DN 80): 14 feet (4.3 m) with 1/2-inch (13-mm) rod.
   j. NPS 3-1/2 (DN 90): 15 feet (4.6 m) with 1/2-inch (13-mm) rod.
   k. NPS 4 (DN 100): 16 feet (4.9 m) with 1/2-inch (13-mm) rod.
   l. NPS 5 (DN 125): 18 feet (5.5 m) with 1/2-inch (13-mm) rod.

m. NPS 6 (DN 150): 20 feet (6 m) with 5/8-inch (16-mm) rod.
n. NPS 8 (DN 200): 23 feet (7 m) with 3/4-inch (19-mm) rod.

9. Install supports for vertical copper tubing every 10 feet (3 m).
10. Install hangers **OR** vinyl-coated hangers, **as directed**, for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
    a. NPS 1 (DN 25) and Smaller: 30 inches (760 mm) with 3/8-inch (10-mm) rod.
    b. NPS 1-1/2 to NPS 2 (DN 40 to DN 50): 36 inches (900 mm) with 3/8-inch (10-mm) rod.
    c. NPS 2-1/2 and NPS 3 (DN 65 and DN 80): 42 inches (1150 mm) with 1/2-inch (13-mm) rod.
    d. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1220 mm) with 1/2-inch (13-mm) rod.
    e. NPS 6 and NPS 8 (DN 150 and DN 200): 54 inches (1350 mm) with 5/8-inch (16-mm) rod.
11. Install supports for vertical PVC piping every 48 inches (1220 mm).

K. Labeling And Identification
1. Install identifying labels and devices for laboratory vacuum piping, valves, and specialties. Comply with requirements in Division 22 Section "Identification For Plumbing Piping And Equipment".
2. Install identifying labels and devices for medical vacuum piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
    a. Medical Vacuum: Black letters on white background.
    b. WAGD: White letters on violet background.
    c. Dental Vacuum: Black boxed letters on white-and-black diagonal stripe background.
    d. HVE: Black boxed letters on white-and-black diagonal stripe background.
    e. Medical Laboratory Vacuum: Black boxed letters on white-and-black checkerboard background.

L. Field Quality Control For Laboratory Facility Nonmedical Vacuum Piping
1. Perform tests and inspections of vacuum piping in nonmedical laboratory facilities.
2. Tests and Inspections:
    a. Piping Leak Tests for Vacuum Piping: Test new and modified parts of existing piping. Cap and fill vacuum piping with oil-free, dry nitrogen. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
        1) Test Pressure for Copper Tubing: 100 psig (690 kPa) **OR** 150 psig (1035 kPa), **as directed**.
        2) Test Pressure for PVC Piping: 50 psig (345 kPa) **OR** 100 psig (690 kPa), **as directed**.
    b. Repair leaks and retest until no leaks exist.
    c. Inspect filters for proper operation.
3. Prepare test reports.

M. Field Quality Control For Healthcare Facility Medical Vacuum Piping
1. Perform tests and inspections of medical vacuum piping systems in healthcare facilities and prepare test reports.
2. Tests and Inspections:
    a. Medical Vacuum Testing Coordination: Perform tests, inspections, verifications, and certification of medical vacuum piping systems concurrently with tests, inspections, and certification of medical compressed-air piping and medical gas piping systems.
    b. Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
        1) Initial blow down.
        2) Initial pressure test.
        3) Cross-connection test.
        4) Piping purge test.

5) Standing pressure test for vacuum systems.
6) Repair leaks and retest until no leaks exist.

c. System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical vacuum piping systems and perform the following tests and inspections:
1) Standing pressure test.
2) Individual-pressurization **OR** Pressure-differential, **as directed**, cross-connection test.
3) Valve test.
4) Master and area alarm tests.
5) Piping purge test.
6) Final tie-in test.
7) Operational vacuum test.
8) Verify correct labeling of equipment and components.

d. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
1) Inspections performed.
2) Procedures, materials, and gases used.
3) Test methods used.
4) Results of tests.

3. Remove and replace components that do not pass tests and inspections and retest as specified above.

N. Demonstration
1. Train the Owner's maintenance personnel to adjust, operate, and maintain medical vacuum alarm systems.

END OF SECTION 22 11 16 00h

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SECTION 22 11 16 00i - GAS PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for gas piping for laboratory and healthcare facilities. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
   a. Carbon dioxide piping and specialties designated "medical carbon dioxide" operating at 50 to 55 psig (345 to 380 kPa).
   b. Helium piping, designated "medical helium" operating at 50 to 55 psig (345 to 380 kPa).
   c. Nitrogen piping and specialties designated "medical nitrogen" operating at 160 to 185 psig (1100 to 1275 kPa) **OR** higher than 200 psig (1380 kPa), **as directed**.
   d. Nitrous oxide piping and specialties designated "medical nitrous oxide" operating at 50 to 55 psig (345 to 380 kPa).
   e. Oxygen piping and specialties designated "medical oxygen" operating at 50 to 55 psig (345 to 380 kPa).

C. Definitions
1. CR: Chlorosulfonated polyethylene synthetic rubber.
2. D.I.S.S.: Diameter-index safety system.
3. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
4. Medical gas piping systems include medical carbon dioxide, medical helium, medical nitrogen, medical nitrous oxide, and medical oxygen nonflammable gas for healthcare facility patient care or for healthcare laboratory applications.
5. Specialty Gas: Gas, other than medical gas, for nonmedical laboratory facility applications.

D. Performance Requirements
1. Seismic Performance: Gas manifolds, Bulk gas storage tanks, Gas manifolds and bulk gas storage tanks, and piping shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
   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."

E. Submittals
1. Product Data: For the following:
   a. Tubes and fittings.
   b. Valves and valve boxes.
   c. Medical gas service connections.
   d. Electrical service connections.
   e. Patient service consoles.
   f. Medical nitrogen pressure control panels.
   g. Ceiling columns. Include integral service connections.
   h. Ceiling hose assemblies. Include integral service connections.
   i. Gas manifolds.
   j. Bulk gas storage tanks. Include rated capacities and operating weights.
   k. Medical gas alarm system components.
   l. Gas cylinder storage racks.
2. Shop Drawings: Diagram power, signal, and control wiring.

3. Piping Material Certification: Signed by Installer certifying that medical gas piping materials comply with NFPA 99 requirements.
4. Brazing certificates.
5. Manufacturer Seismic Qualification Certification: Submit certification that gas manifolds and bulk gas storage tanks, accessories, and components will withstand seismic forces defined in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment". Include the following:
   a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
6. Certificates of Shop Inspection and Data Report for Bulk Gas Storage Tanks: As required by ASME Boiler and Pressure Vessel Code.
7. Field quality-control test reports.
8. Operation and maintenance data.

F. Quality Assurance
1. Installer Qualifications:
   a. Medical Gas Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010 for installers.
2. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the medical gas piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   a. Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.
3. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications"; or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."
4. 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.
5. ASME Compliance: Fabricate and label bulk medical gas storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
6. NFPA Compliance:
   a. Comply with NFPA 50, "Bulk Oxygen Systems at Consumer Sites," for bulk oxygen storage tanks.
   b. Comply with NFPA 99, "Health Care Facilities," for medical gas piping system materials and installation.
7. CGA Compliance: Comply with CGA G-8.1, "Nitrous Oxide Systems at Consumer Sites," for bulk nitrous oxide storage tanks.
8. UL Compliance:
   a. Comply with UL 498, "Attachment Plugs and Receptacles," for electrical service connections.
   b. Comply with UL 544, "Medical and Dental Equipment," for medical gas specialties.

G. Project Conditions
1. Interruption of Existing Specialty and Medical Gas Service(s): Do not interrupt specialty or medical gas service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
   a. Notify the Owner no fewer than two days in advance of proposed interruption of specialty and medical gas service(s).
   b. Do not proceed with interruption of specialty and medical gas service(s) without the Owner's written permission.

1.2 PRODUCTS

A. Pipes, Tubes, And Fittings
1. Copper Medical Gas Tube: ASTM B 819, Type K **OR** Type L, **as directed**, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube and blue for Type L tube.
a. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.
b. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.
c. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.
d. Press-Type Fittings:
1) NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
2) NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.
e. Memory-Metal Couplings: Cryogenic compression fitting made of ASTM F 2063, nickel-titanium, shape-memory-alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.
2. PVC Pipe: ASTM D 1785, Schedule 40 and Schedule 80.
a. PVC Fittings: ASTM D 2466, Schedule 40 **OR** ASTM D 2467, Schedule 80, **as directed**; socket type.

B. Joining Materials
1. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.
2. Threaded-Joint Tape: PTFE.
3. Solvent Cement for Joining PVC Piping: ASTM D 2564. Include primer complying with ASTM F 656.

C. Valves
1. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
2. Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
a. Pressure Rating: 300 psig (2070 kPa) minimum.
b. Ball: Full-port, chrome-plated brass.
c. Seats: PTFE or TFE.
d. Handle: Lever type with locking device, **as directed**.
e. Stem: Blowout proof with PTFE or TFE seal.
f. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
3. Check Valves: In-line pattern, bronze.
a. Pressure Rating: 300 psig (2070 kPa) minimum.
b. Operation: Spring loaded.
c. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
4. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
a. Pressure Rating: 300 psig (2070 kPa) minimum.
b. Ball: Full-port, chrome-plated brass.
c. Seats: PTFE or TFE.
d. Handle: Lever type with locking device, **as directed**.
e. Stem: Blowout proof with PTFE or TFE seal.
f. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
g. Pressure Gage: Manufacturer-installed on one copper-tube extension.
5. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.
a. Interior Finish: Factory-applied white enamel.

b. Cover Plate: Aluminum or extruded-anodized aluminum **OR** Satin-chrome finish steel **OR** Stainless steel with NAAMM AMP 503, No. 4 finish, **as directed**, with frangible or removable windows.
c. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

OR

Zone Valve Boxes: Formed or extruded aluminum with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.
a. Interior Finish: Factory-applied white enamel.
b. Cover Plate: Aluminum or extruded-anodized aluminum **OR** Stainless steel with NAAMM AMP 503, No. 4 finish, **as directed**, with frangible or removable windows.
c. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

6. Emergency Oxygen Connections: Low-pressure oxygen inlet assembly for connection to building oxygen piping systems.
   a. Enclosure: Weatherproof hinged locking cover with caption similar to "Emergency Low-Pressure Gaseous Oxygen Inlet."
   b. Inlet: Manufacturer-installed, NPS 1 or NPS 1-1/4 (DN 25 or DN 32), ASTM B 819, copper tubing with NPS 1 (DN 25) minimum ball valve and plugged inlet.
   c. Safety Valve: Bronze-body, pressure relief valve set at 75 or 80 psig (520 or 550 kPa).
   d. Instrumentation: Pressure gage.
7. Safety Valves: Bronze-body, ASME-construction, poppet, pressure-relief type with settings to match system requirements.
8. Pressure Regulators: Bronze **OR** Stainless-steel, **as directed**, body and trim; spring-loaded, diaphragm-operated, relieving type; manual pressure-setting adjustment; rated for 250-psig (1725-kPa) minimum inlet pressure; and capable of controlling delivered gas pressure within 0.5 psig for each 10-psig (5.0 kPa for each 100-kPa) inlet pressure.

D. Medical Gas Service Connections
1. General Requirements for Medical Gas Service Connections: For specific medical gas pressure and suction service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.
   a. Roughing-in Assembly:
      1) Steel outlet box for recessed mounting and concealed piping.
      2) Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed. Suction inlets to be without secondary valve.
      3) Double seals that will prevent gas leakage.
      4) ASTM B 819, NPS 3/8 (DN 10) copper outlet tube brazed to valve with service marking and tube-end dust cap.
   b. Finishing Assembly:
      1) Brass housing with primary check valve.
      2) Double seals that will prevent gas leakage.
      3) Cover plate with gas-service label.
   c. Quick-Coupler Service Connections: Pressure outlets for carbon dioxide, nitrous xide, oxygen, and <**Insert medical gas**> service connections with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.
   d. D.I.S.S. Service Connections: Pressure outlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.
      1) Medical Carbon Dioxide Service Connections: D.I.S.S. No. 1080.

2) Medical Helium Service Connections: D.I.S.S. No. 1060.
3) Medical Nitrogen Service Connections: D.I.S.S. No. 1120.
4) Medical Nitrous Oxide Service Connections: D.I.S.S. No. 1040.
5) Medical Oxygen Service Connections: D.I.S.S. No. 1240.

e. Cover Plates: One piece, stainless steel, with NAAMM AMP 503, No. 4 finish **OR** metal, with chrome-plated finish **OR** anodized aluminum, **as directed**, and permanent, color-coded, identifying label matching corresponding service.

E. Electrical Service Connections

1. Power Outlets: UL 498, Hospital Grade, 125-V receptacles; color selected. Include the following configurations complying with NEMA WD 1:
   a. L5-20R, locking type, 20 A, single or duplex.
   b. L5-20R, isolated ground, locking type, 20 A, single or duplex.
   c. Explosion proof, 20 A, 2 pole, 3 wire, single; suitable for Class I, Group C hazardous location and interchangeable with receptacles used in nonhazardous areas; flush mounted.
   d. 5-20R, straight blade, 20 A, duplex.
   e. 5-20R, isolated ground, straight blade, 20 A, duplex.
2. Electrical Accessory Outlets: Provide the following configured receptacles in color selected:
   a. Patient Equipment Ground Jack: Single pole, 30 A.
   b. Patient Monitoring: Single, 5 and 37 pin.
3. Wall Outlet Cover Plates: One piece, stainless steel, with NAAMM AMP 503, No. 4 finish **OR** metal, with chrome-plated finish **OR** anodized aluminum, **as directed**, and permanent identifying label.

F. Patient Service Consoles

1. General Requirements for Patient Service Consoles: Recessed- or semirecessed-mounting wall units with medical gas service connections as specified in "Medical Gas Service Connections" Article and electrical service connections as specified in "Electrical Service Connections" Article, **as directed**. Include labels indicating services, and the following:
   a. Recessed- or semirecessed-mounting steel console box or mounting bracket.
   b. Concealed supplies.
   c. Cover Plate: One piece, anodized aluminum **OR** stainless steel, **as directed**, and permanent identifying label with service connections for the following:
      1) Medical Air: Quick-coupler pressure outlet.
      2) Medical Oxygen: Quick-coupler pressure outlet.
      3) Medical Vacuum: Quick-coupler suction inlet.
      4) Medical vacuum bottle bracket.
      5) L5-20R, locking type, 20 A, single **OR** duplex, **as directed**.

G. Medical Nitrogen Pressure Control Panels

1. Description: Steel box and support brackets for recessed roughing-in with stainless-steel or anodized-aluminum cover plate with printed operating instructions. Include manifold assembly consisting of inlet supply valve, inlet supply pressure gage, line-pressure control regulator, outlet supply pressure gage, D.I.S.S. service connection, and piping outlet for remote service connection.
   a. Minimum Working Pressure: 200 psig (1380 kPa).
   b. Line-Pressure Control Regulator: Self-relieving diaphragm type with precision manual adjustment.
   c. Pressure Gages: 0- to 300-psig (0- to 2070-kPa) range.
   d. Service Connection: CGA V-5, D.I.S.S. No. 1120, nitrogen outlet.
   e. Before final assembly, provide temporary dust shield and U-tube for testing.
   f. Label cover plate "Nitrogen Pressure Control."

H. Ceiling Columns

1. General Requirements for Ceiling Columns: Ceiling-mounting units with medical gas service connections as specified in "Medical Gas Service Connections" Article and electrical service

connections as specified in "Electrical Service Connections" Article, **as directed**. Include labels indicating services, and the following:

a. Ceiling-Mounting Plate: Manufacturer's standard plate or roughing-in assembly.
b. Exposed Surfaces: Minimum 0.0375-inch- (0.95-mm-) thick stainless steel with NAAMM AMP 503, No. 4 directional polish.
c. Servicing: Include access panels or means of removing shroud.
d. Blank cover plates for cutouts not having service connections.
e. ASTM B 819, NPS 3/8 (DN 10) copper-tube extensions for connection to medical gas systems.
f. Service Connections: Type and number indicated.
g. Dust Covers: For medical gas service connection.

2. Rigid Ceiling Columns: 44-inch- (1120-mm-) long, rectangular fixed column section with 2 **OR** 4, **as directed**, double intravenous medication hooks. Include 0.078-inch- (2.0-mm-) thick, stainless-steel bottom plate with the following service connections:
   a. Instrument Air: One D.I.S.S. No. 1160 pressure outlet(s).
   b. Medical Air: One quick-coupler **OR** D.I.S.S. No. 1160, **as directed**, pressure outlet(s).
   c. Medical Carbon Dioxide: One quick-coupler **OR** D.I.S.S. No. 1080, **as directed**, pressure outlet(s).
   d. Medical Helium: One D.I.S.S. No. 1060, pressure outlet(s).
   e. Medical Nitrogen: One D.I.S.S. No. 1120 pressure outlet(s).
   f. Medical Nitrous Oxide: One quick-coupler **OR** D.I.S.S. No. 1040, **as directed**, pressure outlet(s).
   g. Medical Oxygen: Two quick-coupler **OR** D.I.S.S. No. 1240, **as directed**, pressure outlets.
   h. Medical Vacuum: Two quick-coupler **OR** D.I.S.S. No. 1220, **as directed**, suction inlets.
   i. Vacuum Bottle Brackets: Two.
   j. WAGD Evacuation: One quick-coupler **OR** D.I.S.S. No. 2220, **as directed**, suction inlet(s).
   k. Power: 2 **OR** 4, **as directed**, L5-20R, locking-type, 20-A, single receptacles.
   l. Patient Equipment: 2 **OR** 4, **as directed**, ground-jack, single-pole, 30-A receptacles.
3. Retractable Ceiling Columns: Manually adjustable using release and lock handles capable of locking column in all positions from fully retracted to fully extended; 15-inch- (380-mm-) long, rectangular counterbalanced telescoping section with 2 **OR** 4, **as directed**, double intravenous medication hooks; and 36-inch- (915-mm-) long, fixed column section. Include 0.078-inch- (2.0-mm-) thick, stainless-steel bottom plate with the following service connections:
   a. Instrument Air: One D.I.S.S. No. 1160 pressure outlet(s).
   b. Medical Air: One quick-coupler **OR** D.I.S.S. No. 1160, **as directed**, pressure outlet(s).
   c. Medical Carbon Dioxide: One quick-coupler **OR** D.I.S.S. No. 1080, **as directed**, pressure outlet(s).
   d. Medical Helium: One D.I.S.S. No. 1060, pressure outlet(s).
   e. Medical Nitrogen: One D.I.S.S. No. 1120 pressure outlet(s).
   f. Medical Nitrous Oxide: One quick-coupler **OR** D.I.S.S. No. 1040, **as directed**, pressure outlet(s).
   g. Medical Oxygen: Two quick-coupler **OR** D.I.S.S. No. 1240, **as directed**, pressure outlets.
   h. Medical Vacuum: Two quick-coupler **OR** D.I.S.S. No. 1220, **as directed**, suction inlets.
   i. Vacuum Bottle Brackets: Two.
   j. WAGD Evacuation: One quick-coupler **OR** D.I.S.S. No. 2220, **as directed**, suction inlet(s).
   k. Power: 2 **OR** 4, **as directed**, L5-20R, locking-type, 20-A, single receptacles.
   l. Patient Equipment: 2 **OR** 4, **as directed**, ground-jack, single-pole, 30-A receptacles.

I. Ceiling Hose Assemblies
   1. Ceiling Hose Assemblies, General: Ceiling-mounting units with medical gas service connections as specified in "Medical Gas Service Connections" Article and electrical service connections as specified in "Electrical Service Connections" Article, **as directed**. Include labels indicating services, and the following:
      a. Ceiling-Mounting Plate: Manufacturer's standard plate or roughing-in assembly.

b. Exposed Surfaces: Minimum 0.0375-inch- (0.95-mm-) thick stainless steel with NAAMM AMP 503, No. 4 directional polish.
c. Servicing: Include access panels or means of removing shroud.
d. Blank cover plates for cutouts not having service connections.
e. ASTM B 819, NPS 3/8 (DN 10) copper-tube extensions for connection to medical gas systems.
f. Service Connections: Type and number indicated.
g. Dust Covers: For medical gas service connection.

2. Hose-Reel Service Assemblies: Individual, concealed, retractable hose-reel units with stainless-steel face plates, steel mounting boxes, factory- or field-fabricated mounting brackets, and color-coded service hoses with adjustable stops and service connections matching hoses. Include 15 feet (4.5 m) minimum of conductive, CR, 1/4- or 5/16-inch- (6.4- or 7.9-mm-) ID, medical gas hoses rated for 200-psig (1380-kPa) minimum working pressure, and the following service connections:
   a. Instrument Air Hose: D.I.S.S. No. 1160 pressure outlet.
   b. Medical Air Hose: Quick-coupler **OR** D.I.S.S. No. 1160, **as directed**, pressure outlet.
   c. Medical Carbon Dioxide Hose: Quick-coupler **OR** D.I.S.S. No. 1080, **as directed**, pressure outlet.
   d. Medical Nitrogen Hose: D.I.S.S. No. 1120 pressure outlet.
   e. Medical Nitrous Oxide Hose: Quick-coupler **OR** D.I.S.S. No. 1040, **as directed**, pressure outlet.
   f. Medical Oxygen Hose: Quick-coupler **OR** D.I.S.S. No. 1240, **as directed**, pressure outlet.
   g. Medical Vacuum Hose: Quick-coupler **OR** D.I.S.S. No. 1220, **as directed**, suction inlet.
   h. WAGD Evacuation Hose: Quick-coupler **OR** D.I.S.S. No. 2220, **as directed**, suction inlet.
   i. Power: L5-20R, locking-type, 20-A, single, power receptacle.
3. Fixed Hose Service Assemblies: Individual, concealed hose connection with stainless-steel face plates, steel mounting boxes, factory- or field-fabricated mounting brackets, and color-coded service hoses with retractor device and service connections matching hoses. Include 72 inches (1830 mm) of conductive, CR, 1/4- or 5/16-inch- (6.4- or 7.9-mm-), ID, medical gas hoses rated for 200-psig (1380-kPa) minimum working pressure, and the following service hose connections:
   a. Instrument Air Hose: D.I.S.S. No. 1160 pressure outlet.
   b. Medical Air Hose: Quick-coupler **OR** D.I.S.S. No. 1160, **as directed**, pressure outlet.
   c. Medical Carbon Dioxide Hose: Quick-coupler **OR** D.I.S.S. No. 1080, **as directed**, pressure outlet.
   d. Medical Nitrogen Hose: D.I.S.S. No. 1120 pressure outlet.
   e. Medical Nitrous Oxide Hose: Quick-coupler **OR** D.I.S.S. No. 1040, **as directed**, pressure outlet.
   f. Medical Oxygen Hose: Quick-coupler **OR** D.I.S.S. No. 1240, **as directed**, pressure outlet.
   g. Medical Vacuum Hose: Quick-coupler **OR** D.I.S.S. No. 1220, **as directed**, suction inlet.
   h. WAGD Evacuation Hose: Quick-coupler **OR** D.I.S.S. No. 2220, **as directed**, suction inlet.
   i. Power: L5-20R, locking-type, 20-A, single, power receptacle.

J. Gas Manifolds
1. Simplex Specialty Gas Manifolds:
   a. Control Panel Unit: Weatherproof cabinet, supply and delivery pressure gages, electrical alarm system connections and transformer, indicator lights or devices, manifold connection, line-pressure regulator, shutoff valves, and safety valve.
   b. Manifold and Header: Nonferrous-metal header for number of cylinders indicated. Units include design for 2000-psig (13.8-MPa) minimum inlet pressure. Include cylinder bank header with inlet (pigtail) connections complying with CGA V-1, individual inlet check valves, shutoff valve, pressure regulator, check valve, and pressure gage.
   c. <**Insert specialty gas**> Manifold: For <**Insert number cylinders**> capacity at 55-psig (380-kPa) line pressure, with electric heater or orifice design that will prevent freezing during high demand.
   d. Specialty Gas Cylinders: Will be furnished by the Owner **OR** Number and type of medical gas cylinders required for complete manifold systems, **as directed**.

e. Label manifold control unit with permanent label identifying specialty gas type and system operating pressure.
f. Mounting: Wall with mounting brackets for manifold control cabinet and header **OR** Floor with support legs for manifold control cabinet, **as directed**.

2. Duplex Specialty Gas Manifolds:
   a. Central Control Panel Unit: Weatherproof cabinet, supply and delivery pressure gages, electrical alarm system connections and transformer, indicator lights or devices, manifold connection, line-pressure regulator, shutoff valves, and safety valve.
   b. Manifold and Headers: Duplex, nonferrous-metal header for number of cylinders indicated, divided into two equal banks. Units include design for 2000-psig (13.8-MPa) minimum inlet pressure. Include cylinder bank headers with inlet (pigtail) connections complying with CGA V-1, individual inlet check valves, shutoff valve, pressure regulator, check valve, and pressure gage.
   c. Operation: Automatic, pressure-switch-activated changeover from one cylinder bank to the other when first bank becomes exhausted, without line-pressure fluctuation or resetting of regulators and without supply interruption by shutoff of either cylinder bank header.
   d. <**Insert specialty gas**> Manifold: For <**Insert number cylinders**> capacity at 55-psig (380-kPa) line pressure, with electric heater or orifice design that will prevent freezing during high demand.
   e. Specialty Gas Cylinders: Will be furnished by the Owner **OR** Number and type of medical gas cylinders required for complete manifold systems, **as directed**.
   f. Label manifold control unit with permanent label identifying specialty gas type and system operating pressure.
   g. Mounting: Wall with mounting brackets for manifold control cabinet and headers **OR** Floor with support legs for manifold control cabinet, **as directed**.
3. Medical Gas Manifolds: Comply with NFPA 99, Ch. 5, for high-pressure medical gas cylinders.
   a. Central Control Panel Unit: Weatherproof cabinet, supply and delivery pressure gages, electrical alarm system connections and transformer, indicator lights or devices, manifold connection, pressure changeover switch, line-pressure regulator, shutoff valves, and safety valve.
   b. Manifold and Headers: Duplex, nonferrous-metal header for number of cylinders indicated, divided into two equal banks. Units include design for 2000-psig (13.8-MPa) minimum inlet pressure, except nitrous oxide manifolds may be designed for 800 psig (5520 kPa) and carbon dioxide manifolds may be designed for 1500 psig (10.35 MPa). Include cylinder bank headers with inlet (pigtail) connections complying with CGA V-1, individual inlet check valves, shutoff valve, pressure regulator, check valve, and pressure gage.
   c. Operation: Automatic, pressure-switch-activated changeover from one cylinder bank to the other when first bank becomes exhausted, without line-pressure fluctuation or resetting of regulators and without supply interruption by shutoff of either cylinder bank header.
   d. Medical Carbon Dioxide Manifolds: For 2 cylinders and 250-cfh (1.97-L/s) **OR** 4 cylinders and 500-cfh (3.94-L/s), **as directed**, capacity at 55-psig (380-kPa) line pressure.
   e. Medical Helium Manifolds: For 2 cylinders and 250-cfh (1.97-L/s) **OR** 4 cylinders and 500-cfh (3.94-L/s), **as directed**, capacity at 55-psig (380-kPa) line pressure.
   f. Medical Nitrous Oxide Manifolds: For 8 cylinders and 1333-cfh (10.5-L/s) **OR** 12 cylinders and 2000-cfh (15.7-L/s), **as directed**, capacity at 55-psig (380-kPa) line pressure, with electric heater or orifice design that will prevent freezing during high demand.
   g. Medical Nitrogen Manifolds: For 8 cylinders and 2000-cfh (15.7-L/s) **OR** 12 cylinders and 3000-cfh (23.6-L/s), **as directed**, capacity at 180-psig (1240-kPa) **OR** higher than 200-psig (1380-kPa), **as directed**, line pressure.
   h. Medical Oxygen Manifolds: For 12 cylinders and 1500-cfh (11.8-L/s) **OR** 20 cylinders 2500-cfh (19.7-L/s), **as directed**, capacity at 55-psig (380-kPa), **as directed**, line pressure.
   i. Medical Gas Cylinders: Will be furnished by the Owner **OR** Number and type of medical gas cylinders required for complete manifold systems, **as directed**.
   j. Label manifold control unit with permanent label identifying medical gas type and system operating pressure.

k. Mounting: Wall with mounting brackets for manifold control cabinet and headers **OR** Floor with support legs for manifold control cabinet, **as directed**.

K. Bulk Gas Storage Tanks
1. Bulk Specialty Gas Storage Tanks:
2. Bulk Medical Gas Storage Tanks:
   a. Bulk Medical Gas Storage Tank Systems: Bulk storage tank with connections for alarm system, continuous supply, and reserve supply that will operate only during emergencies, complying with NFPA 99, "Health Care Facilities."
   b. Controls: Include actuating switch for alarm system connection and means for automatic actuating of reserve supply.
   c. Bulk Medical Gas Storage Tanks: Vertical mounting, double-wall construction with inner vessel fabricated according to ASME Boiler and Pressure Vessel Code for unfired pressure vessels and suitable for medical gas service. Include insulation and vacuum seal between walls. Fabricate outer shell from carbon steel with factory-applied manufacturer's standard protective paint finish suitable for exterior installation. Include the following features, specialties, and components:
      1) Safety Valves: ASME construction with pressure setting to correspond to tank working pressure and as required for component or system being protected.
      2) Pressure Gages: For tank pressure and facility service line pressure.
      3) Contents Gage: High- and low-level indicator with electric signal circuit connection.
      4) Drain Valves: For piping, inner vessel, and outer shell.
      5) Fill Assembly: Fill connection, piping, valves, relief devices, and controls.
      6) Facility Service Assembly: Piping, valves, relief devices, vaporizer, shutoff valve, pressure regulator, line shutoff valve or check valve, and reserve supply connection for connection to building service piping.
      7) Include permanent label showing medical gas type, storage tank capacity, tank pressure rating, vaporizer capacity, and operating instructions.
      8) Liquid Oxygen Storage Tank: Nickel-steel or stainless-steel inner vessel with 250-psig (1725-kPa) minimum working pressure. Include electric **OR** steam **OR** ambient vaporizer, **as directed**.
      9) Liquid Nitrous Oxide Storage Tank: Steel-alloy inner vessel with 300-psig (2070-kPa) minimum working pressure. Include electric **OR** steam, **as directed**, vaporizer.
   d. Oxygen Reserve Supply: Manifold header for high-pressure cylinders, fabricated from copper-tube or brass pipe and fittings and suitable for pressures up to 4000 psig (27.6 MPa). Include header inlet connections complying with CGA V-1, with individual inlet check valves, header shutoff valve, header pressure regulator, line shutoff valve or check valve, pressure gage, and inlet connections for number of cylinders indicated.
   e. Nitrous Oxide Reserve Supply: Manifold header for high-pressure cylinders, fabricated from copper-tube or brass pipe and fittings and suitable for pressures up to 4000 psig (27.6 MPa). Include header inlet connections complying with CGA V-1, with individual inlet check valves, header shutoff valve, header pressure regulator, line shutoff valve or check valve, pressure gage, inlet connections for number of cylinders indicated, and electric heater.

L. Medical Gas Piping Alarm Systems
1. Panels for medical gas piping systems may be combined in single panels with medical compressed-air and medical vacuum piping systems.
2. Components: Designed for continuous service and to operate on power supplied from 120 **OR** 240 **OR** 277, **as directed**,-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.
3. Pressure Switches or Pressure Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
   a. Low-Pressure Operating Range: 0- to 100-psig (0- to 690-kPa).
   b. High-Pressure Operating Range: Up to 250-psig (1725-kPa).

4. General Requirements for Medical Gas Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
   a. Mounting: Exposed, surface **OR** Recessed, **as directed**, installation.
   b. Enclosures: Fabricated from minimum 0.047-inch- (1.2-mm-) thick steel or minimum 0.05-inch- (1.27-mm-) thick aluminum, with knockouts for electrical and piping connections.
5. Master Alarm Panels: With separate trouble alarm signals, pressure gages, and indicators for medical gas piping systems.
   a. Include alarm signals when the following conditions exist:
      1) Medical Carbon Dioxide: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa) and changeover is made to alternate bank.
      2) Medical Helium: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa) and changeover is made to alternate bank.
      3) Medical Nitrogen: Pressure drops below 145 psig (1000 kPa) or rises above 200 psig (1380 kPa) and changeover is made to alternate bank.
      4) Medical Nitrous Oxide (for bulk oxygen storage tank system with cylinder reserve): Liquid level is low, pressure downstream from main shutoff valve drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa), changeover is made to reserve, reserve is in use, and reserve level is low.
      5) Medical Nitrous Oxide (for nitrous oxide manifold system): Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa) and changeover is made to alternate bank.
      6) Medical Oxygen (for bulk oxygen storage tank system with cylinder reserve): Liquid level is low, pressure downstream from main shutoff valve drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa), changeover is made to reserve, reserve is in use, reserve level is low, and reserve pressure is low.
      7) Medical Oxygen (for oxygen manifold system): Pressure downstream from main shutoff valve drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa) and changeover is made to alternate bank.
6. Anesthetizing-Area Alarm Panels: Separate trouble alarm signals; pressure gages; and indicators for medical gas piping systems.
   a. Include alarm signals when the following conditions exist:
      1) Medical Carbon Dioxide: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).
      2) Medical Helium: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).
      3) Medical Nitrous Oxide: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).
      4) Medical Nitrogen: Pressure drops below 145 psig (1000 kPa) or rises above 200 psig (1380 kPa).
      5) Medical Oxygen: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).
7. Area Alarm Panels: Separate trouble alarm signals; pressure and vacuum gages; and indicators for medical gas piping systems.
   a. Include alarm signals when the following conditions exist:
      1) Oxygen: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).
8. Dental Area Alarm Panels: Separate trouble alarm signals; pressure and vacuum gages; and indicators for medical gas piping systems.
   a. Include alarm signals when the following conditions exist:
      1) Medical Nitrogen: Pressure drops below 145 psig (1000 kPa) or rises above 200 psig (1380 kPa) and changeover is made to alternate bank.
      2) Medical Nitrous Oxide (for bulk nitrous oxide storage tank system with cylinder reserve): Liquid level is low, pressure downstream from main shutoff valve drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa), changeover is made to reserve, reserve is in use, and reserve level is low.

3) Medical Nitrous Oxide (for nitrous oxide manifold system): Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa) and changeover is made to alternate bank.
4) Medical Oxygen (for bulk oxygen storage tank system with cylinder reserve): Liquid level is low, pressure downstream from main shutoff valve drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa), changeover is made to reserve, reserve is in use, reserve level is low, and reserve pressure is low.
5) Medical Oxygen (for nitrous oxide manifold system): Pressure downstream from main shutoff valve drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa) and changeover is made to alternate bank.

9. Medical Laboratory Area Alarm Panels: Separate trouble alarm signals; pressure and vacuum gages; and indicators for medical gas piping systems.
   a. Include alarm signals when the following conditions exist:
      1) Medical Carbon Dioxide: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).
      2) Medical Helium: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).
      3) Medical Oxygen: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).

M. Computer Interface Cabinet
1. Description: Wall-mounting, welded-steel, control cabinet with gasketed door, mounting brackets, grounding device, and white-enamel finish for connection of medical gas system alarms to facility computer. Include factory-installed signal circuit boards, power transformer, circuit breaker, wiring terminal board, and internal wiring capable of interfacing 20, **as directed**, alarm signals.

N. Gas Cylinder Storage Racks
1. Wall Storage Racks: Fabricate racks with chain restraints for upright cylinders as indicated or provide equivalent manufactured wall racks.
2. Freestanding Storage Racks: Fabricate racks as indicated or provide equivalent manufactured storage racks.

O. Sleeves
1. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
2. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   a. Underdeck Clamp: Clamping ring with set screws.

P. Escutcheons
1. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and tube and OD that completely covers opening.
2. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.
3. One-Piece, Cast-Brass Escutcheons: With set screw.
   a. Finish: Polished chrome-plated **OR** Rough brass, **as directed**.
4. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.
   a. Finish: Polished chrome-plated **OR** Rough brass, **as directed**.
5. One-Piece, Stamped-Steel Escutcheons: With set screw **OR** spring clips, **as directed**, and chrome-plated finish.
6. Split-Plate, Stamped-Steel Escutcheons: With concealed **OR** exposed-rivet, **as directed**, hinge, set screw **OR** spring clips, **as directed**, and chrome-plated finish.
7. One-Piece, Floor-Plate Escutcheons: Cast iron.
8. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

Q. Grout

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

R. Nitrogen
1. Description: Comply with USP 28 - NF 23 for oil-free dry nitrogen.

1.3 EXECUTION

A. Earthwork
1. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling and for underground warning tapes.

B. Piping Applications
1. Nonhealthcare, Specialty Gas Piping: Type L, copper medical gas tube; wrought-copper fittings; and brazed **OR** press-type fittings and pressure-sealed, **as directed**, joints.
2. Nonhealthcare, Specialty Gas Piping NPS 2-1/2 (DN 65) and Smaller: Type K **OR** Type L, **as directed**, copper medical gas tube; wrought-copper fittings; and brazed **OR** press-type fittings and pressure-sealed, **as directed**, joints.
3. Nonhealthcare, Specialty Gas Piping NPS 3 (DN 80) and Larger: Type K, copper tube; wrought-copper fittings; and brazed **OR** press-type fittings and pressure-sealed, **as directed**, joints.
4. Medical Gas Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
5. Medical Gas Piping Except Nitrogen: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
6. Medical Nitrogen Piping: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
7. Medical Nitrogen Piping NPS 2-1/2 (DN 65) and Smaller: Type K **OR** Type L, **as directed**, copper medical gas tube; wrought-copper fittings; and brazed joints.
8. Medical Nitrogen Piping NPS 3 (DN 80) and Larger: Type K, copper tube; wrought-copper fittings; and brazed joints.
9. Protective Conduit: Use PVC pipe, PVC fittings, and solvent-cemented joints.

C. Piping Installation
1. Drawing plans, schematics, and diagrams indicate general location and arrangement of gas piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
2. Comply with ASSE Standard #6010 for installation of medical gas piping.
3. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
4. 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.
5. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
6. Install piping adjacent to equipment and specialties to allow service and maintenance.
7. Install nipples, unions, and special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications below unless otherwise indicated.
8. Install piping to permit valve servicing.
9. Install piping free of sags and bends.
10. Install fittings for changes in direction and branch connections.

11. Install medical gas piping to medical gas service connections specified in this Section, to medical gas service connections in equipment specified in this Section, and to equipment specified in other Sections requiring medical gas service.
12. Install exterior, buried medical gas piping in protective conduit fabricated with PVC pipe and fittings. Do not extend conduit through foundation wall.
13. Install seismic restraints on gas piping. Seismic-restraint devices are specified in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment".
14. Install medical gas service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
15. Connect gas piping to gas sources and to gas outlets and equipment requiring gas service.
16. Install unions, in copper tubing adjacent to each valve and at final connection to each piece of equipment and specialty.

D. Valve Installation
1. Install shutoff valve at each connection to gas laboratory and healthcare equipment and specialties.
2. Install check valves to maintain correct direction of gas flow from laboratory and healthcare gas supplies.
3. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
4. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.
5. Install pressure regulators on gas piping where reduced pressure is required.
6. Install emergency oxygen connection with pressure relief valve and full-size discharge piping to outside, with check valve downstream from pressure relief valve and with ball valve and check valve in supply main from bulk oxygen storage tank.

E. Joint Construction
1. Ream ends of PVC pipes and remove burrs.
2. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
3. Threaded Joints: Apply appropriate tape to external pipe threads.
4. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free, dry nitrogen during brazing.
5. Pressure-Sealed Joints: Join copper tube and press-type fittings with tools recommended by fitting manufacturer.
6. Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of memory-metal coupling joints.
7. Solvent-Cemented Joints: Clean and dry joining surfaces. Join PVC pipe and fittings according to the following:
   a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   b. Apply primer and join according to ASME B31.9 for solvent-cemented joints and to ASTM D 2672.

F. Gas Service Component Installation
1. Assemble patient service console with service connections. Install with supplies concealed, in walls. Attach console box or mounting bracket to substrate.
2. Install nitrogen pressure-control panels in walls. Attach to substrate.
3. Assemble ceiling columns and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.
4. Assemble ceiling assemblies and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.
5. Install gas manifolds on concrete base, **as directed**, anchored to substrate.
6. Install gas cylinders and connect to manifold piping.

7. Install gas manifolds with seismic restraints as indicated.
8. Install bulk gas storage tanks and reserve supply tanks level on concrete bases. Set tanks and connect gas piping to tanks according to applicable requirements in NFPA 50 for bulk oxygen storage systems, **as directed**. Install tanks level and plumb, firmly anchored to concrete bases; maintain NFPA 50 and tank manufacturer's recommended clearances. Orient tanks so controls and devices are accessible for servicing.
9. Install bulk gas storage tanks and reserve supply tanks with seismic restraints.

G. Medical Gas Piping Alarm System Installation
1. Install medical gas alarm system components in locations required by and according to NFPA 99.
2. Install medical gas area and master alarm panels where indicated.
3. Install computer interface cabinet with connection to medical gas piping alarm system and facility computer.

H. Sleeve Installation
1. Sleeves are not required for core-drilled holes.
2. Permanent sleeves are not required for holes formed by removable PE sleeves.
3. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs using galvanized-steel pipe **OR** galvanized-steel sheet **OR** stack sleeve fittings **OR** PVC pipe, **as directed**.
   a. Wall Penetrations: Cut sleeves to length for mounting flush with both surfaces.
   b. Floor Penetrations: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

   OR

   Install sleeves in new walls and slabs as new walls and slabs are constructed.
4. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
   a. PVC **OR** Steel, **as directed**, Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
   b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum board partitions.
   c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Comply with requirements in Division 07 Section "Sheet Metal Flashing And Trim" for flashing.
      1) Seal space outside of sleeve fittings with grout.
5. 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".

I. Escutcheon Installation
1. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   a. 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 **OR** stamped steel with set screw **OR** stamped steel with set screw or spring clips **OR** stamped steel with spring clips, **as directed**.
      3) Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish **OR** One piece or split casting, cast brass with polished chrome-plated finish **OR** Split casting, cast brass with polished chrome-plated finish **OR** One piece, stamped steel with set screw **OR** One piece or split plate, stamped steel with set screw **OR** Split plate, stamped steel with set screw, **as directed**.

4) Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish **OR** cast brass with rough-brass finish **OR** stamped steel with set screw **OR** stamped steel with spring clips **OR** stamped steel with set screw or spring clips, **as directed**.
5) Bare Piping in Equipment Rooms: One piece, cast brass **OR** stamped steel with set screw **OR** stamped steel with spring clips **OR** stamped steel with set screw or spring clips, **as directed**.
6) Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

b. Existing Piping:
1) Chrome-Plated Piping: Split casting, cast brass with chrome-plated finish.
2) Insulated Piping: Split plate, stamped steel with concealed **OR** exposed-rivet, **as directed**, hinge and spring clips.
3) Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and spring clips, **as directed**.
4) Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish **OR** plate, stamped steel with concealed hinge and set screw, **as directed**.
5) Bare Piping in Unfinished Service Spaces: Split casting, cast brass with polished chrome-plated finish **OR** casting, cast brass with rough-brass finish **OR** plate, stamped steel with concealed hinge and set screw or spring clips **OR** plate, stamped steel with concealed or exposed-rivet hinge and set screw or spring clips **OR** plate, stamped steel with exposed-rivet hinge and set screw or spring clips, **as directed**.
6) Bare Piping in Equipment Rooms: Split casting, cast brass **OR** plate, stamped steel with set screw or spring clips, **as directed**.
7) Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.

J. Hanger And Support Installation
1. Comply with requirements in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment" for seismic-restraint devices.
2. Comply with requirements in Division 22 Section "Hangers And Supports For Plumbing Piping And Equipment" for pipe hanger and support devices.
3. Vertical Piping: MSS Type 8 or 42, clamps.
4. 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.
5. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Division 22 Section "Hangers And Supports For Plumbing Piping And Equipment" for trapeze hangers.
6. Base of Vertical Piping: MSS Type 52, spring hangers.
7. Support horizontal piping within 12 inches (300 mm) of each fitting and coupling.
8. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.
9. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
a. NPS 1/4 (DN 8): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
b. NPS 3/8 and NPS 1/2 (DN 10 and DN 15): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
c. NPS 3/4 (DN 20): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
d. NPS 1 (DN 25): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
e. NPS 1-1/4 (DN 32): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
f. NPS 1-1/2 (DN 40): 10 feet (3 m) with 3/8-inch (10-mm) rod.
g. NPS 2 (DN 50): 11 feet (3.4 m) with 3/8-inch (10-mm) rod.
h. NPS 2-1/2 (DN 65): 13 feet (4 m) with 1/2-inch (13-mm) rod.
i. NPS 3 (DN 80): 14 feet (4.3 m) with 1/2-inch (13-mm) rod.
j. NPS 3-1/2 (DN 90): 15 feet (4.6 m) with 1/2-inch (13-mm) rod.

k. NPS 4 (DN 100): 16 feet (4.9 m) with 1/2-inch (13-mm) rod.
l. NPS 5 (DN 125): 18 feet (5.5 m) with 1/2-inch (13-mm) rod.
m. NPS 6 (DN 150): 20 feet (6 m) with 5/8-inch (16-mm) rod.
n. NPS 8 (DN 200): 23 feet (7 m) with 3/4-inch (19-mm) rod.

10. Install supports for vertical copper tubing every 10 feet (3 m).

K. Labeling And Identification

1. Install identifying labels and devices for specialty gas piping, valves, and specialties. Comply with requirements in Division 22 Section "Identification For Plumbing Piping And Equipment".
2. Install identifying labels and devices for healthcare medical gas piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
   a. Carbon Dioxide: Black or white letters on gray background.
   b. Helium: White letters on brown background.
   c. Nitrogen: White letters on black background.
   d. Nitrous Oxide: White letters on blue background.
   e. Oxygen: White letters on green background or green letters on white background.

L. Field Quality Control For Laboratory Facility Specialty Gas

1. Perform field tests and inspections of specialty gas piping for nonhealthcare laboratory facilities and prepare test reports.
2. Tests and Inspections:
   a. Piping Leak Tests for Specialty Gas Piping: Test new and modified parts of existing piping. Cap and fill specialty gas piping with oil-free, dry nitrogen to pressure of 50 psig (345 kPa) above system operating pressure, but not less than 150 psig (1035 kPa). Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
   b. Repair leaks and retest until no leaks exist.
   c. Inspect specialty gas regulators for proper operation.

M. Field Quality Control For Healthcare Facility Medical Gas

1. Perform tests and inspections of medical gas piping systems in healthcare facilities and prepare test reports.
2. Tests and Inspections:
   a. Medical Gas Piping Testing Coordination: Perform tests, inspections, verifications, and certification of medical gas piping systems concurrently with tests, inspections, and certification of medical compressed-air piping and medical vacuum piping systems.
   b. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
      1) Initial blow down.
      2) Initial pressure test.
      3) Cross-connection test.
      4) Piping purge test.
      5) Standing pressure test for positive pressure medical gas piping.
      6) Standing pressure test for vacuum systems.
      7) Repair leaks and retest until no leaks exist.
   c. System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical gas piping systems and perform the following tests and inspections:
      1) Standing pressure test.
      2) Individual-pressurization **OR** Pressure-differential, **as directed**, cross-connection test.
      3) Valve test.
      4) Master and area alarm tests.
      5) Piping purge test.

6) Piping particulate test.
7) Piping purity test.
8) Final tie-in test.
9) Operational pressure test.
10) Medical gas concentration test.
11) Medical air purity test.
12) Verify correct labeling of equipment and components.
13) Verify the following source equipment:
    a) Medical gas supply sources.

d. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
    1) Inspections performed.
    2) Procedures, materials, and gases used.
    3) Test methods used.
    4) Results of tests.

3. Remove and replace components that do not pass tests and inspections and retest as specified above.

END OF SECTION 22 11 16 00i

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Task	Specification	Specification Description
22 11 16 00	07 63 00 00	Common Work Results for Fire Suppression
22 11 16 00	07 63 00 00a	Common Work Results for Plumbing
22 11 16 00	07 63 00 00b	Common Work Results for HVAC
22 11 19 00	01 22 16 00	No Specification Required
22 11 19 00	22 05 23 00	Piped Utilities Basic Materials And Methods
22 11 19 00	21 05 19 00	Water Distribution
22 11 19 00	07 63 00 00	Common Work Results for Fire Suppression
22 11 19 00	07 63 00 00a	Common Work Results for Plumbing
22 11 19 00	07 63 00 00b	Common Work Results for HVAC
22 11 19 00	22 11 16 00d	Steam And Condensate Piping

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SECTION 22 11 23 13 - WATER DISTRIBUTION PUMPS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for domestic water pumps. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. In-line, sealless centrifugal pumps.
b. Horizontally mounted, in-line, separately coupled centrifugal pumps.
c. Horizontally mounted, in-line, close-coupled centrifugal pumps.
d. Vertically mounted, in-line, close-coupled centrifugal pumps.

C. Definitions
1. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

D. Submittals
1. Product Data: For each type of product indicated. Include materials of construction, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Operation and Maintenance Data: For domestic water pumps to include in operation and maintenance manuals.

E. Quality Assurance
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. UL Compliance: Comply with UL 778 for motor-operated water pumps.

F. Delivery, Storage, And Handling
1. Retain shipping flange protective covers and protective coatings during storage.
2. Protect bearings and couplings against damage.
3. Comply with pump manufacturer's written rigging instructions for handling.

G. Coordination
1. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.2 PRODUCTS

A. In-Line, Sealless Centrifugal Pumps
1. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, sealless, overhung-impeller centrifugal pumps.
2. Pump Construction:
a. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal.
b. Casing: Bronze, with threaded or companion-flange connections.
c. Impeller: Plastic.
d. Motor: Single speed, unless otherwise indicated.

B. Horizontally Mounted, In-Line, Separately Coupled Centrifugal Pumps
   1. Description: Factory-assembled and -tested, in-line, single-stage, separately coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shafts mounted horizontal.
   2. Pump Construction:
      a. Casing: Radially split with threaded companion-flange connections for pumps with NPS 2 (DN 50) pipe connections and flanged connections for pumps with NPS 2-1/2 (DN 65) pipe connections.
      b. Impeller: Statically and dynamically balanced, closed, and keyed to shaft.
      c. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
      d. Coupling: Flexible.
      e. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket.
      f. Bearings: Oil-lubricated; bronze-journal or ball type.
      g. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
   3. Motor: Single speed, with grease-lubricated ball bearings; and resiliently **OR** rigidly, **as directed**, mounted to pump casing.

C. Horizontally Mounted, In-Line, Close-Coupled Centrifugal Pumps
   1. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shaft mounted horizontal.
   2. Pump Construction:
      a. Casing: Radially split with threaded companion-flange connections for pumps with NPS 2 (DN 50) pipe connections and flanged connections for pumps with NPS 2-1/2 (DN 65) pipe connections.
      b. Impeller: Statically and dynamically balanced, closed, and keyed to shaft.
      c. Shaft and Shaft Sleeve: Steel shaft with deflector, with copper-alloy shaft sleeve. Include water slinger on shaft between motor and seal.
      d. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket.
      e. Bearings: Oil-lubricated; bronze-journal or ball type.
      f. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
   3. Motor: Single speed, with grease-lubricated ball bearings; and resiliently or rigidly mounted to pump casing.

D. Vertically Mounted, In-Line, Close-Coupled Centrifugal Pumps
   1. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shaft mounted vertical.
   2. Pump Construction:
      a. Casing: Radially split, cast iron, with wear rings and threaded companion-flange connections for pumps with NPS 2 (DN 50) pipe connections and flanged connections for pumps with NPS 2-1/2 (DN 65) pipe connections. Include pump manufacturer's base attachment for mounting pump on concrete base, **as directed**.
      b. Impeller: Statically and dynamically balanced, closed, and keyed to shaft.
      c. Shaft and Shaft Sleeve: Stainless-steel or steel **OR** Stainless-steel, **as directed**, shaft, with copper-alloy shaft sleeve.
      d. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket. Include water slinger on shaft between motor and seal.
      e. Bearings: Oil-lubricated; bronze-journal or ball type.
      f. Shaft Coupling: Flexible or rigid type if pump is provided with coupling.
   3. Motor: Single speed, with grease-lubricated ball bearings; and rigidly mounted to pump casing.

E. Motors

1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 Section "Common Motor Requirements For Plumbing 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.
   b. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 22.

F. Controls
1. Pressure Switches: Electric, adjustable for control of water-supply pump.
   a. Type: Water-immersion pressure sensor, for installation in piping.
   b. Enclosure: NEMA 250, Type 4X.
   c. Operation of Pump: On or off.
   d. Transformer: Provide if required.
   e. Power Requirement: 24 V, ac **OR** 120 V, ac, **as directed**.
   f. Settings: Start pump at <**Insert pressure**> and stop pump at <**Insert pressure**>.
2. Thermostats: Electric; adjustable for control of hot-water circulation pump.
   a. Type: Water-immersion temperature sensor, for installation in piping.
   b. Range: 50 to 125 deg F (10 to 52 deg C) **OR** 65 to 200 deg F (18 to 93 deg C) **OR** 100 to 240 deg F (38 to 116 deg C), **as directed**.
   c. Enclosure: NEMA 250, Type 4X.
   d. Operation of Pump: On or off.
   e. Transformer: Provide if required.
   f. Power Requirement: 24 V, ac **OR** 120 V, ac, **as directed**.
   g. Settings: Start pump at 105 deg F (41 deg C) **OR** 110 deg F (43 deg C) **OR** 115 deg F (46 deg C), **as directed**, and stop pump at 120 deg F (49 deg C) **OR** 125 deg F (52 deg C), **as directed**.
3. Timers: Electric, for control of hot-water circulation pump.
   a. Type: Programmable, seven-day clock with manual override on-off switch.
   b. Enclosure: NEMA 250, Type 1.suitable for wall mounting.
   c. Operation of Pump: On or off.
   d. Transformer: Provide if required.
   e. Power Requirement: 24 V, ac **OR** 120 V, ac, **as directed**.
   f. Programmable Sequence of Operation: Up to two on-off cycles each day for seven days.
4. Time-Delay Relays: Electric, for control of hot-water circulation pump between water heater and connected hot-water storage tank.
   a. Type: Adjustable time-delay relay.
   b. Range: Up to five minutes.
   c. Setting: Five minutes.
   d. Enclosure: NEMA 250, Type 4X.
   e. Operation of Pump: On or off.
   f. Transformer: Provide if required.
   g. Power Requirement: 24 V, ac **OR** 120 V, ac, **as directed**.
   h. Programmable Sequence of Operation: Limit pump operation to periods of burner operation plus maximum five minutes after the burner stops.

1.3 EXECUTION

A. Examination
1. Examine roughing-in of domestic-water-piping system to verify actual locations of connections before pump installation.

B. Pump Installation
1. Comply with HI 1.4.
2. Install in-line, sealless centrifugal pumps with shaft horizontal unless otherwise indicated.

3. Install horizontally mounted, in-line, separately coupled and close-coupled centrifugal pumps with shaft(s) horizontal.
4. Install vertically mounted, in-line, close-coupled centrifugal pumps with shaft vertical.
5. Pump Mounting: Install vertically mounted, in-line, close-coupled centrifugal pumps with cast-iron base mounted on concrete base using elastomeric pads **OR** elastomeric mounts **OR** restrained spring isolators, **as directed**. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-place Concrete".
   a. Minimum Deflection: 1/4 inch (6 mm) **OR** 1 inch (25 mm), **as directed**.
   b. 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.
   c. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   d. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   e. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install continuous-thread hanger rods and spring hangers **OR** spring hangers with vertical-limit stop, **as directed**, of size required to support pump weight.
   a. Comply with requirements for vibration isolation devices specified in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment". Fabricate brackets or supports as required.
   b. Comply with requirements for hangers and supports specified in Division 22 Section "Hangers And Supports For Plumbing Piping And Equipment".
7. Install pressure switches in water supply piping.
8. Install thermostats in hot-water return piping.
9. Install timers on wall in engineer's office, **as directed**.
10. Install time-delay relays in piping between water heaters and hot-water storage tanks.

C. Connections
1. Comply with requirements for piping specified in Division 22 Section "Domestic Water Piping". Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to pumps to allow service and maintenance.
3. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.
   a. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:
      1) Horizontally mounted, in-line, separately coupled centrifugal pumps.
      2) Horizontally mounted, in-line, close-coupled centrifugal pumps.
      3) Vertically mounted, in-line, close-coupled centrifugal pumps.
      4) Comply with requirements for flexible connectors specified in Division 22 Section "Domestic Water Piping".
   b. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for valves specified in Division 22 Section "General-duty Valves For Plumbing Piping" and comply with requirements for strainers specified in Division 22 Section "Domestic Water Piping Specialties".
   c. Install pressure gage and snubber, **as directed**, at suction of each pump and pressure gage and snubber, **as directed**, at discharge of each pump. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Comply with requirements for pressure gages and snubbers specified in Division 22 Section "Meters And Gages For Plumbing Piping".
4. Comply with Division 22 for electrical connections, and wiring methods.
5. Connect pressure switches, thermostats, time-delay relays, and timers to pumps that they control.
6. Interlock pump between water heater and hot-water storage tank with water heater burner and time-delay relay.

D. Identification
   1. Comply with requirements for identification specified in Division 22 Section "Identification For Plumbing Piping And Equipment" for identification of pumps.

E. Startup Service
   1. Engage a factory-authorized service representative to perform **OR** Perform, **as directed**, startup service.
      a. Complete installation and startup checks according to manufacturer's written instructions.
      b. Check piping connections for tightness.
      c. Clean strainers on suction piping.
      d. Set pressure switches, thermostats, timers, and time-delay relays for automatic starting and stopping operation of pumps.
      e. Perform the following startup checks for each pump before starting:
         1) Verify bearing lubrication.
         2) 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.
         3) Verify that pump is rotating in the correct direction.
      f. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
      g. Start motor.
      h. Open discharge valve slowly.
      i. Adjust temperature settings on thermostats.
      j. Adjust timer settings.

F. Adjusting
   1. Adjust domestic water pumps to function smoothly, and lubricate as recommended by manufacturer.
   2. Adjust initial temperature set points.
   3. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION 22 11 23 13

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SECTION 22 11 23 13a - PACKAGED BOOSTER PUMPS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for packaged booster pumps. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes constant-speed, simplex and multiplex, packaged booster pumps for domestic water piping systems.

C. Submittals
1. Product Data: For each packaged booster pump specified. Include certified performance curves with operating points plotted on curves; and rated capacities of selected models, furnished specialties, and accessories.
   a. Shop Drawings: Design calculations, vibration isolation base details and wiring diagrams.
   b. Manufacturer Seismic Qualification Certification: Submit certification that packaged booster pumps, accessories, and components will withstand seismic forces defined in Division 15 Section "Mechanical Vibration and Seismic Controls."
2. Operation and Maintenance Data

D. Quality Assurance
1. 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.
2. ASME Compliance: Comply with ASME B31.9 for piping.
3. Packaged booster pumps shall be listed and labeled as pumping systems by testing agency acceptable to authorities having jurisdiction.

E. Delivery, Storage, And Handling
1. Retain shipping flange protective covers and protective coatings during storage.
2. Protect bearings and couplings against damage.
3. Comply with pump manufacturer's written rigging instructions for handling.

1.2 PRODUCTS

A. Constant-Speed, Simplex Booster Pumps
1. Description: Factory-assembled and -tested, packaged booster pump with pump, piping, valves, sensors, hydropneumatic tank, and controls mounted on skids or base.
2. System Working-Pressure Rating: 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, minimum.
3. Pump: Overhung impeller, close coupled, single stage, end suction, centrifugal. Comply with UL 778 and with HI 1.1-1.2 and HI 1.3.
   a. Pump Construction: Type 304 stainless steel fitted.
      1) Casing: Radially split, cast iron.
      2) Impeller: ASTM B 584, Type 304 stainless steel; statically and dynamically balanced, closed, and keyed to shaft.
      3) Shaft and Shaft Sleeve: Stainless steel shaft, with copper-alloy shaft sleeve.
      4) Seal: Mechanical.

4. Motor: Single speed, with oil-lubricated bearings, unless otherwise indicated; and directly mounted to pump casing. Select motor that will not overload through full range of pump performance curve. Comply with Division 15 Section "Motors."
5. Control Valve: Adjustable, automatic, direct-acting pressure regulator on pump discharge.
6. Relief Valve: Adjustable, pressure relief type on pump discharge.
7. Piping: ASTM B 88, Type L (ASTM B 88M, Type B), drawn copper water tube; with copper solder-joint pressure fittings, and brazed joints or ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with threaded, cast-iron fittings and threaded joints or stainless steel Victaulic.
8. Valves: Include shutoff valve at each pump suction, and shutoff valve and check valve at each pump discharge.
   a. Shutoff Valves: MSS SP-80, Class 125, bronze, rising-stem gate valve or MSS SP-110, 600-psig (4135-kPa) minimum CWP, bronze ball valve with ends matching piping.
   b. Check Valves: Spring- or lever-loaded, MSS SP-80, Class 125, bronze, swing check valve.
9. Sensors: Pressure and flow switches.
10. Dielectric Fittings: Factory-fabricated union assembly; with insulating material isolating joined dissimilar metals to prevent galvanic action and to stop corrosion; rated for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).
11. Control Panel: NEMA ICS 2 and UL 508; automatic for single-pump, constant-speed operation, with load control and protection functions.
    a. Mounting and Wiring: Factory installed and connected as an integral part of unit.
    b. Enclosure: NEMA ICS 6 **OR** NEMA 250, **as directed**, Type 12. Outdoor - NEMA 3R.
    c. Motor Controller: Full-voltage, combination-magnetic type with undervoltage release feature, motor-circuit-protector-type disconnect, and short-circuit protective device.
       1) Control Voltage: 24-V ac **OR** 120-V ac, **as directed**, with integral control power transformer.
    d. Motor Overload Protection: Overload relay in each phase.
    e. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.
    f. Instrumentation: Unit suction and discharge pressure gages.
    g. Light: Running light for pump.
    h. Alarm Signal Device: Sounds alarm when backup pumps are operating.
    i. High-suction pressure cutout.
    j. High-discharge pressure cutout.
    k. Remote signal contacts.
12. Hydropneumatic Tank: Precharged, diaphragm or bladder tank.
13. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembling and testing. Protect flanges, pipe openings, and pump nozzles.
    a. Electrical Characteristics:
       1) Volts: 120 **OR** 240 **OR** 480, **as directed**.
       2) Phases: Single **OR** Three, **as directed**.
       3) Hertz: 60.

B. Constant-Speed, Multiplex Booster Pumps
1. Description: Factory-assembled and -tested, packaged booster pump with multiple pumps, piping, valves, sensors, and controls on skids or base.
2. System Working-Pressure Rating: 150 psig (1035 kPa) **OR** 175 psig (1200 kPa), **as directed**, minimum.
3. Pump Arrangement: Duplex, with two equal-size pumps **OR** Triplex, with one small lead and two large equal-size lag main pumps, **OR** Triplex, with three equal-size pumps, **as directed**.
4. Pumps: Overhung impeller, close coupled, single stage, end suction, centrifugal. Comply with UL 778 and HI 1.1-1.2 and HI 1.3.
   a. Each Pump:
      1) Orientation: Mounted horizontally **OR** vertically, **as directed**.

2) Construction: Bronze fitted.
   a) Casing: Radially split, cast iron.
   b) Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, closed, and keyed to shaft.
   c) Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
   d) Seal: Mechanical.

5. Pumps: Overhung impeller assembly, separately coupled, vertically mounted, multistage, in-line, centrifugal. Comply with UL 778 and HI 1.1-1.2 and HI 1.3.
   a. Each Pump:
      1) Construction: Stainless-steel fitted.
         a) Casing: Cast-iron base and head sections.
         b) Impellers, Diffusers, and Discharge Sleeve: Stainless steel.
         c) Shaft: Stainless steel.
         d) Seal: Mechanical.
      2) Coupling: Rigid type.
6. Pumps: Overhung impeller, close or rigid coupled, vertically mounted, single stage, in-line, centrifugal. Comply with UL 778 and HI 1.1-1.2 and HI 1.3.
   a. Each Pump:
      1) Construction: Bronze fitted.
         a) Casing: Radially split with wear rings.
         b) Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, closed, and keyed to shaft.
         c) Shaft and Shaft Sleeve: Stainless-steel or steel shaft with copper-alloy shaft sleeve.
         d) Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket. Include water slinger on shaft between motor and seal.
         e) Bearings: Oil lubricated; bronze-journal or ball type.
7. Pumps: Impeller between bearings, separately coupled, horizontally mounted on baseplate, single stage, axially split case, centrifugal. Comply with UL 778 and HI 1.1-1.2 and HI 1.3.
   a. Each Pump:
      1) Construction: Bronze fitted.
         a) Casing: Axially split.
         b) Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, closed, and keyed to shaft.
         c) Shaft and Shaft Sleeve: Stainless-steel or steel shaft with copper-alloy shaft sleeves.
         d) Bearings: Ball type.
         e) Seals: Mechanical.
      2) Shaft Coupling: Flexible with guard.
8. Pumps: Vertical, multistage can. Comply with UL 778 and HI 2.1-2.2.
   a. Construction: Bronze fitted.
      1) Casing: Coated steel.
      2) Impellers: ASTM B 584, cast bronze; statically and dynamically balanced, closed or semiopen, and keyed to shaft.
      3) Bowls: Coated cast iron.
      4) Shaft and Shaft Sleeve: Steel shaft with copper-alloy shaft sleeves.
   b. Coupling: Spool type.
9. Motors: Single speed, with oil-lubricated bearings, unless otherwise indicated. Select motor that will not overload through full range of pump performance curve. Comply with Division 15 Section "Motors."
10. Control Valves: Adjustable, automatic, direct-acting **OR** pilot-operated, **as directed**, pressure regulator on each pump discharge.
11. Relief Valves: Adjustable, pressure relief type on pump discharge.
12. Piping: ASME B31.9 for piping materials and installation.

a. NPS 4 (DN 100) and Smaller: ASTM B 88, Type L (ASTM B 88M, Type B), drawn copper water tube; with copper solder-joint pressure fittings, and brazed joints or ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with threaded, cast-iron fittings and threaded joints.
b. NPS 5 (DN 125) and Larger: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with threaded, cast-iron fittings and threaded joints.
c. Header End Connections:
1) NPS 2 (DN 50) and Smaller: Threaded.
2) NPS 2-1/2 (DN 65) and Larger: Flanged.
d. Piping Option: Piping, including valves and other components, may have grooved ends for grooved joints.

13. Valves: Include shutoff valve at each pump suction, and shutoff valve and check valve at each pump discharge.
a. Shutoff Valves, NPS 2 (DN 50) and Smaller: MSS SP-80, Class 125, bronze rising-stem gate valve or MSS SP-110, 600-psig (4135-kPa) minimum CWP, bronze ball valve with ends matching piping.
b. Shutoff Valves, NPS 2-1/2 (DN 65) and Larger: MSS SP-70, Class 125, bronze-trim, OS&Y, cast-iron gate valve with flanged ends or MSS SP-67, Type I for tight shutoff, 175-psig (1200-kPa) CWP, single-flanged, cast-iron butterfly valve.
c. Check Valves, NPS 2 (DN 50) and Smaller: Spring- or lever-loaded, MSS SP-80, Class 125, bronze, swing check valve.
d. Check Valves, NPS 2-1/2 (DN 65) and Larger: Spring- or lever-loaded, MSS SP-71, Class 125, bronze-trim, cast-iron, swing check valve.

14. Sensors: Pressure and flow switches.

15. Dielectric Fittings: With insulating material isolating joined dissimilar metals to prevent galvanic action and to stop corrosion.
a. NPS 2 (DN 50) and Smaller: Factory-fabricated union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).
b. NPS 2-1/2 (DN 65) and Larger: Factory-fabricated, companion-flange assembly; for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.

16. Control Panel: Factory installed and connected as an integral part of unit complying with NEMA ICS 2 and UL 508; automatic for multiple-pump, constant-speed operation, with load control and protection functions.
a. Enclosure: NEMA ICS 6 **OR** NEMA 250, **as directed**, Type 12.
b. Motor Controller: Full-voltage, combination-magnetic type with undervoltage release feature, motor-circuit-protector-type disconnect, and short-circuit protective device.
1) Control Voltage: 24-V ac **OR** 120-V ac, **as directed**, with integral control power transformer.
c. Motor Overload Protection: Overload relay in each phase.
d. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.
1) Duplex, Automatic, Alternating Starter: Switches lead pump to lag main pump and to two-pump operation.
2) Triplex, Sequence (Lead-Lag-Lag) Starter: Switches lead pump to one lag main pump and to three-pump operation.
e. Instrumentation: Unit suction and discharge pressure gages.
f. Lights: Running light for each pump.
g. Alarm Signal Device: Sounds alarm when backup pumps are operating.
h. High-suction pressure cutout.
i. High-discharge pressure cutout.
j. Remote signal contacts.

17. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembling and testing. Protect flanges, pipe openings, and pump nozzles.

18. Capacity and Characteristics:
    a. Lead Pump:
        1) Electrical Characteristics:
            a) Volts: 120 **OR** 240 **OR** 277 **OR** 480, **as directed**.
            b) Phases: Single **OR** Three, **as directed**.
            c) Hertz: 60.
    b. Each of Two **OR** Three, **as directed**, Lag Pumps:
        1) Electrical Characteristics:
            a) Volts: 120 **OR** 240 **OR** 277 **OR** 480, **as directed**.
            b) Phases: Single **OR** Three, **as directed**.
            c) Hertz: 60.

C. Flexible Connectors
1. Description: Corrugated, bronze inner tubing covered with bronze wire braid. Include copper-tube ends or bronze flanged ends, braze-welded to tubing. Include 150-psig (1035-kPa) **OR** 175-psig (1200-kPa), **as directed**, minimum working-pressure rating and ends according to the following:
    a. NPS 2 (DN 50) and Smaller: Threaded. Provide flanged ends if pump has flanged connections.
    b. NPS 2-1/2 (DN 65) and Larger: Flanged.

D. Building-Automation-System Interface
1. Provide auxiliary contacts in pump controllers for interface to building automation system. Include the following:
    a. On-off status of each pump.
    b. Alarm status.

1.3 EXECUTION

A. Concrete Bases
1. Install concrete bases of dimensions indicated for packaged booster pumps. Refer to Division 15 Section "Basic Mechanical Materials and Methods."
    a. 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 base.
    b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
    c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be imbedded.
    d. Install anchor bolts to elevation required for proper attachment to supported equipment.
2. Cast-in-place concrete materials and placement requirements are specified in Division 3.

B. Booster Pump Installation
1. Install packaged booster pumps level on concrete bases with access for periodic maintenance including removal of pumps, motors, impellers, couplings, and accessories.
    a. Do not dismantle packaged booster pumps or remove individual components.
2. Vibration Isolation: Install on spring isolators with minimum deflection as directed. Vibration isolation devices are specified in Division 15 Section "Mechanical Vibration and Seismic Controls."
3. Support connected domestic water piping so weight of piping is not supported by packaged booster pumps.

C. Connections
1. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

2. Connect domestic water piping to packaged booster pumps. Install suction and discharge pipe equal to or greater than size of unit suction and discharge headers **OR** piping, **as directed**.
   a. Install flexible connectors on piping connections to unit suction and discharge headers **OR** piping, **as directed**. Install flexible connectors same size as piping.
   b. Install shutoff valves on piping connections to each booster pump suction and discharge headers **OR** piping, **as directed**. Install ball, butterfly, or gate valves same size as suction and discharge headers **OR** piping, **as directed**. General-duty valves are specified in Division 15 Section "Valves."
   c. Install union or flanged connections on pump suction and discharge headers **OR** piping, **as directed**, at connection to domestic water piping.
   d. Install piping adjacent to packaged booster pumps to allow service and maintenance.
3. Ground equipment according to Division 16 Section "Grounding and Bonding."
4. Connect wiring according to Division 16 Section "Conductors and Cables."

D. Startup Service
1. Engage a factory-authorized service representative to perform **OR** Perform the following startup service
   a. Complete installation and startup checks according to manufacturer's written instructions.
   b. Check piping connections for tightness.
   c. Clean strainers if any.
   d. Verify that pump controls are correct for required application.
2. Perform the following startup checks for each pump of packaged booster pump unit before starting:
   a. Verify bearing lubrication.
   b. Prime pumps by opening suction valves and closing discharge valves, and prepare pumps for operation.
   c. Start motors.
   d. Open discharge valves slowly.
   e. Adjust settings.
3. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting packaged booster pumps to suit actual occupied conditions. Provide up to two visits to Project outside normal occupancy hours for this purpose.

E. Labeling And Identification
1. Install identifying equipment markers and equipment signs on booster pumps. Labeling and identification materials are specified in Division 15 Section "Mechanical Identification."

END OF SECTION 22 11 23 13a

SECTION 22 11 23 39 - WATER SUPPLY WELLS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for water supply wells. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Cable-tool, Rotary drilled, Reverse-rotary drilled, and Driven water supply wells.
b. Jet, Line-shaft, and Submersible well pumps.

C. Definitions
1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. PA: Polyamide (nylon) plastic.
3. PE: Polyethylene plastic.
4. PP: Polypropylene plastic.
5. PVC: Polyvinyl chloride plastic.

D. Submittals
1. Product Data: Submit certified performance curves and rated capacities of selected well pumps and furnished specialties for each type and size of well pump indicated.
2. Shop Drawings: Show layout and connections for well pumps.
a. Wiring Diagrams: Power, signal, and control wiring.
3. Field quality-control reports.
4. Operation and maintenance data.

E. Quality Assurance
1. Well Driller Qualifications: An experienced water supply well driller licensed in the jurisdiction where Project is located.
2. 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.
3. Comply with AWWA A100 for water supply wells.

F. Project Conditions
1. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
a. Notify the Owner no fewer than seven days in advance of proposed interruption of water service.
b. Do not proceed with interruption of water service without the Owner's written permission.
2. Well Drilling Water: Provide temporary water and piping for drilling purposes. Provide necessary piping for water supply.

1.2 PRODUCTS

A. Well Casings
1. Steel Casing: AWWA C200, single ply, steel pipe with threaded ends and threaded couplings for threaded joints.

2. ABS Casing: ASTM F 480, ABS, Schedule 40 **OR** 80, **as directed**, bell-and-spigot pipe and couplings for solvent-cemented joints.
3. PVC Casing: ASTM F 480 and NSF 14, **as directed**, PVC, Schedule 40 **OR** 80, **as directed**, bell-and-spigot pipe and couplings for solvent-cemented joints. Include NSF listing mark "NSF wc," **as directed**.
4. Pitless Adapter: Fitting, of shape required to fit onto casing, with waterproof seals.
5. Pitless Unit: Factory-assembled equipment that includes pitless adapter.
6. Well Seals: Casing cap, with holes for piping and cables, that fits into top of casing and is removable, waterproof, and vermin proof.

B. Grout
1. Cement: ASTM C 150, Type II.
2. Aggregates: ASTM C 33, fine and coarse grades.
3. Water: Potable.

C. Water Well Screens
1. Screen Material: Fabricated of ASTM A 666, Type 304 stainless steel, welded; with continuous-slot, V-shaped openings that widen inwardly **OR** tube; with slotted or perforated surface and designed for well-screen applications, **as directed**.
   a. Screen Couplings: Butt-type, stainless-steel coupling rings.
   b. Screen Fittings: Screen, with necessary fittings, closes bottom and makes tight seal between top of screen and well casing.
   c. Maximum Entering Velocity: 0.1 fps (0.03 m/s).

D. Pack Materials
1. Coarse, uniformly graded filter sand, maximum 1/8 inch (3 mm) in diameter.
2. Fine gravel, maximum 1/4 inch (6 mm) in diameter.

E. Jet-Type Well Pumps
1. Description: Shallow **OR** Deep, **as directed**,-well-design, jet well pump; self-priming; centrifugal pump capable of continuous operation; with the following features:
   a. Housing: Cast iron.
   b. Impeller: Single stage **OR** Multistage, **as directed**, centrifugal; fabricated of corrosion-resistant materials.
   c. Seals: Mechanical.
   d. Shaft: Stainless steel.
   e. Motor: Manufacturer's standard, NEMA MG 1 motor, panel, and accessories.
   f. Motor Controls: Electronic; variable speed.
   g. Check valve, ejector, and pressure-control valve.
2. Pump Accessories:
   a. Compression Tanks: Comply with requirements in Division 22 Section "Facility Indoor Potable-water Storage Tanks" **OR** Precharged butyl rubber diaphragm, steel shell, fused polymeric lining, and 100-psig (690-kPa) working pressure, **as directed**.
   b. Pressure Switches: For pump control; for installation in piping.
   c. Water Piping: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with threaded ends.
      1) Cast-Iron Fittings: ASME B16.4, threaded, galvanized.
   d. Water Piping: ASTM D 2239, SIDR Numbers 5.3, 7, or 9 PE pipe; made with PE compound number required to give pressure rating not less than 160 psig (1100 kPa) **OR** 200 psig (1380 kPa), **as directed**. Include NSF listing mark "NSF pw."
      1) Fittings for PE Pipe: ASTM D 2609, made of PA, PP, or PVC with serrated, male insert ends matching inside of pipe. Include bands or crimp rings.

F. Line-Shaft Well Pumps
1. Description: Line-shaft, water **OR** oil, **as directed**,-lubricated, vertical-turbine well pump complying with HI 2.1-2.2 and HI 2.3; with the following features:

a. Impeller Material: Stainless steel **OR** Carbon steel **OR** Bronze, **as directed**.
b. Motor: Full-voltage starting, vertical hollow- or solid-shaft, squirrel-cage induction type complying with ANSI C50.10.
c. Pump Base: Cast iron or fabricated steel.
d. Column Pipe: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with threaded ends and cast-iron or steel threaded couplings.

G. Submersible Well Pumps
1. Description: Submersible, vertical-turbine well pump complying with HI 2.1-2.2 and HI 2.3; with the following features:
a. Impeller Material: Stainless steel **OR** Silicon bronze, **as directed**.
b. Motor: Capable of continuous operation under water, with protected submersible power cable.
c. Column Pipe: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with threaded ends and cast-iron or steel threaded couplings.
d. Discharge Piping: ASTM D 2239, SIDR Numbers 5.3, 7, or 9 PE pipe; made with PE compound number required to give pressure rating not less than 160 psig (1100 kPa) **OR** 200 psig (1380 kPa), **as directed**. Include NSF listing mark "NSF pw."
1) Insert Fittings for PE Pipe: ASTM D 2609, made of PA, PP, or PVC with serrated, male insert ends matching inside of pipe. Include bands or crimp rings.

H. Motors
1. General requirements for motors are specified in Division 22 Section "Common Motor Requirements For Plumbing 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.
b. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 22.

1.3 EXECUTION

A. Preparation
1. Pilot-Hole Data: Review pilot-hole test analysis furnished by the Owner.
2. Neighborhood Well Data: Review operating and test analyses.

B. Installation
1. Construct well using cable-tool **OR** rotary drilling **OR** reverse-rotary drilling **OR** driven, **as directed**, method.
2. Take samples of substrata formation at 10-foot (3-m) intervals and at changes in formation throughout entire depth of each water supply well. Carefully preserve samples on-site in glass jars properly labeled for identification.
3. If selecting rotary drilled or reverse-rotary drilled method, excavate for mud pit or provide aboveground structure, acceptable to authorities having jurisdiction, to allow settlement of cuttings and circulation of drill fluids back to well without discharging to on-site waterways.
4. Enlarge pilot hole and install permanent casing, screen, and grout. Install first section of casing with hardened steel driving shoe of an OD slightly larger than casing couplings if threaded couplings are used.
5. Set casing and liners round, plumb, and true to line.
6. Join casing pipe as follows:
a. Ream ends of pipe and remove burrs.
b. Remove scale, slag, dirt, and debris from inside and outside casing before installation.
c. Cut bevel in ends of steel casing pipe and make threaded joints.
d. Clean and make solvent-cemented joints for ABS and PVC casings.
7. If rotary drilled or reverse-rotary drilled well, mix grout in proportions of 1 cu. ft. (0.03 cu. m) or a 94-lb (42.6-kg) sack of cement with 5 to 6 gal. (19 to 23 L) of water. Bentonite clay may be added

in amounts of 3 to 5 lb/cu. ft. (1.4 to 2.3 kg/0.03 cu. m) for a 94-lb (42.6-kg) sack of cement. If bentonite clay is added, water may be increased to 6.5 gal./cu. ft. (25 L/0.03 cu. m) of cement.

8. If rotary drilled or reverse-rotary drilled well, place grout continuously, from bottom to top surface, to ensure filling of annular space in one operation. Do not perform other operations in well within 72 hours after grouting of casing. When quick-setting cement is used, this period may be reduced to 24 hours.
9. Provide permanent casing with temporary well cap. Install with top of casing 36 inches (910 mm) above finished grade, **as directed**.
10. Develop wells to maximum yield per foot (meter) of drawdown.
    a. Extract maximum practical quantity of sand, drill fluid, and other fine materials from water-bearing formation.
    b. Avoid settlement and disturbance of strata above water-bearing formation.
    c. Do not disturb sealing around well casings.
    d. Continue developing wells until water contains no more than 2 ppm of sand by weight when pumped at maximum testing rate.
11. Install jet well pumps with ejector in or attached to pump housing. Place check valve on suction line to prevent drainage of compression tank.
12. Install jet well pumps and pressure and suction lines. Install ejector where pressure and suction lines connect above well screen. Install check valve in suction line, or install foot valve below ejector, to prevent drainage of compression tank.
13. Install line-shaft **OR** submersible, **as directed**, well pumps according to HI 2.1-2.4 and provide access for periodic maintenance.
    a. Before lowering permanent pump into well, lower a dummy pump that is slightly longer and wider than permanent pump to determine that permanent pump can be installed. Correct alignment problems.
    b. Before lowering permanent pump into well, start pump to verify correct rotation.
    c. Securely tighten discharge piping joints.
    d. Locate line-shaft well pump near well bottom; locate motor above grade. Install driver plate to correctly align motor and pump.
    e. Connect motor to submersible pump and locate near well bottom.
        1) Connect power cable while connection points are dry and undamaged.
        2) Do not damage power cable during installation; use cable clamps that do not have sharp edges.
        3) Install water-sealed surface plate that will support pump and piping.

C. Connections
1. Piping installation requirements are specified in Division 22 Section "Facility Water Distribution Piping". Drawings indicate general arrangement of piping, fittings, and specialties.
    a. Connect piping between well pump and water piping.
    b. Connect water distribution system in trench to well pipe at pitless adapter **OR** unit, **as directed**.
    c. Connect building water distribution to well pipe inside well house.
2. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
3. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

D. Well Abandonment
1. Comply with AWWA A100 when abandoning water supply wells. Fill and seal holes and casings and restore ground surface to finished grade.
   OR
   Follow well-abandonment procedures of authorities having jurisdiction. Restore ground surface to finished grade.

E. Field Quality Control

1. Plumbness and Alignment Testing: Comply with AWWA A100.
2. Furnish samples of water-bearing formation to testing laboratory and well-screen manufacturer for mechanical sieve analysis.
3. Prepare reports on static level of ground water, level of water for various pumping rates, and depth to water-bearing strata.
4. Performance Testing: Conduct final pumping tests after wells have been constructed, cleaned, and tested for plumbness and alignment.
   a. Provide discharge piping to conduct water to locations where disposal will not create a nuisance or endanger adjacent property. Comply with requirements of authorities having jurisdiction.
   b. Measure elevation to water level in wells.
   c. Perform two bailer or air-ejection tests to determine expected yield. Test at depths with sufficient quantity of water to satisfy desired yields.
   d. Test Pump: Variable capacity test pump with capacity equal to maximum expected yields at pressure equal to drawdown in wells, plus losses in pump columns and discharge pipes.
   e. Start and adjust test pumps and equipment to required pumping rates.
   f. Record readings of water levels in wells and pumping rates at 30-minute maximum intervals throughout 24-hour minimum period.
   g. Record maximum yields when drawdown is 60 inches (1500 mm) above top of suction screens after designated times.
   h. Operate pumping units continuously for eight hours after maximum drawdown is reached.
   i. Record returning water levels in wells and plot curves of well recovery rates.
   j. Remove sand, stones, and other foreign materials that may become deposited in wells after completing final tests.
5. Water Analysis Testing:
   a. Engage] a qualified testing agency to make bacteriological, physical, and chemical analyses of water from each finished well and report the results. Make analyses according to requirements of authorities having jurisdiction.
      OR
      Analyze water sample from each finished well for bacteriological, physical, and chemical quality and report the results. Make analyses according to requirements of authorities having jurisdiction.

F. Cleaning
1. Disinfect water supply wells according to AWWA A100 and AWWA C654 before testing well pumps.
   OR
   Follow water supply well disinfection procedures required by authorities having jurisdiction before testing well pumps.

G. Protection
1. Water Quality Protection: Prevent well contamination, including undesirable physical and chemical characteristics.
2. Ensure that mud pit will not leak or overflow into streams or wetlands. When well is accepted, remove mud and solids in mud pit from Project site and restore site to finished grade.
3. Provide casings, seals, sterilizing agents, and other materials to eliminate contamination; shut off contaminated water.
4. Exercise care to prevent breakdown or collapse of strata overlaying that from which water is to be drawn.
5. Protect water supply wells to prevent tampering and introducing foreign matter. Retain temporary well cap until installation is complete.

END OF SECTION 22 11 23 39

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SECTION 22 11 23 39a - HYDRONIC PUMPS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for hydronic pumps. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Close-coupled, in-line centrifugal pumps.
b. Close-coupled, end-suction centrifugal pumps.
c. Separately coupled, horizontal, in-line centrifugal pumps.
d. Separately coupled, vertical, in-line centrifugal pumps.
e. Separately coupled, base-mounted, end-suction centrifugal pumps.
f. Separately coupled, base-mounted, double-suction centrifugal pumps.
g. Separately coupled, vertical-mounted, double-suction centrifugal pumps.
h. Separately coupled, vertical-mounted, turbine centrifugal pumps.
i. Automatic condensate pump units.

C. Definitions
1. Buna-N: Nitrile rubber.
2. EPT: Ethylene propylene terpolymer.

D. Submittals
1. Product Data: 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.
2. Shop Drawings: Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
a. Wiring Diagrams: Power, signal, and control wiring.
3. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

E. Quality Assurance
1. 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.
2. UL Compliance: Comply with UL 778 for motor-operated water pumps.

F. Delivery, Storage, And Handling
1. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.
2. Store pumps in dry location.
3. Retain protective covers for flanges and protective coatings during storage.
4. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
5. Comply with pump manufacturer's written rigging instructions.

1.2 PRODUCTS

A. Close-Coupled, In-Line Centrifugal Pumps
1. 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. Rate pump for 125-psig (860-kPa) **OR** 175-psig (1204-kPa) **OR** 250-psig (1720-kPa), **as directed**, minimum working pressure and a continuous water temperature of 200 deg F (93 deg C) **OR** 225 deg F (107 deg C) **OR** 250 deg F (121 deg C), **as directed**.
2. Pump Construction:
a. Casing: Radially split, cast iron, with replaceable bronze wear rings, **as directed**, threaded gage tappings at inlet and outlet, and threaded companion-flange **OR** union end, **as directed**, connections.
b. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
c. Pump Shaft: Steel, with copper-alloy shaft sleeve **OR** Stainless steel**, as directed**.
d. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N **OR** EPT, **as directed**, bellows and gasket. Include water slinger on shaft between motor and seal.
e. Packing Seal: 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.
f. Pump Bearings: Permanently lubricated ball bearings **OR** Oil lubricated; bronze-journal or thrust type, **as directed**.
3. Motor: Single speed, with permanently lubricated **OR** grease-lubricated, **as directed**, ball bearings, unless otherwise indicated; and rigidly mounted to pump casing. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".

B. Close-Coupled, End-Suction Centrifugal Pumps
1. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally. Rate pump for 125-psig (860-kPa) **OR** 175-psig (1204-kPa), **as directed**, minimum working pressure and a continuous water temperature of 225 deg F (107 deg C) **OR** 250 deg F (121 deg C), **as directed**.
2. Pump Construction:
a. Casing: Radially split, cast iron, with replaceable bronze wear rings, **as directed**, drain plug at bottom and air vent at top of volute, threaded gage tappings at inlet and outlet, and threaded companion-flange **OR** flanged, **as directed**, connections.
b. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
c. Pump Shaft: Steel, with copper-alloy shaft sleeve **OR** Stainless steel, **as directed**.
d. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N **OR** EPT, **as directed**, bellows and gasket. Include water slinger on shaft between motor and seal.
e. Pump Bearings: Permanently lubricated ball bearings **OR** Oil lubricated; bronze-journal or thrust type, **as directed**.
f. Motor: Single speed, with permanently lubricated **OR** grease-lubricated, **as directed**, ball bearings, unless otherwise indicated; rigidly mounted to pump casing with integral pump support. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".

C. Separately Coupled, Horizontal, In-Line Centrifugal Pumps
1. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately 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. Rate pump for 125-psig (860-kPa) **OR** 175-psig (1204-kPa), **as**

directed, minimum working pressure and a continuous water temperature of 225 deg F (107 deg C) **OR** 250 deg F (121 deg C), **as directed**.

2. Pump Construction:
   a. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, and threaded companion-flange **OR** union end, **as directed**, connections.
   b. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, and keyed to shaft. Trim impeller to match specified performance.
   c. Pump Shaft: Steel, with copper-alloy shaft sleeve **OR** Stainless steel, **as directed**.
   d. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N **OR** EPT, **as directed**, bellows and gasket. Include water slinger on shaft between motor and seal.
   e. Pump Bearings: Permanently lubricated ball bearings **OR** Oil lubricated; bronze-journal or thrust type, **as directed**.
3. Shaft Coupling: Molded rubber insert with interlocking spider **OR** Interlocking frame with interconnecting springs, **as directed**, capable of absorbing vibration.
4. Motor: Single speed, with permanently lubricated ball **OR** oil-lubricated sleeve, **as directed**, bearings, unless otherwise indicated; and resiliently **OR** rigidly, **as directed**, mounted to pump casing. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".

D. Separately Coupled, Vertical, In-Line Centrifugal Pumps
1. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately 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 vertically. Rate pump for 125-psig (860-kPa) **OR** 175-psig (1204-kPa) **OR** 250-psig (1720-kPa), **as directed**, minimum working pressure and a continuous water temperature of 200 deg F (93 deg C) **OR** 225 deg F (107 deg C) **OR** 250 deg F (121 deg C), **as directed**.
2. Pump Construction:
   a. Casing: Radially split, cast iron, with replaceable bronze wear rings, **as directed**, threaded gage tappings at inlet and outlet, and threaded companion-flange **OR** union end, **as directed**, connections.
   b. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
   c. Pump Shaft: Steel, with copper-alloy shaft sleeve **OR** Stainless steel, **as directed**.
   d. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N **OR** EPT, **as directed**, bellows and gasket. Include water slinger on shaft between motor and seal.
   e. Packing Seal: 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.
   f. Pump Bearings: Permanently lubricated ball bearings **OR** Oil lubricated; bronze-journal or thrust type, **as directed**.
3. Shaft Coupling: Axially split spacer coupling.
4. Motor: Single speed, with permanently lubricated **OR** grease-lubricated, **as directed**, ball bearings, unless otherwise indicated; rigidly mounted to pump casing with lifting eye and supporting lugs in motor enclosure. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".

E. Separately Coupled, Base-Mounted, End-Suction Centrifugal Pumps
1. 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. Rate pump for 125-psig (860-kPa) **OR** 175-psig (1204-kPa) **OR** 250-psig (1720-kPa), **as directed**, minimum working pressure and a continuous water temperature of 200 deg F (93 deg C) **OR** 225 deg F (107 deg C) **OR** 250 deg F (121 deg C), **as directed**.
2. Pump Construction:
   a. Casing: Radially split, cast iron, with replaceable bronze wear rings, **as directed**, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and threaded companion-flange **OR** flanged, **as directed**, connections. Provide integral mount

on volute to support the casing, and attached piping to allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft, **as directed**.

b. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.

c. Pump Shaft: Steel, with copper-alloy shaft sleeve **OR** Stainless steel, **as directed**.

d. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N **OR** EPT, **as directed**, bellows and gasket.

e. Packing Seal: 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.

f. Pump Bearings: Grease-lubricated ball bearings contained in cast-iron housing with grease fittings.

3. 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 **OR** EPDM coupling sleeve for variable-speed applications, **as directed**.

4. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

5. 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.

6. Motor: Single speed, with permanently lubricated **OR** grease-lubricated, **as directed**, ball bearings, unless otherwise indicated; secured to mounting frame, with adjustable alignment. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".

F. Separately Coupled, Base-Mounted, Double-Suction Centrifugal Pumps

1. Description: Factory-assembled and -tested, centrifugal, impeller-between-bearings, separately coupled, double-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal. Rate pump for 125-psig (860-kPa) **OR** 175-psig (1204-kPa) **OR** 250-psig (1720-kPa), **as directed**, minimum working pressure and a continuous water temperature of 200 deg F (93 deg C) **OR** 225 deg F (107 deg C) **OR** 250 deg F (121 deg C), **as directed**.

2. Pump Construction:

a. Casing: Radially **OR** Horizontally, **as directed**, split, cast iron, with replaceable bronze wear rings, **as directed**, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and ASME B16.1, Class 125 **OR** 250, **as directed**, flanges. Casing supports shall allow removal and replacement of impeller without disconnecting piping, **as directed**.

b. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, and keyed to shaft. Trim impeller to match specified performance.

c. Pump Shaft: Stainless steel.

d. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N **OR** EPT, **as directed**, bellows and gasket.

e. Packing Seal: 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.

f. Pump Bearings: Grease-lubricated ball bearings contained in cast-iron housing with grease fittings.

3. 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 **OR** EPDM coupling sleeve for variable-speed applications, **as directed**.

4. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

5. 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.

6. Motor: Single speed, with grease-lubricated ball bearings, unless otherwise indicated; secured to mounting frame, with adjustable alignment. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".

G. Separately Coupled, Vertical-Mounted, Double-Suction Centrifugal Pumps
1. Description: Factory-assembled and -tested, centrifugal, impeller-between-bearings, separately coupled, double-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted vertically. Rate pump for 125-psig (860-kPa) **OR** 175-psig (1204-kPa) **OR** 250-psig (1720-kPa), **as directed**, minimum working pressure and a continuous water temperature of 200 deg F (93 deg C) **OR** 225 deg F (107 deg C) **OR** 250 deg F (121 deg C), **as directed**.
2. Pump Construction:
   a. Casing: Radially split, cast iron, with replaceable bronze wear rings, **as directed**, threaded gage tappings at inlet and outlet, drain plug at bottom of volute, mounting support, and ASME B16.1, Class 125 **OR** 250, **as directed**, flanges.
   b. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, and keyed to shaft. Trim impeller to match specified performance.
   c. Pump Shaft: Stainless steel.
   d. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N **OR** EPT, **as directed**, bellows and gasket.
   e. Packing Seal: 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.
   f. Pump Bearings: Grease-lubricated ball bearings contained in cast-iron housing with grease fittings.
3. Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration.
4. Motor: Single speed, with grease-lubricated ball bearings, unless otherwise indicated; secured to casing. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".

H. Separately Coupled, Vertical-Mounted, Turbine Centrifugal Pumps
1. Description: Factory-assembled and -tested, single-stage **OR** multistage, **as directed**, centrifugal, impeller-between-bearings, end-suction pump as defined in HI 2.1-2.2 and HI 2.3; designed for installation with pump and motor shafts mounted vertically and projecting into a sump. Rate pump for 125-psig (860-kPa) **OR** 175-psig (1204-kPa), **as directed**, minimum working pressure and a continuous water temperature of 200 deg F (93 deg C).
2. Pump Construction:
   a. Pump Bowl: Cast iron, with replaceable bronze wear ring, **as directed**, cone **OR** basket, **as directed**, strainer, and suction bell. Water passages of intermediate bowls shall be coated with porcelain enamel, **as directed**.
   b. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, and keyed to shaft. Trim impeller to match specified performance.
   c. Pump Shaft: Carbon **OR** Stainless, **as directed**, steel sized per AWWA E-101.
   d. Pump Bearings: Water-lubricated bronze and rubber sleeve bearings contained in cast-iron housing.
   e. Pump Column: ASTM A 53/A 53M, Grade B steel pipe.
   f. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Seal shall be replaceable without removing the motor or disturbing the piping.
   g. Packing Seal: 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.
3. Shaft Coupling: Keyed with locking collets.
4. Discharge Head: ASME B16.1, Class 125 **OR** 250, **as directed**, discharge flange with threaded gage tapping. Top of discharge head shall have a registered fit to accurately locate the driver.
5. Drive Ratchet: Nonreversing ratchet.

6. Hollow Shaft Motor: Single speed, with grease-lubricated ball bearings, unless otherwise indicated; secured to discharge head. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".

I. Automatic Condensate Pump Units
1. Description: Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls. Include factory- or field-installed check valve and a 72-inch- (1800-mm-) minimum, electrical power cord with plug.

J. Pump Specialty Fittings
1. Suction Diffuser: Angle pattern, 175-psig (1204-kPa) **OR** 300-psig (2060-kPa), **as directed**, pressure rating, cast **OR** ductile, **as directed**,-iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory-fabricated support.
2. Triple-Duty Valve: Angle or straight pattern, 175-psig (1204-kPa) **OR** 300-psig (2060-kPa), **as directed**, pressure rating, cast **OR** ductile, **as directed**,-iron body, pump-discharge fitting; with drain plug and bronze-fitted shutoff, balancing, and check valve features. Brass gage ports with integral check valve, and orifice for flow measurement.

1.3 EXECUTION

A. Concrete Bases
1. Install concrete bases of dimensions indicated for pumps and controllers. Refer to Division 23 Section "Common Work Results For Hvac"
   a. 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 base.
   b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   d. Install anchor bolts to elevations required for proper attachment to supported equipment.
2. Cast-in-place concrete materials and placement requirements are specified in Division 31.

B. Pump Installation
1. Comply with HI 1.4 **OR** HI 2.4, **as directed**.
2. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.
3. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
4. Install continuous-thread hanger rods and elastomeric hangers **OR** spring hangers **OR** spring hangers with vertical-limit stop, **as directed**, of sufficient size to support pump weight. Vibration isolation devices are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment". Fabricate brackets or supports as required. Hanger and support materials are specified in Division 23 Section "Hangers And Supports For Hvac Piping And Equipment".
5. Suspend vertically mounted, in-line centrifugal pumps independent of piping. Install pumps with motor and pump shafts vertical. Use continuous-thread hanger rods and elastomeric hangers **OR** spring hangers **OR** spring hangers with vertical-limit stop, **as directed**, of sufficient size to support pump weight. Vibration isolation devices are specified in Division 21 Section(s) "Vibration And Seismic Controls For Fire-suppression Piping And Equipment" AND Division 23 Section(s) "Vibration And Seismic Controls For Hvac Piping And Equipment". Hanger and support materials are specified in Division 22 Section(s) "Hangers And Supports For Plumbing Piping And Equipment" AND Division 23 Section(s) "Hangers And Supports For Hvac Piping And Equipment".

6. Set base-mounted pumps on concrete foundation. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.
   a. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches (19 to 38 mm) between pump base and foundation for grouting.
   b. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.
7. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.

C. Alignment
1. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.
2. Comply with pump and coupling manufacturers' written instructions.
3. Adjust pump and motor shafts for angular and offset alignment by methods specified in HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation" **OR** HI 2.1-2.5, "Vertical Pumps for Nomenclature, Definitions, Application and Operation",**as directed**.
4. 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.

D. Connections
1. Piping installation requirements are specified in other Division 21. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to machine to allow service and maintenance.
3. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
4. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
5. Install check valve and throttling **OR** triple-duty, **as directed**, valve on discharge side of pumps.
6. Install Y-type strainer **OR** suction diffuser, **as directed**, and shutoff valve on suction side of pumps.
7. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.
8. Install pressure gages on pump suction and discharge, at integral pressure-gage tapping, or install single gage with multiple input selector valve.
9. Install check valve and gate or ball valve on each condensate pump unit discharge.
10. Install electrical connections for power, controls, and devices.
11. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
12. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

END OF SECTION 22 11 23 39a

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Task	Specification	Specification Description
22 11 23 39	22 05 23 00	Piped Utilities Basic Materials And Methods

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SECTION 22 12 23 13 - ELECTRIC, DOMESTIC WATER HEATERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for electric, water heaters. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following electric water heaters:
   a. Household, small-capacity electric water heaters.
   b. Household, storage electric water heaters.
   c. Household, collector-to-tank, solar-electric water heaters.
   d. Household, collector-to-tank, heat-exchanger-coil, solar-electric water heaters.
   e. Flow-control, instantaneous electric water heaters.
   f. Thermostat-control, instantaneous electric water heaters.
   g. Light-commercial electric water heaters.
   h. Commercial electric booster heaters.
   i. Commercial, storage electric water heaters.
   j. Compression tanks.
   k. Water heater accessories.

C. Submittals
1. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
2. LEED Submittal:
   a. Product Data for Prerequisite EA 2: Documentation indicating that units comply with ASHRAE/IESNA 90.1, Section 7 - "Service Water Heating."
3. Shop Drawings: Diagram power, signal, and control wiring.
4. Manufacturer Seismic Qualification Certification: Submit certification that commercial water heaters, accessories, and components will withstand seismic forces defined in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment".
5. Field quality-control test reports.
6. Operation and maintenance data.
7. Warranty: Special warranty specified in this Section.

D. Quality Assurance
1. 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.
2. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
3. ASME Compliance: Where indicated, fabricate and label commercial water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
4. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for all components that will be in contact with potable water.

E. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric water heaters that fail in materials or workmanship within specified warranty period.
   a. Failures include, but are not limited to, the following:
      1) Structural failures including storage tank and supports.

2) Faulty operation of controls.
3) Deterioration of metals, metal finishes, and other materials beyond normal use.

b. Warranty Period(s): From date of Final Completion:
1) Household Electric Water Heaters:
a) Storage Tank: Five **OR** Six **OR** 10, **as directed**, years.
b) Controls and Other Components: Two **OR** Three, **as directed**, years.
2) Instantaneous Electric Water Heaters: One **OR** Two **OR** Five, **as directed**, year(s).
3) Light-Commercial Electric Water Heaters:
a) Storage Tank: Three **OR** Five, **as directed**, years.
b) Controls and Other Components: Two **OR** Three, **as directed**, years.
4) Commercial Electric Water Heaters:
a) Storage Tank: Three **OR** Five, **as directed**, years.
b) Controls and Other Components: Three **OR** Five, **as directed**, years.
5) Compression Tanks: One year.

1.2 PRODUCTS

A. Household Electric Water Heaters
1. Household, Small-Capacity Electric Water Heaters: Comply with UL 174.
a. Storage-Tank Construction: Corrosion-resistant metal or steel with corrosion-resistant coating, **as directed**.
1) Tappings: ASME B1.20.1 pipe thread.
2) Pressure Rating: 150 psig (1035 kPa).
3) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
b. Factory-Installed Storage-Tank Appurtenances:
1) Drain Valve: ASSE 1005, if tank has drain outlet. Provide hose-end drain valve in piping for water heaters without drain outlet. Hose-end drain valves are specified in Division 22 Section "Domestic Water Piping Specialties".
2) Insulation: Comply with ASHRAE/IESNA 90.1 or ASHRAE 90.2, **as directed**.
3) Jacket: Steel with enameled finish.
4) Heating Element: Electric, screw-in immersion type.
5) Temperature Control: Adjustable thermostat.
6) Safety Control: High-temperature-limit cutoff device or system.
7) Power Supply Cord: 24 to 72 inches (610 to 1830 mm) with plug.
8) Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3 for combination temperature and pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.
2. Household, Standard **OR** Tabletop, **as directed**, Storage Electric Water Heaters: Comply with UL 174.
a. Storage-Tank Construction: Steel.
1) Tappings: ASME B1.20.1 pipe thread.
2) Pressure Rating: 150 psig (1035 kPa).
3) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
b. Factory-Installed Storage-Tank Appurtenances:
1) Anode Rod: Replaceable magnesium.
2) Dip Tube: Provide unless cold-water inlet is near bottom of tank.
3) Drain Valve: ASSE 1005.
4) Insulation: Comply with ASHRAE/IESNA 90.1 or ASHRAE 90.2, **as directed**.
5) Jacket: Steel with enameled finish.
a) Standard: Cylindrical shape.

b) Tabletop: Rectangular shape, with flat-top work surface and raised back.

6) Heat Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.

7) Heating Elements: Two; electric, screw-in immersion type with 12 kW or less total, and wired for nonsimultaneous operation, unless otherwise indicated.

8) Temperature Control: Adjustable thermostat for each element.

9) Safety Control: High-temperature-limit cutoff device or system.

10) Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3 for combination temperature and pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.

3. Household, Collector-to-Tank, Solar-Electric Water Heaters: Comply with UL 174 with piping and electrical connections for UL 1279 solar collector system.

a. Storage-Tank Construction: Steel.

1) Tappings: ASME B1.20.1 pipe thread.

2) Pressure Rating: 150 psig (1035 kPa).

3) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.

b. Factory-Installed Storage-Tank Appurtenances:

1) Sensor electrical connections and tank stud for sensor.

2) Anode Rod: Replaceable magnesium.

3) Dip Tube: Provide unless cold-water inlet is near bottom of tank.

4) Drain Valve: ASSE 1005.

5) Insulation: Comply with ASHRAE/IESNA 90.1 or ASHRAE 90.2, **as directed**.

6) Jacket: Steel with enameled finish.

7) Heat Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.

8) Heating Element: One; electric, screw-in immersion type with 6 kW or less.

9) Temperature Control: Adjustable thermostat for each element.

10) Safety Control: High-temperature-limit cutoff device or system.

11) Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3 for combination temperature and pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.

4. Household, Collector-to-Tank, Heat-Exchanger-Coil, Solar-Electric Water Heaters: Comply with UL 174 with integral coil-type heat exchanger.

a. Storage-Tank Construction: Steel.

1) Tappings: ASME B1.20.1 pipe thread.

2) Pressure Rating: 150 psig (1035 kPa).

3) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.

b. Factory-Installed Storage-Tank Appurtenances:

1) Anode Rod: Replaceable magnesium.

2) Dip Tube: Provide unless cold-water inlet is near bottom of tank.

3) Drain Valve: ASSE 1005.

4) Insulation: Comply with ASHRAE/IESNA 90.1 or ASHRAE 90.2, **as directed**.

5) Jacket: Steel with enameled finish.

6) Heat Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.

7) Heat Exchanger: Corrosion-resistant-metal immersion coil.

8) Heating Element: One; electric, screw-in immersion type with 6 kW or less.

9) Temperature Control: Adjustable thermostat for each element.

10) Safety Control: High-temperature-limit cutoff device or system.

11) Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3 for combination temperature and pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater

working-pressure rating. Select relief valve with sensing element that extends into storage tank.

B. Instantaneous Electric Water Heaters
1. Flow-Control, Instantaneous Electric Water Heaters: Comply with UL 499 for tankless electric (water heater) heating appliance.
a. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.
1) Connections: ASME B1.20.1 pipe thread.
2) Pressure Rating: 150 psig (1035 kPa).
3) Heating Element: Resistance heating system.
4) Temperature Control: Flow-control fitting.
5) Safety Control: High-temperature-limit cutoff device or system.
6) Jacket: Aluminum or steel with enameled finish or plastic.
b. Support: Bracket for wall mounting.
2. Thermostat-Control, Instantaneous Electric Water Heaters: Comply with UL 499 for tankless electric (water heater) heating appliance.
a. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.
1) Connections: ASME B1.20.1 pipe thread.
2) Pressure Rating: 150 psig (1035 kPa).
3) Heating Element: Resistance heating system.
4) Temperature Control: Thermostat.
5) Safety Control: High-temperature-limit cutoff device or system.
6) Jacket: Aluminum or steel with enameled finish or plastic.
b. Support: Bracket for wall mounting.

C. Light-Commercial Electric Water Heaters
1. Description: Comply with UL 174 for household, storage electric water heaters.
a. Storage-Tank Construction: Steel, vertical arrangement.
1) Tappings: ASME B1.20.1 pipe thread.
2) Pressure Rating: 150 psig (1035 kPa).
3) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
b. Factory-Installed Storage-Tank Appurtenances:
1) Anode Rod: Replaceable magnesium.
2) Dip Tube: Provide unless cold-water inlet is near bottom of tank.
3) Drain Valve: ASSE 1005.
4) Insulation: Comply with ASHRAE/IESNA 90.1 or ASHRAE 90.2, **as directed**.
5) Jacket: Steel with enameled finish.
6) Heat Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
7) Heating Elements: Two; electric, screw-in immersion type; wired for simultaneous operation, unless otherwise indicated.
8) Temperature Control: Adjustable thermostat for each element.
9) Safety Control: High-temperature-limit cutoff device or system.
10) Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3 for combination temperature and pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.
c. Special Requirements: NSF 5 construction with legs for off-floor installation.

D. Commercial Electric Water Heaters
1. Commercial Electric Booster Heaters: Comply with UL 1453 requirements for booster-type water heaters.

a. Storage-Tank Construction: Corrosion-resistant metal **OR** Steel, **as directed**.
   1) Tappings: ASME B1.20.1 pipe thread.
   2) Pressure Rating: 150 psig (1035 kPa).
   3) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.

b. Factory-Installed Storage-Tank Appurtenances:
   1) Anode Rod: Replaceable magnesium.
   2) Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
   3) Insulation: Comply with ASHRAE/IESNA 90.1.
   4) Jacket: Rectangular shaped, with stainless-steel front panel, unless otherwise indicated.
   5) Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
      a) Option: Booster heaters with 9 kW or less total may have 2 or 3 elements.
      b) Staging: Input not exceeding 18 kW per step.
   6) Temperature Control: Adjustable thermostat, to setting of at least 180 deg F (82 deg C).
   7) Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
   8) Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3, combination temperature and pressure relief valve. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.
   9) Gages: Combination temperature and pressure type or separate thermometer and pressure gage.

c. Special Requirements: NSF 5 construction with brackets for undercounter **OR** legs for floor, **as directed**, installation.

2. Commercial, Storage Electric Water Heaters: Comply with UL 1453 requirements for storage-tank-type water heaters.

a. Storage-Tank Construction: ASME-code **OR** Non-ASME-code, **as directed**, steel horizontal **OR** vertical, **as directed**, arrangement.
   1) Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.
      a) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
      b) 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.
   2) Pressure Rating: 150 psig (1035 kPa).
   3) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.

b. Factory-Installed Storage-Tank Appurtenances:
   1) Anode Rod: Replaceable magnesium.
   2) Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
   3) Insulation: Comply with ASHRAE/IESNA 90.1.
   4) Jacket: Steel with enameled finish.
   5) Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
      a) Staging: Input not exceeding 18 kW per step.
   6) Temperature Control: Adjustable thermostat.
   7) Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
   8) Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3, for combination temperature and pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

c. Special Requirements: NSF 5 construction.

d. Building Automation System Interface: Normally closed dry contacts for enabling and disabling water heater.

E. Compression Tanks
1. 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.
a. Construction:
1) Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1, pipe thread.
2) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
3) Air-Charging Valve: Factory installed.

F. Water Heater Accessories
1. Combination Temperature and Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.
2. Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include pressure setting less than water heater working-pressure rating.
3. Water Heater Stand and Drain-Pan Units: High-density-polyethylene-plastic, 18-inch- (457-mm-) high, enclosed-base stand complying with IAPMO PS 103 and IAS No. 2. Include integral or separate drain pan with raised edge and NPS 1 (DN 25) drain outlet with ASME B1.20.1 pipe thread.
4. Water Heater Stands: Water heater manufacturer's factory-fabricated steel stand for floor mounting and capable of supporting water heater and water. Include dimension that will support bottom of water heater a minimum of 18 inches (457 mm) above the floor.
5. Water Heater Mounting Brackets: Water heater manufacturer's factory-fabricated steel bracket for wall mounting and capable of supporting water heater and water.
6. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of water heater and include drain outlet not less than NPS 3/4 (DN 20).
7. Piping Manifold Kits: Water heater manufacturer's factory-fabricated inlet and outlet piping arrangement for multiple-unit installation. Include piping and valves for field assembly that are capable of isolating each water heater and of providing balanced flow through each water heater.
8. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2, **as directed**.
9. Water Regulators: ASSE 1003, water-pressure reducing valve. Set at 25-psig- (172.5-kPa-) maximum outlet pressure, unless otherwise indicated.
10. Shock Absorbers: ASSE 1010 or PDI WH 201, Size A water hammer arrester.

G. Source Quality Control
1. Test and inspect water heater storage tanks, specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
2. Hydrostatically test commercial, **as directed**, water heater storage tanks before shipment to minimum of one and one-half times pressure rating.
3. Prepare test reports.

1.3 EXECUTION

A. Water Heater Installation
1. Install commercial water heaters on concrete bases.
a. Exception: Omit concrete bases for commercial water heaters if installation on stand, bracket, suspended platform, or direct on floor is indicated.

b. Concrete base construction requirements are specified in Division 22 Section "Common Work Results For Plumbing".

2. Install 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.
3. Install seismic restraints for light-commercial and commercial water heaters. Anchor to substrate.
4. 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.
5. Install combination temperature and pressure relief valves in water piping for water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
6. 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 water heaters that do not have tank drains. Refer to Division 22 Section "Domestic Water Piping Specialties" for hose-end drain valves.
7. Install thermometer on outlet piping of water heaters. Refer to Division 22 Section "Meters And Gages For Plumbing Piping" for thermometers.
8. Install thermometers on inlet and outlet piping of household, collector-to-tank, solar-electric water heaters. Refer to Division 22 Section "Meters And Gages For Plumbing Piping" for thermometers.
9. Install pressure gage(s) on inlet and outlet of commercial electric water- heater piping. Refer to Division 22 Section "Meters And Gages For Plumbing Piping" for pressure gages.
10. Assemble and install inlet and outlet piping manifold kits for multiple water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each water heater. Include shutoff valve, thermometer in each water heater inlet and outlet, and throttling valve in each water heater outlet. Refer to Division 22 Section "General-duty Valves For Plumbing Piping" for general-duty valves and to Division 22 Section "Meters And Gages For Plumbing Piping" for thermometers.
11. Install water regulator, with integral bypass relief valve, in booster-heater inlet piping and water hammer arrester in booster-heater outlet piping.
12. Install piping-type heat traps on inlet and outlet piping of water heater storage tanks without integral or fitting-type heat traps.
13. Fill water heaters with water.
14. Charge compression tanks with air.

B. Connections

1. Piping installation requirements are specified in other Division 14. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.
3. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
4. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

C. Field Quality Control

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
2. Perform the following field tests and inspections and prepare test reports:
   a. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
   b. Operational Test: After electrical circuitry has been energized, confirm proper operation.
   c. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

D. Demonstration
1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial and instantaneous electric water heaters.

END OF SECTION 22 12 23 13

SECTION 22 12 23 13a - FUEL-FIRED, DOMESTIC WATER HEATERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for fuel-fired water heaters. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following fuel-fired water heaters:
   a. Household, atmospheric, storage, gas water heaters.
   b. Household, direct-vent, storage, gas water heaters.
   c. Household, power-vent, storage, gas water heaters.
   d. Instantaneous, tankless, gas water heaters.
   e. Commercial, atmospheric, storage, gas water heaters.
   f. Commercial, power-burner, storage, gas water heaters.
   g. Commercial, power-vent, storage, gas water heaters.
   h. Commercial, high-efficiency, gas water heaters.
   i. Commercial, coil-type, finned-tube, gas water heaters.
   j. Commercial, grid-type, finned-tube, gas water heaters.
   k. Compression tanks.
   l. Water heater accessories.

C. Definitions
1. LP Gas: Liquefied-petroleum fuel gas.

D. Submittals
1. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
2. LEED Submittal:
   a. Product Data for Prerequisite EA 2: Documentation indicating that units comply with ASHRAE/IESNA 90.1-2004, Section 7 - "Service Water Heating."
3. Shop Drawings: Diagram power, signal, and control wiring.
4. Manufacturer Seismic Qualification Certification: Submit certification that commercial water heaters, accessories, and components will withstand seismic forces defined in Division 15 Section "Mechanical Vibration and Seismic Controls." Include the following:
5. Field quality-control test reports.
6. Operation and maintenance data.
7. Warranty: Special warranty specified in this Section.

E. Quality Assurance
1. 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.
2. ASHRAE/IESNA 90.1-2004Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004.
3. ASME Compliance:
   a. Where ASME-code construction is indicated, fabricate and label commercial water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   b. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.

4. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9" for all components that will be in contact with potable water.
5. All water heaters must meet all new guidelines effective 01-01-08 SCAQMD Rule 1121 amended 2004 to take effect 01-01-08.

F. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired water heaters that fail in materials or workmanship within specified warranty period.
   a. Failures include, but are not limited to, the following:
      1) Structural failures including storage tank and supports.
      2) Faulty operation of controls.
      3) Deterioration of metals, metal finishes, and other materials beyond normal use.
   b. Warranty Period(s): From date of Substantial Completion:
      1) Household, Gas Water Heaters:
         a) Storage Tank: Five **OR** Six **OR** 10, **as directed**, years.
         b) Controls and Other Components: Two **OR** Three, **as directed**, years.
      2) Instantaneous, Gas Water Heaters:
         a) Heat Exchanger: Five years.
         b) Controls and Other Components: Three years.
      3) Commercial, Gas Water Heaters:
         a) Storage Tank: Three **OR** Five, **as directed**, years.
         b) Controls and Other Components: Three **OR** Five, **as directed**, years.
      4) Compression Tanks: One year.

1.2 PRODUCTS

A. Household, Gas Water Heaters
1. Household, Atmospheric, Storage, Gas Water Heaters: Comply with ANSI Z21.10.1/CSA 4.1.
   a. Storage-Tank Construction: Steel.
      1) Tappings: ASME B1.20.1 pipe thread.
      2) Pressure Rating: 150 psig (1035 kPa).
      3) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
   b. Factory-Installed, Storage-Tank Appurtenances:
      1) Anode Rod: Replaceable magnesium.
      2) Dip Tube: Provide unless cold-water inlet is near bottom of tank.
      3) Drain Valve: ASSE 1005.
      4) Insulation: Comply with ASHRAE/IESNA 90.1-2004 or ASHRAE 90.2-2004, **as directed**.
      5) Jacket: Steel with enameled finish.
      6) Burner: For use with atmospheric water heaters and for natural-gas **OR** LP-gas, **as directed**, fuel.
      7) Automatic Ignition: ANSI Z21.20, electric, automatic, gas-ignition system.
      8) Temperature Control: Adjustable thermostat.
      9) Heat Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
      10) Combination Temperature and Pressure Relief Valve: ANSI Z21.22/CSA 4.4. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.
   c. Draft Hood: Low-profile-type, draft diverter; complying with ANSI Z21.12.
   d. Automatic Damper: ANSI Z21.66, electrically operated **OR** mechanically activated **OR** thermally activated, **as directed**, automatic-vent-damper device with size matching draft hood.

2. Household, Direct-Vent, Storage, Gas Water Heaters: Comply with ANSI Z21.10.1/CSA 4.1.
   a. Storage-Tank Construction: Steel.
      1) Tappings: ASME B1.20.1 pipe thread.
      2) Pressure Rating: 150 psig (1035 kPa).
      3) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
   b. Factory-Installed, Storage-Tank Appurtenances:
      1) Anode Rod: Replaceable magnesium.
      2) Dip Tube: Provide unless cold-water inlet is near bottom of tank.
      3) Drain Valve: ASSE 1005.
      4) Insulation: Comply with ASHRAE/IESNA 90.1-2004 or ASHRAE 90.2-2004, **as directed**.
      5) Jacket: Steel with enameled finish.
      6) Burner: For use with direct-vent water heaters and for natural-gas **OR** LP-gas, **as directed**, fuel.
      7) Automatic Ignition: ANSI Z21.20, electric, automatic, gas-ignition system.
      8) Temperature Control: Adjustable thermostat.
      9) Heat Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
      10) Combination Temperature and Pressure Relief Valve: ANSI Z21.22/CSA 4.4. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.
   c. Direct-Vent System: Through-wall **OR** Through-roof, **as directed**, coaxial- or double-channel, vent assembly with water heater manufacturers' outside intake/exhaust screen.
3. Household, Power-Vent, Storage, Gas Water Heaters: Comply with ANSI Z21.10.1/CSA 4.1.
   a. Storage-Tank Construction: Steel.
      1) Tappings: ASME B1.20.1 pipe thread.
      2) Pressure Rating: 150 psig (1035 kPa).
      3) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
   b. Factory-Installed, Storage-Tank Appurtenances:
      1) Anode Rod: Replaceable magnesium.
      2) Dip Tube: Provide unless cold-water inlet is near bottom of tank.
      3) Drain Valve: ASSE 1005.
      4) Insulation: Comply with ASHRAE/IESNA 90.1-2004 or ASHRAE 90.2-2004, **as directed**.
      5) Jacket: Steel with enameled finish.
      6) Burner: For use with power-vent water heaters and for natural-gas **OR** LP-gas, **as directed**, fuel.
      7) Automatic Ignition: ANSI Z21.20, electric, automatic, gas-ignition system.
      8) Temperature Control: Adjustable thermostat.
      9) Heat Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
      10) Combination Temperature and Pressure Relief Valve: ANSI Z21.22/CSA 4.4. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.
   c. Power-Vent System: Exhaust fan, interlocked with burner.

B. Instantaneous, Gas Water Heaters
   1. Description: Comply with ANSI Z21.10.3/CSA 4.3, except storage is not required.
      a. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.
         1) Tappings: ASME B1.20.1 pipe thread.
         2) Pressure Rating: 150 psig (1035 kPa).
         3) Heat Exchanger: Copper tubing.

4) Insulation: Comply with ASHRAE/IESNA 90.1-2004 or ASHRAE 90.2-2004, **as directed**.
5) Burner: For use with tankless water heaters and for natural-gas **OR** LP-gas, **as directed**, fuel.
6) Automatic Ignition: Manufacturer's proprietary system for automatic, gas ignition.
7) Temperature Control: Adjustable thermostat.
8) Jacket: Metal with enameled finish or plastic.

b. Support: Bracket for wall mounting.

C. Commercial, Gas Water Heaters

1. Commercial, Atmospheric, Storage, Gas Water Heaters: Comply with ANSI Z21.10.3/CSA 4.3.

a. Storage-Tank Construction: ASME-code **OR** Non-ASME-code, **as directed**, steel with 150-psig (1035-kPa) working-pressure rating.

1) Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.

a) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
b) 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.

2) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
3) Lining: Cement **OR** Glass **OR** Nickel plate **OR** Phenolic coating **OR** Sheet copper, **as directed**, complying with NSF 61 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.

b. Factory-Installed, Storage-Tank Appurtenances:

1) Anode Rod: Replaceable magnesium.
2) Dip Tube: Provide unless cold-water inlet is near bottom of tank.
3) Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
4) Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
5) Jacket: Steel with enameled finish.
6) Burner: For use with atmospheric water heaters and for natural-gas **OR** LP-gas, **as directed**, fuel.
7) Automatic Ignition: ANSI Z21.20, electric, automatic, gas-ignition system.
8) Temperature Control: Adjustable thermostat.
9) Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
10) Combination Temperature and Pressure Relief Valves: ANSI Z21.22/CSA 4.4. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

c. Special Requirements: NSF 5 construction.

d. Draft Hood: Draft diverter; complying with ANSI Z21.12.

e. Automatic Damper: ANSI Z21.66, electrically operated **OR** mechanically activated **OR** thermally activated, **as directed**, automatic-vent-damper device with size matching draft hood.

f. Building Automation System Interface: Normally closed dry contacts for enabling and disabling water heater.

2. Commercial, Power-Burner, Storage, Gas Water Heaters: Comply with ANSI Z21.10.3/CSA 4.3.

a. Storage-Tank Construction: ASME-code **OR** Non-ASME-code, **as directed**, steel with 150-psig (1035-kPa) working-pressure rating.

1) Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.

a) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.

b) 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.

2) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.

3) Lining: Cement **OR** Glass **OR** Nickel plate **OR** Phenolic coating **OR** Sheet copper, **as directed**, complying with NSF 61 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.

b. Factory-Installed, Storage-Tank Appurtenances:

1) Anode Rod: Replaceable magnesium.

2) Dip Tube: Provide unless cold-water inlet is near bottom of tank.

3) Drain Valve: Corrosion-resistant metal complying with ASSE 1005.

4) Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.

5) Jacket: Steel with enameled finish.

6) Combination Temperature and Pressure Relief Valves: ANSI Z21.22/CSA 4.4. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

c. Burner: Comply with UL 795 for power-burner water heaters and for natural-gas **OR** LP-gas, **as directed**, fuel.

1) Automatic Ignition: ANSI Z21.20, electric, automatic, gas-ignition system.

d. Temperature Control: Adjustable thermostat.

e. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.

f. Special Requirements: NSF 5 construction.

g. Draft Hood: Draft diverter; complying with ANSI Z21.12.

h. Building Automation System Interface: Normally closed dry contacts for enabling and disabling water heater.

3. Commercial, Power-Vent, Storage, Gas Water Heaters: Comply with ANSI Z21.10.3/CSA 4.3.

a. Storage-Tank Construction: ASME-code **OR** Non-ASME-code, **as directed**, steel with 150-psig (1035-kPa) working-pressure rating.

1) Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.

a) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.

b) 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.

2) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.

3) Lining: Cement **OR** Glass **OR** Nickel plate **OR** Phenolic coating **OR** Sheet copper, **as directed**, complying with NSF 61 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.

b. Factory-Installed, Storage-Tank Appurtenances:

1) Anode Rod: Replaceable magnesium.

2) Dip Tube: Provide unless cold-water inlet is near bottom of tank.

3) Drain Valve: Corrosion-resistant metal complying with ASSE 1005.

4) Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.

5) Jacket: Steel with enameled finish.

6) Burner: For use with power-vent water heaters and for natural-gas **OR** LP-gas, **as directed**, fuel.

7) Automatic Ignition: ANSI Z21.20, electric, automatic, gas-ignition system.

8) Temperature Control: Adjustable thermostat.

9) Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.

10) Combination Temperature and Pressure Relief Valves: ANSI Z21.22/CSA 4.4. Include one or more relief valve with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

c. Special Requirements: NSF 5 construction.

d. Power-Vent System: Exhaust fan, interlocked with burner.

e. Building Automation System Interface: Normally closed dry contacts for enabling and disabling water heater.

4. Commercial, High-Efficiency, Gas Water Heaters: Comply with ANSI Z21.10.3/CSA 4.3.

a. Description: Manufacturer's proprietary design to provide at least 84 **OR** 85 **OR** 88 **OR** 95, **as directed**, percent combustion efficiency at optimum operating conditions. Following features and attributes may be modified or omitted if water heater otherwise complies with requirements for performance.

b. Storage-Tank Construction: ASME-code steel with 150-psig (1035-kPa) minimum working-pressure rating.

1) Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.

a) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.

b) 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.

2) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.

3) Lining: Cement **OR** Glass **OR** Nickel plate **OR** Phenolic coating **OR** Sheet copper, **as directed**, complying with NSF 61 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.

c. Factory-Installed, Storage-Tank Appurtenances:

1) Anode Rod: Replaceable magnesium.

2) Dip Tube: Provide unless cold-water inlet is near bottom of tank.

3) Drain Valve: Corrosion-resistant metal complying with ASSE 1005.

4) Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.

5) Jacket: Steel with enameled finish.

6) Combination Temperature and Pressure Relief Valves: ANSI Z21.22/CSA 4.4. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

d. Burner or Heat Exchanger: Comply with UL 795 or approved testing agency requirements for high-efficiency water heaters and for natural-gas **OR** LP-gas, **as directed**, fuel.

e. Temperature Control: Adjustable thermostat.

f. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.

g. Building Automation System Interface: Normally closed dry contacts for enabling and disabling water heater.

h. Draft Hood: Draft diverter; complying with ANSI Z21.12.

5. Commercial, Coil-Type, Finned-Tube, Gas Water Heaters: Comply with ANSI Z21.13 for hot-water boilers.

a. Description: Packaged unit with boiler, storage tank, pump, piping, and controls.

b. Boiler Construction: ASME code with 160-psig (1100-kPa) working-pressure rating for hot-water-boiler-type water heater.

1) Heat Exchanger: Helix or spiral, finned-copper-tube coils with bronze headers.

2) Connections: Factory fabricated of materials compatible with boiler. Attach to boiler before testing.

a) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.

b) 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.

c. Boiler Appurtenances:
1) Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire boiler except connections and controls.
2) Jacket: Steel with enameled finish.
3) Burner: For use with coil-type, finned-tube water heaters and for natural-gas **OR** LP-gas, **as directed**, fuel.
4) Temperature Control: Adjustable, storage tank temperature-control fitting and flow switch, interlocked with circulator and burner.
5) Safety Control: Automatic, high-temperature-limit cutoff device or system.
6) Automatic Ignition: Intermittent electronic ignition complying with ANSI Z21.20.

d. Building Automation System Interface: Normally closed dry contacts for enabling and disabling water heater.

e. Support: Steel base or skids.

f. Draft Hood: Draft diverter; complying with ANSI Z21.12.

g. Automatic Damper: ANSI Z21.66, electrically operated **OR** mechanically activated **OR** thermally activated, **as directed**, automatic-vent-damper device with size matching draft hood.

h. Hot-Water Storage Tank: Connected with piping to circulating pump and water heater.
1) Construction: According to ASME Boiler and Pressure Vessel Code: Section VIII, steel with 150-psig (1035-kPa) **OR** 125-psig (860-kPa), **as directed**, working-pressure rating.
2) Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
a) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
b) 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.
3) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
4) Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
5) Jacket: Steel with enameled finish.
6) Anode Rods: Factory installed, magnesium.
7) Drain Valve: Corrosion-resistant metal complying with ASSE 1005, factory installed.
8) Combination Temperature and Pressure Relief Valves: ANSI Z21.22/CSA 4.4. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

i. Circulating Pump: UL 778, all-bronze, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3. Include mechanical seals, 125-psig (860-kPa) minimum working-pressure rating, and 225 deg F (107 deg C) continuous-water-temperature rating.

j. Piping: Copper tubing; copper, solder-joint fittings; and brazed or flanged joints.

k. Mounting: Water heater, tank, and accessories factory mounted on skids.

6. Commercial, Grid-Type, Finned-Tube, Gas Water Heaters: Comply with ANSI Z21.13 for hot-water boilers.
a. Description: Packaged unit with boiler, storage tank, pump, piping, and controls.
b. Boiler Construction: ASME code with 160-psig (1100-kPa) working-pressure rating for hot-water-boiler-type water heater.
1) Heat Exchanger: Horizontal, straight, finned-copper tubes with bronze headers.
2) Connections: Factory fabricated of materials compatible with boiler. Attach to boiler before testing.
a) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.

b) 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.

c. Boiler Appurtenances:
   1) Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire boiler except connections and controls.
   2) Jacket: Steel with enameled finish.
   3) Burner: For use with grid-type, finned-tube water heaters and for natural-gas **OR** LP-gas, **as directed**, fuel.
   4) Temperature Control: Adjustable, storage tank temperature-control fitting and flow switch, interlocked with circulator and burner.
   5) Safety Control: Automatic, high-temperature-limit cutoff device or system.
   6) Automatic Ignition: Intermittent electronic ignition complying with ANSI Z21.20.

d. Building Automation System Interface: Normally closed dry contacts for enabling and disabling water heater.

e. Support: Steel base or skids.

f. Draft Hood: Draft diverter; complying with ANSI Z21.12.

g. Automatic Damper: ANSI Z21.66, electrically operated **OR** mechanically activated **OR** thermally activated, **as directed**, automatic-vent-damper device with size matching draft hood.

h. Hot-Water Storage Tank: Connected with piping to circulating pump and water heater.
   1) Construction: According to ASME Boiler and Pressure Vessel Code: Section VIII, steel with 150-psig (1035-kPa) **OR** 125-psig (860-kPa), **as directed**, working-pressure rating.
   2) Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
      a) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
      b) 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.
   3) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
   4) Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
   5) Jacket: Steel with enameled finish.
   6) Anode Rods: Factory installed, magnesium.
   7) Drain Valve: Corrosion-resistant metal complying with ASSE 1005, factory installed.
   8) Combination Temperature and Pressure Relief Valves: ANSI Z21.22/CSA 4.4. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

i. Circulating Pump: UL 778, all-bronze, centrifugal, overhung-impeller, separately-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3. Include mechanical seals, 125-psig (860-kPa) minimum working-pressure rating, and 225 deg F (107 deg C) continuous-water-temperature rating.

j. Piping: Copper tubing; copper, solder-joint fittings; and brazed or flanged joints.

k. Mounting: Water heater, tank, and accessories factory mounted on skids.

D. Compression Tanks
   1. 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.
      a. Construction:
         1) Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.

2) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
3) Air-Charging Valve: Factory installed.

E. Water Heater Accessories
1. Gas Shutoff Valves: ANSI Z21.15/CGA 9.1, manually operated. Furnish for installation in piping.
2. Gas Pressure Regulators: ANSI Z21.18, appliance type. Include pressure rating, capacity, and pressure differential required between gas supply and water heater.
3. Gas Automatic Valves: ANSI Z21.21, appliance, electrically operated, on-off automatic valve.
4. Combination Temperature and Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select each relief valve with sensing element that extends into storage tank.
   a. Gas Water Heaters: ANSI Z21.22/CSA 4.4.
5. Pressure Relief Valves: Include pressure setting less than working-pressure rating of water heater.
   a. Gas Water Heaters: ANSI Z21.22/CSA 4.4.
6. Water Heater Stands: Water heater manufacturer's factory-fabricated steel stand for floor mounting and capable of supporting water heater and water. Provide dimension that will support bottom of water heater a minimum of 18 inches (457 mm) above the floor.
7. Water Heater Mounting Brackets: Water heater manufacturer's factory-fabricated steel bracket for wall mounting and capable of supporting water heater and water.
8. Drain Pans: Corrosion-resistant metal with raised edge. Provide dimensions not less than base of water heater and include drain outlet not less than NPS 3/4 (DN 20).
9. Piping Manifold Kits: Water heater manufacturer's factory-fabricated inlet and outlet piping arrangement for multiple-unit installation. Include piping and valves for field assembly that is capable of isolating each water heater and of providing balanced flow through each water heater.
10. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1-2004 or ASHRAE 90.2-2004, **as directed**.

F. Source Quality Control
1. Test and inspect water heater storage tanks, specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
2. Hydrostatically test commercial water heater storage tanks before shipment to minimum of one and one-half times pressure rating.
3. Prepare test reports.

1.3 EXECUTION

A. Water Heater Installation
1. Install commercial water heaters on concrete bases.
   a. Exception: Omit concrete bases for commercial water heaters if installation on stand, bracket, suspended platform, or direct on floor is indicated.
   b. Concrete base construction requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."
2. Install 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.
3. Install seismic restraints for commercial water heaters. Anchor to substrate.
4. Install gas water heaters according to NFPA 54.
5. Install gas shutoff valves on gas supplies to gas water heaters without shutoff valves.
6. Install gas pressure regulators on gas supplies to gas water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
7. Install automatic gas valves on gas supplies to gas water heaters, if required for operation of safety control.

8. 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.
9. Install combination temperature and pressure relief valves in water piping for water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
10. 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 water heaters that do not have tank drains. Refer to Division 15 Section "Plumbing Specialties" for hose-end drain valves.
11. Install thermometer on outlet piping of water heaters. Refer to Division 15 Section "Meters and Gages" for thermometers.
12. Install pressure gage(s) on inlet and outlet piping of commercial, fuel-fired water heater piping. Refer to Division 15 Section "Meters and Gages" for pressure gages.
13. Assemble and install inlet and outlet piping manifold kits for multiple water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each water heater. Include shutoff valve and thermometer in each water heater inlet and outlet, and throttling valve in each water heater outlet. Refer to Division 15 Section "Valves" for general-duty valves and to Division 15 Section "Meters and Gages" for thermometers.
14. Install piping-type heat traps on inlet and outlet piping of water heater storage tanks without integral or fitting-type heat traps.
15. Fill water heaters with water.
16. Charge compression tanks with air.

B. Connections
1. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.
3. Ground equipment according to Division 16 Section "Grounding and Bonding."
4. Connect wiring according to Division 16 Section "Conductors and Cables."

C. Field Quality Control
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
2. Perform the following field tests and inspections and prepare test reports:
   a. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
   b. Operational Test: After electrical circuitry has been energized, confirm proper operation.
   c. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

D. Demonstration
1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain instantaneous and commercial water heaters.

END OF SECTION 22 12 23 13a

SECTION 22 12 23 26 - UNDERGROUND STORAGE TANKS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of underground storage tanks. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Intent of Work
1. It is the intent of this specification to ensure that the work, as completed, shall meet or exceed all applicable codes, ordinances, rules and regulations of every authority having jurisdiction in the area.
2. The installation shall include all necessary equipment, controls, valves and fittings, excavation, backfill as described or called for on the plans. In some cases, the Contractor shall prepare the plans. In any case, the Contractor shall obtain all permits at his expense.
3. The Contractor shall install equipment in accordance with manufacturer's recommendations. Where drawings (if any) and specification conflict with manufacturer's recommendations, it shall be the Contractor's responsibility to bring this to the attention of the Owner before installation.
4. The overall intent shall be that the Contractor shall provide everything required to make a complete and operational job in every respect.

C. Codes And Standards
1. Reference is to the latest edition of the code or standard unless otherwise noted. Comply with the latest EPA requirements.
2. The codes and standards referred to are the minimum standards. Where the requirements of these specifications and the accompanying drawings (if any) exceed those of the codes and standards, the drawings and specifications shall supersede.
3. The installation shall conform to provisions of the NFPA requirement with latest amendments.
4. The entire installation including all equipment shall conform to The Occupational and Safety Health Act of 1970, and all EPA regulations.

D. Visit To Site: Bidders are advised to visit the site and carefully examine the existing conditions before submitting bids, as no allowance will be made for lack of knowledge of existing conditions where such conditions may reasonably be determined by observation.

E. Permits
1. Obtain all permits required for the installation of this work and pay all fees in connection therewith. Permits and fees involved in removal of any item from the site shall be included.
2. Provide copies of inspection and testing certificates from all agencies and authorities having jurisdiction.

F. Layout Basis
1. The layout, which must be stamped by an Engineer registered in the State in which the Project is located, is based upon the use of particular items of equipment, identified by manufacturer's make and model number. Dimensions, arrangements, efficiency and service connections required for these particular items have been considered in making the layout. Contractor shall submit any deviations proposed with his bid.
2. The Contractor may use the equipment of any manufacturer listed as approved for substitution provided they have the proper connections, capacities, efficiency and dimensions. Variances from the requirements stated herein shall be sustainable reasons for disapproval of the submitted equipment. All costs arising from variances in substituted items shall be paid for by the Contractor.

3. Equivalent products by other manufacturers must be submitted to the the Owner for prior approval at least ten (10) days prior to bid date.

G. Submittals
1. All submittals shall bear a stamp or notation indicating that the Contractor has reviewed the submittals for compliance with drawings, governing authorities and specifications.
2. All submittals shall bear sufficient notations to clearly indicate the specific make, model number, accessories, capacities, options, and specification paragraph numbers.
3. All submittals shall indicate complete compliance with all performance and specification requirements as herein specified and/or indicated or shall specifically list any exceptions. Exceptions shall be subject to approval by the the Owner.
4. The review (by the the Owner) of equipment does not relieve the Contractor of the responsibility for compliance with the contract documents or authorities as specified.
5. Contractor shall coordinate electrical characteristics of equipment with electrical specifications and the available power characteristics.
6. Materials requiring shop drawing submittals shall not be installed prior to shop drawings being reviewed by the the Owner. The Contractor agrees that failure to conform to the above may result in removal of all installed materials that have been disapproved from the project. Installation of specified equipment will be mandatory. Removal of disapproved equipment shall be at the sole expense of the Contractor.
7. Submit the following for review via shop drawings (to be approved or disapproved):
   a. Xerxes or approved equal, double wall (do not unload manually). Size and capacity.
   b. Bury depth.
   c. Bed and backfill (not over 7'-0" traffic and no traffic).
   d. Double walls when continuous vacuum pump and monitor are used require a maximum burial depth of three (3) feet from tank top to grade.
   e. When not subjected to traffic loads, use 24" backfill or 12" minimum backfill plus 4" re-bar reinforced concrete on top.
   f. When subjected to traffic loads, use 48" backfill or 30" minimum backfill plus 6" of re-bar reinforced concrete.
   g. If tank is 12'-0" in diameter (actually, 7'-11" is manufactured for large gallonage) then, no traffic shall be provided with 42" minimum cover, or 38" backfill plus 4" re-bar reinforced concrete. With traffic, use 38" backfill plus 6" of asphalt or 6" of re-bar reinforced concrete.
   h. Monitoring fittings, fiberglass reservoir, vapor sensor 4" tank fittings, tank fill tube insert, venting, stage two vapor recovery system, manway and manway extensions, manway risers, site monitoring wells, barricades, installation check list, hydrostatic tank monitoring.
   i. Job site safety precautions.
   j. Reservoir fiberglass sensor.
   k. Reservoir leak detection.
   l. Electronic control panels, sensor circuit, transmission contact switch power source circuit, alarm bell, alarm bell silence button, control panel false alarms, etc.
   m. Piping sump bottom, usually 28 3/8" x 30".
   n. Flex connectors to piping.
   o. Unions, nipples, manway cover, FRP fitting, opening for stage II vapor recovery line if required.
   p. 3" pipe sump fitting.
   q. When using piping sump sensor equal to Owens Corning fiberglass model PSS, submit system including electrical power supply and signal wiring.
   r. Control panel equal to Owens Corning fiberglass model SB-0011B (single circuit) or SB-0014B (4 circuit) as applicable.
   s. Fiberglass pipe and fittings equal to "Ameron" type Dualoy 3000/L pressure rated and with chemically resistant epoxy resin for the service intended. The Dualoy 3000/L shall be a secondary containment system. No other product piping will be acceptable.

H. Guarantee

1. Contractor shall guarantee that if any materials or workmanship covered by these specifications proves defective within one (1) year, such defects shall be corrected by the Contractor at once without charge to the Owner.

1.2 PRODUCTS:

A. Double-Wall Fiberglass Underground Storage Tanks

1. The Contractor shall provide and install the "fiberglass" underground storage tanks of the specified volume and diameter.
2. The tank shall be of fiberglass. Tank laminates shall be constructed of 100% resin and fiberglass reinforcements without sand fillers. Ribs are to be integrally cast into tank body. Tanks shall bear the listing mark of Underwriters' Laboratories, Inc. Tank shall have an annular space between the primary and secondary shell walls to allow for free flow and containment of all leaked product from primary tank. This space shall be filled at the factory with a brine solution for hydrostatic monitoring. Tanks shall be as manufactured by Xerxes Corporation, Minneapolis, MN or approved equal as judged by the Owner.
3. The tank shall comply with the following governing standards:
   a. ASTM Standard Document No. 4021-81
   b. Underwriters' Laboratories, Inc. (UL.) File #MH-9061 (N) for underground storage of flammable liquids. A UL certification plate shall be attached to each tank.
   c. Military Specification No. MIL-T-52777(A)
   d. Factory Mutual Systems approval J.I. IG4AO.AF
   e. National Sanitation Foundation, Standard 14
   f. National Fire Protection Association (NFPA-30), (NFPA-30A) Flammable and Combustible Liquid Code and (NFPA-31) Standard for Installation of Oil Burning Equipment.
4. The tank shall be capable of the following loading conditions:
   a. Internal load: Tank shall withstand 5 psi air pressure test with 5 to 1 safety factor. Contractor shall test prior to installation as this is to test for leakage. Maximum test pressure is 5 psi.
   b. Vacuum Test: Every tank shall be tested to 11.5 inches (primary tank) and 9.5 inches (secondary tank) mercury vacuum by the tank manufacturer to assure structural integrity.
   c. Surface Loads: Tank shall withstand surface H-20 axle load when properly installed according to current manufacturer's installation instruction (32,000 lbs.).
   d. External hydrostatic pressure: Tank shall withstand 7' of overburden with the hole fully flooded with 7:1 safety factor against buckling.
5. Provide glass fiber-reinforced plastic straps for the tank shown. Provide number and location of straps as specified by the manufacturer. Each strap shall be capable of withstanding the buoyancy load of 25,000 lbs. for 8' tank diameter. Straps shall be standard as supplied by the tank manufacturer. A concrete pad or concrete deadman must be used with anchor straps as recommended by tank manufacturer.
6. The Contractor shall provide fiberglass piping sump with fittings as indicated. The piping sump shall be manufactured by Xerxes Corporation or approved equal and supplied with tanks.
   a. The piping sump shall be installed so that it is suitable for monitoring the double-wall piping system and containment of its product. Piping sump shall be located on tanks 22" minimum manway.
7. All tank fittings shall be standard (proofed tight) as supplied by the tank manufacturer. The tank shall have an opening for one each of the following:
   a. Fill/Manual Gauging
   b. Vent/Overfill/Stage One Vapor Recovery
   c. Pump (pressure system) or supply and return (suction system)
   d. In tank gauging automatic inventory control
   e. Others as shown or required by the operating agency
8. The tank shall have a factory filled brine interstitial and reservoir for continuous monitoring of both inner and outer walls.

9. Tank to be installed per manufacturer installation instructions which will be inspected as it progresses.

B. Spill Protection
1. Universal model 70CD, or approved equal, spill containment shall be used as containment basin for spills during filling. A manual valve, if so required, shall be used to return any spilled product back to tank.

C. Overfill Prevention
1. Universal model 37, or approved equal, float valve is to be used for overfill prevention. The automatic shut off device must stop the flow of product being delivered when tank is 90% full. Access must be provided.

D. Stage One Vapor Recovery
1. Stage one vapor recovery is incorporated into the access assembly of the overfill prevention access way. See drawing for details. (Less than 10,000 gales per month through flow)

E. Stage Two Vapor Recover
1. Piping for stage two vapor recovery will be installed for future use. Required for gasoline motor fuel only. (More than 10,000 gales per month through flow)

F. Tank Trim
1. Surface manholes shall have all cast iron rim and minimum 10" galvanized steel skirt. Tank trim shall have Universal Valve.

G. Submersible Turbine Pump Specifications
1. General Pump Specifications: The pump shall be designed to pump gasoline, diesel, kerosene and jet fuel. The entire pumping assembly shall have UL listing and shall meet all requirements of UL79. The pump discharge head and manifold assembly shall be manufactured from ASTM A 48 Class 30 grey iron. The pump shall be available in 1/3, 3/4, and 1-1/2 hp sizes and shall be manufactured to the proper length as determined by the tank diameter, type of tank, and bury depth. The pump motor shall have a thermal over current overload protector with automatic reset. The pump motor assembly shall be clearly marked with pertinent information including Model, Horsepower, Voltage, Phase, and Manufacturer. The pump motor shall be a permanent split phase capacitor type, and shall incorporate a 15 mfd capacitor. The pumping unit shall not incorporate any flexible diaphragms and all sealing shall be accomplished with "o" ring or UL recognized fiber gaskets. The pump shall have a removable intake screen with openings no greater than 3/32 inch. The pump shall be manufactured by FE Petro, Inc., McFarland, WI. or approved equal as judged by the the Owner.
2. Installation and Maintenance Specifications: The pump shall have a two-wire field connection and an easy access ground wire terminal, and shall incorporate a wire seal plug which will accommodate three wires. The pump shall incorporate a port for line pressure testing that shall be sealed with a 1/4 NPT pipe plug. The pump unit shall have a fully extractable head in order to permit removal of the pump motor assembly without disturbing the discharge piping or the electrical wiring. The product in the pipelines shall be held in place by a line check valve that shall have a minimum sealing of 170 lbs when the pump is not running. The line check valve shall be independent of the removable head and shall be easily accessible. The removal of the extractable portion of the pump shall not disturb product in the pipelines downstream of the check valve. During the removal of the extractable portion of the pump, product contained in the discharge manifold of the pump shall drain automatically into the storage tank. The pump motor shall be interchangeable by horsepower with different manufacturers' product.
3. Operation Specifications: The pump shall have an air/vapor elimination system that returns air or vapors to the underground storage tank through a tube discharging near the top of the pump motor assembly. The pump unit shall contain a built-in expansion relief valve that relieves pressure above pumping pressure but below 50 psi. The pump motor shall utilize the product

being pumped for lubrication of the motor bearings and for cooling the stator, and this fluid shall discharge into the underground storage tank at the top of the motor. The pump shall have siphon capability built into the pump as standard.

H. Piping System

1. All piping fittings and adhesives shall be UL listed made of fiberglass double wall. Pipe shall be in compliance with ASTM D 2996 and classified by designation code RTRP-11AF-3111. Pipe shall be filament wind of continuous glass filament. Pipe must have a minimum bend radius of 50 feet on 2" primary (80 feet on 3" secondary) to allow settling of tank. Pipe shall have maximum tensile loads of 1160 lbs, compressive loads 2210 lbs at 75 degrees Fahrenheit on 2" primary. 3" pipe shall have tensile load of 2020 lbs at 75 degrees and compressive loads of 3850 lbs. Pipe to be factory proof tested at 1000 psig-2", 700 psig-3". Pipe shall be Smith Fiberglass Red thread II, or approved equal as judged by the Owner.
2. Vent piping shall have secondary containment. Vent shall not be sloped less than 1/4" per foot downward to tank.
3. Product piping shall have secondary containment. Product piping shall not be sloped less than 1/8" per foot downward toward tank.
4. All piping must slope back toward tank.
5. All piping must be installed as per manufacturer installation instructions. the Owner shall monitor each installation daily.

I. Leak Detection

1. Tank shall have a Pullulert FD241RRA, or approved equal, float probe mounted on the brine filled hydrostatic reservoir. The system shall monitor both the inner and outer walls of the tank.
   a. Alarm Conditions:
      1) Hydrocarbons in hydrostatic reservoir
      2) A loss of fluid in reservoir
2. Piping shall have a Pollulert FD241RRA, or approved equal, float probe mounted in the piping sump. System shall monitor the piping sump compartment that has to be designed to catch any leaked product from the primary piping system. This probe shall distinguish the difference between water and hydrocarbons and alarm on any one or both conditions.
3. Remote monitoring piping sumps shall be installed only if piping can not be sloped toward tank. The Contractor shall use as many remote monitoring piping sumps as needed to assure that all sections of piping are monitored. All monitoring sumps shall have a Pollulert FD241RRA or approved equal probe for leak detection.
4. Control panel shall have probe status for wet, dry, or hydrocarbon. Alarm conditions are to be selectable. Control panel must have installed relay or provision for installing relays for remote alarms. Control panel shall have both visual and audible alarm. System shall have a two year warranty from date of manufacture. Ground water probes shall be adjustable 1/8" to 2" for product detection. Probes shall be wired by a single cable run. Systems must be UL listed for Class 1, Division 1, Group D locations and meet all existing EPA regulations. Leak detection shall be Pollulert systems or approved equal.
5. Submersible pump shall have a mechanical in-line leak detector with a free floating check valve. Leak detector shall be vaporless LD2000 or approved equal.

J. In Tank Gauging System

1. Gauging system shall provide inventory management designed to continuously monitor underground storage tanks. System must provide information on inventory, delivery of fuel, and product through-put. System must measure fuel levels, water level and fuel temperature. This is to ensure proper compensated level readings. System shall have five temperature sensors, two floats, one for product level, one for water interface. System shall have a 48 character LCD display and internal thermal printer. System shall utilize a magnetostrictive probe and have visual, audible alarm with automatic printout. The system shall be designed to have 16 input on/off devices, RS232 port full duplex with adjustable baud rate. Tank gauging system shall be Pollulert system or approved equal.

K. Test For Pipe
1. Test of the piping system shall be made per manufacturer's recommendations.
2. Furnish the Owner with a certificate stating that all piping has been tested as specified and has been shown to be tight.
3. The piping systems may be tested in sections if necessary, but a final test may be required of the entire piping system at the completion of the system. The final test shall be made while pipe is exposed to view where possible.
4. Both primary and secondary pipe must be tested.

L. Test For Tank
1. Pre-installation: All Xerxes or approved equal tanks shall be tested prior to shipment, but it is required that all tanks be tested by the Contractor prior to installation. After installation and before final backfilling to grade, the tank must be retested to assure that no damage occurred during installation.
2. Hose/Valve Assembly: In order to test the tank, the hose/valve assembly must be connected from the reservoir to a service fitting. The hose/valve assembly will already be connected from the reservoir to a service fitting when the tank is shipped. If the hose/valve assembly is not connected when the tank is delivered, contact the Customer Service Representative at the Xerxes or other plant nearest you, before attempting to test the tank.
3. Primary (Internal) Tank Test: Prior to installation, check to see that all service and monitor fittings are plugged and tightened, except the service fitting with a temporary plastic plug. Close the valve on the hose/valve assembly. Remove the temporary plastic plug and connect the pressure source to the service fitting. Pressure test the primary (internal) tank to 5 psig for 60 minutes.
4. Secondary (External) Tank Test:
   a. CAUTION: Never pressurize the secondary tank or (annular space) without connecting it to the primary tank. The secondary tank and primary tank will be properly connected if the hose/valve assembly is in place as shipped. Failure to have the secondary tank and primary tank properly connected could potentially result in tank failure and personal injury, and will void all warranties.
   b. While the primary tank is still under pressure, open the valve on the hose/valve assembly until the pressure stabilizes. Once the pressure has stabilized, either add or subtract air pressure to stabilize the pressure at 5 psig. Observe the tank for any liquid on the exterior surface and check the gauge at the pressure source for any drop in pressure.
   c. After completing the test, relieve the pressure at the source.

M. Product Dispenser
1. A fiberglass containment box shall be installed with each product dispenser. Containment box shall be as manufactured by Petro Fiberglass or approved equal. Double wall pipe shall terminate inside containment box. A flex connector as manufactured by Dana Everflex or approved equal shall be used to connect product pipe to the shear valve within the containment box. The shear valve shall be air tested at the factory and shall not lose its seal when its top is removed for service. Shear valve shall be Universal model 521 or approved equal. Each product dispensing hose shall be equipped with a re-connectable breakaway featuring a pressure balancing chamber to prevent nuisance breaks and shall disconnect at 200 lbs. A hose coupling shall separate the breakaway and hose swivel. The nozzle shall have a means of automatically stopping flow if the nozzle is not at the proper dispensing angle. Nozzle shall be of die-cast construction UL listed and have a flow equalizer to maintain 10 GPM flow. Breakaway, hose coupling, hose swivel, and nozzle shall be as manufactured by Husky or approved equal. Dispenser shall be compatible with vapor recovery systems.
2. Transition boxes shall be provided for underground to aboveground with sensors.

END OF SECTION 22 12 23 26

Task	Specification	Specification Description
22 12 23 26	22 05 23 00	Piped Utilities Basic Materials And Methods
22 13 16 00	22 05 23 00	Piped Utilities Basic Materials And Methods
22 13 16 00	22 11 23 39	Water Supply Wells
22 13 16 00	22 05 76 00	Sanitary Sewerage
22 13 16 00	07 63 00 00	Common Work Results for Fire Suppression
22 13 16 00	07 63 00 00a	Common Work Results for Plumbing
22 13 16 00	07 63 00 00b	Common Work Results for HVAC
22 13 16 00	22 11 16 00a	Sanitary Waste And Vent Piping
22 13 16 00	22 11 16 00b	Storm Drainage Piping

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SECTION 22 13 19 00 - HIGH-EFFICIENCY PARTICULATE FILTRATION

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for high-efficiency particulate filtration. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. HEPA rigid-cell box filters.
b. HEPA V-bank cell filters.
c. HEPA filter diffusers.
d. HEPA filter fan modules.
e. ULPA filters.
f. 95 percent DOP filters.
g. Front- and rear-access filter frames.
h. Side-service housings.
i. Filter gages.

C. Submittals
1. Product Data: For each type of product indicated. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.
2. LEED Submittals:
a. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with applicable requirements in ASHRAE 62.1, Section 5, "Systems and Equipment."
3. Shop Drawings: For air filters. Include plans, elevations, sections, details, and attachments to other work.
a. Show filter rack assembly, dimensions, materials, and methods of assembly of components.
b. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.
c. Wiring Diagrams: For power, signal, and control wiring.
4. Field quality-control reports.
5. Operation and Maintenance Data: For each type of filter and rack to include in emergency, operation, and maintenance manuals.

D. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended use.
2. ASHRAE Compliance:
a. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
3. Comply with IEST-RP-CC001.3.
4. Comply with UL 586.
5. Comply with IEST-RP-CC007.1.
6. Comply with NFPA 90A and NFPA 90B.

E. Coordination
1. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

1.2 PRODUCTS

A. HEPA Rigid-Cell Box Filters
1. Description: Factory-fabricated, disposable, packaged air filters with media perpendicular to airflow and with holding frames.
2. Filter Unit Class: UL 900, Class 1 **OR** Class 2, **as directed**.
3. Media: Fibrous material, constructed so individual pleats are maintained under rated-airflow conditions.
   a. Internal Separators: None **OR** Aluminum in media folds, **as directed**.
   b. Gasket Material: None **OR** Neoprene **OR** Blue gel, **as directed**.
   c. Gasket Location: None **OR** Upstream **OR** Upstream and Downstream **OR** Downstream, **as directed**.
   d. Faceguard Material: Aluminum **OR** Stainless steel, **as directed**.
   e. Faceguard Location: None **OR** Upstream **OR** Upstream and Downstream **OR** Downstream, **as directed**.
4. Filter-Media Frames:
   a. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
   b. Materials: Stainless steel **OR** Fire-retardant plywood **OR** Fabricated aluminum **OR** Fire-retardant particleboard **OR** Galvanized sheet **OR** Non-fire-retardant particleboard, **as directed**.
   c. Style: Box **OR** Double-turned flange **OR** Deep channel **OR** Double-turned flange, one side, **as directed**.
5. Mounting Frames: Welded galvanized steel with gaskets and fasteners; suitable for bolting together into built-up filter banks.

B. HEPA V-Bank Cell Filters
1. Description: Factory-fabricated, disposable, packaged air filters with media at an angle to airflow and with holding frames.
2. Filter Unit Class: UL 900, Class 1 **OR** Class 2, **as directed**.
3. Media: Fibrous material, constructed so individual pleats are maintained under rated-airflow conditions.
   a. Internal Separators: None **OR** Aluminum in media folds, **as directed**.
   b. Gasket Material: None **OR** Neoprene **OR** Blue gel, **as directed**.
   c. Gasket Location: None **OR** Upstream **OR** Upstream and Downstream **OR** Downstream, **as directed**.
   d. Faceguard Material: Aluminum **OR** Stainless steel, **as directed**.
   e. Faceguard Location: None **OR** Upstream **OR** Upstream and Downstream **OR** Downstream, **as directed**.
4. Filter-Media Frames:
   a. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
   b. Materials: Stainless steel **OR** Fire-retardant plywood **OR** Fabricated aluminum **OR** Fire-retardant particleboard **OR** Galvanized sheet **OR** Non-fire-retardant particleboard, **as directed**.
   c. Style: Box **OR** Double-turned flange **OR** Deep channel **OR** Double-turned flange, one side, **as directed**.
5. Mounting Frames: Welded galvanized steel with gaskets and fasteners; suitable for bolting together into built-up filter banks.

C. HEPA Filter Diffusers
1. Description: Factory-fabricated, individually ducted, HEPA filter-holding ceiling modules.
2. Media: Fibrous glass, constructed of continuous sheets with closely spaced pleats with glass filament separators.
   a. Media to Module Side Bond: Urethane sealant.

b. Media to Frame Side Bond: Polyurethane foam **OR** Silicone **OR** Neoprene adhesive **OR** Fiberglass-mat packing **OR** Thermosetting sealant **OR** Knife edge in fluid-filled channel, **as directed**.
c. Application: Class 100 **OR** Class 10 **OR** Class 1, **as directed**, clean room.

3. Casing:
   a. Configuration: Ducted inlet **OR** Plenum inlet **OR** Plenum inlet with prefilter, **as directed**.
   b. Module Material: Extruded aluminum, 16 gage with mill finish.
   c. Suspension: Ceiling grid.
4. Accessories:
   a. Diffusion damper.
   b. Diffusion-damper adjustment port.
   c. Filter test port.

D. HEPA Filter Fan Modules
1. Description: Factory-fabricated, HEPA filter ceiling module with fan.
2. Casing:
   a. Configuration: Ducted inlet **OR** Plenum inlet **OR** Plenum inlet with prefilter, **as directed**.
   b. Module Material: Extruded aluminum, 16 gage with mill finish.
   c. Suspension: Ceiling grid **OR** Independent, **as directed**.
3. Media: Fibrous glass, constructed of continuous sheets with closely spaced pleats with aluminum separators **OR** vinyl-coated aluminum separators **OR** separators of ribbons of filter media, **as directed**.
   a. Frame Material: 3/4-inch- (19-mm-) thick, fire-retardant plywood **OR** 3/4-inch- (19-mm-) thick, fire-retardant particleboard **OR** 3/4-inch- (19-mm-) thick plywood **OR** 3/4-inch- (19-mm-) thick particleboard **OR** Galvanized steel **OR** Aluminized steel **OR** Cadmium-plated steel **OR** Stainless steel **OR** Aluminum, **as directed**.
   b. Media to Frame Side Bond: Polyurethane foam **OR** Silicone **OR** Neoprene adhesive **OR** Fiberglass-mat packing **OR** Thermosetting sealant **OR** Knife edge in fluid-filled channel, **as directed**.
   c. Face Gasket: Neoprene expanded rubber **OR** Ceramic fiber **OR** Silicone, **as directed**.
   d. Faceguard: Plastic **OR** Stainless steel, **as directed**.
4. Accessories: Filter test port.
5. Control: Variable speed.
6. Motor:
   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 Equipment".
   b. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 22.
   c. Type: Permanent-split capacitor with SCR for speed adjustment **OR** Electronically commutated motor, **as directed**.
   d. Fan-Motor Assembly Isolation: Rubber isolators.
   e. Enclosure: Open dripproof **OR** Totally enclosed, fan cooled **OR** Totally enclosed, air over **OR** Open, externally ventilated **OR** Totally enclosed, nonventilated **OR** Severe duty **OR** Explosion proof **OR** Dust-ignition-proof machine, **as directed**.
   f. Enclosure Materials: Cast iron **OR** Cast aluminum **OR** Rolled steel, **as directed**.
   g. Motor Bearings: <**Insert special requirements**>.
   h. Unusual Service Conditions:
      1) Ambient Temperature: <**Insert deg F (deg C)**>.
      2) Altitude: <**Insert feet (m)**> above sea level.
      3) High humidity.
   i. Efficiency: Premium efficient.
   j. NEMA Design: <**Insert designation**>.
   k. Service Factor: <**Insert value**>.
   l. Motor Speed: Single speed **OR** Multispeed, **as directed**.
      1) Speed Control: Infinitely adjustable with pneumatic-electric and electronic controls.

E. ULPA Filters
1. Description: Factory-fabricated, ULPA filters with holding casing.
2. Media: Fibrous glass, constructed of continuous sheets with closely spaced pleats with aluminum separators **OR** vinyl-coated aluminum separators **OR** separators of ribbons of filter media, **as directed**.
3. Frame Material: 3/4-inch- (19-mm-) thick, fire-retardant plywood **OR** 3/4-inch- (19-mm-) thick, fire-retardant particleboard **OR** 3/4-inch- (19-mm-) thick plywood **OR** 3/4-inch- (19-mm-) thick particleboard **OR** Galvanized steel **OR** Aluminized steel **OR** Cadmium-plated steel **OR** Stainless steel **OR** Aluminum, **adected**.
4. Media to Frame Side Bond: Polyurethane foam **OR** Silicone **OR** Neoprene adhesive **OR** Fiberglass-mat packing **OR** Thermosetting sealant **OR** Knife-edge in fluid-filled channel, **as directed**.
5. Face Gasket: Neoprene expanded rubber **OR** Ceramic fiber **OR** Silicone, **as directed**.
6. Mounting Frames: Construct downstream corners of holding device with cushion pads to protect media. Provide bolted filter-sealing mechanism to mount and continuously seal each individual filter.

F. 95 Percent DOP Filters
1. Description: Factory-fabricated, 95 percent DOP filters with holding casing.
2. Media: Fibrous glass, constructed of continuous sheets with closely spaced pleats with aluminum separators **OR** vinyl-coated aluminum separators **OR** separators of ribbons of filter media, **as directed**.
3. Frame Material: 3/4-inch- (19-mm-) thick, fire-retardant plywood **OR** 3/4-inch- (19-mm-) thick, fire-retardant particleboard **OR** 3/4-inch- (19-mm-) thick plywood **OR** 3/4-inch- (19-mm-) thick particleboard **OR** Galvanized steel **OR** Aluminized steel **OR** Cadmium-plated steel **OR** Stainless steel **OR** Aluminum, **as directed**.
4. Frame Style: Box single header **OR** Double header **OR** Double turned flange **OR** 3/4-inch- (19-mm-) deep channel, **as directed**.
5. Media to Frame Side Bond: Polyurethane foam **OR** Silicone **OR** Neoprene adhesive **OR** Fiberglass-mat packing **OR** Thermosetting sealant **OR** Knife edge in fluid-filled channel, **as directed**.
6. Face Guard Material: Galvanized **OR** Aluminum, **as directed**, mesh.
7. Face Guard Location: Upstream **OR** Upstream and Downstream **OR** Downstream, **as directed**.
8. Gasket Material: Neoprene expanded rubber **OR** Ceramic fiber **OR** Silicone, **as directed**.
9. Gasket Location: Upstream **OR** Upstream and Downstream **OR** Downstream, **as directed**.
10. Mounting Frames: Construct downstream corners of holding device with cushion pads to protect media. Provide bolted filter-sealing mechanism to mount and continuously seal each individual filter.

G. Front- And Rear-Access Filter Frames
1. Framing System: Aluminum framing members with access for either upstream (front) or downstream (rear) filter servicing, cut to size and prepunched for assembly into modules. Vertically support filters to prevent deflection of horizontal members without interfering with either filter installation or operation.
2. Prefilters: Incorporate a separate track, removable from front or back.
3. Sealing: Factory-installed, positive-sealing device for each row of filters to ensure seal between gasketed filter elements to prevent bypass of unfiltered air.
4. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

H. Side-Service Housings
1. Description: Factory-assembled, side-service housings, constructed of 0.064-inch- (1.6-mm-) thick, galvanized steel **OR** stainless steel **OR** double-wall casing with 1-inch (25-mm) insulation, **as directed**, to hold filters. Side servicing is through gasketed access doors on one side, and

housings are capable of connection to other housings. Equip housings with metal slide channel tracks with clamping mechanisms to hold filters, and the following:
a. Pressure tap and fitting.
b. DOP/freon test ports.
c. Decontamination ports.
d. Isolation dampers.
e. Lifting lugs.

2. Prefilters: Integral tracks to accommodate 2-, 4-, and 6-inch- (50-, 100-, and 150-mm-) thick, disposable filters.
3. Access Doors: Continuous gaskets on perimeter and positive-locking swivel, **as directed**, devices. Provide ribbed bagging rim behind access door and PVC bags for bag-in, bag-out arrangement, **as directed**. Arrange so filter cartridges can be loaded from an access door for each tier and section of the following:
   a. Combination prefilter and HEPA filter.
      OR
      Prefilter.
      OR
      HEPA filter.
   b. Upstream and downstream test section.
4. Sealing: Incorporate positive-sealing gasket material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.
5. Accessories:
   a. Filter change-out trays.
   b. Document-storage pocket.
   c. Filter removal rod.
6. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

I. Filter Gages
1. Diaphragm type with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.
   a. Diameter: 4-1/2 inches (115 mm) **OR** 2 inches (50 mm), **as directed**.
   b. Scale Range for Filter Media Having a Recommended Final Resistance of 0.5-Inch wg (125 Pa) or Less: 0- to 0.5-inch wg (0 to 125 Pa).
   c. Scale Range for Filter Media Having a Recommended Final Resistance of 0.5- to 1.0-Inch wg (125 to 250 Pa) or Less: 0- to 1.0-inch wg (0 to 250 Pa).
   d. Scale Range for Filter Media Having a Recommended Final Resistance of 1.0- to 2.0-Inch wg (250 to 500 Pa) or Less: 0- to 2.0-inch wg (0 to 500 Pa).
   e. Scale Range for Filter Media Having a Recommended Final Resistance of 2.0- to 3.0-Inch wg (500 to 750 Pa) or Less: 0- to 3.0-inch wg (0 to 750 Pa).
   f. Scale Range for Filter Media Having a Recommended Final Resistance of 3.0- to 4.0-Inch wg (750 to 1000 Pa) or Less: 0- to 4.0-inch wg (0 to 1000 Pa).
2. Manometer-Type Filter Gage: Molded plastic, with epoxy-coated aluminum scale, logarithmic-curve tube gage with integral leveling gage; graduated to read from 0- to 3.0-inch wg (0 to 750 Pa) and accurate within 3 percent of full-scale range.
3. Accessories: Static-pressure tips, tubing, gage connections, and mounting bracket.

1.3 EXECUTION

A. Installation
1. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.
2. Install filters in position to prevent passage of unfiltered air.
3. Install filter gage for each filter bank.

4. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters that were used during construction and testing with new, clean filters.
5. Install filter-gage static-pressure tips upstream and downstream from filters. Install filter gages on filter banks with separate static-pressure taps upstream and downstream from filters. Mount filter gages on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gages.
6. Coordinate filter installations with duct and air-handling unit installations.

B. Field Quality Control
1. Perform tests and inspections.
2. Tests and Inspections:
   a. Operate automatic roll filters to demonstrate compliance with requirements.
   b. Test for leakage of unfiltered air while system is operating.
   c. HEPA Filters: Pressurize housing to a minimum of 3.0-inch wg (750 Pa) or to designed operating pressure, whichever is higher; test housing joints, door seals, and sealing edges of filter with soapy water to check for air leaks.
   d. HEPA Filters: Pressurize housing to a minimum of 3.0-inch wg (750 Pa) or to designed operating pressure, whichever is higher; and test housing joints, door seals, and sealing edges of filter for air leaks according to pressure-decay method in ASME N510.
3. Air filter will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports.

C. Cleaning
1. After completing system installation and testing, adjusting, and balancing air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION 22 13 19 00

Task	Specification	Specification Description
22 13 19 13	22 13 19 00	High-Efficiency Particulate Filtration

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SECTION 22 13 19 26 - INTERCEPTORS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for interceptors. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Grease interceptors.
b. Oil interceptors.
c. Sand interceptors.

C. Definitions
1. FRP: Fiberglass-reinforced plastic.
2. PP: Polypropylene plastic.

D. Submittals
1. Product Data: For each type of metal and plastic interceptor indicated. Include materials of fabrication, dimensions, rated capacities, retention capacities, operating characteristics, size and location of each pipe connection, furnished specialties, and accessories.
2. Shop Drawings: For each type and size of precast-concrete interceptor indicated.
a. Include materials of construction, dimensions, rated capacities, retention capacities, location and size of each pipe connection, furnished specialties, and accessories.
3. Coordination Drawings: Interceptors, drawn to scale, on which the following items are shown and coordinated with each other, based on input from Installers of the items involved:
a. Interceptors.
b. Piping connections. Include size, location, and elevation of each.
c. Interface with underground structures and utility services.

E. Project Conditions
1. Interruption of Existing Sewer Services: Do not interrupt services to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sewer services according to requirements indicated:
a. Notify the Owner no fewer than seven days in advance of proposed interruption of service.
b. Do not proceed with interruption of sewer services without the Owner's written permission.

1.2 PRODUCTS

A. Grease Interceptors
1. Grease Interceptors: Precast concrete complying with ASTM C 913, by Jensen Pre-Cast or approved equivalent.
a. Include rubber-gasketed joints, vent connections (if required), manholes, compartments or baffles, and piping or openings to retain grease and to permit wastewater flow, unless directed otherwise.
b. Structural Design Loads:
1) Light-Traffic Load: Comply with ASTM C 890, A-8 (ASSHTO HS10-44).
2) Medium-Traffic Load: Comply with ASTM C 890, A-12 (ASSHTO HS15-44).
3) Heavy-Traffic Load: Comply with ASTM C 890, A-16 (ASSHTO HS20-44).
4) Walkway Load: Comply with ASTM C 890, A-03.

c. Resilient Pipe Connectors (if required): ASTM C 923 (ASTM C 923M), cast or fitted into interceptor walls, for each pipe connection.

d. Steps: Individual FRP steps or FRP ladder **OR** Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP **OR** ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP, **as directed**, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of interceptor to finished grade is less than 60 inches (1500 mm).

e. Grade Rings (if required): Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, to match diameter of manhole frame and cover.

f. Manhole Frames and Covers: Ferrous; 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser with 4-inch- (100-mm-) minimum width flange and 26-inch- (660-mm-) diameter cover.

1) Ductile Iron: ASTM A 536, Grade 60-40-18, unless otherwise indicated.

2) Gray Iron: ASTM A 48, Class 35, unless otherwise indicated.

3) Include indented top design with lettering cast into cover, using wording equivalent to "INTERCEPTOR," or “GREASE INTERCEPTOR,” or “SANITARY SEWER."

B. Oil Interceptors

1. Oil Interceptors: Precast concrete comply with ASTM C 913.

a. Include rubber-gasketed joints, vent connections, manholes, compartments or baffles, and piping or openings to retain grease and to permit wastewater flow.

b. Structural Design Loads:

1) Light-Traffic Load: Comply with ASTM C 890, A-8 (ASSHTO HS10-44).

2) Medium-Traffic Load: Comply with ASTM C 890, A-12 (ASSHTO HS15-44).

3) Heavy-Traffic Load: Comply with ASTM C 890, A-16 (ASSHTO HS20-44).

4) Walkway Load: Comply with ASTM C 890, A-03.

c. Resilient Pipe Connectors (if required): ASTM C 923 (ASTM C 923M), cast or fitted into interceptor walls, for each pipe connection.

d. Steps: Individual FRP steps or FRP ladder **OR** Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP **OR** ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP, **as directed**,, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of interceptor to finished grade is less than 60 inches (1500 mm).

e. Grade Rings (if required): Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, to match diameter of manhole frame and cover.

f. Manhole Frames and Covers: Ferrous; 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser with 4-inch- (100-mm-) minimum width flange and 26-inch- (660-mm-) diameter cover.

1) Ductile Iron: ASTM A 536, Grade 60-40-18, unless otherwise indicated.

2) Gray Iron: ASTM A 48, Class 35, unless otherwise indicated.

3) Include indented top design with lettering cast into cover, using wording equivalent to "INTERCEPTOR," or “OIL INTERCEPTOR,” or “SANITARY SEWER."

g. Waste-oil storage tank and piping are specified in Division 15 Section "Facility Fuel-Oil Piping."

2. Oil Interceptors: Factory-fabricated, cast-iron or steel body; with removable sediment bucket or strainer, baffles, vents, and flow-control fitting on inlet.

a. Inlet, Outlet, Vent, and Waste-Oil Outlet Piping Connections: Hub, hubless, or threaded, unless otherwise indicated.

b. Extension (if required): Cast-iron or steel shroud, full size of interceptor, extending from top of interceptor to grade.

c. Cover: Cast iron or steel, with steel reinforcement to provide ASTM C 890, A-03, walkway load, **as directed**.
d. Comply with requirements in Division 15 Section "Facility Fuel-Oil Piping" for waste-oil storage tank and piping

3. Oil Interceptors: Plastic body; with removable sediment bucket or strainer, baffles, vents, and flow-control fitting on inlet.
   a. Inlet, Outlet, Vent, and Waste-Oil Outlet Piping Connections: Hub, hubless, or threaded, unless otherwise indicated.
   b. Extension (if required): Plastic shroud, full size of interceptor, extending from top of interceptor to grade.
   c. Cover: Plastic with steel reinforcement to provide ASTM C 890, A-03, walkway load, as **directed**.
   d. Waste-oil storage tank and piping are specified in Division 15 Section "Facility Fuel-Oil Piping."

C. Sand Interceptors
1. Description: Factory-fabricated, cast-iron or steel body and inlet grate; with settlement chamber and removable basket or strainer.
2. Outlet Piping Connection: Hub, hubless, or threaded, unless otherwise indicated.
3. Grate: Cast iron or steel with reinforcement to provide ASTM C 890, A-03, walkway load, **as directed**.

D. Precast-Concrete Manhole Risers
1. Precast-Concrete Manhole Risers: ASTM C 478 (ASTM C 478M) **OR** ASTM C 913, **as directed**, with rubber-gasket joints.
   a. Structural Design Loads:
      1) Light-Traffic Load: Comply with ASTM C 890, A-8 (ASSHTO HS10-44).
      2) Medium-Traffic Load: Comply with ASTM C 890, A-12 (ASSHTO HS15-44).
      3) Heavy-Traffic Load: Comply with ASTM C 890, A-16 (ASSHTO HS20-44).
      4) Walkway Load: Comply with ASTM C 890, A-03.
   b. Length: From top of underground concrete structure to grade.
   c. Riser Sections: 3-inch (75-mm) minimum thickness and 36-inch (915-mm) diameter.
   d. Top Section: Eccentric cone, unless otherwise indicated. Include top of cone to match grade ring size.
   e. Gaskets: ASTM C 443 (ASTM C 443M), rubber.
   f. Steps: Individual FRP steps or FRP ladder **OR** Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP **OR** ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP, **as directed**, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals.
2. Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, diameter matching manhole frame and cover, and height as required to adjust the manhole frame and cover to indicated elevation and slope.
3. Manhole Frames and Covers (if required): Ferrous; 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser with 4-inch- (100-mm-) minimum width flange and 26-inch- (660-mm-) diameter cover.
   a. Ductile Iron: ASTM A 536, Grade 60-40-18, unless otherwise indicated.
   b. Gray Iron: ASTM A 48, Class 35, unless otherwise indicated.
   c. Include indented top design with lettering cast into cover, using wording equivalent to the following:
      1) Grease Interceptors in Sanitary Sewerage System: "INTERCEPTOR" **OR** “GREASE INTERCEPTOR” **OR** “SANITARY SEWER", **as directed.**
      2) Oil Interceptors in Sanitary Sewerage System: "INTERCEPTOR" **OR** “OIL INTERCEPTOR” **OR** “SANITARY SEWER", **as directed**.

1.3 EXECUTION

A. Earthwork
   1. Excavating, trenching, and backfilling are specified in Division 2 Section "Earthwork."

B. Installation
   1. Install precast-concrete interceptors according to ASTM C 891. Set level and plumb.
   2. Install manhole risers from top of underground concrete interceptors to manholes and gratings at finished grade.
   3. Set tops of manhole frames and covers flush with finished surface in pavements. Set tops 3 inches (75 mm) above finish surface elsewhere, unless otherwise indicated.
   4. Set tops of grating frames and grates flush with finished surface.
   5. Set metal and plastic interceptors level and plumb.
   6. Set tops of metal interceptor covers flush with finished surface in pavements. Set tops 3 inches (75 mm) above finish surface elsewhere, unless otherwise indicated.
   7. Install piping and oil storage tanks according to Division 15 Section "Facility Fuel-Oil Piping."

C. Connections
   1. Piping installation requirements are specified in other Division 2 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
   2. Make piping connections between interceptors and piping systems.

D. Identification
   1. Identification materials and installation are specified in Division 2 Section "Earthwork." Arrange for installation of green warning tapes directly over piping and at outside edges of underground interceptors.
      a. Use warning tapes or detectable warning tape over ferrous piping.
      b. Use detectable warning tape over nonferrous piping and over edges of underground structures.

END OF SECTION 22 13 19 26

Task	Specification	Specification Description
22 13 19 26	22 13 19 00	High-Efficiency Particulate Filtration
22 13 19 33	22 05 23 00	Piped Utilities Basic Materials And Methods
22 13 19 33	22 05 76 00	Sanitary Sewerage
22 13 19 33	22 05 23 00a	General-Duty Valves for Plumbing Piping
22 13 19 33	22 05 23 00b	General-Duty Valves for HVAC Piping
22 13 19 33	22 13 19 00	High-Efficiency Particulate Filtration
22 13 19 36	22 13 19 00	High-Efficiency Particulate Filtration
22 13 23 00	22 13 19 26	Interceptors

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SECTION 22 13 29 13 - PACKAGED SEWAGE PUMPING STATIONS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for packaged sewage pumping stations. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes dry-well, packaged pumping stations with dry-well or vacuum-primed sewage pumps.
2. This Section includes wet-well, packaged pumping stations with submersible or submersible grinder or wet-well-mounting sewage pumps.

C. Performance Requirements
1. Pressure Rating of Sewage Pumps and Discharge Piping Components: At least equal to sewage pump discharge pressure, but not less than 125 psig (860 kPa).
2. Pressure Rating of Other Piping Components: At least equal to system operating pressure.

D. Submittals
1. Product Data: Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.
2. Shop Drawings: Show fabrication and installation details for each packaged pumping station. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   a. Wiring Diagrams: Power, signal, and control wiring.
3. Product Certificates: For sewage pumps, signed by product manufacturer.
4. Manufacturer Seismic Qualification Certification
5. Field quality-control test reports.
6. Maintenance Data: For packaged pumping stations to include in maintenance manuals.

E. Quality Assurance
1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
2. Testing Agency Qualifications: Nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.
3. 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.
4. Comply with HI 1.1-1.2, "Centrifugal Pumps for Nomenclature and Definitions"; HI 1.3, "Centrifugal Pumps for Design and Application"; and HI 1.4, "Centrifugal Pumps for Installation, Operation and Maintenance," for sewage and sump pumps.
5. Comply with UL 778, "Motor-Operated Water Pumps," for sewage and sump pumps.

F. Project Conditions
1. Interruption of Existing Sanitary Sewer Service: Do not interrupt sanitary sewer service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sanitary sewer service according to requirements indicated:
   a. Notify the Owner no fewer than two days in advance of proposed interruption of sanitary sewer service.

b. Do not proceed with interruption of sanitary sewer service without the Owner's written permission.

1.2 PRODUCTS

A. Dry-Well, Packaged Sewage Pumping Stations
1. Dry-Well, Packaged Sewage Pumping Stations with Dry-Well Sewage Pumps:
a. Description: Factory fabricated, assembled, and tested with wet well for comminutor and collection of sanitary sewage and with dry equipment chamber for sewage pumps, controls, and accessories.
1) Orientation: Shell underground with dry equipment chamber underground with top flush with grade **OR** partially recessed underground **OR** above grade **OR** underground with entrance tube to grade, **as directed**.
2) Shell: Factory fabricated from structural-steel plate **OR** fiberglass, **as directed**.
3) Entrance Tube: From dry compartment to entrance at grade, and of size required to replace largest piece of equipment, but not smaller than 36 inches (914 mm) in diameter.
4) Cathodic Protection: as directed by the Owner, exterior magnesium anode(s).
5) Comminutor: Full size of sewage inlet pipe.
6) Sewage Pumps: Two **OR** Three, **as directed**, dry-well-type, nonclog sewage pumps with controls and piping. Include ASTM A 48/A 48M, Class 25, nonclog, cast-iron impeller capable of passing solids of 3-inch (76-mm) minimum diameter; mechanical or stuffing-box seals; and pedestal-mounted motor.
2. Dry-Well, Packaged Sewage Pumping Stations with Vacuum-Primed Sewage Pumps:
a. Description: Factory fabricated, assembled, and tested with wet well for comminutor and collection of sanitary sewage and with dry equipment chamber for sewage pumps, vacuum pumps, controls, and accessories.
1) Orientation: Shell underground with dry equipment chamber underground with top flush with grade **OR** partially recessed underground **OR** above grade **OR** underground with entrance tube to grade, **as directed**.
2) Shell: Factory fabricated from structural-steel plate **OR** fiberglass, **as directed**.
3) Entrance Tube: From dry compartment to entrance at grade, and of size required to replace largest piece of equipment, but not smaller than 36 inches (914 mm) in diameter.
4) Cathodic Protection: as directed by the Owner, exterior magnesium anode(s).
5) Comminutor: Full size of sewage inlet pipe.
6) Sewage Pumps: Two **OR** Three, **as directed**, dry-chamber-mounting, vacuum-primed, nonclog sewage pumps located in dry compartment above wet pit, with controls and piping. Include ASTM A 48/A 48M, Class 25, nonclog, cast-iron impeller capable of passing solids of 3-inch (76-mm) minimum diameter; mechanical or stuffing-box seals; pedestal-mounted motor; and suction piping extending to bottom of wet pit.
7) Vacuum Pumps: Duplex arrangement with controls, vacuum piping, and vent piping of size and capacity required for system. Include automatic alternator, with manual disconnect switch, to change sequence of lead-lag vacuum pumps at completion of each cycle.

B. Wet-Well, Packaged Sewage Pumping Stations
1. Wet-Well, Packaged Sewage Pumping Stations with Submersible Sewage Pumps:
a. Description: Factory fabricated, assembled, and tested with wet well for comminutor, sewage pumps and collection of sanitary sewage and with sewage pumps and dry equipment chamber for controls and accessories.

1) Orientation: Shell underground with dry equipment chamber underground with top flush with grade **OR** partially recessed underground **OR** above grade **OR** underground with entrance tube to grade, **as directed**.
2) Shell: Factory fabricated from structural-steel plate **OR** fiberglass, **as directed**.
3) Entrance Tube: From dry compartment to entrance at grade, and of size required to replace largest piece of equipment, but not smaller than 36 inches (914 mm) in diameter.
4) Cathodic Protection: as directed by the Owner, exterior magnesium anode(s).
5) Comminutor: Full size of sewage inlet pipe.
6) Sewage Pumps: Two **OR** Three, **as directed**, submersible-type sewage pumps, with guide rail, quick-disconnect system, controls, and piping. Include ASTM A 48/A 48M, Class 25, nonclog, cast-iron impeller capable of passing solids of 3-inch (76-mm) minimum diameter; and hermetically sealed motor with moisture-sensing probe, mechanical seals, and waterproof power cable.

2. Wet-Well, Packaged Sewage Pumping Stations with Submersible Grinder Sewage Pumps:
   a. Description: Factory fabricated, assembled, and tested with wet well for sewage pumps and collection of sanitary sewage and with dry equipment chamber for controls and accessories.
      1) Orientation: Shell underground with dry equipment chamber underground with top flush with grade **OR** partially recessed underground **OR** above grade **OR** underground with entrance tube to grade, **as directed**.
      2) Shell: Factory fabricated from structural-steel plate **OR** fiberglass, **as directed**.
      3) Entrance Tube: From dry compartment to entrance at grade, and of size required to replace largest piece of equipment, but not smaller than 36 inches (914 mm) in diameter.
      4) Cathodic Protection: as directed by the Owner, exterior magnesium anode(s).
      5) Sewage Pumps: Two **OR** Three, **as directed**, submersible grinder-type sewage pumps, with guide rail, quick-disconnect system, controls, and piping. Include stainless-steel grinder impeller and hermetically sealed motor with moisture-sensing probe, mechanical seals, and waterproof power cable.
         a) If Project has more than one wet-well, packaged sewage pumping station with submersible grinder sewage pumps,
3. Wet-Well, Packaged Sewage Pumping Stations with Wet-Well-Mounting Sewage Pumps:
   a. Description: Factory fabricated, assembled, and tested with wet well for comminutor, sewage pumps and collection of sanitary sewage and with suspended sewage pumps and dry equipment chamber for pump motors, controls, and accessories.
      1) Orientation: Shell underground with dry equipment chamber underground with top flush with grade **OR** partially recessed underground **OR** above grade **OR** underground with entrance tube to grade, **as directed**.
      2) Shell: Factory fabricated from structural-steel plate **OR** fiberglass, **as directed**.
      3) Entrance Tube: From dry compartment to entrance at grade, and of size required to replace largest piece of equipment, but not smaller than 36 inches (914 mm) in diameter.
      4) Cathodic Protection: as directed by XXXXcontractingpositiontheXXX, exterior magnesium anode(s).
      5) Comminutor: Full size of sewage inlet pipe.
      6) Sewage Pumps: Two **OR** Three, **as directed**, wet-well-mounting-type, nonclog sewage pumps suspended from dry-compartment floor, with controls and piping. Include ASTM A 48/A 48M, Class 25, nonclog, cast-iron impeller capable of passing solids of 3-inch (76-mm) minimum diameter; grease-lubricated bearings and stuffing-box seal; shaft coupling; and pedestal-mounted motor.

C. Comminutors:
   1. Description: Motor-operated, single- or twin-shaft, cutter- or grinder-design unit with controls; for pipeline installation.
      a. Body: Stainless steel or ductile iron with flanged ends and access plate.

b. Cutting Elements: Motor-driven rotor and stationary cutters or grinders of hardened stainless or heat-treated steel.
c. Motor: Explosion proof, directly connected to body.
d. Control Panel: NEMA 250, Type 12 enclosure for installation in dry equipment chamber.

D. Controls
1. Control Sequence of Operation: Cycle each sewage pump on and off automatically to maintain wet-well sewage level. Automatic control operates both pumps in parallel if wet-well level rises above starting point of low-level pump, until shutoff level is reached. Automatic alternator, with manual disconnect switch, changes sequence of lead-lag sewage pumps at completion of each pumping cycle.
2. Self-Purging, Air-Bubbler System: Senses variations of sewage level in wet well. Include duplex-arrangement oilless air compressors to furnish bubbler air; filters; air-storage reservoir; piping; airflow meter with needle valve adjustment for airflow regulation; sewage depth gage; air-bubbler piping to wet well; and pressure-sensing, dustproof mercury switches.
3. Electrode **OR** Float-Switch **OR** Pressure-Switch **OR** Ultrasonic, **as directed**, System: Senses variations of sewage level in wet well. Include high and low adjustments capable of operating on 6-inch (150-mm) minimum differential of liquid level.
4. Motor Controllers: Magnetic, full voltage, nonreversing. Include undervoltage release, thermal-overload heaters in each phase, manual reset buttons, and hand-automatic selector switches. Include circuit breakers to provide branch-circuit protection for each controller.
5. 120-V accessory controls with 15-A, single-phase circuit breakers or fuses for each item.
6. Control Panel: Enclosure complying with UL 508A and with UL 508A, Supplement SB, **as directed**, with separate compartments and covers for controllers, circuit breakers, transformers, alternators, and single-phase controls. Include 20-A duplex receptacle in NEMA WD 1, Configuration 5-20R mounted on exterior of control panel.
   a. Mounting: Inside, on dry-chamber wall **OR** Outside, on pedestal, at grade, **as directed**.
   b. Enclosure: NEMA 250, Type 1 **OR** 4 **OR** 4X, **as directed**.
7. Install labels on panel face to identify switches and controls.
8. Wiring: Tin-copper wiring.
9. Connection for Portable Generator: Nonautomatic (manual) transfer switch with receptacle matching generator electrical power requirements. Nonautomatic transfer switches are specified in Division 26 Section "Transfer Switches" and receptacles are specified in Division 26 Section "Wiring Devices".

E. Accessories
1. Lighting: Minimum of 2, UL 1571, heavy-duty, cast-metal, wet-location-type fixtures with 100-W bulbs and guards in service area. Locate switches, with pilot lights, at chamber entrance.
2. Submersible Sump Pump:
   a. Discharge Size: NPS 1-1/4 (DN 32) minimum.
   b. Pump End Bell and Motor Shell: Cast iron.
   c. Motor: 1/3 hp, 1750-rpm, hermetically sealed, capacitor-start, with built-in overload protection.
   d. Impeller: ASTM B 584, cast bronze or ASTM B 36/B 36M, brass.
   e. Shaft: Stainless steel.
   f. Bearings: Grease-lubricated, factory-sealed ball bearings.
   g. Seals: Mechanical.
   h. Accessories: Inlet strainer.
   i. Controls: Float switch.
3. Dehumidifier: Electric refrigeration system, adjustable humidistat, reverse-acting thermostat for low-temperature cutoff controls, and condensate pump with drain piping to sump.
   a. Dehumidification system capacity adequate to remove at least 15 pints (7 L) of water per day from service area air that is 80 deg F (27 deg C) with a relative humidity of 60 percent.
4. Ventilation: Electrically powered ventilation system. Include centrifugal blower with 4-inch- (100-mm-) round exhaust vent designed to keep out rain, insects, and other foreign matter; limit switch

to start blower if entrance door or lid is opened; 0- to 15-minute timer; and separate manual switch.
    a. Ventilating system capacity to change air in dry equipment chamber every two minutes.
5. Heater: Electric, 1.5 kW minimum, with fan and thermostat control.
6. High-Water Audio Alarm: Horn for audio indication of station high-water level, energized by separate level-detecting device. Include alarm silencer switch and relay in station.
7. Remote Alarm Circuit: Include contacts for connection to remote alarm panel.

F. Motors
1. General requirements for motors are specified in Division 22 Section "Common Motor Requirements For Plumbing Equipment".

G. Miscellaneous Materials
1. Structural Steel: ASTM A 6/A 6M, W or HP shapes, or ASTM A 36/A 36M, plates or beams.
2. Grout: ASTM C 1107, Grade B, nonshrink cement grout.
    a. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
3. Concrete: Concrete is specified in Division 03 Section "Cast-in-place Concrete".

H. Packaged Sewage Pumping Station Fabrication
1. Fabricate shell from structural-steel plate with continuous welds to make watertight and gastight construction.
    a. Walls: 1/4-inch (6.4-mm) minimum thickness.
    b. Top and Bottom Heads: 3/8-inch (9.5-mm) minimum thickness. Weld reinforcing steel to top and bottom heads.
    c. Entrance-Tube Walls: 1/4-inch (6.4-mm) minimum thickness.
    d. Weld steel access ladder and air vent to shell and entrance tube, **as directed**.
    e. Apply three coats of epoxy resin to interior and exterior surfaces.
    f. Include at least two **OR** four, **as directed**, exterior magnesium anode(s) for cathodic protection.
2. Fabricate shell from fiberglass with structural-steel reinforcement.
    a. Attach structural-steel reinforcement to top and bottom heads.
    b. Fabricate shell with continuous joints to make watertight and gastight construction.
    c. Attach air vent to pump chamber and entrance tube, **as directed**.
    d. Ladder: Steel **OR** Fiberglass, **as directed**.
3. Install sump, 18 inches (450 mm) in diameter by 10 inches (254 mm) deep in dry-chamber floor. Slope floor toward sump and fasten rubber mat to floor walkway with cement.
4. Entrance tube may be furnished separately for field installation.
5. Entrance Cover: Waterproof and corrosion resistant, with lock. Include way to open cover from inside tube if cover is locked.
6. Air Vent: Duct fabricated from corrosion-resistant material, extended to above grade, outlet turned down, and with insect screen in outlet.
7. Factory fabricate piping between unit components.
    a. Use galvanized-steel pipe and cast-iron fittings or ductile-iron pipe and fittings.
    b. Use fittings for changes in direction and branch connections.
    c. Flanged and union joints may be used instead of joints specified.
    d. Use dielectric fittings for connections between ferrous- and copper-alloy piping.
8. Piping Connections: Unless otherwise indicated, make the following piping connections:
    a. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment having NPS 2 (DN 50) or smaller threaded pipe connection.
    b. 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 having flanged pipe connection.
9. Valves: Ferrous alloy.
    a. Sewage Pump Piping: Include gate valve on each pump inlet and gate and check valves on each discharge pipe.
    b. Sump Pump Piping: Include ball or gate and check valves on discharge pipe.

c. Compressed-Air Piping: Include ball and check valves on discharge pipe from each air compressor.
d. Vacuum Piping: Include ball and check valves on inlet pipe to each vacuum pump.

10. Wiring: Tin-coated copper.

I. Source Quality Control
1. Test and inspect sewage and sump, **as directed**, pumps according to HI 1.6, "Centrifugal Pump Tests." Include test recordings that substantiate correct performance of pumps at design head, capacity, suction lift, speed, and horsepower.
2. Test accessories and controls through complete cycle. Include test recordings that substantiate correct performance.

1.3 EXECUTION

A. Earthwork
1. Excavation, trenching, and backfilling are specified in Division 31 Section "Earth Moving".

B. Installation
1. Install packaged sewage pumping station components where indicated, according to specific equipment and piping arrangement indicated.
2. Shell Base Supports: Form from structural-steel beams, of number and lengths required to support bottom of shell and to anchor beams to concrete foundation.
   a. Use elevator blocks attached to bottom of shell to slope station floor 1 inch in 10 feet (25.4 mm in 3 m) down toward sump.
3. Grout under and around shell. Ensure that there are no voids between foundation slab and underslab of pumping station.
4. Fill voids between shell sidewalls, sleeves, and piping and make watertight seal with grout.
5. Connect anode conductors to grounding lugs on steel housing.
6. Join separate sections of housing by field welding.
7. Field weld entrance tube to housing.

C. Connections
1. Sanitary sewer piping installation requirements are specified in Division 22 Section "Facility Sanitary Sewers". Drawings indicate general arrangement of piping.
2. Install piping adjacent to machine to allow service and maintenance.
3. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
4. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

D. Identification
1. Install identifying labels permanently attached to equipment.
2. Install operating instruction signs permanently attached to equipment or on pumping station wall near equipment.
3. Arrange for installing green warning tape or detectable warning tape over outside edges of underground packaged sewage pumping stations. Tape materials and their installation are specified in Division 31 Section "Earth Moving".

E. Painting
1. Prepare and paint ferrous piping in wet wells, structural-steel supports, and anchor devices with coal-tar epoxy-polyamide paint according to SSPC-Paint 16.
2. Paint field-welded areas to match factory coating.

F. Field Quality Control

1. Testing Agency: Engage a qualified testing agency to perform field tests and inspections and prepare test reports.
2. 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.
3. Perform tests and inspections and prepare test reports.
   a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
4. Tests and Inspections:
   a. After installing packaged sewage pumping stations and after electrical circuitry has been energized, test for compliance with requirements. Furnish water required for pump tests.
   b. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
   c. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Remove and replace packaged sewage pumping stations that do not pass tests and inspections and retest as specified above.

G. Startup Service
1. Engage a factory-authorized service representative to perform startup service.
   a. Complete installation and startup checks according to manufacturer's written instructions.
   b. Adjust pump, accessory, and control settings, and safety and alarm devices.

H. Demonstration
1. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain packaged sewage pumping stations.

END OF SECTION 22 13 29 13

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SECTION 22 13 29 13a - LIFT STATION

1.1 GENERAL

A. Description Of Work
1. This Specification covers the furnishing and installation of sewage lift stations. Work includes but is not limited to earthwork, installation of watertight precast concrete sump basin, basin access cover, submersible sewage pumps, pump guide rail system, pump control system, valves and piping and electrical connections as required. Specific sizes of basins, pumps, and piping shall be as follows or as directed by the Owner.

B. Submittals
1. Product Data: For each type of product indicated.
   a. Pipe and fittings
   b. Check valves
   c. Gate valves
   d. Submersible sewage grinder pumps
   e. Pump motor
   f. Flexible flanged coupling
2. Operation and Maintenance Data: Include pumps, alarms, and motors. Data for submersible sewage grinder pump station data shall include all information on all equipment, alarm panel and controls, pumps and pump performance curves, and station layout.

C. Delivery, Storage, and Handling of Materials
1. Delivery and Storage: Inspect materials delivered to site for damage. Unload and store with minimum handling. Store materials in enclosures or under protective covering. Store rubber gaskets not to be installed immediately under cover, out of direct sunlight. Do not store materials directly on the ground. Keep interior of pipes and fittings free of dirt and debris.
2. Handling: Handle pipe, fittings, valves, and other accessories in such manner as to ensure delivery to the trench in sound, undamaged condition. Avoid injury to coatings and linings on pipe and fittings; make satisfactory repairs if coatings or linings are damaged. Carry pipe to the trench; do not drag it.

1.2 PRODUCTS

A. Precast Concrete Sump Basin(s)
1. Precast Concrete Sump Basin shall be constructed in conformance with Division 2 Section “Underground Ducts and Utility Structures.” Basin shall have an integral bottom base section.
2. Joint Sealant: Seal all joints with EZ Stik Butyl Gasket as manufactured by Concrete Products Supply Co., or approved equal. Install in accordance with manufacturer’s recommendations.
3. Pipe Opening Seals.
4. Waterproofing: Waterproof interior of concrete sump with one coat of Koppers Coal Tar Bitumastic Black or approved equal. Repair all damaged coating before final backfill. Do not coat cover of basin.
5. Access Hatch - Aluminum Hinged Frame and Cover Model EC-3HD by Syracuse Castings, Cicero, NY (315) 699-2601, or approved equal. Frame and cover shall be heavy duty, rated for H-20 Loadings. Frame shall be angle style frame. Material shall be 6061-T6 aluminum for bars, angles and extrusions. 1/4" diamond plate shall be 5086 aluminum. Unit designed heavy duty, for H-20 wheel loads where not subject to high density traffic. Unit supplied with a heavy duty pneu-spring, for ease of operation when opening cover. Each hatch shall be equipped with a hold open arm. Door shall lock open in the 90 degree position. Hinges shall be of heavy duty design. Material shall be a brass alloy with a 65,000 psi tensile strength. Each hinge shall have a Grade 316 Stainless Steel, 3/8" diameter hinge pin. Exterior of frame, which comes in contact

with concrete shall have one coat black bituminous paint. Unit supplied with a recessed stainless steel slamlock. Angle frame must be completely encased in concrete. Both bearing plates must be fully supported by a bed of concrete.

6. The unit shall be supplied with aluminum safety grate. Safety Grate shall be made of 6061-T6 aluminum with a minimum ultimate strength of 38,000 psi and a minimum yield strength of 35,000 psi as per ASTM B221. Grate design shall use safety factors as defined in the "Specifications for Aluminum Structures", by the Aluminum Association, Inc., 5th edition, DEC. 1986 for "Bridge Type Structures."
   a. Grating shall be designed to withstand a minimum live load of 300 pounds per square foot. Deflection shall not exceed 1/150th of the span.
   b. Grate openings shall be 4" x 4", which will allow for visual inspection of the pit once the access hatch is open.
   c. Each grate shall be provided with a stainless steel, safety check chain. Chain will prevent the grating from falling into the pit.
   d. Welding shall be in accordance with ANSI/AWS D1.2 "Structural Welding Code for Aluminum."

B. Submersible Sewage Pump System
1. Submersible sewage effluent pumps shall be sized as directed by the Owner and specified herein. Pump shall be heavy duty cast iron with stainless steel fasteners. The impeller shall be semi-open, non-clog, engineered plastic capable of passing 3/4" solids. Pump motor shall be oil filled. Pumps shall be equal to SHE-F Series as manufactured by Aurora Pump, or approved equal. Specific pump performance data shall conform to the following:

   1/2 HP Pumps 230 volt/single phase/60 Hz/2" NPT/ 3450 rpm
   40 gpm @ 42 ft. TDH
   50 gpm @ 32 ft. TDH
   60 gpm @ 18 ft. TDH

   1 HP Pumps 230 volt/single phase/60 Hz/2" NPT/3450 rpm
   20 gpm @ 80 ft. TDH
   30 gpm @ 76 ft. TDH
   40 gpm @ 71 ft. TDH
   50 gpm @ 65 ft. TDH

C. Duplex Guide Rail System: Complete package system shall be as manufactured by Moran Manufacturing Inc., or approved equal, as follows.
1. The guide rail assembly shall be constructed of Type 304 stainless steel and shall consist of a minimum of two rails, a bottom base plate, a minimum of one cross brace every 18 inches between the rails and a wall brace, all welded together to provide the maximum structural integrity. The rails shall be round to provide a non-binding surface during installation and removal of the pump. The guide rail assembly shall be installed as a one piece unit and shall be bolted with stainless anchor bolts to the basin bottom and the basin wall a minimum of two places each.
2. The pump bracket assembly shall consist of a top bracket and a bottom bracket. The brackets shall be fabricated of 1/4" steel material and shall be painted with coal tar epoxy paint at such rate as to provide a minimum 10 mil thickness. The top bracket shall be attached to the discharge piping above the pump disconnect and shall be constructed in such a manner that pump cannot be removed from the guide rail assembly except when removing pump out the top of the sump basin. The bottom bracket shall be attached to the pump at the discharge connection and shall guide the pump along the guide rail assembly to ensure proper alignment of the pump.
3. A 3/16" min. (7 x 9) stainless steel lifting cable, 10 ft. longer than the sump depth, shall be furnished for lifting and lowering the pump in the sump basin. The stainless steel lifting cable

shall be of the 18-8 type 302/304 stainless steel and shall have minimum nominal breaking strength of 15 times the weight of the pump. It shall be substantially attached to the top of the pump and shall have a formed loop at the other end.

4. The discharge piping shall include a cast iron ball check valve, with a natural rubber ball and clean out port with plug for easy access, a brass quick disconnect fitting, with an O-ring stem brass gate valve, per pump. All other piping shall be schedule 40 stainless steel.
5. The station shall have a gate valve extension handle per valve which will allow the gate valve to be operated from a maximum of 6" below the basin cover. The handle shall be constructed of a minimum of 3/8" dia. Type 304 stainless steel. The handle shall be held in place by being attached to the gate valve and by the guide rail wall brace.
6. All internal metal parts that are not brass, galvanized steel, or stainless steel shall be painted with coal-tar epoxy paint to resist corrosion, unless otherwise noted.
7. Mercury level control switches shall be provided for lead pump on, lag pump on and high level alarm, pumps off and low level alarm.
8. The mercury switch shall be encapsulated in polyurethane foam for corrosion and shock resistance. Level switches shall be weighted to hold position in the sump. The cord connecting the control shall be No. 16-2, rated for 13 amps, and shall be type C-SJO. To ensure optimum longevity, mercury contacts shall be of the mercury-to-mercury type and encapsulated in a glass tube and shall be rated for 20 amps at 115 VAC.
9. The manufacturer of the lift station shall furnish a limited warranty for 18 months from the date of shipment or 12 months from start-up (whichever occurs first), that all equipment shall be free from defects in design, materials and workmanship. The lift station manufacturer shall furnish replacement parts for any component proven defective whether of his or other manufacturer during the warranty period, excepting only those items which are normally consumed in service, such as (but not limited to) light bulbs, oil, grease, packing, etc.
10. Installation instructions shall be furnished with the station.

D. Control System

1. This system shall be controlled and protected by a packaged system as manufactured by Rombus, or approved equal. The control shall provide automatic start, stop and alternation of 2 pumps, and shall provide an audible alarm as well as visual indication of high level conditions.
2. The control panel shall be pre-wired in a NEMA 3R weatherproof enclosure, and all necessary components including the following: single phase lightning arrestor for protection of the pumps, NEMA rated contractor and thermal magnetic circuit breaker for each pump, a main control/alarm circuit fused disconnect switch, separately fused control and alarm circuits, panel mounted duplex alternating relays, control relays, and terminal blocks for the connection on all external wiring. Provide a 20 amp/115v convenience outlet in each panel on its own GFCI circuit breaker. Multi-colored circuitry is to be used within the control panel to facilitate trouble shooting.
3. Mounted inside the enclosure shall be hand-off-auto switches and run pilot lights for each pump circuit; normal-off-test switch and alarm pilot light for high level alarm; float test toggle switches for each float to override floats to simulate operation; non-resettable elapsed time meters for each pump. Include reversing switch.
4. Mounted remotely from the Control Panel shall be a 4" 120V alarm bell and a flashing alarm light.

E. System Operation: As the level in the sump rises to the lead pump on level, the pump selected as lead by the alternator will come on line, and will pump the level down to the pump off level. The pump will then turn off, and the alternator will cycle, selecting the other pump as lead for the next cycle. If, with the lead pump running, the level in the tank continues to rise to the lag pump on level, the lag pump will come on line, alarms will sound, and will run with the lead pump until the pumps off level has been reached. The pumps will then be turned off, and the alternator will cycle. If level continues to drop to the low level alarm float, alarm circuits will be activated.

1. Placing the T-O-N switch into the off position will de-energize the alarm bell and flashing light, but the alarm pilot light will remain illuminated until the alarm condition has been cleared. When the alarm pilot light is extinguished, the T-O-N switch may be reset to the normal position, and the alarm will stand ready for the next alarm.

1.3 EXECUTION

A. The Contractor shall excavate the station site to the elevations as required to meet project requirements. Compact the subgrade and install crushed stone.

B. Install lift station in accordance with manufacturer’s recommendations. Perform additional exterior waterproofing as required to repair original coating and to achieve a watertight sump basin. The discharge piping shall be extended and connected to the sewage force mains. Backfill material shall be approved by the Owner. No backfill material shall have any dimension greater than 6". Backfill material within 15" of basin shall not have a dimension greater than 2".

C. The Lift Station control panel shall be mounted to the building nearby and shall have sufficient cord supplied by the Lift Station manufacturer to avoid any splices. All necessary electrical connections between pumps, flow controls and control panel shall be made in accordance with manufacturer's recommendations. No splices shall be made in the basin. Lightning protection shall be provided in the panel.

D. Install pump power conductors in rigid steel conduit between Lift Station and Control Panel.

E. Upon completion, the Lift Station shall be tested to assure there is no leakage and that the pumps, controls and alarm are operating satisfactorily. The Lift Station manufacturer's representative shall be present during initial start up and testing. Three (3) Lift Station operation and maintenance manuals shall be provided.

END OF SECTION 22 13 29 13a

SECTION 22 13 29 13b - SEWAGE PUMPS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for sewage pumps. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Submersible effluent pumps.
b. Submersible sewage pumps.
c. Wet-pit-volute sewage pumps.
d. Sewage-pump, reverse-flow assemblies.
e. Sewage-pump basins and basin covers.
f. Progressing-cavity sewage pumps.
g. Packaged, submersible sewage-pump units.
h. Packaged wastewater-pump units.

C. Submittals
1. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Wiring Diagrams: For power, signal, and control wiring.
3. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

D. Quality Assurance
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. UL Compliance: Comply with UL 778 for motor-operated water pumps.

E. Delivery, Storage, And Handling
1. Retain shipping flange protective covers and protective coatings during storage.
2. Protect bearings and couplings against damage.
3. Comply with pump manufacturer's written rigging instructions for handling.

F. Coordination
1. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.2 PRODUCTS

A. Submersible Effluent Pumps
1. Submersible, Fixed-Position, Single-Seal Effluent Pumps:
a. Description: Factory-assembled and -tested effluent-pump unit.
b. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal effluent pump as defined in HI 1.1-1.2 and HI 1.3.
c. Pump Casing: Cast iron, with open inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
d. Impeller: Statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron **OR** ASTM A 532/A 532M, abrasion-resistant cast iron **OR** ASTM B 584, cast bronze, **as**

directed, and stainless steel, **as directed**, closed or semiopen design for clear wastewater, and keyed and secured to shaft.

e. Pump and Motor Shaft: Stainless steel **OR** steel, **as directed**, with factory-sealed, grease-lubricated ball bearings.

f. Seal: Mechanical.

g. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

1) Motor Housing Fluid: Air **OR** Oil, **as directed**.

h. Controls (rod-and-float type):

1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**, **OR** Type 30 for wet conditions.

2) Switch Type: Pedestal-mounted float switch with float rods and rod buttons.

3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.

4) Float Guides: Brass pipe or other restraint for floats and rods in basins of depth greater than 60 inches (1500 mm).

5) High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

i. Controls (float- and pressure-switch types):

1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**; pedestal-mounted **OR** wall-mounted, **as directed**, **OR** Type 30 for wet conditions.

2) Switch Type: Mechanical-float **OR** Mercury-float **OR** Pressure, **as directed**, type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.

3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.

4) High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

j. Control-Interface Features:

1) Remote Alarm Contacts: For remote alarm interface.

2) Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

a) On-off status of pump.

b) Alarm status.

2. Submersible, Fixed-Position, Double-Seal Effluent Pumps:

a. Description: Factory-assembled and -tested effluent-pump unit.

b. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal effluent pump as defined in HI 1.1-1.2 and HI 1.3.

c. Pump Casing: Cast iron, with open inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.

d. Impeller: Statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron **OR** ASTM A 532/A 532M, abrasion-resistant cast iron **OR** ASTM B 584, cast bronze, **as directed**, and stainless steel, **as directed**, closed or semiopen design for clear wastewater, and keyed and secured to shaft.

e. Pump and Motor Shaft: Stainless steel **OR** steel, **as directed**, with factory-sealed, grease-lubricated ball bearings.

f. Seals: Mechanical.

g. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.

h. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

1) Motor Housing Fluid: Air **OR** Oil, **as directed**.

i. Controls (rod-and-float type):

1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**, **OR** Type 30 for wet conditions.
2) Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
4) Float Guides: Brass pipe or other restraint for floats and rods in basins of depth greater than 60 inches (1500 mm).
5) High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

j. Controls (float- and pressure-switch types):
1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**; pedestal-mounted **OR** wall-mounted, **as directed**, **OR** Type 30 for wet conditions.
2) Switch Type: Mechanical-float **OR** Mercury-float **OR** Pressure, **as directed**, type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
4) High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

k. Control-Interface Features:
1) Remote Alarm Contacts: For remote alarm interface.
2) Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
a) On-off status of pump.
b) Alarm status.

3. Submersible, Quick-Disconnect, Single-Seal Effluent Pumps:
a. Description: Factory-assembled and -tested effluent-pump unit with guide-rail supports.
b. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal effluent pump as defined in HI 1.1-1.2 and HI 1.3.
c. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail support.
d. Impeller: Statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron **OR** ASTM A 532/A 532M, abrasion-resistant cast iron **OR** ASTM B 584, cast bronze, **as directed**, and stainless steel, **as directed**, closed or semiopen design for clear wastewater, and keyed and secured to shaft.
e. Pump and Motor Shaft: Stainless steel **OR** steel, **as directed**, with factory-sealed, grease-lubricated ball bearings.
f. Seal: Mechanical.
g. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
1) Motor Housing Fluid: Air **OR** Oil, **as directed**.
h. Controls (rod-and-float type):
1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**, **OR** Type 30 for wet conditions.
2) Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
4) Float Guides: Brass pipe or other restraint for floats and rods in basins of depth greater than 60 inches (1500 mm).
5) High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
i. Controls (float- and pressure-switch types):
1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**; pedestal-mounted **OR** wall-mounted, **as directed**, **OR** Type 30 for wet conditions.

2) Switch Type: Mechanical-float **OR** Mercury-float **OR** Pressure, **as directed**, type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
4) High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

j. Control-Interface Features:
1) Remote Alarm Contacts: For remote alarm interface.
2) Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
a) On-off status of pump.
b) Alarm status.

k. Guide-Rail Supports:
1) Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
2) Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
3) Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
4) Pump Yoke: Motor-mounted or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
5) Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
6) Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
7) Lifting Cable: Stainless steel; attached to pump and cover at manhole.

4. Submersible, Quick-Disconnect, Double-Seal Effluent Pumps:
a. Description: Factory-assembled and -tested effluent-pump unit with guide-rail supports.
b. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal effluent pump as defined in HI 1.1-1.2 and HI 1.3.
c. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail support.
d. Impeller: Statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron **OR** ASTM A 532/A 532M, abrasion-resistant cast iron **OR** ASTM B 584, cast bronze, **as directed**, and stainless steel, **as directed**, closed or semiopen design for clear wastewater, and keyed and secured to shaft.
e. Pump and Motor Shaft: Stainless steel **OR** steel, **as directed**, with factory-sealed, grease-lubricated ball bearings.
f. Seals: Mechanical.
g. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
h. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
1) Motor Housing Fluid: Air **OR** Oil, **as directed**.

i. Controls (rod-and-float type):
1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**, **OR** Type 30 for wet conditions.
2) Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
4) Float Guides: Brass pipe or other restraint for floats and rods in basins of depth greater than 60 inches (1500 mm).
5) High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

j. Controls (float- and pressure-switch types):

1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**; pedestal-mounted **OR** wall-mounted, **as directed**, **OR** Type 30 for wet conditions.
2) Switch Type: Mechanical-float **OR** Mercury-float **OR** Pressure, **as directed**, type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
4) High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

k. Control-Interface Features:
1) Remote Alarm Contacts: For remote alarm interface.
2) Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
a) On-off status of pump.
b) Alarm status.

l. Guide-Rail Supports:
1) Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
2) Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
3) Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
4) Pump Yoke: Motor-mounted or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
5) Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
6) Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
7) Lifting Cable: Stainless steel; attached to pump and cover at manhole.

B. Submersible Sewage Pumps
1. Submersible, Fixed-Position, Single-Seal Sewage Pumps:
a. Description: Factory-assembled and -tested sewage-pump unit.
b. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
c. Pump Casing: Cast iron, with open inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
d. Impeller: Statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron **OR** ASTM A 532/A 532M, abrasion-resistant cast iron **OR** ASTM B 584, cast bronze, **as directed**, and stainless steel, **as directed**, nonclog, open, or semiopen design for solids handling, and keyed and secured to shaft.
e. Pump and Motor Shaft: Stainless steel **OR** steel, **as directed**, with factory-sealed, grease-lubricated ball bearings.
f. Seal: Mechanical.
g. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
1) Motor Housing Fluid: Air **OR** Oil, **as directed**.
h. Controls (rod-and-float type):
1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**.
2) Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
4) Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches (1500 mm).
5) High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

i. Controls (float- and pressure-switch types):
   1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**; pedestal-mounted **OR** wall-mounted, **as directed**.
   2) Switch Type: Mechanical-float **OR** Mercury-float **OR** Pressure, **as directed**, type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
   3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
   4) High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

j. Control-Interface Features:
   1) Remote Alarm Contacts: For remote alarm interface.
   2) Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
      a) On-off status of pump.
      b) Alarm status.

2. Submersible, Fixed-Position, Double-Seal Sewage Pumps:
   a. Description: Factory-assembled and -tested sewage-pump unit.
   b. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
   c. Pump Casing: Cast iron, with open inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
   d. Impeller: Statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron **OR** ASTM A 532/A 532M, abrasion-resistant cast iron **OR** ASTM B 584, cast bronze, **as directed**, and stainless steel, **as directed**, nonclog, open, or semiopen design for solids handling, and keyed and secured to shaft.
   e. Pump and Motor Shaft: Stainless steel **OR** steel, **as directed**, with factory-sealed, grease-lubricated ball bearings.
   f. Seals: Mechanical.
   g. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
   h. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
      1) Motor Housing Fluid: Air **OR** Oil, **as directed**.
   i. Controls (rod-and-float type):
      1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**.
      2) Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
      3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
      4) Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches (1500 mm).
      5) High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
   j. Controls (float- and pressure-switch types):
      1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**; pedestal-mounted **OR** wall-mounted, **as directed**.
      2) Switch Type: Mechanical-float **OR** Mercury-float **OR** Pressure, **as directed**, type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
      3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
      4) High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
   k. Control-Interface Features:
      1) Remote Alarm Contacts: For remote alarm interface.

2) Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
   a) On-off status of pump.
   b) Alarm status.

3. Submersible, Quick-Disconnect, Single-Seal Sewage Pumps:
   a. Description: Factory-assembled and -tested sewage-pump unit with guide-rail supports.
   b. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
   c. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail support.
   d. Impeller: Statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron **OR** ASTM A 532/A 532M, abrasion-resistant cast iron **OR** ASTM B 584, cast bronze, **as directed**, and stainless steel, **as directed**, nonclog, open, or semiopen design for solids handling, and keyed and secured to shaft.
   e. Pump and Motor Shaft: Stainless steel **OR** steel, **as directed**, with factory-sealed, grease-lubricated ball bearings.
   f. Seal: Mechanical.
   g. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
      1) Motor Housing Fluid: Air **OR** Oil, **as directed**.
   h. Controls (rod-and-float type):
      1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**.
      2) Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
      3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
      4) Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches (1500 mm).
      5) High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
   i. Controls (float- and pressure-switch types):
      1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**; pedestal-mounted **OR** wall-mounted, **as directed**.
      2) Switch Type: Mechanical-float **OR** Mercury-float **OR** Pressure, **as directed**, type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
      3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
      4) High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
   j. Control-Interface Features:
      1) Remote Alarm Contacts: For remote alarm interface.
      2) Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
         a) On-off status of pump.
         b) Alarm status.
   k. Guide-Rail Supports:
      1) Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
      2) Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
      3) Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
      4) Pump Yoke: Motor-mounted or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
      5) Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.

6) Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
7) Lifting Cable: Stainless steel; attached to pump and cover at manhole.

4. Submersible, Quick-Disconnect, Double-Seal Sewage Pumps:
   a. Description: Factory-assembled and -tested sewage-pump unit with guide-rail supports.
   b. Pump type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
   c. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail support.
   d. Impeller: Statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron **OR** ASTM A 532/A 532M, abrasion-resistant cast iron **OR** ASTM B 584, cast bronze, **as directed**, and stainless steel, **as directed**, nonclog, open, or semiopen design for solids handling, and keyed and secured to shaft.
   e. Pump and Motor Shaft: Stainless steel **OR** steel, **as directed**, with factory-sealed, grease-lubricated ball bearings.
   f. Seals: Mechanical.
   g. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
   h. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
      1) Motor Housing Fluid: Air **OR** Oil, **as directed**.
   i. Controls (rod-and-float type):
      1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**.
      2) Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
      3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
      4) Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches (1500 mm).
      5) High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
   j. Controls (float- and pressure-switch types):
      1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**; pedestal-mounted **OR** wall-mounted, **as directed**.
      2) Switch Type: Mechanical-float **OR** Mercury-float **OR** Pressure, **as directed**, type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
      3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
      4) High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
   k. Control-Interface Features:
      1) Remote Alarm Contacts: For remote alarm interface.
      2) Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
         a) On-off status of pump.
         b) Alarm status.
   l. Guide-Rail Supports:
      1) Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
      2) Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
      3) Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
      4) Pump Yoke: Motor-mounted or casing-mounted yokes or other attachments for aligning pump during connection of flanges.

5) Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
6) Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
7) Lifting Cable: Stainless steel; attached to pump and cover at manhole.

5. Submersible, Quick-Disconnect, Grinder Sewage Pumps:
   a. Description: Factory-assembled and -tested, grinder sewage-pump unit with guide-rail supports.
   b. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
   c. Pump Casing: Cast iron, with open inlet, and discharge fittings for connection to guide-rail supports.
   d. Impeller: Bronze or stainless steel; statically and dynamically balanced, with stainless-steel cutter, grinder, or slicer assembly; capable of handling solids; and keyed and secured to shaft.
   e. Pump and Motor Shaft: Stainless steel **OR** steel, **as directed**, with factory-sealed, grease-lubricated ball bearings.
   f. Seal: Mechanical.
   g. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
      1) Motor Housing Fluid: Air **OR** Oil, **as directed**.
   h. Controls (rod-and-float type):
      1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**, **OR** Type 12 for wet conditions.
      2) Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
      3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
      4) Float Guides: Brass pipe or other restraint for floats and rods in basins of depth greater than 60 inches (1500 mm).
      5) High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
   i. Controls (float- and pressure-switch types):
      1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**; pedestal-mounted **OR** wall-mounted, **as directed**, **OR** Type 12 for wet conditions.
      2) Switch Type: Mechanical-float **OR** Mercury-float **OR** Pressure, **as directed**, type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
      3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
      4) High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
   j. Control-Interface Features:
      1) Remote Alarm Contacts: For remote alarm interface.
      2) Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
         a) On-off status of pump.
         b) Alarm status.
   k. Guide-Rail Supports:
      1) Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
      2) Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
      3) Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
      4) Pump Yoke: Motor-mounted or casing-mounted yokes or other attachments for aligning pump during connection of flanges.

5) Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
6) Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
7) Lifting Cable: Stainless steel; attached to pump and cover at manhole.

6. Submersible, Quick-Disconnect, Progressing-Cavity, Grinder Sewage Pumps:
   a. Description: Factory-assembled and -tested progressing-cavity, grinder sewage-pump unit with guide-rail supports.
   b. Pump Type: Submersible, progressing-cavity, single-screw rotary, grinder sewage pump as defined in HI 3.1-3.5.
   c. Pump Body: Cast iron.
   d. Pump Bearings: Radial and thrust types.
   e. Pump Shaft: Steel.
   f. Rotor: Stainless steel.
   g. Stator: Buna-N **OR** Natural rubber, **as directed**.
   h. Seal: Packing gland and mechanical types.
   i. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
   j. Controls (rod-and-float type):
      1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**, **OR** Type 12 for wet conditions.
      2) Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
      3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
      4) Float Guides: Brass pipe or other restraint for floats and rods in basins of depth greater than 60 inches (1500 mm).
      5) High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
   k. Controls (float- and pressure-switch types):
      1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**; pedestal-mounted **OR** wall-mounted, **as directed**, **OR** Type 12 for wet conditions.
      2) Switch Type: Mechanical-float **OR** Mercury-float **OR** Pressure, **as directed**, type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
      3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
      4) High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
   l. Control-Interface Features:
      1) Remote Alarm Contacts: For remote alarm interface.
      2) Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
         a) On-off status of pump.
         b) Alarm status.
   m. Guide-Rail Supports:
      1) Standard: SWPA's "Submersible Sewage Pumping Systems (SWPA) Handbook."
      2) Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover.
      3) Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
      4) Pump Yoke: Motor-mounted or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
      5) Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.

6) Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
7) Lifting Cable: Stainless steel; attached to pump and cover at manhole.

C. Wet-Pit-Volute Sewage Pumps
1. Description: Factory-assembled and -tested sewage-pump unit.
2. Pump Type: Wet-pit-volute, single-stage, separately-coupled, overhung-impeller, centrifugal sewage pump as defined in HI 1.1-1.2 and HI 1.3.
3. Pump Casing: Cast iron, with open inlet and threaded or flanged connection for discharge piping.
4. Pump Shaft: Stainless-steel **OR** steel, **as directed**.
5. Impeller: Statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron **OR** ASTM A 532/A 532M, abrasion-resistant cast iron **OR** ASTM B 584, cast bronze, **as directed**, nonclog, open, or semiopen design for solids handling, and keyed and secured to shaft.
6. Sleeve Bearings: Bronze. Include oil-lubricated, intermediate sleeve bearings at 48-inch (1200-mm) maximum intervals if basin depth is more than 48 inches (1200 mm), and grease-lubricated, ball-type thrust bearings.
7. Pump and Motor Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
8. Pump Discharge Piping: Factory or field fabricated, galvanized, ASTM A 53/A 53M, Schedule 40, steel pipe with ASME B16.1, Class 125, cast-iron flanges and flanged fittings or ASME B16.4, Class 125, gray iron threaded fittings, **as directed**.
   a. Modify piping configuration to accommodate reverse-flow assembly.
9. Support Plate: Cast iron or coated steel and strong enough to support pumps, motors, and controls. Refer to Part 1.2 "Sewage-Pump Basins and Basin Covers" Article for requirements.
10. Shaft Seal: Stuffing box, with graphite-impregnated braided-yarn rings and bronze packing gland.
11. Motor: Single-speed; grease-lubricated ball bearings and mounted on vertical, cast-iron pedestal.
12. Controls (rod-and-float type):
   a. Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**, **OR** Type 12 for wet conditions.
   b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
   c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
   d. Float Guides: Brass pipe or other restraint for floats and rods in basins of depth greater than 60 inches (1500 mm).
   e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
13. Controls (float- and pressure-switch types):
   a. Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**; pedestal-mounted **OR** wall-mounted, **as directed**, **OR** Type 12 for wet conditions.
   b. Switch Type: Mechanical-float **OR** Mercury-float **OR** Pressure, **as directed**, type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
   c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
   d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
14. Control-Interface Features:
   a. Remote Alarm Contacts: For remote alarm interface.
   b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
      1) On-off status of pump.
      2) Alarm status.

D. Sewage-Pump, Reverse-Flow Assemblies
1. Description: Factory-fabricated, sewage pump reverse-flow assembly for factory or field assembly and installation in sewage pump basin. Include the following corrosion-resistant-metal components:

a. Inlet Fitting: One combination inlet-overflow strainer fitting.
b. Valves: Two shutoff valves and two check valves.
c. Strainers: Two strainer housings with reverse-flow, self-flushing strainers.
d. Pipe and Fittings: Size and configuration required to connect to sewage pumps and piping.

E. Sewage-Pump Basins And Basin Covers
1. Basins: Factory-fabricated, watertight, cylindrical, basin sump with top flange and sidewall openings for pipe connections.
   a. Material: Cast iron **OR** Fiberglass **OR** Polyethylene **OR** Concrete, **as directed**.
   b. Reinforcement: Mounting plates for pumps, fittings, guide-rail supports if used, and accessories.
   c. Anchor Flange: Same material as or compatible with basin sump, cast in or attached to sump, in location and of size required to anchor basin in concrete slab.
2. Basin Covers: Fabricate metal cover with openings having gaskets, seals, and bushings; for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.
   a. Reinforcement: Steel or cast iron, capable of supporting foot traffic for basins installed in foot-traffic areas.

F. Progressing-Cavity Sewage Pumps
1. Description: Factory-assembled and -tested progressing-cavity, single-screw rotary pump as defined in HI 3.1-3.5.
2. Pump Body: Cast iron with feet for base or floor installation.
3. Pump Bearings: Radial and thrust types.
4. Pump Shaft: Steel.
5. Rotor: Chrome-plated steel.
6. Stator: Buna-N **OR** Natural rubber, **as directed**.
7. Seals: Packing gland and mechanical types.
8. Coupling: Flexible.
9. Motor: Single-speed; grease-lubricated ball bearings.

G. Packaged, Submersible Sewage-Pump Units
1. Packaged, Submersible, Grinder, Sewage-Pump Units:
   a. Description: Factory-assembled and -tested, automatic-operation, basin-mounted, grinder, sewage-pump unit.
   b. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.
   c. Pump Casing: Cast iron.
   d. Impeller: Stainless-steel grinder, cutter, or slicer type with shredding ring.
   e. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
   f. Control (for simplex pump unit): Manufacturer's standard panel for one pump.
   g. Controls (for duplex pump unit): Automatic, with mechanical- or mercury-float switches and alternator.
   h. Pump Discharge Piping: Factory or field fabricated, galvanized, ASTM A 53/A 53M, Schedule 40, steel pipe with ASME B16.4, Class 125, gray iron threaded fittings, **as directed**.
   i. Basin: Watertight plastic, **as directed**, and of size required for pumps, with inlet pipe connection and gastight cover with pump discharge and vent connections.
2. Packaged, Submersible, Nonclog, Sewage-Pump Units:
   a. Description: Factory-assembled and -tested, automatic-operation, basin-mounted, sewage-pump unit.
   b. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.

c. Pump Casing: Cast iron.
d. Impeller: Brass or cast iron; statically and dynamically balanced, non-clog design, and capable of handling 2-inch (50-mm) diameter solids.
e. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
f. Control (for simplex pump units): Manufacturer's standard panel for one pump, with reversing switch.
g. Controls (for duplex pump unit): Automatic, with mechanical- or mercury-float switches and alternator.
h. Pump Discharge Piping: Factory or field fabricated, galvanized, ASTM A 53/A 53M, Schedule 40, steel pipe with ASME B16.4, Class 125, gray iron threaded fittings, **as directed**.
i. Basin: Watertight plastic, **as directed**, and of size required for pumps, with inlet pipe connection and gastight cover with pump discharge and vent connections.

H. Packaged Wastewater-Pump Units
1. Packaged, Wet-Pit-Volute, Wastewater-Pump Units:
a. Description: Factory-assembled and -tested, automatic-operation, basin-mounted, effluent-pump unit.
b. Pump Type: Wet-pit-volute, single-stage, separately-coupled, overhung-impeller centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.
c. Pump Body and Impeller: Corrosion-resistant materials.
d. Motor: With built-in overload protection and mounted vertically on basin cover.
e. Power Cord: Three-conductor, waterproof cable of length required but not less than 72 inches (1830 mm) and with grounding plug and cable-sealing assembly for connection at pump.
f. Control: Float switch.
g. Pump Discharge Piping: Factory or field fabricated, galvanized, ASTM A 53/A 53M, Schedule 40, steel pipe with ASME B16.4, Class 125, gray iron threaded fittings, **as directed**.
h. Basin: Watertight, aluminum, plastic, or coated steel with inlet pipe connection and gastight cover with vent and pump discharge connections.
2. Packaged, Submersible Wastewater-Pump Units:
a. Description: Factory-assembled and -tested, automatic-operation, effluent-pump unit with basin.
b. Pump Type: Submersible, end-suction, single-stage, overhung-impeller, centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.
c. Pump Body and Impeller: Corrosion-resistant materials.
d. Pump Seals: Mechanical.
e. Motor: Hermetically sealed, capacitor-start type, with built-in overload protection.
f. Power Cord: Three-conductor, waterproof cable of length required but not less than 72 inches (1830 mm) and with grounding plug and cable-sealing assembly for connection at pump.
g. Control: Float switch.
h. Pump Discharge Piping: Factory or field fabricated, galvanized, ASTM A 53/A 53M, Schedule 40, steel pipe with ASME B16.4, Class 125, gray iron threaded fittings, **as directed**.
i. Basin: Watertight plastic with inlet pipe connection and gastight cover with vent and pump discharge connections.

I. Motors
1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 15 Section "Common Motor Requirements for Plumbing 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.
b. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 16 Sections.
2. Motors for submersible pumps shall be hermetically sealed.

1.3 EXECUTION

A. Earthwork
1. Excavation and filling are specified in Division 2 Section "Earthwork."

B. Examination
1. Examine roughing-in for plumbing piping to verify actual locations of sanitary drainage and vent piping connections before sewage pump installation.

C. Installation
1. Pump Installation Standards:
a. Comply with HI 1.4 for installation of centrifugal pumps.
b. Comply with HI 3.1-3.5 for installation of progressing-cavity sewage pumps.
2. Equipment Mounting (for equipment supported on slabs-on-grade): Install progressing-cavity sewage pumps on concrete base using elastomeric pads **OR** elastomeric mounts **OR** restrained spring isolators, **as directed**. Comply with requirements for concrete base specified in Division 3 Section "Cast-in-Place Concrete."
a. Minimum Deflection: 1/4 inch (6 mm) **OR** 1 inch (25 mm), **as directed**.
b. 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.
c. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
d. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
e. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Equipment Mounting: Install progressing-cavity sewage pumps using elastomeric pads **OR** elastomeric mounts **OR** restrained spring isolators, **as directed**. Comply with requirements for vibration isolation devices specified in Division 15 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
a. Minimum Deflection: 1/4 inch (6 mm) **OR** 1 inch (25 mm), **as directed**.
4. Equipment Mounting: Install progressing-cavity sewage pumps on vibration isolation equipment base. Comply with requirements specified in Division 15 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
5. Wiring Method (for pumps with wall-mounted controls): Comply with requirements in Division 16 Section "Conductors and Cables."
6. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

D. Connections
1. Comply with requirements for piping specified in Division 15 Section "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to equipment to allow service and maintenance.

E. Field Quality Control
1. Perform tests and inspections.
2. Tests and Inspections:
a. Perform each visual and mechanical inspection.

b. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
c. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3. Pumps and controls will be considered defective if they do not pass tests and inspections.
4. Prepare test and inspection reports.

F. Startup Service
1. Engage a factory-authorized service representative to perform **OR** Perform, **as directed**, startup service.
a. Complete installation and startup checks according to manufacturer's written instructions.

G. Adjusting
1. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.
2. Adjust control set points.

H. Demonstration
1. Train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

END OF SECTION 22 13 29 13b

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Task	Specification	Specification Description
22 13 29 16	22 13 29 13b	Sewage Pumps
22 13 29 33	01 22 16 00	No Specification Required

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SECTION 22 14 29 13 - SUMP PUMPS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for sump pumps. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Submersible sump pumps.
b. Wet-pit-volute sump pumps.
c. Sump-pump basins and basin covers.
d. Packaged drainage-pump units.

C. Submittals
1. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Wiring Diagrams: For power, signal, and control wiring.
3. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

D. Quality Assurance
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. UL Compliance: Comply with UL 778 for motor-operated water pumps.

E. Delivery, Storage, And Handling
1. Retain shipping flange protective covers and protective coatings during storage.
2. Protect bearings and couplings against damage.
3. Comply with pump manufacturer's written rigging instructions for handling.

1.2 PRODUCTS

A. Submersible Sump Pumps
1. Submersible, Fixed-Position, Single-Seal Sump Pumps:
a. Description: Factory-assembled and -tested sump-pump unit.
b. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 1.1-1.2 and HI 1.3.
c. Pump Casing: Cast iron, with strainer inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
d. Impeller: Statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron **OR** ASTM A 532/A 532M, abrasion-resistant cast iron **OR** ASTM B 584, cast bronze, **as directed**, semiopen, **as directed**, design for clear wastewater handling, and keyed and secured to shaft.
e. Pump and Motor Shaft: Stainless steel **OR** steel, **as directed**, with factory-sealed, grease-lubricated ball bearings.
f. Seal: Mechanical.

g. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
   1) Motor Housing Fluid: Air **OR** Oil, **as directed**.
h. Controls (rod-and-float type):
   1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**.
   2) Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
   3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
   4) Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches (1500 mm).
   5) High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
i. Controls (float- and pressure-switch types):
   1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**; pedestal-mounted **OR** wall-mounted, **as directed**.
   2) Switch Type: Mechanical-float **OR** Mercury-float **OR** Pressure, **as directed**, type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
   3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
   4) High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
j. Control-Interface Features:
   1) Remote Alarm Contacts: For remote alarm interface.
   2) Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
      a) On-off status of pump.
      b) Alarm status.

2. Submersible, Fixed-Position, Double-Seal Sump Pumps:
   a. Description: Factory-assembled and -tested sump-pump unit.
   b. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 1.1-1.2 and HI 1.3.
   c. Pump Casing: Cast iron, with strainer inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
   d. Impeller: Statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron **OR** ASTM A 532/A 532M, abrasion-resistant cast iron **OR** ASTM B 584, cast bronze, **as directed**, semiopen, **as directed**, design for clear wastewater handling, and keyed and secured to shaft.
   e. Pump and Motor Shaft: Stainless steel **OR** steel, **as directed**, with factory-sealed, grease-lubricated ball bearings.
   f. Seals: Mechanical.
   g. Moisture-Sensing Probe: Internal moisture sensor and moisture alarm.
   h. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
      1) Motor Housing Fluid: Air **OR** Oil, **as directed**.
   i. Controls (rod-and-float type):
      1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**.
      2) Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
      3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
      4) Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches (1500 mm).

5) High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

j. Controls (float- and pressure-switch types):
1) Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**; pedestal-mounted **OR** wall-mounted, **as directed**.
2) Switch Type: Mechanical-float **OR** Mercury-float **OR** Pressure, **as directed**, type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
3) Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
4) High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

k. Control-Interface Features:
1) Remote Alarm Contacts: For remote alarm interface.
2) Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
a) On-off status of pump.
b) Alarm status.

B. Wet-Pit-Volute Sump Pumps
1. Description: Factory-assembled and -tested sump-pump unit.
2. Pump Type: Wet-pit-volute, single-stage, separately-coupled, overhung-impeller, centrifugal sump pump as defined in HI 1.1-1.2 and HI 1.3.
3. Pump Casing: Cast iron, with strainer inlet and threaded connection for NPS 2 (DN 50) and smaller and flanged connection for NPS 2-1/2 (DN 65) and larger discharge piping.
4. Impeller: Statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron **OR** ASTM A 532/A 532M, abrasion-resistant cast iron **OR** ASTM B 584, cast bronze, **as directed**, semiopen, **as directed**, design for clear wastewater handling, and keyed and secured to shaft.
5. Sleeve Bearings: Bronze. Include oil-lubricated, intermediate sleeve bearings at 48-inch (1200-mm) maximum intervals if basin depth is more than 48 inches (1200 mm), and grease-lubricated, ball-type thrust bearings.
6. Pump and Motor Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
7. Pump Discharge Piping: Factory or field fabricated, galvanized, ASTM A 53/A 53M, Schedule 40, steel pipe with ASME B16.1, Class 125, cast-iron flanges and flanged fittings or ASME B16.4, Class 125, gray iron threaded fittings, **as directed**.
8. Support Plate: Cast iron or coated steel and strong enough to support pumps, motors, and controls. Refer to Part 1.2 "Sump-Pump Basins and Basin Covers" Article for requirements.
9. Shaft Seal: Stuffing box, with graphite-impregnated braided-yarn rings and bronze packing gland.
10. Motor: Single-speed; grease-lubricated ball bearings and mounting on vertical, cast-iron pedestal.
11. Controls (rod-and-float type):
a. Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**.
b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches (1500 mm).
e. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
12. Controls (float- and pressure-switch types):
a. Enclosure: NEMA 250, Type 1 **OR** Type 4X, **as directed**; pedestal-mounted **OR** wall-mounted, **as directed**.
b. Switch Type: Mechanical-float **OR** Mercury-float **OR** Pressure, **as directed**, type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.

c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

13. Control-Interface Features:
a. Remote Alarm Contacts: For remote alarm interface.
b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
1) On-off status of pump.
2) Alarm status.

C. Sump-Pump Basins And Basin Covers
1. Basins: Factory-fabricated, watertight, cylindrical, basin sump with top flange and sidewall openings for pipe connections.
a. Material: Cast iron **OR** Fiberglass **OR** Polyethylene, **as directed**.
b. Reinforcement: Mounting plates for pumps, fittings, and accessories.
c. Anchor Flange: Same material as or compatible with basin sump, cast in or attached to sump, in location and of size required to anchor basin in concrete slab.
2. Basin Covers: Fabricate metal cover with openings having gaskets, seals, and bushings; for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.
a. Reinforcement: Steel or cast iron, capable of supporting foot traffic for basins installed in foot-traffic areas.

D. Packaged Drainage-Pump Units
1. Packaged Pedestal Drainage-Pump Units:
a. Description: Factory-assembled and -tested, automatic-operation, freestanding, sump-pump unit.
b. Pump Type: Wet-pit-volute, single-stage, separately-coupled, overhung-impeller centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.
c. Pump Casing: Corrosion-resistant material, with strainer inlet, design that permits flow into impeller, and vertical discharge for piping connection.
d. Impeller: Aluminum, brass, or plastic.
e. Motor: With built-in overload protection and mounted vertically on sump pump column.
f. Power Cord: Three-conductor, waterproof cable of length required but not less than 72 inches (1830 mm), with grounding plug and cable-sealing assembly for connection at pump.
g. Control: Float switch.
2. Packaged Submersible Drainage-Pump Units:
a. Description: Factory-assembled and -tested, automatic-operation, basin-mounted, sump-pump unit.
b. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.
c. Casing: Metal.
d. Impeller: Brass.
e. Pump Seal: Mechanical.
f. Motor: Hermetically sealed, capacitor-start type, with built-in overload protection.
g. Power Cord: Three-conductor, waterproof cable of length required but not less than 72 inches (1830 mm), with grounding plug and cable-sealing assembly for connection at pump.
h. Pump Discharge Piping: Factory or field fabricated, galvanized, ASTM A 53/A 53M, Schedule 40, steel pipe with ASME B16.4, Class 125, gray iron threaded fittings, **as directed**.
i. Control: Motor-mounted float switch.

j. Basin: Plastic.

E. Motors
1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 Section "Common Motor Requirements For Plumbing 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.
b. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 22.
2. Motors for submersible pumps shall be hermetically sealed.

1.3 EXECUTION

A. Earthwork
1. Excavation and filling are specified in Division 31 Section "Earth Moving".

B. Examination
1. Examine roughing-in for plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

C. Installation
1. Pump Installation Standards: Comply with HI 1.4 for installation of sump pumps.

D. Connections
1. Comply with requirements for piping specified in Division 22 Section "Facility Storm Drainage Piping". Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to equipment to allow service and maintenance.

E. Field Quality Control
1. Perform tests and inspections.
2. Tests and Inspections:
a. Perform each visual and mechanical inspection.
b. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
c. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Pumps and controls will be considered defective if they do not pass tests and inspections.
4. Prepare test and inspection reports.

F. Startup Service
1. Engage a factory-authorized service representative to perform **OR** Perform, **as directed**, startup service.
a. Complete installation and startup checks according to manufacturer's written instructions.

G. Adjusting
1. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.
2. Adjust control set points.

H. Demonstration
1. Train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

END OF SECTION 22 14 29 13

Task	Specification	Specification Description
22 14 29 13	22 05 23 00	Piped Utilities Basic Materials And Methods

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SECTION 22 15 13 00 - GENERAL-SERVICE PACKAGED AIR COMPRESSORS AND RECEIVERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for general-service packaged air compressors and receivers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. Section Includes:
a. Lubricated, reciprocating air compressors.
b. Oil-free, reciprocating air compressors.
c. Oilless, reciprocating air compressors.
d. Oil-free, rotary-screw air compressors.
e. Oil-flooded, rotary-screw air compressors.
f. Oil-free, rotary, sliding-vane air compressors.
g. Oil-sealed, rotary, sliding-vane air compressors.
h. Inlet-air filters.
i. Air-cooled, compressed-air aftercoolers.
j. Water-cooled, compressed-air aftercoolers.
k. Refrigerant compressed-air dryers.
l. Desiccant compressed-air dryers.
m. Computer interface cabinet.

C. Definitions
1. Actual Air: Air delivered from air compressors. Flow rate is delivered compressed air measured in acfm (actual L/s).
2. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
3. Standard Air: Free air at 68 deg F (20 deg C) and 1 atmosphere (29.92 in. Hg) before compression or expansion and measured in scfm (standard L/s).

D. Performance Requirements
1. Delegated Design: Design compressed-air equipment mounting, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Seismic Performance: Compressed-air equipment shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

E. Submittals
1. Product Data: For each type of product indicated.
a. Wiring Diagrams: For power, signal, and control wiring.
2. Delegated-Design Submittal: For compressed-air equipment mounting indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
a. Detail fabrication and assembly of supports.
b. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

3. Seismic Qualification Certificates: For compressed-air equipment, accessories, and components, from manufacturers.
4. Operation and Maintenance Data.

F. Quality Assurance
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. ASME Compliance: Fabricate and label receivers to comply with ASME Boiler and Pressure Vessel Code.

1.2 PRODUCTS

A. General Requirements For Packaged Air Compressors And Receivers
1. General Description: Factory-assembled, -wired, -piped, and -tested; electric-motor-driven; air-cooled; continuous-duty air compressors and receivers that deliver air of quality equal to intake air.
2. Control Panels: Automatic control station with load control and protection functions. Comply with NEMA ICS 2 and UL 508.
   a. Enclosure: NEMA ICS 6, Type 12 control panel unless otherwise indicated.
   b. Motor Controllers: Full-voltage, combination magnetic type with undervoltage release feature and motor-circuit-protector-type disconnecting means and short-circuit protective device.
   c. Control Voltage: 120-V ac or less, using integral control power transformer.
   d. Motor Overload Protection: Overload relay in each phase.
   e. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.
   f. Automatic control switches to alternate lead-lag compressors for duplex **OR** sequence lead-lag compressors for multiplex, **as directed**, air compressors.
   g. Instrumentation: Include discharge-air pressure gage, air-filter maintenance indicator, hour meter, compressor discharge-air and coolant temperature gages, and control transformer.
   h. Alarm Signal Device: For connection to alarm system to indicate when backup air compressor is operating.
3. Receivers: Steel tank constructed according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   a. Pressure Rating: At least as high as highest discharge pressure of connected compressors, and bearing appropriate code symbols.
   b. Interior Finish: Corrosion-resistant coating.
   c. Accessories: Include safety valve, pressure gage, drain, and pressure-reducing valve.
4. Mounting Frame: Fabricate mounting and attachment to pressure vessel with reinforcement strong enough to resist packaged equipment movement during a seismic event when base is anchored to building structure.

B. Lubricated, Reciprocating Air Compressors
1. Compressor(s): Lubricated, reciprocating-piston type with lubricated compression chamber and crankcase.
   a. Submerged gear-type oil pump.
   b. Oil filter.
   c. Combined high discharge-air temperature and low lubrication-oil pressure switch.
   d. Belt guard totally enclosing pulleys and belts.

C. Oil-Free, Reciprocating Air Compressors
1. Compressor(s): Oil-free, reciprocating-piston type with nonlubricated compression chamber, lubricated crankcase, and of construction that prohibits oil from entering compression chamber.

a. Submerged gear-type oil pump.
b. Oil filter.
c. Combined high discharge-air temperature and low lubrication-oil pressure switch.
d. Belt guard totally enclosing pulleys and belts.

D. Oilless, Reciprocating Air Compressors
1. Compressor(s): Oilless (nonlubricated), reciprocating-piston type, with sealed oil-free bearings, that will deliver air of quality equal to intake air.
a. High discharge-air temperature switch.
b. Belt guard totally enclosing pulleys and belts.

E. Oil-Free, Rotary-Screw Air Compressors
1. Compressor(s): Oil-free, rotary-screw type with nonlubricated helical screws and lubricated gear box, and of construction that prohibits oil from entering compression chamber.
a. Coupling: Nonlubricated, flexible type.
b. Cooling/Lubrication System: Unit-mounted, air-cooled exchanger package prepiped to unit; with air pressure circulation system with coolant stop valve, full-flow coolant filter, and thermal bypass valve.
c. Air Filter: Dry type, with maintenance indicator and cleanable replaceable filter element.
d. Air/Coolant Receiver and Separation System: 150-psig- (1035-kPa-) rated steel tank with ASME safety valve, coolant-level gage, multistage air-coolant separator element, minimum pressure valve, blowdown valve, discharge check valve, coolant stop valve, full-flow coolant filter, and thermal bypass valve.
e. Capacity Control: Capacity modulation between zero and 100 percent air delivery, with operating pressures between 50 and 100 psig (345 and 690 kPa). Include necessary control to hold constant pressure. When air demand is zero, unload compressor by using pressure switch and blowdown valve.

F. Oil-Flooded, Rotary-Screw Air Compressors
1. Compressor(s): Oil-flooded, rotary-screw type with lubricated helical screws and lubricated gear box.
a. Coupling: Nonlubricated, flexible type.
b. Cooling/Lubrication System: Unit-mounted, air-cooled exchanger package prepiped to unit; with air pressure circulation system with coolant stop valve, full-flow coolant filter, and thermal bypass valve.
c. Air Filter: Dry type, with maintenance indicator and cleanable replaceable filter element.
d. Air/Coolant Receiver and Separation System: 150-psig- (1035-kPa-) rated steel tank with ASME safety valve, coolant-level gage, multistage air-coolant separator element, minimum pressure valve, blowdown valve, discharge check valve, coolant stop valve, full-flow coolant filter, and thermal bypass valve.
e. Capacity Control: Capacity modulation between zero and 100 percent air delivery, with operating pressures between 50 and 100 psig (345 and 690 kPa). Include necessary control to hold constant pressure. When air demand is zero, unload compressor by using pressure switch and blowdown valve.

G. Oil-Free, Rotary, Sliding-Vane Air Compressors
1. Compressor(s): Oil-free, nonpulsating, rotary, sliding-vane type with nonlubricated sliding vanes.
a. Cleanable inlet screens.
b. Outlet silencers on discharge connections.

H. Oil-Sealed, Rotary, Sliding-Vane Air Compressors
1. Compressor(s): Nonpulsating, rotary, sliding-vane type with oil-sealed sliding vanes.
a. Cleanable inlet screens.
b. Outlet silencers and oil-mist separators on discharge connections.

I. Inlet-Air Filters

1. Description: Combination inlet-air filter-silencer, suitable for remote installation, for each air compressor.
   a. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
   b. Capacity: Match capacity of air compressor, with filter having collection efficiency of 99 percent retention of particles larger than 10 micrometers.
2. Description: Combination inlet-air filter-silencer, suitable for remote installation, for multiple air compressors.
   a. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
   b. Capacity: Match total capacity of connected air compressors, with filter having collection efficiency of 99 percent retention of particles larger than 10 micrometers.

J. Air-Cooled, Compressed-Air Aftercoolers
1. Description: Electric-motor-driven, fan-operation, finned-tube unit; rated at 250 psig (1725 kPa) and leak tested at 350-psig (2415-kPa) minimum air pressure; in capacities indicated. Size units to cool compressed air in compressor-rated capacities to 10 deg F (6 deg C) above summertime maximum ambient temperature. Include moisture separator and automatic drain.

K. Water-Cooled, Compressed-Air Aftercoolers
1. Description: Shell and tube unit, rated at 250 psig (1725 kPa) and leak tested at 350-psig (2415-kPa) minimum air pressure, in capacities indicated. Include moisture separator and automatic drain.

L. Refrigerant Compressed-Air Dryers
1. Description: Noncycling, air-cooled, electric-motor-driven unit with steel enclosure and capability to deliver 35 deg F (2 deg C), 100-psig (690-kPa) air at dew point. Include automatic ejection of condensate from airstream, step-down transformers, disconnect switches, inlet and outlet pressure gages, thermometers, automatic controls, and filters.

M. Desiccant Compressed-Air Dryers
1. Description: Twin-tower unit with purge system, mufflers, and capability to deliver plus 10 deg F (minus 12 deg C), 100-psig (690-kPa) air at dew point. Include dew point controlled purge, step-down transformers, disconnect switches, inlet and outlet pressure gages, thermometers, automatic controls, and filters.

N. Computer Interface Cabinet
1. Description:
   a. Wall mounting.
   b. Welded steel with white enamel finish.
   c. Gasketed door.
   d. Grounding device.
   e. Factory-installed, signal circuit boards.
   f. Power transformer.
   g. Circuit breaker.
   h. Wiring terminal board.
   i. Internal wiring capable of interfacing 20 alarm signals.

O. Motors
1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 Section "Common Motor Requirements For Plumbing 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.

b. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 22.

1.3 EXECUTION

A. Equipment Installation
1. Equipment Mounting:
a. Install air compressors, aftercoolers, and air dryers on concrete bases using elastomeric pads **OR** elastomeric mounts **OR** restrained spring isolators, **as directed**. Comply with requirements in Division 03 Section "Cast-in-place Concrete". Comply with requirements for vibration isolation devices specified in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment".
1) Minimum Deflection: 1/4 inch (6 mm) **OR** 1 inch (25 mm), **as directed**.
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) For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
4) Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5) Install anchor bolts to elevations required for proper attachment to supported equipment.
b. Install air compressors, aftercoolers, and air dryers using elastomeric pads **OR** elastomeric mounts **OR** restrained spring isolators, **as directed**. Comply with requirements for vibration isolation devices specified in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment".
1) Minimum Deflection: 1/4 inch (6 mm) **OR** 1 inch (25 mm), **as directed**.
c. Install air compressors, aftercoolers, and air dryers on vibration isolation inertia bases. Comply with requirements specified in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment".
d. Install air compressors, aftercoolers, and air dryers on concrete bases. Comply with requirements in Division 03 Section "Cast-in-place Concrete".
1) Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
2) For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3) Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4) Install anchor bolts to elevations required for proper attachment to supported equipment.
e. Install water-cooled, compressed-air aftercoolers and desiccant compressed-air dryers on concrete bases. Comply with requirements in Division 03 Section "Cast-in-place Concrete".
1) Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
2) For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3) Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4) Install anchor bolts to elevations required for proper attachment to supported equipment.
2. Install compressed-air equipment anchored to substrate.
3. Arrange equipment so controls and devices are accessible for servicing.

4. Maintain manufacturer's recommended clearances for service and maintenance.
5. Install the following devices on compressed-air equipment:
   a. Thermometer, Pressure Gage, and Safety Valve: Install on each compressed-air receiver.
   b. Pressure Regulators: Install downstream from air compressors and dryers.
   c. Automatic Drain Valves: Install on aftercoolers, receivers, and dryers. Discharge condensate over nearest floor drain.

B. Connections
1. Comply with requirements for piping specified in Division 22 Section "General-service Compressed-air Piping". Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to machine to allow service and maintenance.

C. Identification
1. Identify general-service air compressors and components. Comply with requirements for identification specified in Division 22 Section "Identification For Plumbing Piping And Equipment".

D. Startup Service
1. Perform startup service.
   a. Complete installation and startup checks according to manufacturer's written instructions.
   b. Check for lubricating oil in lubricated-type equipment.
   c. Check belt drives for proper tension.
   d. Verify that air-compressor inlet filters and piping are clear.
   e. Check for equipment vibration-control supports and flexible pipe connectors and verify that equipment is properly attached to substrate.
   f. Check safety valves for correct settings. Ensure that settings are higher than air-compressor discharge pressure but not higher than rating of system components.
   g. Check for proper seismic restraints.
   h. Drain receiver tanks.
   i. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   j. Test and adjust controls and safeties.

E. Demonstration
1. Train Owner's maintenance personnel to adjust, operate, and maintain air compressors, aftercoolers, and air dryers.

END OF SECTION 22 15 13 00

SECTION 22 15 13 00a - HVAC INSTRUMENTATION AND CONTROLS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for HVAC instrumentation and controls. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

C. Definitions
1. DDC: Direct digital control.
2. I/O: Input/output.
3. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.
4. MS/TP: Master slave/token passing.
5. PC: Personal computer.
6. PID: Proportional plus integral plus derivative.
7. RTD: Resistance temperature detector.

D. System Performance
1. Comply with the following performance requirements:
   a. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
   b. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
   c. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
   d. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
   e. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
   f. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
   g. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
   h. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
      1) Water Temperature: Plus or minus 1 deg F (0.5 deg C).
      2) Water Flow: Plus or minus 5 percent of full scale.
      3) Water Pressure: Plus or minus 2 percent of full scale.
      4) Space Temperature: Plus or minus 1 deg F (0.5 deg C).
      5) Ducted Air Temperature: Plus or minus 1 deg F (0.5 deg C).
      6) Outside Air Temperature: Plus or minus 2 deg F (1.0 deg C).
      7) Dew Point Temperature: Plus or minus 3 deg F (1.5 deg C).
      8) Temperature Differential: Plus or minus 0.25 deg F (0.15 deg C).
      9) Relative Humidity: Plus or minus 5 percent.
      10) Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
      11) Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
      12) Airflow (Terminal): Plus or minus 10 percent of full scale.

13) Air Pressure (Space): Plus or minus 0.01-inch wg (2.5 Pa).
14) Air Pressure (Ducts): Plus or minus 0.1-inch wg (25 Pa).
15) Carbon Monoxide: Plus or minus 5 percent of reading.
16) Carbon Dioxide: Plus or minus 50 ppm.
17) Electrical: Plus or minus 5 percent of reading.

E. Submittals

1. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
   a. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
   b. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
   c. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.
2. 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.
   a. Bill of materials of equipment indicating quantity, manufacturer, and model number.
   b. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
   c. Wiring Diagrams: Power, signal, and control wiring.
   d. Details of control panel faces, including controls, instruments, and labeling.
   e. Written description of sequence of operation.
   f. Schedule of dampers including size, leakage, and flow characteristics.
   g. Schedule of valves including flow characteristics.
   h. DDC System Hardware:
      1) Wiring diagrams for control units with termination numbers.
      2) Schematic diagrams and floor plans for field sensors and control hardware.
      3) Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
   i. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
   j. Controlled Systems:
      1) Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
      2) Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
      3) Written description of sequence of operation including schematic diagram.
      4) Points list.
3. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.
4. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with LonWorks.
5. Software and Firmware Operational Documentation: Include the following:
   a. Software operating and upgrade manuals.
   b. Program Software Backup: On a magnetic media or compact disc, complete with data files.
   c. Device address list.
   d. Printout of software application and graphic screens.
   e. Software license required by and installed for DDC workstations and control systems.

6. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.
7. Field quality-control test reports.
8. Operation and maintenance data.

F. Quality Assurance
1. 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.
2. Comply with ASHRAE 135 for DDC system components.

G. Delivery, Storage, And Handling
1. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.
2. System Software: Update to latest version of software at Project completion.

1.2 PRODUCTS

A. Control System
1. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.
2. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.
3. Control system shall include the following:
   a. Building intrusion detection system specified in Division 28 Section "Intrusion Detection".
   b. Building clock control system specified in Division 27 Section "Clock Systems".
   c. Building lighting control system specified in Division 26 Section "Network Lighting Controls".
   d. Fire alarm system specified in Division 28 Section(s) "Digital, Addressable Fire-alarm System" OR "Zoned (dc Loop) Fire-alarm System", **as directed**.

B. DDC Equipment
1. Operator Workstation: One **OR** Two, **as directed**, PC-based microcomputer(s) with minimum configuration as follows:
   a. Motherboard: With 8 integrated USB 2.0 ports, integrated Intel Pro 10/100 (Ethernet), integrated audio, bios, and hardware monitoring.
   b. Processor: Intel Pentium 4, <**Insert clock speed**> MHz.
   c. Random-Access Memory: 512 MB.
   d. Graphics: Video adapter, minimum 1280 x 1024 **OR** 1600 x 1200, **as directed**, pixels, 64-MB video memory, with TV out.
   e. Monitor: 17 inches (430 mm) **OR** 19 inches (480 mm), **as directed**, LCD color.
   f. Keyboard: QWERTY, 105 keys in ergonomic shape.
   g. Floppy-Disk Drive: 1.44 MB.
   h. Hard-Disk Drive: 80 GB.
   i. CD-ROM Read/Write Drive: 48x24x48.
   j. Mouse: Three button, optical.
   k. Uninterruptible Power Supply: 2 kVa.
   l. Operating System: Microsoft Windows XP Professional with high-speed Internet access.
      1) ASHRAE 135 Compliance: Workstation shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

2) LonWorks Compliance: Control units shall use LonTalk protocol and communicate using EIA/CEA 709.1 datalink/physical layer protocol.

m. Printer: Black-and-white, laser-jet type as follows:
1) Print Head: 1200 x 1200 dpi resolution.
2) Paper Handling: Minimum of 250 sheet trays.
3) Print Speed: Minimum of 120 characters per second.

n. Printer: Color, ink-jet type as follows:
1) Print Head: 4800 x 1200 dpi optimized color resolution.
2) Paper Handling: Minimum of 100 sheets.
3) Print Speed: Minimum of 17 ppm in black and 12 ppm in color.

o. Application Software:
1) I/O capability from operator station.
2) System security for each operator via software password and access levels.
3) Automatic system diagnostics; monitor system and report failures.
4) Database creation and support.
5) Automatic and manual database save and restore.
6) Dynamic color graphic displays with up to 10 screen displays at once.
7) Custom graphics generation and graphics library of HVAC equipment and symbols.
8) Alarm processing, messages, and reactions.
9) Trend logs retrievable in spreadsheets and database programs.
10) Alarm and event processing.
11) Object and property status and control.
12) Automatic restart of field equipment on restoration of power.
13) Data collection, reports, and logs. Include standard reports for the following:
a) Current values of all objects.
b) Current alarm summary.
c) Disabled objects.
d) Alarm lockout objects.
e) Logs.
14) Custom report development.
15) Utility and weather reports.
16) Workstation application editors for controllers and schedules.
17) Maintenance management.

p. Custom Application Software:
1) English language oriented.
2) Full-screen character editor/programming environment.
3) Allow development of independently executing program modules with debugging/simulation capability.
4) Support conditional statements.
5) Support floating-point arithmetic with mathematic functions.
6) Contains predefined time variables.

2. Diagnostic Terminal Unit: Portable notebook-style, PC-based microcomputer terminal capable of accessing system data by connecting to system network with minimum configuration as follows:

a. System: With one integrated USB 2.0 port, integrated Intel Pro 10/100 (Ethernet), integrated audio, bios, and hardware monitoring.
b. Processor: Intel Pentium 4, <**Insert clock speed**> MHz.
c. Random-Access Memory: 128 MB.
d. Graphics: Video adapter, minimum 800 x 600 **OR** 1024 x 768, **as directed**, pixels, 64-MB video memory.
e. Monitor: 17 inches (430 mm) **OR** 19 inches (480 mm), **as directed**, LCD color.
f. Keyboard: QWERTY 105 keys in ergonomic shape.
g. Floppy-Disk Drive: 1.44 MB.
h. Hard-Disk Drive: 800 MB.
i. CD-ROM Read/Write Drive: 48x24x48.
j. Pointing Device: Touch pad or other internal device.

3. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.
   a. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.
   b. Stand-alone mode control functions operate regardless of network status. Functions include the following:
      1) Global communications.
      2) Discrete/digital, analog, and pulse I/O.
      3) Monitoring, controlling, or addressing data points.
      4) Software applications, scheduling, and alarm processing.
      5) Testing and developing control algorithms without disrupting field hardware and controlled environment.
   c. Standard Application Programs:
      1) Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, antishort cycling, PID control, DDC with fine tuning, and trend logging.
      2) HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
      3) Chiller Control Programs: Control function of condenser-water reset, chilled-water reset, and equipment sequencing.
      4) Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
      5) Remote communications.
      6) Maintenance management.
      7) Units of Measure: Inch-pound and SI (metric).
   d. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
   e. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
   f. LonWorks Compliance: Control units shall use LonTalk protocol and communicate using EIA/CEA 709.1 datalink/physical layer protocol.
4. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.
   a. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
   b. Stand-alone mode control functions operate regardless of network status. Functions include the following:
      1) Global communications.
      2) Discrete/digital, analog, and pulse I/O.
      3) Monitoring, controlling, or addressing data points.
   c. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
   d. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
   e. LonWorks Compliance: Control units shall use LonTalk protocol and communicate using EIA/CEA 709.1 datalink/physical layer protocol.
5. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.
   a. Binary Inputs: Allow monitoring of on-off signals without external power.
   b. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
   c. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.

d. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights, **as directed**.
e. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer, **as directed**.
f. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
g. Universal I/Os: Provide software selectable binary or analog outputs.

6. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
   a. Output ripple of 5.0 mV maximum peak to peak.
   b. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
   c. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.
7. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:
   a. Minimum dielectric strength of 1000 V.
   b. Maximum response time of 10 nanoseconds.
   c. Minimum transverse-mode noise attenuation of 65 dB.
   d. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

C. Unitary Controllers
1. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.
   a. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.
   b. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock, **as directed**. Perform automatic system diagnostics; monitor system and report failures.
   c. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.
   d. LonWorks Compliance: Communicate using EIA/CEA 709.1 datalink/physical layer protocol using LonTalk protocol.
   e. Enclosure: Dustproof rated for operation at 32 to 120 deg F (0 to 50 deg C).
   f. Enclosure: Waterproof rated for operation at 40 to 150 deg F (5 to 65 deg C).

D. Alarm Panels
1. Unitized cabinet with suitable brackets for wall or floor mounting. Fabricate of 0.06-inch- (1.5-mm-) thick, furniture-quality steel or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish. Provide common keying for all panels, **as directed**.
2. Indicating light for each alarm point, single horn, acknowledge switch, and test switch, mounted on hinged cover.
   a. Alarm Condition: Indicating light flashes and horn sounds.
   b. Acknowledge Switch: Horn is silent and indicating light is steady.
   c. Second Alarm: Horn sounds and indicating light is steady.
   d. Alarm Condition Cleared: System is reset and indicating light is extinguished.
   e. Contacts in alarm panel allow remote monitoring by independent alarm company.

E. Analog Controllers
1. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.
2. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F (minus 23 to plus 21 deg C), and single- or double-pole contacts.
3. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.
   a. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.
4. Fan-Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55 percent and on-off action below minimum fan speed. Controller shall briefly apply full voltage, when motor is started, to rapidly bring motor up to minimum speed. Equip with filtered circuit to eliminate radio interference.
5. Receiver Controllers: Single- or multiple-input models with control-point adjustment, direct or reverse acting with mechanical set-point adjustment with locking device, proportional band adjustment, authority adjustment, and proportional control mode.
   a. Remote-control-point adjustment shall be plus or minus 20 percent of sensor span, input signal of 3 to 13 psig (21 to 90 kPa).
   b. Proportional band shall extend from 2 to 20 percent for 5 psig (35 kPa).
   c. Authority shall be 20 to 200 percent.
   d. Air-supply pressure of 18 psig (124 kPa), input signal of 3 to 15 psig (21 to 103 kPa), and output signal of zero to supply pressure.
   e. Gages: 1-1/2 inches (38 mm) **OR** 2-1/2 inches (64 mm) **OR** 3-1/2 inches (89 mm), **as directed**, in diameter, 2.5 percent wide-scale accuracy, and range to match transmitter input or output pressure.

F. Time Clocks
1. Seven-day, programming-switch timer with synchronous-timing motor and seven-day dial; continuously charged, nickel-cadmium-battery-driven, eight-hour, power-failure carryover; multiple-switch trippers; minimum of two and maximum of eight signals per day with two normally open and two normally closed output contacts.
2. Solid-state, programmable time control with 4 **OR** 8, **as directed**, separate programs each with up to 100 on-off operations; 1-second resolution; lithium battery backup; keyboard interface and manual override; individual on-off-auto switches for each program; 365-day calendar with 20 programmable holidays; choice of fail-safe operation for each program; system fault alarm; and communications package allowing networking of time controls and programming from PC.

G. Electronic Sensors
1. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
2. Thermistor Temperature Sensors and Transmitters:
   a. Accuracy: Plus or minus 0.5 deg F (0.3 deg C) **OR** 0.36 deg F (0.2 deg C), **as directed**, at calibration point.
   b. Wire: Twisted, shielded-pair cable.
   c. Insertion Elements in Ducts: Single point, 8 inches (200 mm) **OR** 18 inches (460 mm), **as directed**, long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
   d. Averaging Elements in Ducts: 36 inches (915 mm) long, flexible **OR** 72 inches (1830 mm) long, flexible **OR** 18 inches (460 mm) long, rigid, **as directed**; use where prone to temperature stratification or where ducts are larger than 10 sq. ft. (1 sq. m).
   e. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches (64 mm).
   f. Room Sensor Cover Construction: Manufacturer's standard locking covers.
      1) Set-Point Adjustment: Concealed **OR** Exposed, **as directed**.
      2) Set-Point Indication: Concealed **OR** Keyed **OR** Exposed, **as directed**.

3) Thermometer: Concealed **OR** Exposed **OR** Red-reading glass **OR** Spiral bimetal, **as directed**.
4) Color: As selected from manufacturer's full range.
5) Orientation: Vertical **OR** Horizontal, **as directed**.

g. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
h. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

3. RTDs and Transmitters:
a. Accuracy: Plus or minus 0.2 percent at calibration point.
b. Wire: Twisted, shielded-pair cable.
c. Insertion Elements in Ducts: Single point, 8 inches (200 mm) **OR** 18 inches (460 mm), **as directed**, long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
d. Averaging Elements in Ducts: 18 inches (460 mm) long, rigid **OR** 24 inches (610 mm) long, rigid **OR** 48 inches (1200 mm) long, rigid **OR** 24 feet (7.3 m) long, flexible, **as directed**; use where prone to temperature stratification or where ducts are larger than 9 sq. ft. (0.84 sq. m); length as required.
e. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches (64 mm).
f. Room Sensor Cover Construction: Manufacturer's standard locking covers.
1) Set-Point Adjustment: Concealed **OR** Exposed, **as directed**.
2) Set-Point Indication: Concealed **OR** Keyed **OR** Exposed\, **as directed**.
3) Thermometer: Concealed **OR** Exposed **OR** Red-reading glass **OR** Spiral bimetal, **as directed**.
4) Color: As selected from manufacturer's full range.
5) Orientation: Vertical **OR** Horizontal, **as directed**.

g. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
h. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

4. Humidity Sensors: Bulk polymer sensor element.
a. Accuracy: 5 **OR** 2, **as directed**, percent full range with linear output.
b. Room Sensor Range: 20 to 80 percent relative humidity.
c. Room Sensor Cover Construction: Manufacturer's standard locking covers.
1) Set-Point Adjustment: Concealed **OR** Exposed, **as directed**.
2) Set-Point Indication: Concealed **OR** Keyed **OR** Exposed, **as directed**.
3) Thermometer: Concealed **OR** Exposed **OR** Red-reading glass **OR** Spiral bimetal, **as directed**.
4) Color: As selected from manufacturer's full range.
5) Orientation: Vertical **OR** Horizontal, **as directed**.

d. Duct Sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.
e. Outside-Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of 32 to 120 deg F (0 to 50 deg C) **OR** minus 22 to plus 185 deg F (minus 30 to plus 85 deg C) **OR** minus 40 to plus 170 deg F (minus 40 to plus 76 deg C), **as directed**.
f. Duct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.

5. Pressure Transmitters/Transducers:
a. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
1) Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
2) Output: 4 to 20 mA.
3) Building Static-Pressure Range: 0- to 0.25-inch wg (0 to 62 Pa).
4) Duct Static-Pressure Range: 0- to 5-inch wg (0 to 1240 Pa).

b. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig (1034-kPa) operating pressure; linear output 4 to 20 mA.
c. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig (1034-kPa) operating pressure and tested to 300-psig (2070-kPa); linear output 4 to 20 mA.
d. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
e. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

6. Room Sensor Cover Construction: Manufacturer's standard locking covers.
   a. Set-Point Adjustment: Concealed **OR** Exposed, **as directed**.
   b. Set-Point Indication: Concealed **OR** Keyed **OR** Exposed, **as directed**.
   c. Thermometer: Concealed **OR** Exposed **OR** Red-reading glass **OR** Spiral bimetal, **as directed**.
   d. Color: As selected from manufacturer's full range.
   e. Orientation: Vertical **OR** Horizontal, **as directed**.
7. Room sensor accessories include the following:
   a. Insulating Bases: For sensors located on exterior walls.
   b. Guards: Locking; heavy-duty, transparent plastic; mounted on separate base **OR** Metal wire, tamperproof **OR** Locking, solid metal, ventilated, **as directed**.
   c. Adjusting Key: As required for calibration and cover screws.

H. Pneumatic Sensors
1. Pneumatic Transmitters: Vibration and corrosion resistant.
   a. Space-Temperature Sensors: Linear-output type, 50 to 100 deg F (10 to 38 deg C) range, with blank locking covers matching room thermostats.
   b. Room Return-Air Temperature Sensors: Linear-output type with bimetal sensing element and corrosion-proof construction, 50 to 100 deg F (10 to 38 deg C) range, designed to be mounted in light troffers.
   c. Duct-Mounted or Immersion-Type Temperature Sensors: Range as required for 3- to 15-psig (21- to 103-kPa) output signal.
   d. Temperature Transmitters: Rigid-stem type with bimetal sensing elements unless averaging is required, 3- to 15-psig (21- to 103-kPa) output signal.
      1) Averaging-Element Sensors: Single- or multiple-unit capillary elements.
      2) Tamperproof Sensors: Corrosion-resistant construction, suitable for mounting on vibrating surface with exposed capillary protected with temperature-compensated armor or protective tubing.
      3) Pipe-Mounted Temperature-Sensing Elements: Rod-and-tube type; with separable wells filled with heat-conductive compound.
      4) Outdoors: Provide bulb shield with mounting bracket.
   e. Space and Duct Humidity Transmitters: One pipe, directly proportional, with minimum sensing span of 20 to 80 percent relative humidity for 3- to 15-psig (21- to 103-kPa) output signal, corrosion resistant and temperature compensated, and with factory-calibrated adjustment.
      1) Space Mounting: With covers to match thermostats.
   f. Differential-Pressure Transmitters: One pipe, direct acting for gas, liquid, or steam service; pressure sensor and transmitter of linear-output type; with range of 0 to 50 psig (0 to 344 kPa), and 3- to 15-psig (21- to 103-kPa) output signal.
   g. Differential-Air-Pressure Transmitters: One pipe, direct acting, double bell; unidirectional with suitable range for expected input; and temperature compensated.
      1) Accuracy: 5 percent of full range and 2 percent of full scale at midrange.
      2) Output Signal: 3 to 15 psig (21 to 103 kPa).
2. Digital-to-Pneumatic Transducers: Convert plus or minus 12-V dc pulse-width-modulation outputs, or continuous proportional current or voltage to 0 to 20 psig (0 to 140 kPa).
3. Pneumatic Valve/Damper Position Indicator: Potentiometer mounted in enclosure with adjustable crank-arm assembly connected to damper to transmit 0 to 100 percent valve/damper travel.

I. Status Sensors
   1. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg (0 to 1240 Pa).
   2. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig (55 to 414 kPa), piped across pump.
   3. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.
   4. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.
   5. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.
   6. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.
   7. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
   8. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.

J. Gas Detection Equipment
   1. Carbon Monoxide Detectors: Single or multichannel, dual-level detectors using solid-state plug-in sensors with a 3-year minimum life; suitable over a temperature range of 32 to 104 deg F (0 to 40 deg C); with 2 factory-calibrated alarm levels at 50 and 100 **OR** 35 and 200, **as directed**, ppm.
   2. Carbon Dioxide Sensor and Transmitter: Single detectors using solid-state infrared sensors; suitable over a temperature range of 23 to 130 deg F (minus 5 to plus 55 deg C) and calibrated for 0 to 2 percent, with continuous or averaged reading, 4- to 20-mA output;, for wall mounting.
   3. Oxygen Sensor and Transmitter: Single detectors using solid-state zircon cell sensing; suitable over a temperature range of minus 32 to plus 1100 deg F (0 to 593 deg C) and calibrated for 0 to 5 percent, with continuous or averaged reading, 4- to 20-mA output; for wall mounting.
   4. Occupancy Sensor: Passive infrared, with time delay, daylight sensor lockout, sensitivity control, and 180-degree field of view with vertical sensing adjustment; for flush mounting.

K. Flow Measuring Stations
   1. Duct Airflow Station: Combination of air straightener and multiport, self-averaging pitot tube station.
      a. Casing: Galvanized-steel frame.
      b. Flow Straightener: Aluminum honeycomb, 3/4-inch (20-mm) parallel cell, 3 inches (75 mm) deep.
      c. Sensing Manifold: Copper manifold with bullet-nosed static pressure sensors positioned on equal area basis.

L. Thermostats
   1. Combination Thermostat and Fan Switches: Line-voltage thermostat with push-button or lever-operated fan switch.
      a. Label switches "FAN ON-OFF" **OR** "FAN HIGH-LOW-OFF" **OR** "FAN HIGH-MED-LOW-OFF", **as directed**.
      b. Mount on single electric switch box.
   2. Electric, solid-state, microcomputer-based room thermostat with remote sensor.
      a. Automatic switching from heating to cooling.
      b. Preferential rate control to minimize overshoot and deviation from set point.
      c. Set up for four separate temperatures per day.
      d. Instant override of set point for continuous or timed period from 1 hour to 31 days.
      e. Short-cycle protection.

f. Programming based on weekday, Saturday, and Sunday **OR** every day of week, **as directed**.
g. Selection features include degree F or degree C display, 12- or 24-hour clock, keyboard disable, remote sensor, and fan on-auto.
h. Battery replacement without program loss.
i. Thermostat display features include the following:
1) Time of day.
2) Actual room temperature.
3) Programmed temperature.
4) Programmed time.
5) Duration of timed override.
6) Day of week.
7) System mode indications include "heating," "off," "fan auto," and "fan on."

3. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed set-point adjustment, 55 to 85 deg F (13 to 30 deg C) set-point range, and 2 deg F (1 deg C) maximum differential.
4. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; listed for electrical rating; with concealed set-point adjustment, 55 to 85 deg F (13 to 30 deg C) set-point range, and 2 deg F (1 deg C) maximum differential.
a. Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.
b. Selector Switch: Integral, manual on-off-auto.
5. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature; with copper capillary and bulb, unless otherwise indicated.
a. Bulbs in water lines with separate wells of same material as bulb.
b. Bulbs in air ducts with flanges and shields.
c. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit; adequately supported.
d. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
e. On-Off Thermostat: With precision snap switches and with electrical ratings required by application.
f. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.
6. Fire-Protection Thermostats: Listed and labeled by an NRTL acceptable to authorities having jurisdiction; with fixed or adjustable settings to operate at not less than 75 deg F (24 deg C) above normal maximum operating temperature, and the following:
a. Reset: Manual.
OR
Reset: Automatic, with control circuit arranged to require manual reset at central control panel; with pilot light and reset switch on panel labeled to indicate operation.
7. Pneumatic Room Thermostats: One **OR** Two **OR** Three, **as directed**, pipe(s), fully proportional with adjustable throttling range and tamperproof locking settings, direct or reverse acting as required. Factory calibrated at 2.5 psig/deg F (17.2 kPa/deg C).
a. Factory Calibration: 2.5 psig/deg F (17.2 kPa/deg C).
b. Range: 45 to 85 deg F (7 to 30 deg C).
c. Sensitivity Adjustment Range: 1 to 4 psig/deg F (7 to 27.6 kPa/deg C).
d. Dual-Temperature Thermostats: Automatic changeover from normal setting to lower setting for unoccupied cycles, with manual-reset lever to permit return to normal temperatures during unoccupied cycles, with automatic reset to normal during next cycle of operation.
e. Limits: Field adjustable, to limit setting cooling set point below 75 deg F (24 deg C), and heating set point above 75 deg F (24 deg C).
f. Room Thermostat Cover Construction: Manufacturer's standard locking covers.
1) Set-Point Adjustment: Concealed **OR** Exposed, **as directed**.

2) Set-Point Indication: Concealed **OR** Keyed **OR** Exposed, **as directed**.
3) Thermometer: Concealed **OR** Exposed **OR** Red-reading glass **OR** Spiral bimetal, **as directed**.
4) Color: As selected from manufacturer's full range.
5) Orientation: Vertical **OR** Horizontal, **as directed**.

g. Room thermostat accessories include the following:
1) Insulating Bases: For thermostats located on exterior walls.
2) Thermostat Guards: Locking; heavy-duty, transparent plastic; mounted on separate base **OR** Metal wire, tamperproof **OR** Locking, solid metal, ventilated, **as directed**.
3) Adjusting Key: As required for calibration and cover screws.
4) Aspirating Boxes: For flush-mounted aspirating thermostats.
5) Set-Point Adjustment: 1/2-inch- (13-mm-) diameter, adjustment knob.

8. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.
9. Airstream Thermostats: Two-pipe, fully proportional, single-temperature type; with adjustable set point in middle of range, adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.
10. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic-, **as directed**, reset switch that trips if temperature sensed across any 12 inches (300 mm) of bulb length is equal to or below set point.
a. Bulb Length: Minimum 20 feet (6 m).
b. Quantity: One thermostat for every 20 sq. ft. (2 sq. m) of coil surface.
11. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic-, **as directed**, reset switch that trips if temperature sensed across any 12 inches (300 mm) of bulb length is equal to or above set point.
a. Bulb Length: Minimum 20 feet (6 m).
b. Quantity: One thermostat for every 20 sq. ft. (2 sq. m) of coil surface.
12. Heating/Cooling Valve-Top Thermostats: Proportional acting for proportional flow, with molded-rubber diaphragm, remote-bulb liquid-filled element, direct and reverse acting at minimum shutoff pressure of 25 psig (172 kPa), and cast housing with position indicator and adjusting knob.

M. Humidistats
1. Pneumatic Room Humidistats: Wall-mounting, proportioning type with adjustable throttling range, 20 to 90 **OR** 55 to 95 **OR** 25 to 65, **as directed**, percent operating range, and cover matching room thermostat cover.
2. Duct-Mounting Humidistats: Electric insertion, 2-position type with adjustable, 2 percent throttling range, 20 to 80 percent operating range, and single- or double-pole contacts.
3. Pneumatic Duct-Mounting Humidistats: Proportioning type with adjustable throttling range, 20 to 90 **OR** 55 to 95 **OR** 25 to 65, **as directed**, percent operating range, in galvanized-steel duct box.

N. Actuators
1. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
a. Comply with requirements in Division 23 Section "Common Motor Requirements For Hvac Equipment".
b. 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.
c. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2 (DN 65): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).
d. Spring-Return Motors for Valves Larger Than NPS 2-1/2 (DN 65): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).
e. 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).

f. 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).

2. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
   a. Valves: Size for torque required for valve close off at maximum pump differential pressure.
   b. Dampers: Size for running torque calculated as follows:
      1) Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. (86.8 kg-cm/sq. m) of damper.
      2) Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. (62 kg-cm/sq. m) of damper.
      3) Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft (49.6 kg-cm/sq. m) of damper.
      4) Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. (37.2 kg-cm/sq. m) of damper.
      5) 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.
      6) 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.
   c. Coupling: V-bolt and V-shaped, toothed cradle.
   d. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
   e. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
   f. Power Requirements (Two-Position Spring Return): 24 **OR** 120 **OR** 230, **as directed**,-V ac.
   g. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
   h. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
   i. Temperature Rating: Minus 22 to plus 122 deg F (Minus 30 to plus 50 deg C) **OR** 40 to 104 deg F (5 to 40 deg C), **as directed**.
   j. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F (Minus 30 to plus 121 deg C).
   k. Run Time: 12 seconds open, 5 seconds closed **OR** 30 seconds **OR** 60 seconds **OR** 120 seconds, **as directed**.
3. Pneumatic Valve Operators: Rolling-diaphragm, spring-loaded, piston type with spring range as required and start-point adjustment and positioning relay, **as directed**. Operator shall maintain full shutoff at maximum pump differential pressure.
4. Pneumatic Damper Operators: Rolling-diaphragm, piston type with adjustable stops and spring return, sized to operate with sufficient reserve power to provide smooth modulating action or two-position action. Where actuators operate in sequence, provide pilot positioners.
   a. Pilot Positioners: With the following characteristics:
      1) Start Point: Adjustable from 2 to 12 psig (14 to 83 kPa).
      2) Operating Span: Adjustable from 5 to 13 psig (35 to 90 kPa).
      3) Linearity: Plus or minus 10 percent of output signal span.
      4) Hysteresis: 3 percent of span.
      5) Response: 0.25-psig (1723-Pa) input change.
      6) Maximum Pilot Signal Pressure: 20 psig (140 kPa).
      7) Maximum Control Air-Supply Pressure: 60 psig (410 kPa).
   b. Actuator Housing: Molded or die-cast zinc or aluminum. Terminal unit actuators may be high-impact plastic with ambient temperature rating of 50 to 140 deg F (10 to 60 deg C) unless located in return-air plenums, **as directed**.
   c. Inlet-Vane Operators: High pressure, with pilot positioners.

O. Control Valves
1. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
2. Hydronic system globe valves shall have the following characteristics:

a. NPS 2 (DN 50) and Smaller: Class 125 **OR** 250, **as directed**, bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.
b. NPS 2-1/2 (DN 65) and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
c. Internal Construction: Replaceable plugs and stainless-steel or brass seats.
   1) Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.
   2) Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.
d. Sizing: 3-psig (21-kPa) **OR** 5-psig (35-kPa), **as directed**, maximum pressure drop at design flow rate or the following:
   1) Two Position: Line size.
   2) Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.
   3) Three-Way Modulating: Twice the load pressure drop, but not more than value specified above.
e. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
f. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

3. Steam system globe valves shall have the following characteristics:
   a. NPS 2 (DN 50) and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.
   b. NPS 2-1/2 (DN 65) and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
   c. Internal Construction: Replaceable plugs and stainless-steel seats.
      1) Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom of guided plugs.
      2) Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom of guided plugs.
   d. Sizing: For pressure drop based on the following services:
      1) Two Position: 20 percent of inlet pressure.
      2) Modulating 15-psig (103-kPa) Steam: 80 percent of inlet steam pressure.
      3) Modulating 16- to 50-psig (110- to 350-kPa) Steam: 50 percent of inlet steam pressure.
      4) Modulating More Than 50-psig (350-kPa) Steam: As indicated.
   e. Flow Characteristics: Modified linear characteristics.
   f. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of operating (inlet) pressure.
4. Butterfly Valves: 200-psig (1380-kPa), 150-psig (1034-kPa) maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.
   a. Body Style: Wafer **OR** Lug **OR** Grooved, **as directed**.
   b. Disc Type: Nickel-plated ductile iron **OR** Aluminum bronze **OR** Elastomer-coated ductile iron **OR** Epoxy-coated ductile iron, **as directed**.
   c. Sizing: 1-psig (7-kPa) maximum pressure drop at design flow rate.
5. Terminal Unit Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.
   a. Rating: Class 125 for service at 125 psig (860 kPa) and 250 deg F (121 deg C) operating conditions.
   b. Sizing: 3-psig (21-kPa) maximum pressure drop at design flow rate, to close against pump shutoff head.

c. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

6. Self-Contained Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.
   a. Rating: Class 125 for service at 125 psig (860 kPa) and 250 deg F (121 deg C) operating conditions.
   b. Thermostatic Operator: Wax **OR** Liquid, **as directed**,-filled integral **OR** remote, **as directed**, sensor with integral **OR** remote, **as directed**, adjustable dial.

P. Dampers
1. Dampers: AMCA-rated, parallel **OR** opposed, **as directed**,-blade design; 0.108-inch- (2.8-mm-) minimum thick, galvanized-steel or 0.125-inch- (3.2-mm-) minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch- (1.6-mm-) thick galvanized steel with maximum blade width of 8 inches (200 mm) and length of 48 inches (1220 mm).
   a. Secure blades to 1/2-inch- (13-mm-) diameter, zinc-plated axles using zinc-plated hardware, with oil-impregnated sintered bronze **OR** nylon, **as directed**, blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
   b. Operating Temperature Range: From minus 40 to plus 200 deg F (minus 40 to plus 93 deg C).
   c. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.
      OR
      Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. (50 L/s per sq. m) of damper area, at differential pressure of 4-inch wg (1000 Pa) when damper is held by torque of 50 in. x lbf (5.6 N x m); when tested according to AMCA 500D.

Q. Air Supply
1. Control and Instrumentation Tubing: Copper tubing complying with ASTM B 88, Type K (ASTM B 88M, Type A) or ASTM B 280 Type ACR.
   a. Fittings: Cast-bronze solder fittings complying with ASME B16.18; or wrought-copper solder fittings complying with ASME B16.22, except forged-brass compression-type fittings at connections to equipment.
   b. Joining Method: Soldered or brazed.
   OR
   Control and Instrumentation Tubing: ASTM D 2737 Type FR plenum-rated polyethylene, flame-retardant, nonmetallic tubing rated for 30 psig (207 kPa) and ambient temperature range of 10 to 150 deg F (minus 13 to plus 65 deg C) with flame-retardant harness for multiple tubing.
   c. Fittings: Compression or push-on polyethylene fittings.
2. Tank: ASME storage tank with drain test cock, automatic moisture removal trap, tank relief valve, and rubber-cork vibration isolation mounting pads.
3. Duplex Air Compressor: Capacity to supply compressed air to temperature-control system.
   a. Pressure control with adjustable electric contacts, set to start and stop both compressors at different pressures.
   b. Electrical alternation set with motor starters and disconnect to operate compressors alternately or on time schedule.
4. Simplex Air Compressor: Tank-mounting compressor with capacity to supply compressed air to temperature-control system, with starter and disconnect.
   a. Pressure control with adjustable electric contacts, set to start and stop compressor.
5. Compressor Type: Reciprocating **OR** Scroll, **as directed**.
6. Size compressor and tank to operate compressor not more than 20 **OR** 30, **as directed**, minutes during a 60-minute period.
7. Compressor Accessories: Low-resistance intake-air filter, and belt guards.

8. System Accessories: Air filter rated for 97 percent efficiency at rated airflow, and combination filter/pressure-reducing station or separate filter and pressure-reducing station.
9. Refrigerated Air Dryer: Self-contained, refrigerated air dryer complete with heat exchangers, moisture separator, internal wiring and piping, and with manual bypass valve.
   a. Heat Exchangers: Air-to-refrigerant coils with centrifugal-type moisture separator and automatic trap assembly.
   b. Refrigeration Unit: Hermetically sealed, operating to maintain dew point of 13 deg F (minus 11 deg C) at 20 psig (140 kPa), housed in steel cabinet with access door and panel.
   c. Accessories: Air-inlet temperature gage, air-inlet pressure gage, on-off switch, high-temperature light, power-on light, refrigerant gage on back, air-outlet temperature gage, air-outlet pressure gage, and with contacts for remote indication of power status and high-temperature alarm.
10. Desiccant Dryer: Obtains dew point in pneumatic air piping between compressor and tank at least 15 deg F (minus 9 deg C) below inlet-air dew point at design conditions.
11. Pressure Gages: Black letters on white background, 2-1/2 inches (64 mm) in diameter, flush or surface mounting, with front calibration screw to match sensor, and having a graduated scale in psig (kPa).
12. Instrument Pressure Gages: Black letters on white background, 1-1/2 inches (38 mm) in diameter, stem mounted, with suitable dial range.
13. Diaphragm Control and Instrument Valves: 1/4-inch (6-mm) forged-brass body with reinforced polytetrafluoroethylene diaphragm, stainless-steel spring, and color-coded phenolic handle.
14. Gage Cocks: Tee or level handle, bronze, rated for 125 psig (860 kPa).
15. Relays: For summing, reversing, and amplifying highest or lowest pressure selection; with adjustable I/O ratio.
16. Switches: With indicating plates and accessible adjustment; calibrated and marked.
17. Pressure Regulators: Zinc or aluminum castings with elastomeric diaphragm, balanced construction to automatically prevent pressure buildup, and producing flat reduced-pressure curve.
18. Particle Filters: Zinc or aluminum castings with 97 percent filtration efficiency at rated airflow, quick-disconnect service devices, and aluminum or plastic bowl with metal guard and manual drain cock.
19. Combination Filter/Regulators: Zinc or aluminum castings with elastomeric diaphragm, balanced construction to automatically prevent pressure buildup, and producing flat reduced-pressure curve; with threaded pipe connections, quick-disconnect service devices, and aluminum or plastic bowl with metal guard and manual drain cock.
20. Airborne Oil Filter: Filtration efficiency of 99.9 percent for airborne lubricating oil particles of 0.025 micron or larger.
21. Pressure Relief Valves: ASME rated and labeled.
   a. High Pressure: Size for installed capacity.
   b. Low Pressure: Size for installed capacity of pressure regulators and set at 20 percent above low pressure.
22. Pressure-Reducing Stations: Two parallel pressure regulators.

R. Control Cable
1. Electronic and fiber-optic cables for control wiring are specified in Division 27 Section "Communications Horizontal Cabling".

1.3 EXECUTION

A. Installation
1. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.
2. Connect and configure equipment and software to achieve sequence of operation specified.

3. Mount compressor and tank unit on elastomeric mounts **OR** spring isolators with 1-inch (25 mm) static deflection **OR** restrained spring isolators with 1-inch (25-mm) static deflection, **as directed**. Vibration isolators are specified in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment". Isolate air supply with wire-braid-reinforced rubber hose. Secure and anchor according to manufacturer's written instructions and seismic-control requirements.
   a. Pipe manual and automatic drains to nearest floor drain.
   b. Supply instrument air from compressor units through filter, pressure-reducing valve, and pressure relief valve, with pressure gages and shutoff and bypass valves.
4. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches (1220 mm) **OR** 60 inches (1530 mm), **as directed**, above the floor.
   a. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
5. Install guards on thermostats in the following locations:
   a. Entrances.
   b. Public areas.
   c. Where indicated.
6. Install automatic dampers according to Division 23 Section "Air Duct Accessories".
7. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
8. Install labels and nameplates to identify control components according to Division 23 Section "Identification For Hvac Piping And Equipment".
9. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping".
10. Install steam and condensate instrument wells, valves, and other accessories according to Division 23 Section "Steam And Condensate Heating Piping".
11. Install refrigerant instrument wells, valves, and other accessories according to Division 23 Section "Refrigerant Piping".
12. Install duct volume-control dampers according to Division 21 specifying air ducts.
13. Install electronic and fiber-optic cables according to Division 27 Section "Communications Horizontal Cabling".

B. Pneumatic Piping Installation
1. Install piping in mechanical equipment rooms inside mechanical equipment enclosures, in pipe chases, or suspended ceilings with easy access.
   a. Install copper tubing with maximum unsupported length of 36 inches (915 mm), for tubing exposed to view.
   b. Install polyethylene tubing in metallic raceways or electrical metallic tubing. Electrical metallic tubing materials and installation requirements are specified in Division 26 Section "Underfloor Raceways For Electrical Systems".
2. Install terminal single-line connections, less than 18 inches (460 mm) in length, with copper or polyethylene tubing run inside flexible steel protection.
3. In concealed locations such as pipe chases and suspended ceilings with easy access, install copper **OR** polyethylene bundled and sheathed **OR** polyethylene tubing in electrical metallic, **as directed**, tubing. Electrical metallic tubing materials and installation requirements are specified in Division 26 Section "Raceway And Boxes For Electrical Systems".
4. In concrete slabs, furred walls, or ceilings with no access, install copper or polyethylene tubing in electrical metallic tubing or vinyl-jacketed polyethylene tubing.
   a. Protect embedded-copper and vinyl-jacketed polyethylene tubing with electrical metallic tubing extending 6 inches (150 mm) above finished slab and 6 inches (150 mm) into slab. Pressure test tubing before and after pour for leak and pinch.
   b. Install polyethylene tubing in electrical metallic tubing extending 6 inches (150 mm) above floor line; pull tubing into electrical metallic tubing after pour.
5. Install tubing with sufficient slack and flexible connections to allow for vibration of piping and equipment.
6. Purge tubing with dry, oil-free compressed air before connecting control instruments.

a. Bridge cabinets and doors with flexible connections fastened along hinge side; protect against abrasion. Tie and support tubing.

7. Number-code or color-code control air piping for future identification and service of control system, except local individual room control tubing.
8. Pressure Gages or Test Plugs: Install on branch lines at each receiver controller and on signal lines at each transmitter, except individual room controllers.

C. Electrical Wiring And Connection Installation

1. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway And Boxes For Electrical Systems".
2. Install building wire and cable according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".
3. Install signal and communication cable according to Division 27 Section "Communications Horizontal Cabling".
   a. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
   b. Install exposed cable in raceway.
   c. Install concealed cable in raceway.
   d. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
   e. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
   f. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
   g. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
4. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
5. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

D. Field Quality Control

1. Perform the following field tests and inspections and prepare test reports:
   a. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
   b. Test and adjust controls and safeties.
   c. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   d. Pressure test control air piping at 30 psig (207 kPa) or 1.5 times the operating pressure for 24 hours, with maximum 5-psig (35-kPa) loss.
   e. Pressure test high-pressure control air piping at 150 psig (1034 kPa) and low-pressure control air piping at 30 psig (207 kPa) for 2 hours, with maximum 1-psig (7-kPa) loss.
   f. Test calibration of pneumatic **OR** electronic, **as directed**, controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
   g. Test each point through its full operating range to verify that safety and operating control set points are as required.
   h. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
   i. Test each system for compliance with sequence of operation.
   j. Test software and hardware interlocks.
2. DDC Verification:
   a. Verify that instruments are installed before calibration, testing, and loop or leak checks.
   b. Check instruments for proper location and accessibility.
   c. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.

d. Check instrument tubing for proper fittings, slope, material, and support.
e. Check installation of air supply for each instrument.
f. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
g. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
h. Check temperature instruments and material and length of sensing elements.
i. Check control valves. Verify that they are in correct direction.
j. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
k. Check DDC system as follows:
   1) Verify that DDC controller power supply is from emergency power supply, if applicable.
   2) Verify that wires at control panels are tagged with their service designation and approved tagging system.
   3) Verify that spare I/O capacity has been provided.
   4) Verify that DDC controllers are protected from power supply surges.

3. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

E. Adjusting

1. Calibrating and Adjusting:
   a. Calibrate instruments.
   b. Make three-point calibration test for both linearity and accuracy for each analog instrument.
   c. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
   d. Control System Inputs and Outputs:
      1) Check analog inputs at 0, 50, and 100 percent of span.
      2) Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
      3) Check digital inputs using jumper wire.
      4) Check digital outputs using ohmmeter to test for contact making or breaking.
      5) Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
   e. Flow:
      1) Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
      2) Manually operate flow switches to verify that they make or break contact.
   f. Pressure:
      1) Calibrate pressure transmitters at 0, 50, and 100 percent of span.
      2) Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
   g. Temperature:
      1) Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
      2) Calibrate temperature switches to make or break contacts.
   h. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
   i. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
   j. Provide diagnostic and test instruments for calibration and adjustment of system.
   k. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.
2. Adjust initial temperature and humidity set points.

3. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

F. Demonstration
1. Train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls.

END OF SECTION 22 15 13 00a

Task	Specification	Specification Description
22 15 13 00	23 09 00 00	BAS CONTROLS CONTRACTOR

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SECTION 22 15 19 13 - BUIDING AUTOMATION SYSTEMS

1.1 GENERAL

A. Description Of Work

1. Work under this section consists of furnishing, installing, testing, commissioning and guarantee of a complete Building Automation System (BAS), with equipment located as shown on the drawings and specified herein. The term "provide," when used in this specification shall be interpreted to mean "furnish and install." The following is a general summary of the work:
   a. Provide Building Automation monitoring and control of:
      1) All packaged and built-up air-handling units, including fan motors, dampers, valves, inlet vanes, heating, cooling and heat reclamation coils, humidification and dehumidification equipment, and other related sensors and devices.
      2) All packaged and built-up chiller and heating plants, including all motors, chillers, dampers, valves, heat exchangers, pumps, and other related sensors and devices.
      3) All other points being monitored.
      4) All damper controls.
      5) All general monitoring and alarms.
   b. Installation and wiring of digital controllers, associated system hardware, software and peripherals.
   c. Start-up, commissioning, training and service.
   d. Installation of new monitoring and control points.
2. The point list on the drawings identifies the minimum points that are to be addressed by the Building Automation System and incorporated into the Building Automation System. If other points are required to accomplish the sequences of operation specified, they shall be provided as necessary to accomplish a complete and functional system.
3. The Contractor shall furnish and install a complete Building Automation System, including all necessary hardware and all user interface, operating and applications software necessary to: view web paged based graphics and summary lists of object values; make changes in operating parameters, alarms, events, and schedules; override values; and archive as called for in this specification. All software required for these operations will be turned over to the Owner ready for use including a backup copy of all configuration data including I/O addressing, operating parameters, set points, schedules and all similar information.
4. All work performed under this section of the specifications shall comply with all codes, laws and governing bodies, and all electrical equipment installed shall be UL labeled. If the drawings and/or specifications are in conflict with governing codes, the Contractor shall submit a proposal with appropriate modifications to the project to meet code restrictions. If this specification and associated drawings exceed governing code requirements, this specification will govern.
5. The Contractor shall obtain, maintain, and pay for all necessary construction permits and licenses.
6. The Contractor shall execute his work in such a manner as to cause the minimum interference to the operation of the building.
7. The Contractor shall furnish and install all actuators including necessary linkages, wire, and power wiring.
8. The Contractor shall provide all necessary power and control wiring for the system.

1.2 PROTECTION

A. This Contractor shall be entirely responsible for all material and equipment furnished in connection with his work. Special care shall be taken to properly protect all parts thereof from theft, damage or deterioration during the entire construction period in such a manner as may be necessary, or as directed by the Owner. Special care shall be taken to insure electronic equipment such as central processing units (CPU's) are properly protected from temperature, humidity, vibration, dirt or dust.

B. The Owner's property and the property of other contractors shall be scrupulously respected at all times. Provide drop cloths and anti-static visqueen or similar barriers where dust and debris is generated, to protect adjacent areas.

1.3 SYSTEM DESCRIPTION

A. The Building Automation System shall be a fully integrated collection of network level controllers, modular input/output devices, application specific controllers, configuration, programming, and web server software, all designed, manufactured and supplied by one manufacturer to work together as a complete system.

B. The system shall be of a distributed design of fully intelligent, stand-alone field programmable microprocessor based controllers operating in a multi-tasking, multi-user environment, and shall include all related interconnecting wire and conduit.

C. The system shall include computer software and hardware, programmable controllers, local area networks (LAN), sensors, transducers, control devices, and actuators.

D. The system shall include field programmable and configurable, stand-alone application specific controllers for variable air volume terminals, heat pumps, fan coil units, unit ventilators, packaged air handling and rooftop units, and all other HVAC terminal devices.

E. The system shall include controls for radiation, reheat coils, unit heaters, fan coils, and the like when directly connected to the controllers.

F. The system shall include room sensors, thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories required to operate, monitor and control mechanical systems, and to perform functions specified.

G. The contractor shall furnish and supply all installation, supervision, adjustments, and fine-tuning necessary for a complete and fully operational system.

1.4 SUBMITTALS FOR REVIEW

A. Product Data:
   1. Provide manufacturer's standard data sheets for each system component and software application.

B. Shop Drawings:
   1. Indicate network cable schematic, showing programmable controller locations, interface panels, and network data conductors.
   2. List connected data points, including connected controller and input device.
   3. Provide preliminary sample system graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations.
   4. Show system configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
   5. Provide narrative description and sequence of operation for application software.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

A. Project Record Documents:
   1. Record actual locations of all control components, including controllers, interface panels and associated power circuits, thermostats, and sensors.

2. Revise shop drawings to reflect actual installation and operating sequences. 3. Include data specified in "Submittals" in final "Record Documents" form.

B. Operation and Maintenance Data:
1. Include interconnection wiring diagrams of all field installed systems and equipment with identified and numbered, system components and devices.
2. Include keyboard and/or screen illustrations and step-by-step procedures indexed for each operator function.
3. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

C. Warranty**:** Submit manufacturers' warranty and ensure all forms have been filled out and recorded in Owners name and registered with manufacturer.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications:
1. The BAS manufacturer shall have a minimum of twenty f2d) years' satisfactory experience in the design and manufacturer of control systems and shall be:
   a. Delta Controls
   b. Teletrol Systems, Inc.
   c. Automated Logic
   d. Tour Andover Controls

1.7 REGULATORY REQUIREMENTS

A. Products Requiring Electrical Connection:
1. Listed and classified by Underwriters Laboratories Inc., or a testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.8 EQUIPMENT SELECTION AND APPROVAL

A. The selection of materials and equipment furnished under this contract shall be governed by the following:
1. Where trade names, brands, or manufacturers of equipment or materials are listed in the specification, the exact equipment listed shall be furnished. Where more than one name is used, the Contractor shall have the option of selecting between any one of the several specified. All products shall be of the first quality line of manufacturers listed.

B. Before submittal of shop drawings, the Contractor and his supplier shall verify that adequate space is available for servicing of the equipment.

C. If extensive changes in equipment layout or electrical wiring and equipment are brought about by the use of equipment which is not compatible with the layout shown on the drawings, necessary changes shall be deemed to be included in the Job Order.

D. Approval by Owner/Engineer of shop drawings shall not relieve the Contractor from responsibility for errors in the shop drawings. Deviations from specification and drawing requirements shall be called to the Engineer's attention in a separate clearly stated notification at the time of submittal for the Engineer's review and approval.

1.9 PREINSTALLATION MEETING

A. Convene [one] week before starting work of this Section.

B. Require attendance of parties directly affecting the work of this Section.

1.10 WARRANTY

A. Correct defective Work within a [one] year period after Substantial Completion.

B. Provide a 24 [twenty-four] month manufacturer's warranty for repair of all microprocessor based control modules.

C. Provide a 24 [twenty-four] month manufacturer's warranty for upgrade of all software provided by the control manufacturer.

1.11 START-UP AND TESTING

A. Prior to testing and verifying proper system operation, the Contractor shall verify with the Owner and Engineer the start-up/testing procedure proposed. The Owner and Engineer must approve the checkout procedure prior to start-up/testing.

B. The Contractor shall coordinate with owner a start-up date for Owner-Engineer participation.

C. On the start-up date, the Contractor shall have an on-site qualified field technician place the system in operation, making such tests, adjustments, and changes as may be found necessary to ensure successful operation of the equipment and system.

D. The Contractor shall test and verify proper operation for each control loop.

E. Each control loop check will verify that the Digital Controller, H-O-A switch, fail- safe control and electric interlocks are operating as intended to accomplish the control strategy.

F. Each input and output will be checked to verify that correct terminations/designation of **I/O** is in place.

G. Communications to the BAS shall be tested and verified to be in working order.
   1. Off-site network and/or dial-up communications to the BAS will be tested as well as on-site communications to all controllers.
   2. Network and/or dial-out communications by the BAS will be tested to verify that the BAS is able to initiate and respond to communications with designated workstations off-site.

H. Proper operation of all on-site operator interface hardware will be verified.

I. Downloading of applications programs will be tested when applicable from on-site or off-site locations to verify proper operation of downloading procedure.

J. Web pages and trend charts will be retrieved to verify proper operation/format.

K. All tests will be documented and performed in the presence of the Owner & Engineer by the Contractor. All testing must be performed and all deficiencies corrected to the Owner's satisfaction. The contractor shall certify that all deficiencies have been corrected.

1.12 TRAINING

A. The contractor shall provide training for owner operating personnel sufficient to upgrade knowledge to include operation of the new components.

B. Training shall include a minimum of 3 training sessions of 4 hours each. The first two sessions shall occur after complete system is activated. The scheduling of sessions shall be coordinated with building personnel. The final session shall take place a minimum of three months apart from previous sessions. This is intended to allow testing and private training by the building personnel.

1.13 MAINTENANCE SERVICE

A. Provide service and maintenance of Building Automation System for one year from Date of Substantial Completion.

1.14 PROTECTION OF SOFTWARE RIGHTS

A. Prior to delivery of software, the Owner and the party providing the software will enter into a software license agreement with provisions for the following:
   1. Limiting use of software to equipment provided under these specifications.
   2. Limiting copying
   3. Preserving confidentiality.
   4. Prohibiting transfer to a third party.

1.15 BAS SYSTEM REQUIREMENTS OVERVIEW

A. Provide a Building Automation System (BAS) based on ASHRAE 135-2001 and Basic IT Standards.
   1. It is the intent of this specification to require the contractor to provide a control system based on ASHRAE 135-2001 and Basic. IT Standards. In particular, the control system provided under this specification shall have the following attributes:
      a. The Data Server and Network Level Controllers (NLC's), System Level Controllers (SLC's) shall use Hyper Text Transfer Protocol (HTTP), and Extensible Markup Language (XML) over HTTP, as their standard communications protocols to exchange data, configurations, programming and messages between the BAS controller and server.
      b. Each Network Level Controller (NLC), System Level Controller and each Data Server shall include a web server.
      c. The End User Workstation Software must be Internet explorer 6.5 or higher web browser. No additional software package from the controls manufacturer shall be required on any workstation. Systems that require such a package to be installed will not be accepted.
      d. Ethernet at 100 Mb must be the standard means of communication on all major components: Data Server and all Network Level Controllers. Systems that require a router to achieve Ethernet connectivity will not be accepted.
      e. A Client / Server architecture must be employed with a PC acting as a Data Server for the system. The Data Server shall aggregate all Historical and Alarm/Event data to a central database, as well as perform Web serving functions including hosting Web Pages and providing data for the web browser-based Operator workstations. The Data Server shall also function as a master back up location for all Network Level Controller (NLC's) control programs and configurations.
      f. Updates to both the operating software and specific control algorithms for controlled points shall be capable of being delivered over the Internet, a web based, WAN or LAN connection.
      g. The User shall be able to log onto the control system through any (non dial up) Internet connection or from within the organization's intranet. With the proper access code, and security

requirements met, there shall be no restrictions on what location a user may log onto the control system from (except those intentionally imposed by the customer).

h. I/O Point and other configuration data must be stored as XML files on the Data Server to facilitate access by XML-based "Web Service" applications.

i. Historical data must be stored in an ODBC compliant database to allow access by common third party analysis and reporting tools such as Microsoft Excel ™ Crystal Reports ™ etc.

j. To minimize the exposure of individual controllers to Internet traffic, the Network Level Controller's (NLC's), System Level Controller's (SLC's) network connections must be capable of being placed behind a firewall on the customer's internal network. With the Data Server on a protected, Internet accessible firewall port, the Network Level Controllers on the internal network must be fully accessible.

B. Provide a very flexible programming environment for the system designer

1. Flexible programming must be provided for by simultaneously allowing both graphical programming using function blocks, and line-based programming, using a widely known language such as JavaScript or Visual Basic. The Graphical Programming system must allow for the creation of new function blocks, and not limit the system designer to only the function blocks provided by the manufacturer.

C. Provide "safe" BACnet connectivity

1. The system must be able to share live data values with other BACnet compliant systems over BACnet/IP and BACnet/MSTP.
2. The system shall be configurable such that Property Reads and Writes to or from specific points or objects will be disallowed while allowing reads and writes to and from other properties or objects, if so desired by the user. Systems without this capability will not be accepted.

1.16 BROWSER-BASED OPERATOR WORKSTATION SOFTWARE

A. General

1. Operator Workstation software shall be fully browser-based, Internet and intranet capable. The system must be installed in a manner whereby the control system may be operated remotely through a typical online IP connection without the use of a dial up modem.
2. Web Browsers of choice shall be Microsoft Internet ExplorerTM 6.5 or later.

B. Graphical Web Pages

1. Server based web pages, viewable through the Browser-based Operator Workstation Software, shall provide the user with visualizations of building and mechanical equipment or any other device controlled or monitored by the system.
2. At a minimum, a graphical web page shall be provided for:
   a. Each building floor with environmental information
   b. Each controlled Air Handling Package Unit Ventilation or Terminal Unit
   c. Each Significant piece or grouping of controlled Equipment (Boilers, Chillers, UPSs, etc)
3. The BAS must be able to display the value of all system objects on Web pages. At a minimum, this shall include all system Points, Setpoints, Schedules, Calendars, and Alarms. System Points, Setpoints, Schedule and Calendar values must also be capable of being edited through the Browser-based Operator Workstation Software.
4. Each user's privileges to view Web pages, and change or modify object values displayed on them, shall be governed by the privileges attached to that user's Security Role.

C. Tabular Summary List Web Pages

1. A system of Tabular Summary List web pages must be provided. Each Summary List will display all objects of a given type as well as the present value of each object in a given NLC. More detail for each object shall be provided when the user selects a given object from the summary list. A summary list must be provided for each of the following object types:

a. I/O Points
b. Pseudo or Software Values
c. Schedules
d. Calendars
e. Groups

D. Alarm and Event Management
1. The system shall be capable of presenting active and historical alarms and events in a tabular format through the web browser interface. This view shall permit sorting of alarms and events. This view shall permit acknowledging alarms.
2. Alarms which require acknowledgement must remain in a New Alarm View until they are acknowledged.
3. The system shall be capable of emailing alarm messages to users as alarm conditions occur.
4. The system shall be capable of paging alarm messages to users as alarm conditions occur.

E. Schedules and Calendars
1. From the summary lists of all schedules and calendars, the user must be able to select a particular schedule or calendar and modify start and stop times, days of week, dates, etc through the web browser interface.

F. Data Trending
1. User must be able to easily display historical data in trend charts, through the web browser interface. The system must support multiple trend charts displaying at one time. Each trend chart must have the appearance of a strip chart recorder with values plotted against the Y-axis, and time on the X-axis.
2. User must be able to scroll on the X-axis of a trend chart and move through the entire collected data history file for these data objects.
3. Trend charts shall be automatically refreshed with new data at a user configurable interval.
4. The system must be capable of collecting and archiving values and change of value events for any system object. At a minimum, this shall include I/O points, pseudopoints, and setpoints.

G. Groups
1. The user must be able to create custom Groups of objects, and add any number of objects to each group, through the web browser. All members of a user-created group shall be displayed in a single list, which must also display the present value of each object.

H. Security
1. Before accessing different system activities, the user must be required to login. If the login username and password challenge is answered properly, System shall allow the user access to those privileges listed in his Security Profile.
2. A user with System Administrator privileges must be able to add users to the system and define and/or modify each user's Security Profile. Administrators must also be able to create user roles or profiles which define a specific set of user privileges, and then assign these profiles to as many users as desired.

1.17 DATA SERVER

A. Data Server Software
1. Capability - Shall be capable of providing all functions listed in Section 2.3, BROWSER-BASED OPERATOR WORKSTATION SOFTWARE, through a common web browser such as Microsoft Internet Explorer Tm 6.5 or later.
2. Historical trend data from the Network Level Controllers (NLC's) System Level Controller's (SLC's) shall be aggregated to a database by the Data Server on a regular basis. This database must be accessible as an ODBC compliant data source for third party data analysis and reporting applications such as MYSQL, Crystal Reports™, or Microsoft Excel™.
3. Alarm and Event occurrences from the Network Level Controllers shall be aggregated to a database by the Data Server on a regular basis. This database must be accessible as an ODBC compliant data

source for third party data analysis and reporting applications such as MYSQL, Crystal Reports™, or Microsoft Excel ™.

4. The Data Server shall function as a central back-up location for control programs and configuration data for each Network Level Controller, (NLC).
5. Security and User Access - System must allow individual Users to be assigned to specific Access Roles. Each Role must be able to be customized to allow or disallow access to View and Modify (if available) each of the following object types:
   a. I/O Points
   b. Pseudo or Software Values
   c. Alarm Occurrences
   d. Event Occurrences
   e. Schedules
   f. Calendars
   g. Alarm & Event Log Settings
   h. Alarm Notification Settings
   i. Groups
   j. Web pages

B. Data Server Hardware
1. Tower Workstation or Rack mounted Server (minimum requirements):
2. Microsoft Windows 2003 Workstation or XP professional.
3. Configuration: IBM compatible Pentium 4 @ 3.06 GHz or faster microcomputer based system.
4. Minimum memory: 4 Gig bytes RAM.
5. Video Adapter: Super video color graphics adapter (SVGA), [64] Mbytes video memory, [1024x768] minimum resolution.
6. [Display: 24 inch non-interlaced color monitor, [1024x768] resolution at [75] Hz refresh rate, maximum 0.28 mm dot pitch.]
7. Keyboard: Low profile, detachable, having Qwerty layout plus a 10 key numeric keypad, dedicated function keys.
8. Hard disk drive: 250 G byte minimum.
9. CDROM drive: CDROM 32X Read minimum.
10. Mouse: [Microsoft] Optical with scroll wheel.
11. Network Adapter: Ethernet 10/100Base-TX adapter with PCI bus interface or integrated with motherboard.

1.18 NETWORK LEVEL CONTROLLERS

A. General
1. All primary HVAC equipment shall be controlled by a Network Level Controller, (NLC). This includes built-up Air Handling Units, Roof Top Package Units, Unit Ventilation Units, Heat Pumps, Variable Air Volume Systems which have more than 24 total inputs and outputs, and central heating or central cooling plants.

B. Network Communications - Communications to the Data Server, third party BACnet devices and other Network Level Controllers shall be via Information Technology standard Ethernet Category 5 cable and 100Mbs connection. Network Level Controllers, (NLC's) using 10Mbs Ethernet or other networks or busses shall not be accepted. The following networks shall be provided:
1. Network Port: Ethernet 10/100Base-TX supporting TCP/IP protocol.
2. Application Specific Controller and Modular I/O Subnetworks: The Network Level Controller shall have a minimum of three (3) RS-485 ports, at least two (2) capable of running BACnet MS/TP protocol.

C. Shall contain Internal Web Server supporting:
1. Hypertext Markup Language (HTML)
2. Extensible Markup Language (XML)

D. Programming Language:
   1. Network Level Controller, (NLC) shall support a Graphical Programming system for control program generation using graphical program modules such as PID, Timers, etc.
   2. Network Level Controller, (NLC) shall also support a standard line-based programming language, such as JavaScript or Visual Basic to facilitate the development of custom sequences on a line-by-line basis. Units not supporting both a Graphical Programming system and a line-based programming language for control program creation will not be accepted.

E. BACnet Support
   1. The Network Level Controllers (NLC) shall communicate using the BACnet/IP protocol over an onboard 100Mbs Ethernet connection between NLC's and Third Party BACnet/IP devices. Units unable to use BACnet/IF' without a BACnet router shall not be accepted.
   2. Network Level Controller, (NLC) shall be configurable such that Property Reads and Writes to/from *specific* points or objects may be disallowed while allowing reads and writes to/from other properties or objects, if so desired by the user. Systems without this capability will not be accepted.
   3. The Network Level Controller, (NLC) shall contain one or more RS485 ports which shall run the MS/TP BACnet protocol to other BACnet devices.

F. Non-BACnet Interfaces:
   1. At least one of the RS-485 ports shall be capable of using additional protocols to interface to other devices or network buses. The NLC must have the capability of communicating with the BAS manufactures Legacy equipment.

G. Two Piece construction
   1. Main Electronics CPU and Program storage memory portion shall easily separate from the base portion. All fixed wiring must be attached to base, no wiring, except low voltage connectors such as serial or network connectors may be terminated on the CPU and memory section.

H. Self-Diagnostic Routines — Shall include routines to test functionality of hardware and software at power up and any software restart. Error conditions must be displayed on an LCD or similar display panel on the Network Level Controller.

I. Real-Time Clock: Internal clock with battery backup to maintain accurate time during a power failure, maintenance, etc., must be included.

J. FLASH Memory: At a minimum, 16 MB of FLASH memory must be included.

K. All control programs, objects and other configuration data must be backed-up in FLASH memory. This data must be loaded into the controller in case of reset due to malfunction, power loss, or other failure.

L. Application Specific Controllers: The Network Level Controller shall manage and supervise a network of Application Specific Controllers (ASCs) by passing, at a minimum, the following information between the Network Level Controller and ASCs:
   1. Global Strategies such as Demand Limiting, etc.
      a. Schedule changes
   2. Related Equipment status
   3. Outdoor and other temperatures, etc.

M. Modular Input/Output Points:
   1. The Network Level Controller, (NLC) shall support a flexible system of modular Input and Output Points such that the number of inputs and outputs may be closely matched to the requirements of the equipment controlled by each Network Level Controller.

N. In addition to the tasks enumerated above, the Network Level Controller shall also perform each of the following functions:
   1. Monitor or control each input/output point.

2. Acquire, process, and transfer information to operator workstations and other controllers on network.
3. Accept, process, and execute commands from operator workstations.
4. Run both database and control functions simultaneously.
5. Record, evaluate, and report changes of state or value that occur among controlled or monitored points. Continue to perform control functions on local points regardless of status of network.
6. Perform in stand-alone mode:
   a. Full control using last known values for remote points or using contingencies for stale remote points.
   b. Scanning and alarm processing.
   c. Trend logging.
   d. Run time accumulation
7. Operator/Test Mode:
   a. Inhibit scanning and calculation of input points and issue manual control of input point values from operator workstations.

O. Control output points from operator workstations.

1.19 SYSTEM LEVEL CONTROLLERS (SLC's)

A. General
1. All primary HVAC equipment shall be controlled by a System Level Controller, (SLC). This includes built-up Air Handling Units, Roof Top Package Units, Unit Ventilation Units, Heat Pumps, Variable Air Volume Systems which have more than 32 total inputs and outputs, and central heating or central cooling plants.

B. Network Communications: Communications to the Data Server, third party BACnet devices and other Network Level Controllers shall be via Information Technology standard Ethernet Category 5 cable and 100Mbs connection. System Level Controllers, (SLC's) using 10Mbs Ethernet or other networks or busses shall not be accepted. The following networks shall be provided:
1. Network Port: Ethernet 10/100Base-TX supporting TCP/IP protocol.
2. Application Specific Controller and Modular I/O Sub-networks: The Network Level Controller shall have a minimum of three (3) RS-485 ports, at least two (2) capable of running BACnet MS/TP protocol.

C. Shall contain Internal Web Server supporting:
1. Hypertext Markup Language (HTML)
2. Extensible Markup Language (XML)

D. Programming Language:
1. System Level Controller, (SLC) shall support a Graphical Programming system for control program generation using graphical program modules such as PID, Timers, etc.
2. System Level Controller, (SLC) shall also support a standard line-based programming language, such as JavaScript or Visual Basic to facilitate the development of custom sequences on a line-by-line basis. Units not supporting both a Graphical Programming system and a line-based programming language for control program creation will not be accepted.

E. BACnet Support
1. The System Level Controllers (SLC) shall communicate using the BACnet/IP protocol over an onboard 100Mbs Ethernet connection between NLC's and Third Party BACnet/IP devices. Units unable to use BACnet/IP without a BACnet router shall not be accepted.
2. System Level Controller, (SLC) shall be configurable such that Property Reads and Writes to/from *specific* points or objects may be disallowed while allowing reads and writes to/from other properties or objects, if so desired by the user. Systems without this capability will not be accepted.
3. The System Level Controller, (SLC) shall contain one or more RS485 ports which shall run the MS/TP BACnet protocol to other BACnet devices.

F. Non-BACnet Interfaces:
   1. At least one of the RS-485 ports shall be capable of using additional protocols to interface to other devices or network buses. The SLC must have the capability of communicating with Modbus protocols.
      a. Global Strategies such as Demand Limiting, etc.
      b. Schedule changes
      c. Related Equipment status
      d. Outdoor and other temperatures, etc.

G. Internal Input/Output Points:
   1. The System Level Controller, (SLC) shall support an internal system of Input and Output Points such that the number of inputs and outputs may be closely matched to the requirements of the equipment controlled by each System Level Controller.

H. Modular Input/Output Points:
   1. The System Level Controller, (SLC) shall support a flexible system of modular Input and Output Points such that the number of inputs and outputs may be closely matched to the requirements of the equipment controlled by each Network Level Controller.

I. In addition to the tasks enumerated above, the System Level Controller shall also perform each of the following functions:
   1. Monitor or control each input/output point.
   2. Acquire, process, and transfer information to operator workstations and other controllers on network.
   3. Accept, process, and execute commands from operator workstations.
   4. Run both database and control functions simultaneously.
   5. Record, evaluate, and report changes of state or value that occur among controlled or monitored points. Continue to perform control functions on local points regardless of status of network.
   6. Perform in stand-alone mode:
      a. Full control using last known values for remote points or using contingencies for stale remote points.
      b. Scanning and alarm processing.
      c. Trend logging.
      d. Run time accumulation.
   7. Operator/Test Mode:
      a. Inhibit scanning and calculation of input points and issue manual control of input point values from operator workstations.

J. Control output points from operator workstations.

1.20 BACnet COMPLIANT INPUT/OUTPUT POINT MODULES:

A. General
   1. I/O Modules shall be from the same manufacturer as the Network Level Controllers.
   2. I/O Modules shall utilize 24 Vac or less for supply power.
   3. At a minimum, all I/O modules shall operate from 32 degrees F (0 degrees C) to 140 degrees F (60 degrees C).
   4. Analog Input points must have, at a minimum, 12-bit resolution
   5. Input Points must support each of the following signal types:
      a. 0 — 10 Vdc
      b. 4 — 20 mA
      c. 10K Thermistor
      d. 100 ohm Platinum RTD
      e. Contact Closure
      f. 24 Vac "wet" input
   6. Output points must support each of the following signal types:

a. Start/Stop Control: Relay (5 amps at up to 277 Vac)
b. Start/Stop Control: Triac
c. Pulse Width Modulation: 0.1 second maximum resolution, 25.5 second minimum span
d. 0 — 10 Vdc
e. 4 — 20 mA

7. Analog Outputs must have, at a minimum, 8-bit resolution.
8. Each Binary Output shall have a hand/off/auto switch. Each Analog Output shall have a hand/auto switch and a potentiometer for setting the hand override value.

B. BACnet Compliance
1. Modular Input/Output Systems shall employ the BACnet MS/TP communications protocol at not less than115 Kbps for communications with a Network Level Controller.

1.21 BACnet APPLICATION SPECIFIC CONTROLLERS

A. General: BACnet Application Specific Controllers (ASCs) shall be from the same manufacturer as the Network Level Controller, NLC, System Level Controller, SLC, and shall be provided for all listed Air Handling Units (unless controlled by modular I/O), Packaged Rooftop HVAC units, VAV, Fan Coil Units and Unit Ventilators and Split Systems.

B. The ASCs shall be stand-alone devices that support pre-programmed HVAC sequences and/or custom user programmed sequences.

C. Memory: the ASCs shall use FLASH memory to store control program sequences and configuration, so that no backup battery is required.

D. Power supply: 24 VAC or less.

E. Controller Functions:
1. Monitor or control each input/output point.
2. Perform control independently from the Network Level Controller and System Level Controllers.
3. Acquire, process, and transfer information to Network Level Controllers and System Level Controllers over the network.
4. Accept, process, and execute commands from Network Level Controllers and System Level Controllers.
5. Run both database and control functions simultaneously.
6. Perform in stand-alone mode:
a. Full control using last known values for remote points or using contingencies for stale remote points.
b. Scanning and alarm processing; maximum scan time: 1 second.
7. Operator/Test Mode:
a. Inhibit scanning and calculation of input points and issue manual control of input point values from operator workstations.
b. Control output points from operator workstations.

F. Programming Language: The software tool used to configure the ASC shall employ a Wizard system to assist the designer in configuring I/O points, setpoints, and other items which define the "Personality" of the ASCs. PID loops and 2 position control routines must be available.

G. Input Types supported. At a minimum, the following input types must be supported:
1. 10 K thermistor
2. 0 — 5 VDC
3. Dry Contact Closure

H. Multifunction Room Sensor: Must allow occupant to modify occupancy status and adjust temperature setpoint. In the case of VAV type ASCs, the sensor must also allow the balancing technician to enter an Air Balance mode which shall allow him to calibrate ASC airflow readings from this room mounted sensor.

I. Output Types supported: At a minimum, the following output types must be supported (Only the signal types required to match the equipment being controlled must be present in a particular ASC however):
   1. Binary Output
   2. Pulse Width Modulation (0 — 25 seconds, .1 second resolution)
   3. 10 Vdc

J. VAV type ASCs shall include:
   1. Integral electric Damper Actuator appropriate for the VAV box damper size
   2. Integral Air Flow Transducer: 0 — 1" w.c. true differential pressure transducer.

1.22 BACnet Modular INPUT AND OUTPUT DEVICES

A. BACnet binary inputs devices:
   1. All BACnet binary inputs shall be electrically isolated from the BAS either by optical isolation or relays (dry contact closures).
      a. When relays are used, transient suppression shall be placed across the relay contacts.
   2. Pressure Switches
      a. Pressure switches shall have a repetitive accuracy of plus or minus one percent (1%) of their operating range and shall withstand up to 150 percent of rated pressure. Sensors shall be diaphragm or Bourdon tube. Actuation shall be adjustable over the operating pressure range. Switch shall have a snap-action spot dry contact rated for the application. Switch contacts shall be wiping contacts and shall have adjustable differential setting.
   3. Control Relays:
      a. Control relays shall be rated for the application, with spot dry contacts enclosed in a dustproof enclosure shall have a silver cadmium contact with a minimum life span rating of one million operations.
   4. Fan Status Flow:
      a. Provide a 2-position differential pressure switch across the fan to prove flow.

B. BACnet binary outputs devices:
   1. BACnet digital outputs shall be electrically isolated from the BAS either by optical isolation or relays.
      a. When relays are used, transient suppression shall be placed across the coils.

C. BACnet analog inputs devices:
   1. General
      a. Sensors and signal conditioning equipment provided shall be of a type that is universally accepted in the industry.
      b. Transducers may be supplied as an integral unit with the field sensor, mounted separately from the sensor in a field interface panel or packaged as part of the Controller or I/O Module, providing specific sensing accuracy is achieved. All transducers shall be capable of being field calibrated.
      c. Sensing ranges and accuracies given are for the normal values anticipated. The actual sensor range will be dictated by the maximum and minimum sensed values anticipated and standard sensor ranges.
      d. All sensors shall be calibrated at the midpoint of the expected sensed values.
      e. Analog Output signals shall be of one of the following forms: 0-10 Vdc or 4-20 mA.
      f. Sensor/transducer shall be appropriately factory packaged for the location. Supplier/Contractor packaging of raw sensors shall not be permitted. Provide packaging as follows:
         1) Architectural housing for space wall mounting.
         2) Weatherproof/sunshield housing for outside mounting.
         3) Thermal well housing for water applications.

4) Dust and physical protection housing for duct mounting.

g. Sensor/transducer shall be appropriately selected to withstand ambient conditions, such as:
   1) Moisture or condensation, where it is a factor.
   2) Vibration from ductwork, equipment, etc.
   3) Reasonably expected transient conditions such as temperatures, pressures, humidity, etc., outside the normal sensing range.

h. Sensor/transducer shall be appropriately selected to most closely match the expected sensing range.

i. The system shall maintain the specified end-to-end accuracy throughout the warranty period from sensor to controller read-out. System end-toend accuracy shall not exceed two times the specified element accuracy.

2. Temperature Sensors:
   a. Temperature sensors shall be thermistors or RTDs. Thermocouples, or solid-state temperature sensors shall not be allowed. Sensor Time Constant shall not exceed 5 seconds for a 60% response to a step change in temperature. Sensor repeatability shall be 0.1 degrees F or better. Sensors and transmitters shall be manufactured by the control supplier, unless the manufacturer's equipment cannot meet these specifications.
   b. Space temperature sensor element shall be accurate within plus or minus: 0.5 degrees F for range from 40 degrees F to 100 degrees F.
   c. Duct temperature sensing elements shall be accurate within plus or minus 0.5 degrees F for range from 40 degrees F to 110 degrees F for single point applications, and plus or minus 1.0 degrees F for range of 40 degrees F to 110 degrees F for averaging applications.
3. Pressure Sensors:
   a. Supply duct static pressure sensing shall be accurate within plus or minus 0.05 inches water gauge over a range of 0 to 1.25 inches.
      1) Sensors shall be mounted within 10 feet of discharge of the fan, or in the location of existing sensor replaced.

D. BACnet Analog output devices.
1. Output Transducers:
   a. Provide electric to pneumatic transducer capable of producing an analog pneumatic output proportional to the voltage or current input:
   b. Network Level Controllers shall not use pulse width modulation.
   c. Where an analog output is called for but the application specific controller can only provide binary outputs:
      1) Provide actuators specifically designed for electric pulse width modulation with its position proportional to the pulse width input with resolution equal to or greater than 0.5% of full scale.
      2) Provide actuators specifically designed for electric pulse width modulation with its position proportional to the pulse width input with resolution equal to or greater than 0.5% of full scale.
      3) Pulsed feed and bleed solenoids or any other method that does not control the output device's position proportionally to output shall not be used.

E. Pulse input (10 pulses/second).

F. Pulse output (0-25.5 seconds in duration with 0.1 second resolution).

1.23 LOCAL AREA NETWORKS (LAN)

A. Ethernet LAN
1. Shall be the exclusive media for network communications between Network Level Controllers, System Level Controllers, Data Servers and Operator Workstations.
2. Shall be Ethernet at 100 Mb.

3. Shall employ the TCP/IP protocol.
4. Shall be capable of utilizing commonly available Ethernet hubs, switches, routers and gateways.
5. Shall be capable of sharing building's computer LAN, WAN and Internet connections.
6. Cabling shall be Category 5e data cable. Plenum rated cable shall be utilized in cavities used as air plenums. Direct burial cable shall be used underground.
7. Optical isolators and lightening protection shall be utilized where penetrating the building envelope.

B. RS-485 LAN:
1. Shall be utilized for network communications between I/O modules and Network Level Controllers, System Level Controllers, as well as between ASC modules Network Level Controllers and System Level Controllers.
2. Cable model must be that specified by Network Level Controller manufacturer. Utilize plenum rated cable for use in cavities used as air plenums. Utilize direct burial cable for underground use.
3. Provide optical isolator and lightening protection where penetrating building envelope.

1.24 LOAD CONTROL PROGRAMS

A. Demand Limiting
1. Monitor total power consumption per power meter and shed associated loads automatically to reduce power consumption to an operator set maximum demand level.
2. Input: Pulse count from incoming power meter connected to pulse accumulator in controller.
3. Sliding window KW demand calculations shall be supported.
4. Automatically shed loads throughout the demand interval selecting loads with independently adjustable on and off times.
5. Demand Target: Minimum of 3 per demand meter; change targets based upon (1) time, (2) temperature, and (3) Date.

B. Duty Cycling
1. Periodically stop and start loads, based on space temperature, and according to various On/Off patterns.
2. Modify off portion of cycle based on operator specified comfort parameters. Maintain total cycle time by increasing on portion of cycle by same amount that off portion is reduced.

C. Automatic Time Scheduling:
1. Self-contained programs for automatic start/stop/scheduling of building loads.
2. For any control program or point, Weekly (Normal), Exception, and Holiday schedules must be supported, as well as the necessary priority relationships between them. This relationship is Exception Schedule is higher priority than Holiday Schedule, which is higher priority than Weekly Schedule.
3. The programmer shall be able to assign any number of points or programs to one schedule; conversely, each point can have its own individual time schedule.
4. Schedule will have, at most, 1 minute resolution.
5. Time schedule operations may be:
   a. Start
   b. Optimized Start
   c. Stop
   d. Optimized Stop

D. Start/Stop Time Optimization:
1. Perform optimized start/stop as function of current temperature conditions.
2. Adaptive and self-tuning, adjust to changing conditions automatically.
3. For each point under control, establish and modify:
   a. Occupancy period.
   b. Desired temperature at beginning of Occupancy period.
   c. Desired temperature at end of Occupancy period.

E. Night Setback/Setup Program: Reduce heating space temperature setpoint or raise cooling space temperature setpoint during unoccupied hours, in conjunction with scheduled start/stop and optimum start/stop programs.

F. Calculated Points: Define calculations and totalizations computed from monitored points (analog/digital points), constants, or other calculated points.
   1. Employ arithmetic, algebraic, Boolean, and special function operations.
   2. Treat calculated values like any other point value, use for any function that a "hard wired" point might be used for.

1.25 HVAC CONTROL PROGRAMS

A. General
   1. Identify each HVAC Control system.

B. Control Functions: Each controller, shall include BAS software such that the system designer may customize control strategies and sequences of operation by defining the appropriate control loop algorithms and choosing the optimum loop parameters.
   1. Control loops: Defined using "blocks" that are analogous to standard control devices.
   2. Output: Paired or individual digital outputs for pulse-width modulation, and analog outputs, as required.
   3. Control Block Examples:
      a. PID with analog or pulse-width modulation output
      b. Floating control with pulse-width modulated outputs.
      c. Two-position control.
      d. Primary and secondary reset schedule selector.
      e. Hi/Lo signal selector.
      f. Single pole double throw relay.
      g. Single pole double throw time delay relay with delay before break, delay before make and interval time capabilities.

C. Supply Air Reset:
   1. Monitor heating and cooling loads in building spaces, terminal reheat systems, both hot deck and cold deck temperatures on dual duct and multizone systems, single zone unit discharge temperatures.
   2. Adjust discharge temperatures to most energy efficient levels satisfying measured load by:
      a. Raising cooling temperatures to highest possible value.
      b. Reducing heating temperatures to lowest possible level.

D. Enthalpy Switchover:
   1. Calculate outside and return air enthalpy using measured temperature and relative humidity; determine energy expended and control outside and return air dampers.

E. Chiller Control:
   1. Control function of condenser water reset, chilled water reset, and chiller sequencing.
   2. Condenser Water Reset: Automatically reset controlled condenser water temperature using measured outside wet bulb temperature and load being handled.
   3. Chilled Water Reset: Automatically reset controlled chilled water temperature satisfying cooling coil requiring greatest cooling.
   4. Chiller Sequencing: Determine which combination of chillers will most efficiently satisfy chilled water load, by cycling chillers, based on comparing load to switchover limits defined for each chiller.

F. Boiler Control
   1. Hot Water Reset: Automatically reset controlled heating water temperature satisfying heating coil requiring greatest heating.

1.26 SPECIAL REQUIREMENTS

A. The following guidelines are recommended. Any deviation from these guidelines is to be avoided as you will be made to comply before job acceptance.
   1. Excess wire shall not be looped or coiled in the controller cabinet.
   2. Incorporate electrical noise suppression techniques in relay control circuits.
   3. There shall be no drilling of the controller cabinet after controls are mounted inside.
   4. Careful striping of wire while inside the cabinet is required to ensure that no wire strand fragments land on circuit boards.
   5. Use manufacturer specified wire for all network connections
   6. Use approved optical isolation and lightning protection when penetrating building envelope.
   7. Read installation instructions carefully. Any unavoidable deviations must be approved, in writing, prior to installation.

1.27 EXAMINATION

A. Verify that power is available to the controllers and to the operator workstation. Verify that field end devices, wiring, and pneumatic tubing are installed prior to installation proceeding.

1.28 INSTALLATION

A. Install controllers and other hardware in position on permanent walls where not subject to excessive vibration.

B. Install software in controllers and in operator workstation. Implement all features of programs to specified requirements and appropriate to sequence of operation.

C. Provide a 120 Vac, 15 amp dedicated circuit to each Network Level Controller and accessories location. Power to ASCs may be shared provided the wiring conventions documented in the installation literature are observed.

D. Provide conduit and electrical wiring. Electrical material and installation shall be in accordance with appropriate requirements of Division 16.

1.29 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate complete and operating system to Owner.

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Task	Specification	Specification Description
22 15 19 13	22 15 13 00	General-Service Packaged Air Compressors and Receivers
22 15 19 13	23 09 00 00	BAS CONTROLS CONTRACTOR
22 15 19 13	07 21 13 13a	DIRECT DIGITAL CONTROLS AND BUILDING AUTOMATION SYSTEMS
22 15 19 13	22 15 13 00a	HVAC Instrumentation And Controls
22 15 19 19	22 15 13 00	General-Service Packaged Air Compressors and Receivers
22 15 19 19	23 09 00 00	BAS CONTROLS CONTRACTOR
22 15 19 19	22 15 13 00a	HVAC Instrumentation And Controls

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SECTION 22 31 16 00 - WATER SOFTENERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for water softeners. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes household and commercial water softeners.
a. Chemicals.
b. Water testing kits.

C. Definitions
1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. FRP: Fiberglass-reinforced plastic.
3. PE: Polyethylene plastic.
4. PVC: Polyvinyl chloride plastic.

D. Submittals
1. Product Data: For each type of water softener and water testing kit indicated.
2. Shop Drawings: Include plans, elevations, sections, details, and connections to piping systems.
a. Include wiring diagrams.
3. Manufacturer Seismic Qualification Certification
4. Field quality-control test reports.
5. Operation and Maintenance Data: For water softeners to include in emergency, operation, and maintenance manuals.
6. Warranty: Special warranty specified in this Section.

E. Quality Assurance
1. 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.
2. ASME Compliance for Steel Tanks: Fabricate and label mineral tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, where indicated.
3. ASME Compliance for FRP Tanks: Fabricate and label mineral tanks to comply with ASME Boiler and Pressure Vessel Code: Section X, where indicated.

F. Warranty
1. Manufacturer's standard form in which manufacturer agrees to repair or replace components of water softener that fail in materials or workmanship within Five years from date of Final Completion.

1.2 PRODUCTS

A. Household Water Softeners
1. Description: Factory-assembled, fully-automatic, pressure-type water softener.
a. Configuration: Unit with one mineral tank and one brine tank or cabinet-style, combination mineral and brine tank unit with equivalent characteristics.
b. Mineral Tank: Steel or FRP, with coating or liner suitable for potable-water service and 125-psig (860-kPa) minimum pressure rating.

c. Comply with NSF 61, "Drinking Water System Components--Health Effects."
d. Controls: For fully automatic operation.
e. Brine Tank: Combination measuring and wet-salt storing system.
   1) Tank and Cover Material: FRP or molded PE.
   2) Brine Valve: Float operated and plastic fitted for automatic control of brine withdrawn and freshwater refill.
   3) Size: Large enough for at least two regenerations at full salting.
f. Factory-Installed Accessories:
   1) Piping, valves, tubing, and drains.
   2) Sampling cock.
   3) Main-operating-valve position indicator.

B. Commercial Water Softeners
1. Description: Factory-assembled, pressure-type water softener.
   a. Comply with NSF 61, "Drinking Water System Components--Health Effects."
   b. Configuration: Single unit with one mineral tank **OR** Twin unit with two mineral tanks **OR** Triple unit with three mineral tanks, **as directed**, and one brine tank, factory mounted on skids, **unless directed otherwise**.
   c. Mineral Tanks: FRP, pressure-vessel quality.
      1) Construction: Non-ASME code **OR** Fabricated and stamped to comply with ASME Boiler and Pressure Vessel Code: Section X, "Fiber-Reinforced Plastic Pressure Vessels," **as directed**.
      2) Pressure Rating: 100 psig (690 kPa) **OR** 125 psig (860 kPa), **as directed** , minimum.
      3) Wetted Components: Suitable for water temperatures from 40 to at least 100 deg F (5 to at least 38 deg C) **OR** 40 to at least 120 deg F (5 to at least 49 deg C) **OR** 40 to at least 150 deg F (5 to at least 66 deg C), **as directed**.
      4) Freeboard: 50 percent minimum for backwash expansion above normal resin bed level.
      5) Support Legs or Skirt: Constructed of structural steel, welded to tank before testing and labeling.
      6) Upper Distribution System: Single, point type, fabricated from galvanized-steel pipe and fittings.
      7) Lower Distribution System: Hub and radial-arm or header-lateral type; fabricated from nonmetallic pipe and fittings with individual, fine-slotted, nonclogging plastic strainers; arranged for even flow distribution through resin bed.
      8) Liner: PE, ABS, or other material suitable for potable water.
   d. Mineral Tanks: Steel **OR** Stainless steel, **as directed**, electric welded; pressure-vessel quality.
      1) Fabricate supports and attachments to tank with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure.
      2) Construction: Non-ASME code **OR** Fabricated and stamped to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," **as directed**.
      3) Pressure Rating: 100 psig (690 kPa) **OR** 125 psig (860 kPa) **OR** 150 psig (1035 kPa), **as directed**, minimum.
      4) Wetted Components: Suitable for water temperatures from 40 to at least 100 deg F (5 to at least 38 deg C) **OR** 40 to at least 120 deg F (5 to at least 49 deg C) **OR** 40 to at least 150 deg F (5 to at least 66 deg C), **as directed**.
      5) Freeboard: 50 percent minimum for backwash expansion above normal resin bed level.
      6) Handholes: 4 inches (102 mm) round or 4 by 6 inches (102 by 152 mm) elliptical, in top head and lower sidewall of tanks 30 inches (762 mm) and smaller in diameter.
      7) Manhole: 11 by 15 inches (280 by 380 mm) in top head of tanks larger than 30 inches (762 mm) in diameter.

8) Support Legs or Skirt: Constructed of structural steel, welded to tank before testing and labeling.
9) Finish: Hot-dip galvanized on exterior and interior of tank after fabrication, unless tank is stainless steel.
10) Finish: Exterior of tank spray painted with rust-resistant prime coat, 2- to 3-mil (0.051- to 0.076-mm) dry film thickness. Interior sandblasted and lined with epoxy-polyamide coating, 8- to 10-mil (0.203- to 0.254-mm) dry film thickness.
11) Upper Distribution System: Single, point type, fabricated from galvanized-steel pipe and fittings.
12) Lower Distribution System: Hub and radial-arm or header-lateral type; fabricated from PVC pipe and fittings with individual, fine-slotted, nonclogging PE strainers; arranged for even flow distribution through resin bed.
13) Liner: PE, ABS, or other material suitable for potable water.

e. Controls: Automatic; factory mounted on unit and factory wired.
1) Adjustable duration of various regeneration steps.
2) Push-button start and complete manual operation.
3) Electric time clock and switch for automatic operation, except for manual return to service.
4) Sequence of Operation: Program multiport pilot-control valve to automatically pressure-actuate main operating valve through steps of regeneration.
5) Pointer on pilot-control valve shall indicate cycle of operation.
6) Means of manual operation of pilot-control valve if power fails.

f. Controls: Fully automatic; factory mounted on unit and factory wired.
1) Adjustable duration of various regeneration steps.
2) Push-button start and complete manual operation.
3) Electric time clock and switch for fully automatic operation, adjustable to initiate regeneration at any hour of day and any day of week or at fixed intervals.
4) Sequence of Operation: Program multiport pilot-control valve to automatically pressure-actuate main operating valve through steps of regeneration and return to service.
5) Pointer on pilot-control valve shall indicate cycle of operation.
6) Means of manual operation of pilot-control valve if power fails.
7) Main Operating Valves: Industrial, automatic, multiport, diaphragm type with the following features:
a) Slow opening and closing, nonslam operation.
b) Diaphragm guiding on full perimeter from fully open to fully closed.
c) Isolated dissimilar metals within valve.
d) Self-adjusting, internal, automatic brine injector that draws brine and rinses at constant rate independent of pressure.
e) Valve for single mineral-tank unit with internal automatic bypass of raw water during regeneration.
f) Sampling cocks for soft water.
g) Special tools are not required for service.
8) Flow Control: Automatic, to control backwash and flush rates over wide variations in operating pressures, and that does not require field adjustments.
a) Meter Control: Equip each mineral tank with signal-register-head water meter that will produce electrical signal indicating need for regeneration on reaching hand-set total in gallons (liters). Design so signal will continue until reset.
b) Demand-Initiated Control:
i. Equip single mineral-tank units with automatic-reset-head water meter that electrically activates cycle controller to initiate regeneration at preset total in gallons (liters). Design so head automatically resets to preset total in gallons (liters) for next service run.
ii. Equip each mineral tank of twin mineral-tank units with automatic-reset-head water meters that electrically activate cycle controllers to initiate regeneration at preset total in gallons (liters). Design so heads

automatically reset to preset total in gallons (liters) for next service run. Include electrical lockout to prevent simultaneous regeneration of both tanks.

iii. Equip each mineral tank of twin mineral-tank units with automatic-reset-head water meter in common outlet header that electrically activates cycle controller to automatically regenerate one mineral tank at preset total in gallons (liters) and divert flow to other tank. Set to repeat with other tank. Include electrical lockout to prevent simultaneous regeneration of both tanks.

iv. Equip each mineral tank of multiple mineral-tank units with automatic-reset-head water meters that electrically activate cycle controllers to automatically regenerate at preset total in gallons (liters). Design so heads automatically reset to preset total in gallons (liters) for next service run. Include electrical lockouts to prevent simultaneous regeneration of more than one tank.

v. Equip each mineral tank of multiple mineral-tank units with automatic-reset-head water meter in common outlet header that electrically activates cycle controller to automatically regenerate one mineral tank at preset total in gallons (liters) and divert flow to other tanks. Set to repeat with other tanks. Include electrical lockouts to prevent simultaneous regeneration of more than one tank.

g. Brine Tank: Combination measuring and wet-salt storing system.
   1) Tank and Cover Material: Fiberglass, 3/16 inch (4.8 mm) thick; or molded PE, 3/8 inch (9.5 mm) thick.
   2) Brine Valve: Float operated and plastic fitted for automatic control of brine withdrawn and freshwater refill.
   3) Size: Large enough for at least four regenerations at full salting.

h. Factory-Installed Accessories:
   1) Piping, valves, tubing, and drains.
   2) Sampling cocks.
   3) Main-operating-valve position indicators.
   4) Water meters.

2. Capacity and Characteristics:
   a. Service: Cold **OR** Hot, **as directed**, water.
   b. Number of Mineral Tanks: One **OR** Two, **as directed**.

C. Chemicals
1. Mineral: High-capacity, sulfonated-polystyrene ion-exchange resin that is stable over entire pH range with good resistance to bead fracture from attrition or shock.
   a. Exchange Capacity: 30,000 grains/cu. ft. (69 kg/cu. m) of calcium carbonate of resin when regenerated with 15 lb (6.8 kg) of salt.
2. Salt for Brine Tanks: High-purity sodium chloride; free of dirt and foreign material. Rock and granulated forms are not acceptable.
   a. Form: Processed, food-grade salt pellets **OR** plain salt pellets **OR** crystallized solar salt from shallow ponds and milled into irregular particles **OR** plain, brine block salt, **as directed**.

D. Water Testing Sets
1. Description: Manufacturer's standard water-hardness testing apparatus and chemicals with testing procedure instructions. Include metal container suitable for wall mounting.

1.3 EXECUTION

A. Concrete Bases

1. Install concrete bases of dimensions indicated for commercial water softeners. Refer to Division 22 Section "Common Work Results For Plumbing".

B. Water Softener Installation
1. Install household water softeners on floor. Anchor water softener and brine tanks to substrate.
2. Install commercial water softener equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor mineral and brine tanks and floor-mounting accessories to substrate.
3. Install seismic restraints for tanks and floor-mounting accessories and anchor to building structure.
4. Install brine lines and fittings furnished by equipment manufacturer but not specified to be factory installed.
5. Prepare mineral-tank distribution system and underbed for minerals and place specified mineral into mineral tanks.
6. Install water testing sets mounted on wall, unless otherwise indicated, and near water softeners.

C. Connections
1. Piping installation requirements are specified in other Division 14.. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to equipment to allow service and maintenance.
3. Make piping connections between water-softener-unit headers and dissimilar-metal water piping with dielectric fittings. Dielectric fittings are specified in Division 22 Section "Common Work Results For Plumbing".
4. Install shutoff valves on raw-water inlet and soft-water outlet piping of each mineral tank, and on inlet and outlet headers.
   a. Metal general-duty valves are specified in Division 22 Section "General-duty Valves For Plumbing Piping".
   b. Plastic valves are specified in Division 22 Section "Domestic Water Piping".
   c. Exception: Water softeners with factory-installed shutoff valves at locations indicated.
5. Install pressure gages on raw-water inlet and soft-water outlet piping of each mineral tank. Pressure gages are specified in Division 22 Section "Meters And Gages For Plumbing Piping".
   a. Exception: Water softeners with factory-installed pressure gages at locations indicated.
   b. Exception: Household water softeners.
   c. Exception: Water softeners in hot-water service.
6. Install valved bypass water piping around water softeners.
   a. Metal general-duty valves are specified in Division 22 Section "General-duty Valves For Plumbing Piping".
   b. Plastic valves are specified in Division 22 Section "Domestic Water Piping".
   c. Water piping is specified in Division 22 Section "Domestic Water Piping".
   d. Exception: Household water softeners.
   e. Exception: Water softeners in hot-water service.
7. Install drains as indirect wastes to spill into open drains or over floor drains.
8. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
9. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

D. Field Quality Control
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
2. Perform the following field tests and inspections and prepare test reports:
   a. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

b. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
c. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3. Remove and replace malfunctioning water softeners that do not pass tests and inspections and retest as specified above.

E. Startup Service
1. Engage a factory-authorized service representative to perform startup service.
   a. Complete installation and startup checks according to manufacturer's written instructions.
2. Add water to brine tanks and fill with salt.
   a. Household Water Softeners: Processed food-grade salt pellets **OR** plain salt pellets **OR** crystallized solar salt, **as directed**.
   b. Commercial Water Softeners: Plain salt pellets **OR** Crystallized solar salt **OR** Plain, brine block salt **OR** Food-grade salt pellets, **as directed**.
3. Sample water softener effluent after startup and at three consecutive seven-day intervals (total of four samples), and prepare certified test reports for required water performance characteristics. Comply with the following:
   a. ASTM D 859, "Test Method for Silica in Water."
   b. ASTM D 1067, "Test Methods for Acidity or Alkalinity of Water."
   c. ASTM D 1068, "Test Methods for Iron in Water."
   d. ASTM D 1126, "Test Method for Hardness in Water."
   e. ASTM D 1129, "Terminology Relating to Water."
   f. ASTM D 3370, "Practices for Sampling Water from Closed Conduits."

F. Demonstration
1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial water softeners.

END OF SECTION 22 31 16 00

Task	Specification	Specification Description
22 33 00 00	22 12 23 13	Electric, Domestic Water Heaters
22 33 30 16	22 12 23 13	Electric, Domestic Water Heaters
22 33 30 16	22 12 23 13a	Fuel-Fired, Domestic Water Heaters
22 33 33 00	22 12 23 13	Electric, Domestic Water Heaters

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SECTION 22 34 36 00 - WATER-TUBE BOILERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for water-tube boilers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes packaged, factory-fabricated and -assembled, gas-fired, finned water-tube boilers, trim, and accessories for generating hot water.
2. This Section includes packaged, water-tube boilers, trim, and accessories for generating hot water or steam with the following configurations, burners, and outputs:
   a. Factory and Field assembled.
   b. Atmospheric gas, Forced-draft gas, Oil, and Combination gas and oil burner.

C. Submittals
1. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.
2. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.
   a. Design calculations and vibration isolation base details, signed and sealed by a qualified professional engineer.
      1) Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
      2) Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails and equipment mounting frames.
   b. Wiring Diagrams: Power, signal, and control wiring.
3. Manufacturer Seismic Qualification Certification: Submit certification that boiler, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment". Include the following:
4. Source quality-control test reports.
5. Field quality-control test reports.
6. Operation and maintenance data.
7. Warranty: Special warranty specified in this Section.
8. Other Informational Submittals:
   a. ASME "A" Stamp Certification and Report: Submit "A" stamp certificate of authorization as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.
   b. Startup service reports.

D. Quality Assurance
1. 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.
2. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.
3. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
4. 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."

5. I=B=R Compliance: Boilers shall be tested and rated according to HI's "Rating Procedure for Heating Boilers" and "Testing Standard for Commercial Boilers," with I=B=R emblem on a nameplate affixed to boiler.
6. UL Compliance: Test boilers for compliance with UL 726, "Oil-Fired Boiler Assemblies" **OR** UL 726, "Oil-Fired Boiler Assemblies" and UL 795, "Commercial-Industrial Gas Heating Equipment" **OR** UL 795, "Commercial-Industrial Gas Heating Equipment", **as directed**. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

E. Warranty
1. Special Warranty for Finned Water-Tube Boilers: Manufacturer's standard form in which manufacturer agrees to repair or replace heat exchangers damaged by thermal shock and vent dampers of boilers that fail in materials or workmanship within specified warranty period.
   a. Warranty Period for Heat Exchangers: 20 years from date of Final Completion.
   b. Warranty Period for Vent Dampers: Five years from date of Final Completion.
2. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace drums, tubes, headers, cabinets, atmospheric gas burners, and pressure vessels of boilers that fail in materials or workmanship within specified warranty period.
   a. Warranty Period for Drums, Tubes, Headers, Cabinets, and Atmospheric Gas Burner: Five years from date of Final Completion, pro rata.
   b. Warranty Period for Pressure Vessel: 20 years from date of Final Completion, for thermal shock.

1.2 PRODUCTS

A. Finned Water-Tube Boilers
1. Description: Factory-fabricated, -assembled, and -tested boiler with tubes sealed into headers pressure tight, and set on a steel base; including insulated jacket, flue-gas vent, combustion-air intake connections, water supply and return connections, and controls.
2. Heat Exchanger:
   a. Finned copper **OR** steel **OR** copper-nickel, **as directed**, tubing with stainless-steel baffles.
   b. Bronze **OR** Cast-iron **OR** Steel, **as directed**, headers.
   c. Single-pass **OR** Two-pass, **as directed**, horizontal **OR** vertical **OR** coil, **as directed**, configuration.
   d. Tubes shall be sealed in header with silicone O-ring gaskets **OR** by welding **OR** by mechanically rolling tubes in header, **as directed**.
3. Combustion Chamber Internal Insulation: Interlocking panels of refractory insulation, high-temperature cements, mineral fiber, and ceramic refractory tile for service temperatures to 2000 deg F (1100 deg C).
4. Casing:
   a. Jacket: Sheet metal **OR** Stainless steel, **as directed**, with snap-in or interlocking closures.
   b. Control Compartment Enclosure: NEMA 250, Type 1A.
   c. Finish: Baked enamel over primer **OR** Baked enamel over galvanizing **OR** Powder coated, **as directed**.
   d. Insulation: Minimum 1-inch- (25-mm-) **OR** 2-inch- (50-mm-), **as directed**, thick, mineral-fiber insulation surrounding the heat exchanger.
   e. Draft Hood: Integral **OR** External, **as directed**.
   f. Combustion-Air Connection: Inlet duct collar and sheet metal closure over burner compartment.
   g. Mounting base to secure boiler with accessory for mounting on combustible surface, **as directed**.
      1) Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler pressure vessel, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration And

Seismic Controls For Hvac Piping And Equipment" when mounting base is anchored to building structure.

5. Burner:
   a. Burner Tubes and Orifices: Stainless steel, for natural **OR** propane, **as directed**, gas. Mount burner tubes in a slide-out burner drawer for ease of inspection, **as directed**.
      1) Sealed Combustion: Factory-mounted centrifugal fan to draw outside air into boiler and discharge into burner compartment.
      2) Direct Vent: Factory-mounted centrifugal fan to draw flue gas out of boiler and discharge into boiler vent.
   b. Vertical Burner:
      1) High-temperature stainless steel **OR** Ceramic, **as directed**, to fire in a 360-degree pattern.
      2) Burner shall have a viewing port for observation of burner operation and a factory-mounted centrifugal fan to supply room **OR** outside, **as directed**, air through a replaceable 99 percent efficient (1-micrometer particles) filter, **as directed**, to boiler burner.
      3) Fan shall be controlled to prepurge and postpurge the combustion chamber before firing.
   c. Gas Train for Commercial Boilers: Control devices and full-modulation **OR** on-off **OR** low-high-low **OR** proportional, **as directed**, control sequence shall comply with requirements in AGA **OR** ASME CSD-1 **OR** FMG **OR** IRI **OR** UL, **as directed**. In addition to these requirements, include shutoff cock, pressure regulator, and control valve.
   d. Gas Train for Residential Boilers: Combination gas valve with manual shutoff, pressure regulator, and pilot adjustment.
   e. Pilot: Standing **OR** Intermittent-electric-spark **OR** Hot-surface, **as directed**, pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.
   f. Flue-Gas Recirculation Fans: Centrifugal fans on burner assembly to recirculate flue gas to decrease oxides of nitrogen emissions to less than 30 ppm.

   g. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements For Hvac Equipment".
6. Trim:
   a. Aquastat Controllers: Operating, firing rate, **as directed**, and high limit.
   b. Safety Relief Valve: ASME rated.
   c. Pressure and Temperature Gage: Minimum 3-1/2-inch- (89-mm-) diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.
   d. Boiler Air Vent: Automatic **OR** Manual, **as directed**.
   e. Drain Valve: Minimum NPS 3/4 (DN 20) hose-end gate valve.
   f. Circulation Pump: Non-overloading, in-line pump with split-capacitor motor having thermal-overload protection and lubricated bearings; designed to operate at specified boiler pressures and temperatures.
7. Controls:
   a. Refer to Division 23 Section "Instrumentation And Control For Hvac".
      OR
      Boiler operating controls shall include the following devices and features:
      1) Control transformer.
      2) Motorized Vent Damper: Interlocked with burner to open before burner starts. If damper fails to open, stop burner operation.
      3) Set-Point Adjust: Set points shall be adjustable.
      4) Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain space temperature in response to thermostat with heat anticipator located in heated space.
         OR

Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature. At 0 deg F (minus 17 deg C) outside-air temperature, set supply-water temperature at 200 deg F (93 deg C); at 60 deg F (15 deg C) outside-air temperature, set supply-water temperature at 140 deg F (60 deg C).

5) Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.

b. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.

1) High Cutoff: Manual **OR** Automatic, **as directed**, reset stops burner if operating conditions rise above maximum boiler design temperature.

2) Water Flow Switch: Automatic-reset paddle-switch shall prevent burner operation on low water flow.

3) Blocked Vent Safety Switch: Manual-reset switch factory mounted on draft diverter.

4) Rollout Safety Switch: Factory mounted on boiler combustion chamber.

5) 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) Monitoring: On/off status, common trouble alarm **OR** low water level alarm, **as directed**.

2) Control: On/off operation, hot water supply temperature set-point adjustment, **as directed**.

3) 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.

B. Steel **OR** Flexible, **as directed**, Water-Tube Boilers

1. Description: Factory-fabricated and assembled **OR** Field-assembled, **as directed**, water-tube boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket, flue-gas vent, supply and return connections, and controls.

2. Heat-Exchanger Design: Straight steel tubes rolled into steel headers.

a. Accessible head plates at both ends.

b. Handholes or couplings, **as directed**, in headers for water-side inspections.

c. Accessible drain and blowdown tappings, both high and low, for surface and mud removal.

d. Lifting lugs on top of boiler.

e. Built-in air separator.

3. Heat-Exchanger Design: Bent steel tubes swaged **OR** welded, **as directed**, into steel headers with membrane waterwall design, **as directed**.

a. Limit tube configurations to two **OR** four, **as directed**.

b. Accessible drain and blowdown tappings, both high and low, for surface and mud removal.

c. Accessible inspection ports in drum, mud legs, and tube manifolds.

d. Lifting lugs on top of boiler.

e. Built-in air separator.

4. Combustion Chamber: Equipped with minimum 2-1/2-inch (64-mm) **OR** 3-inch (75-mm) **OR** 4-inch (100-mm), **as directed**, 2700 deg F (1482 deg C) poured refractory on floor and minimum 2-inch (50-mm) **OR** 3-1/2-inch (89-mm), **as directed**, lap-jointed cast refractory with fiber-blanket joint seals on side walls. Combustion chamber shall have flame observation ports in front and back **OR** back, **as directed**.

5. Casing:

a. Insulation: Minimum 2-inch (50-mm) thick, lightweight refractory; 1-inch (25-mm) thick insulating board; galvanized-steel membrane, and 2-inch (50-mm) thick, mineral-fiber insulation surrounding the heat exchanger and combustion chamber **OR** 2-inch (50-mm)

thick, mineral-fiber insulation surrounding the heat exchanger and combustion chamber, **as directed**.

b. Top Flue Connection: Constructed of aluminized steel **OR** stainless steel, **as directed**.

c. Jacket: Mirror-finish stainless steel, with screw-fastened closures.
OR
Jacket: Sheet metal **OR** Galvanized sheet metal, **as directed**, with screw-fastened closures and baked-enamel **OR** powder-coated, **as directed**, protective finish.

d. Mounting base to secure boiler to concrete base.

1) Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration And Seismic Controls For Hvac Piping And Equipment" when mounting base is anchored to building structure.

e. Control Compartment Enclosure: NEMA 250, Type 1A.

6. Draft Diverter **OR** Barometric Damper, **as directed**: Galvanized-steel assembly with flue-gas thermometer.

7. Burner - Atmospheric Gas Burners:

a. Burner and Orifices: Stainless steel **OR** Cast iron, **as directed**, for natural **OR** propane, **as directed**, gas.

b. Gas Train for Commercial Boilers: Control devices and full-modulation **OR** on-off **OR** low-high-low, **as directed**, control sequence shall comply with requirements in AGA **OR** ASME CSD-1 **OR** FMG **OR** IRI **OR** UL, **as directed**.

c. Gas Train for Residential Boilers: Combination gas valve with manual shutoff, pressure regulator, and pilot adjustment.

d. Pilot: Standing **OR** Intermittent-electric-spark, **as directed**, pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.

8. Burner - Forced-Draft Gas Burners:

a. Burner: Welded construction with multivane, stainless-steel, flame-retention diffuser for natural **OR** propane, **as directed**, gas. Mount burner on hinged access door to permit access to combustion chamber, **as directed**.

b. Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor; with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.

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.

c. Gas Train: Control devices and modulating **OR** on-off **OR** low-high-low, **as directed**, control sequence shall comply with requirements in AGA **OR** ASME CSD-1 **OR** FMG **OR** IRI **OR** UL, **as directed**.

d. Pilot: Intermittent **OR** Interrupted, **as directed**,-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.

e. Flue-Gas Recirculation: Burner connections shall be equipped for recirculating flue gas.

1) Maximum Oxides of Nitrogen Emissions: 20 **OR** 30, **as directed**, ppm.

9. Burner - Oil Burners:

a. Burner: Welded construction with multivane, stainless-steel, flame-retention diffuser for fuel oil. Mount burner on hinged access door to permit access to combustion chamber, **as directed**.

b. Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor; with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.

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.

c. Oil Supply: Control devices and modulating **OR** on-off **OR** low-high-low, **as directed**, control sequence shall comply with requirements in ASME CSD-1 **OR** FMG **OR** IRI **OR** UL, **as directed**.

1) Oil Pump: Two-stage, gear-type oil pump integral to and directly driven by blower, **as directed**, shall be capable of producing 300-psig (2070-kPa) discharge pressure and 15-inch Hg (50.7-kPa) vacuum.
2) Oil Piping Specialties:
a) Suction-line, manual, gate valve.
b) Removable-mesh oil strainer.
c) 0- to 30-inch Hg (0- to 101.3-kPa) vacuum; 0- to 30-psig (0- to 207-kPa) vacuum-pressure gage.
d) 0- to 300-psig (0- to 2070-kPa) oil-nozzle pressure gage.
e) Nozzle-line, solenoid-safety-shutoff oil valve.

d. Pilot: Intermittent **OR** Interrupted, **as directed**,-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff solenoid using cadmium sulfide **OR** UV scanner, **as directed**, flame-safety control.

e. Flue-Gas Recirculation: Burner connections shall be equipped for recirculating flue gas.
1) Maximum Oxides of Nitrogen Emissions: 30 ppm.

10. Burner - Combination Gas and Oil Burners:

a. Burner: Welded construction with multivane, stainless-steel, flame-retention diffuser for fuel oil and natural **OR** propane, **as directed** gas. Mount burner on hinged access door to permit access to combustion chamber, **as directed**.

b. Blower: Forward-curved centrifugal fan integral to burner, directly driven by motor; with adjustable, dual-blade damper assembly and locking quadrant to set air-fuel ratio.
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.

c. Oil Supply: Control devices and modulating **OR** on-off **OR** low-high-low, **as directed**, control sequence shall comply with requirements in ASME CSD-1 **OR** FMG **OR** IRI, **as directed**.
1) Oil Pump: Two-stage, gear-type oil pump integral to and directly driven by blower, **as directed**, shall be capable of producing 300-psig (2070-kPa) discharge pressure and 15-inch Hg (50.7-kPa) vacuum.
2) Oil Piping Specialties:
a) Suction-line, manual, gate valve.
b) Removable-mesh oil strainer.
c) 0- to 30-inch Hg (0- to 101.3-kPa) vacuum; 0- to 30-psig (0- to 207-kPa) vacuum-pressure gage.
d) 0- to 300-psig (0- to 2070-kPa) oil-nozzle pressure gage.
e) Nozzle-line, solenoid-safety-shutoff oil valve.

d. Gas Train: Control devices and modulating **OR** on-off **OR** low-high-low, **as directed**, control sequence shall comply with requirements in ASME CSD-1 **OR** FMG **OR** IRI **OR** UL, **as directed**.

e. Gas Pilot: Intermittent **OR** Interrupted, **as directed**,-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.

f. Oil Pilot: Intermittent **OR** Interrupted, **as directed**,-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff solenoid with cadmium sulfide **OR** UV scanner, **as directed**, flame-safety control.

g. Flue-Gas Recirculation: Burner connections shall be equipped for recirculating flue gas.
1) Maximum Oxides of Nitrogen Emissions: 20 **OR** 30, **as directed**, ppm.

11. Trim for Hot-Water Boilers:

a. Include devices sized to comply with ANSI B31.1, "Power Piping **OR** ANSI B31.9, "Building Services Piping", **as directed**.

b. Aquastat Controllers: Operating, firing rate, **as directed**, and high limit.

c. Safety Relief Valve: ASME rated.

d. Pressure and Temperature Gage: Minimum 3-1/2-inch- (89-mm-) diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.
e. Boiler Air Vent: Automatic **OR** Manual, **as directed**.
f. Drain Valve: Minimum NPS 3/4 (DN 20) hose-end gate valve.
g. Tankless Heater: Carbon-steel **OR** Bronze, **as directed**, header with copper-tube heat exchanger, mounted in a port of upper drum and sealed with fiber gasket.
1) Tappings NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
2) Tappings 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.

12. Trim for Steam Boilers:
a. Include devices sized to comply with ANSI B31.1, "Power Piping **OR** ANSI B31.9, "Building Services Piping", **as directed**.
b. Pressure Controllers: Operating, firing rate, **as directed**, and high limit.
c. Safety Relief Valve:
1) Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.
2) Description: Fully enclosed steel spring with adjustable pressure range and positive shutoff; factory set and sealed.
a) Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.
d. Pressure Gage: Minimum 3-1/2-inch (89-mm) diameter. Gage shall have normal operating pressure about 50 percent of full range.
e. Water Column: Minimum 12-inch (300-mm) glass gage with shutoff cocks.
f. Drain Valves: Minimum NPS 3/4 (DN 20) or nozzle size with hose-end connection.
g. Blowdown Valves: Factory-installed bottom and surface, slow-acting blowdown valves same size as boiler nozzle. Blowdown valves shall be combination of slow and quick acting as required by ANSI B31.1, **as directed**.
h. Stop Valves: Boiler inlets and outlets, except safety relief valves or preheater inlet and outlet, shall be equipped with stop valve in an accessible location as near as practical to boiler nozzle and same size or larger than nozzle. Valves larger than NPS 2 (DN 50) shall have rising stem.
i. Stop-Check Valves: Factory-installed, stop-check valve and stop valve at boiler outlet with free-blow drain valve factory installed between the two valves and visible when operating stop-check valve.
j. Tankless Heater: Carbon-steel header with copper-tube heat exchanger, mounted in a port of upper manifold and sealed with fiber gasket.
1) Tappings NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
2) Tappings 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.

13. Controls:
a. Refer to Division 23 Section "Instrumentation And Control For Hvac".
OR
Boiler operating controls shall include the following devices and features:
1) Control transformer.
2) Set-Point Adjust: Set points shall be adjustable.
3) Operating Pressure Control for Steam Boilers: Factory wired and mounted to cycle burner.
4) Low-Water Cutoff and Pump Control for Steam Boilers: Cycle feedwater pump(s) for makeup water control.

5) Sequence of Operation for Hot-Water Boilers: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain space temperature in response to thermostat with heat anticipator located in heated space.
OR
Sequence of Operation for Hot-Water Boilers: Electric, factory-fabricated and field-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature. At 0 deg F (minus 17 deg C) outside-air temperature, set supply-water temperature at 200 deg F (93 deg C); at 60 deg F (15 deg C) outside-air temperature, set supply-water temperature at 140 deg F (60 deg C).
6) Sequence of Operation for Steam Boilers: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain a constant steam pressure. Maintain pressure set point plus or minus 10 percent.
7) Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.

b. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
1) High Cutoff: Manual **OR** Automatic, **as directed**, reset stops burner if operating conditions rise above maximum boiler design temperature for hot-water boiler or design pressure for steam boiler.
2) Low-Water Cutoff Switch: Electronic (for hot-water boilers) or Float and electronic (for steam boilers) probe shall prevent burner operation on low water. Cutoff switch shall be manual **OR** automatic, **as directed**,-reset type.
3) Blocked Vent Safety Switch (Atmospheric Boilers): Manual-reset switch factory mounted on draft diverter.
4) Rollout Safety Switch (Atmospheric Boilers): Factory mounted on boiler combustion chamber.
5) 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) Monitoring: On/off status, common trouble alarm **OR** low water level alarm, **as directed**.
2) Control: On/off operation, hot water supply temperature set-point adjustment **OR** steam pressure adjustment, **as directed**.
3) 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.

C. Electrical Power
1. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 22.
OR
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.
a. House in NEMA 250, Type 1 enclosure.
b. Wiring shall be numbered and color-coded to match wiring diagram.
c. Install factory wiring outside of an enclosure in a metal, **as directed**, raceway.
d. Field power interface shall be to wire lugs **OR** fused disconnect switch **OR** nonfused disconnect switch **OR** circuit breaker, **as directed**.
e. Provide branch power circuit to each motor and to controls with disconnect switch or circuit breaker, **as directed**.

f. Provide each motor with overcurrent protection.

D. Venting Kits
1. Vent Damper (for Finned Water-Tube Boilers): Motorized, UL listed for use on atmospheric burner boiler equipped with draft hood; motor to open and close damper; stainless-steel vent coupling and damper blade; keyed wiring harness connector plug; and dual-position switches to permit burner operation.
2. Kit: Complete system, ASTM A 959, Type 29-4C, **as directed**, stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap, and sealant.
3. Combustion-Air Intake: Stainless steel, pipe, vent terminal with screen, inlet air coupling, and sealant.

E. Source Quality Control
1. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.
2. Burner and Hydrostatic Test (for Factory-Assembled Boilers): 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.
3. Allow the Owner access to source quality-control testing of boilers. Notify the Owner 14 days in advance of testing.

1.3 EXECUTION

A. Boiler Installation
1. 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 31.
2. Vibration Isolation: Elastomeric isolator pads **OR** mounts, **as directed**, 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".
3. Install gas-fired boilers according to NFPA 54.
4. Install oil-fired boilers according to NFPA 31.
5. Assemble boiler tubes in sequence and seal each tube joint.
6. Assemble and install boiler trim.
7. Install electrical devices furnished with boiler but not specified to be factory mounted.
8. Install control wiring to field-mounted electrical devices.

B. Connections
1. Piping installation requirements are specified in other Division 21. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to boiler to allow service and maintenance.
3. 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.
4. Connect oil piping full size to burner inlet with shutoff valve and union.
5. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.
6. Connect steam and condensate piping to supply-, return-, and blowdown-boiler tappings with shutoff valve and union or flange at each connection.
7. Install piping from safety relief valves to nearest floor drain (for hot-water boilers).
8. Install piping from safety valves to drip-pan elbow and to nearest floor drain (for steam boilers).
9. 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.
10. Boiler Flue Venting (for Finned Water-Tube Boilers):
    a. Install venting kit and combustion-air intake.

b. Connect full size to boiler connections. Comply with requirements in Division 23 Section "Breechings, Chimneys, And Stacks".

11. Connect breeching to full size of boiler outlet. Comply with requirements in Division 23 Section "Breechings, Chimneys, And Stacks" for venting materials.
12. Install flue-gas recirculation duct from vent to burner. Comply with requirements in Division 23 Section "Breechings, Chimneys, And Stacks" for recirculation duct materials.
13. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
14. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

C. Field Quality Control

1. Perform tests and inspections and prepare test reports.
   a. 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. Tests and Inspections:
   a. Perform installation and startup checks according to manufacturer's written instructions.
   b. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
   c. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
   d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
      1) Burner Test (for Field-Assembled Boilers): Adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency.
      2) Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and water temperature **OR** steam pressure, **as directed**.
      3) Set field-adjustable switches and circuit-breaker trip ranges as indicated.
3. Remove and replace malfunctioning units and retest as specified above.
4. Occupancy Adjustments: When requested within 12 months of date of Final 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.
5. Performance Tests, as directed:
   a. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
   b. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment in order to comply.
   c. Perform field performance tests to determine the capacity and efficiency of the boilers.
      1) For dual-fuel boilers, perform tests for each fuel.
      2) Test for full capacity.
      3) Test for boiler efficiency at low fire 20, 40, 60, 80, 100, 80, 60, 40 and 20, **as directed**, percent of full capacity. Determine efficiency at each test point.
   d. Repeat tests until results comply with requirements indicated.
   e. Provide analysis equipment required to determine performance.
   f. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
   g. Notify the Owner in advance of test dates.
   h. Document test results in a report and submit to the Owner.

D. Demonstration

1. Train the Owner's maintenance personnel to adjust, operate, and maintain boilers.

END OF SECTION 22 34 36 00

Task	Specification	Specification Description
22 34 36 00	22 12 23 13	Electric, Domestic Water Heaters
22 34 46 00	22 12 23 13a	Fuel-Fired, Domestic Water Heaters

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SECTION 22 35 23 00 - DOMESTIC WATER HEAT EXCHANGERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for heat exchangers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following heat exchangers:
a. Heating-fluid-in-coil, instantaneous heat exchangers.
b. Domestic-water-in-coil, instantaneous heat exchangers.
c. Heating-fluid-in-U-tube-coil, instantaneous heat exchangers.
d. Circulating, compact heat exchangers.
e. Circulating, storage heat exchangers.
f. Noncirculating, compact heat exchangers.
g. Noncirculating, storage heat exchangers.
h. Brazed-plate heat exchangers.
i. Frame-and-plate heat exchangers.
j. Heat reclaimers.
k. Compression tanks.
l. Heat-exchanger accessories.

C. Submittals
1. Product Data: For each type and size of heat exchanger indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
2. Shop Drawings: Diagram power, signal, and control wiring.
3. Manufacturer Seismic Qualification Certification
4. Source quality-control test reports.
5. Field quality-control test reports.
6. Operation and Maintenance Data: For heat exchangers to include in emergency, operation, and maintenance manuals.
7. Warranty: Special warranty specified in this Section.

D. Quality Assurance
1. 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.
2. ASME Compliance: Where ASME-code construction is indicated, fabricate and label heat-exchanger storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9" for all components that will be in contact with water.

E. Warranty
1. Manufacturer's standard form in which manufacturer agrees to repair or replace components of heat exchangers that fail in materials or workmanship within specified warranty period.
a. Failures include, but are not limited to, the following:
1) Structural failures including heat exchanger, storage tank, and supports.
2) Faulty operation of controls.
3) Deterioration of metals, metal finishes, and other materials beyond normal use.
b. Warranty Period(s): From date of Final Completion:

1) Instantaneous Heat Exchangers:
   a) Tube Coil and Shell: One year.
   b) Controls and Other Components: One year.
2) Circulating, Storage Heat Exchangers:
   a) Storage Tank: Five years.
   b) Tube Coil: Five years.
   c) Controls and Other Components: Three years.
3) Noncirculating, Storage Heat Exchangers:
   a) Storage Tank: Five years.
   b) Tube Coil: Five years.
   c) Controls and Other Components: Three years.
4) Plate Heat Exchangers:
   a) Brazed-Plate Type: One year.
   b) Plate-and-Frame Type: One year.
5) Heat Reclaimers: One year.
6) Compression Tanks: One year.

1.2 PRODUCTS

A. Instantaneous Heat Exchangers
   1. Heating-Fluid-in-Coil, Instantaneous Heat Exchangers:
      a. Description: Packaged assembly of tank, heat-exchanger coils, controls, and specialties for heating domestic water with heating hot water **OR** steam, **as directed**, in heat-exchanger coils.
      b. Construction: ASME-code, negligible-capacity, copper-lined, carbon-steel shell with 150-psig (1035-kPa) minimum working-pressure rating.
         1) Tappings: Factory fabricated of materials compatible with heat-exchanger shell. Attach tappings to shell before testing and labeling.
            a) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
            b) 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.
         2) Insulation: Complying with ASHRAE/IESNA 90.1, unless otherwise indicated, and suitable for operating temperature. Surround entire shell and nozzle except connections and controls.
         3) Heat-Exchanger Coils: Copper **OR** Copper nickel **OR** Stainless-steel, **as directed**, helix-wound coils for heating fluid with pressure rating equal to or greater than heating-fluid supply pressure.
         4) Temperature Control: Adjustable thermostat that operates control valve and that is capable of maintaining outlet-water temperature within 4 deg F (2 deg C) of setting.
         5) Safety Control: Automatic, high-temperature-limit cutoff device or system.
         6) Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3, for combination temperature and pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of heat exchanger. Select one relief valve with sensing element that extends into storage tank.
      c. Miscellaneous Components for Heating Hot-Water Unit: Control valve, valves, and piping. Include components fitted for pneumatic control.
      d. Miscellaneous Components for Steam Unit: Strainers, steam-control valve, steam trap, valves, pressure gage, thermometer, and piping. Include components fitted for pneumatic control.
         1) Exception: Steam trap is not required if manufacturer's written instructions direct that it not be used.
      e. Stand: Factory fabricated for floor mounting.

2. Domestic-Water-in-Coil, Instantaneous Heat Exchangers:
   a. Description: Tankless, packaged assembly of heat-exchanger coils, controls, and specialties for heating domestic water in coils with steam in shell.
   b. Construction: ASME code, with cast-iron or steel shell for steam.
      1) Cast-Iron Shell Pressure Rating: 75 psig (517 kPa).
      2) Steel Shell Pressure Rating: 150 psig (1035 kPa).
      3) Insulation: Complying with ASHRAE/IESNA 90.1, unless otherwise indicated, and suitable for operating temperature. Surround entire shell and nozzle except connections and controls.
   c. Heat-Exchanger Coils: Spiral-wound, copper or copper-alloy **OR** stainless-steel, **as directed**, coils for domestic water.
   d. Temperature Control: Adjustable thermostat that operates steam-control valve and that is capable of maintaining outlet-water temperature within 3 deg F (2 deg C) of setting.
   e. Safety Control: Automatic, high-temperature-limit cutoff device or system.
   f. Miscellaneous Components: Strainers, steam-control valve, steam trap, valves, and piping.
   g. Stand: Factory fabricated for floor mounting.
3. Heating-Fluid-in-U-Tube-Coil, Instantaneous Heat Exchangers:
   a. Description: Tankless, packaged assembly of heat-exchanger coil, controls, and specialties for heating domestic water in shell with heating hot water **OR** steam, **as directed**, in coil.
   b. Construction: ASME-code, negligible-capacity, copper-lined, carbon-steel or copper-alloy shell with 150-psig (1035-kPa) minimum working-pressure rating.
      1) Configuration: Horizontal **OR** Vertical, **as directed**.
      2) Shell Tappings: Factory fabricated of materials compatible with water heater shell. Attach tappings to shell before testing and labeling.
         a) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
         b) 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.
      3) Insulation: Complying with ASHRAE/IESNA 90.1, unless otherwise indicated, and suitable for operating temperature. Surround entire shell and nozzle except connections and controls.
      4) Heat-Exchanger Coil: Copper, double-wall **OR** single-wall, **as directed**, U tubes for heating fluid.
         a) Tube Pressure Rating: Equal to or greater than heating-fluid supply pressure.
   c. Temperature Control: Adjustable thermostat that operates steam-control valve and that is capable of maintaining outlet-water temperature within 5 deg F (3 deg C) of setting.
   d. Safety Control: Automatic, high-temperature-limit cutoff device or system.
   e. Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3, for combination temperature and pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of heat exchanger. Select one relief valve with sensing element that extends into shell.
   f. Miscellaneous Components for Heating Hot-Water Unit: Control valve, valves, and piping. Include components fitted for pneumatic control.
   g. Miscellaneous Components for Steam Unit: Strainers, steam-control valve, steam trap, valves, pressure gage, thermometer, and piping. Include components fitted for pneumatic control.
   h. Stand: Factory fabricated for floor mounting.

B. Circulating, Storage Heat Exchangers
   1. Circulating, Compact Heat Exchangers:
      a. Description: Packaged, small-capacity, hot-water storage tank with heat-exchanger coil; circulator; controls; and specialties for heating domestic water with heating hot water **OR** steam, **as directed**, in coil.

b. Flow Pattern: Standard-flow arrangement, with water from bottom of storage tank circulated across heat-exchanger coil and returned to tank. Include hot-water outlet located at top of tank and temperature sensor in tank.

c. Storage Tank Construction: ASME-code, vertical; copper-silicon or corrosion-resistant metal with 150-psig (1035-kPa) working-pressure rating. Include nozzle and head for heat-exchanger tube coil.

1) Configuration: Vertical.

2) Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing and labeling.

a) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.

b) 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.

3) Insulation: Complying with ASHRAE/IESNA 90.1, unless otherwise indicated, and suitable for operating temperature. Surround entire storage tank and nozzle except connections and controls.

d. Heat-Exchanger Coil: NPS 3/4 (DN 20) **OR** NPS 1-1/4 (DN 32), **as directed**, diameter, vented, double-wall, copper or copper-alloy, U tubes with tube sheet and supporting baffles.

1) Heat-Exchanger Pressure Rating: Equal to or greater than heating-fluid supply pressure.

e. Temperature Control: Adjustable thermostat.

f. Safety Control: Automatic, high-temperature-limit cutoff device or system. Include automatic low-water cutoff device or system.

g. Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3, for combination temperature and pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of heat exchanger. Select one relief valve with sensing element that extends into storage tank.

h. Gages: Factory-mounted thermometer and pressure gage.

i. Circulating Pump: UL 778, all-bronze, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3. Include mechanical seals, 125-psig (860-kPa) minimum working-pressure rating, and 225 deg F (107 deg C) continuous-water-temperature rating.

1) Pump Control: Sensor for operating pump and control valve.

j. Miscellaneous Components for Heating Hot-Water Units: Control valve, valves, and piping.

k. Miscellaneous Components for Steam Units: Strainers, steam-control valve, steam trap, valves, and piping.

l. Support: Factory mounted on skids.

m. Energy Management System Interface: Normally closed dry contacts for enabling and disabling heat exchanger.

2. Circulating, Storage Heat Exchangers:

a. Description: Packaged, large-capacity, hot-water storage tank with heat-exchanger coil, circulator, controls, and specialties for heating domestic water with heating hot water **OR** steam, **as directed**, in coil.

b. Flow Pattern: Standard-flow arrangement, with water from bottom of storage tank circulated across heat-exchanger coil and returned to tank. Include hot-water outlet located at top of tank and temperature sensor in tank.

c. Flow Pattern: Reverse-flow arrangement, with water from storage tank drawn across heat-exchanger coil and returned to bottom of tank. Include hot-water outlet and temperature sensor located in or at coil shell.

d. Storage Tank Construction: ASME-code steel with 125-psig (860-kPa) **OR** 150-psig (1035-kPa), **as directed**, working-pressure rating. Include nozzle and head for heat-exchanger tube coil.

1) Configuration: Horizontal **OR** Vertical, **as directed**.
2) Manhole: 11 by 15 inches (280 by 380 mm) in end head of horizontal **OR** sidewall of vertical, **as directed**, storage tank shell.
3) Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing and labeling.
   a) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
   b) 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.
4) Lining: Cement **OR** Glass **OR** Nickel plate **OR** Phenolic coating **OR** Sheet copper, **as directed**, complying with NSF 61 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.
5) Anode Rods: Factory installed, magnesium.
6) Insulation: Complying with ASHRAE/IESNA 90.1, unless otherwise indicated, and suitable for operating temperature. Surround entire storage tank and nozzle except connections and controls.

e. Heat-Exchanger Coil: NPS 3/4 (DN 20) **OR** NPS 1-1/4 (DN 32), **as directed**, diameter, vented, double-wall, copper or copper-alloy, U tubes with tube sheet and supporting baffles.
   1) Heat-Exchanger Pressure Rating: Equal to or greater than heating-fluid supply pressure.

f. Temperature Control: Adjustable temperature aquastat, mounted in storage tank shell head, unless otherwise indicated.

g. Safety Control: Automatic, high-temperature-limit cutoff device or system. Include automatic low-water cutoff device or system.

h. Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3, for combination temperature and pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of heat exchanger. Select one relief valve with sensing element that extends into storage tank.

i. Gages: Factory-mounted thermometer and pressure gage.

j. Circulating Pump: UL 778, all-bronze, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3. Include mechanical seals, 125-psig (860-kPa) minimum working-pressure rating, and 225 deg F (107 deg C) continuous-water-temperature rating.
   1) Pump Control: Sensor for operating pump and control valve.

k. Support: Factory mounted on skids.

l. Energy Management System Interface: Normally closed dry contacts for enabling and disabling heat exchanger.

C. Noncirculating, Storage Heat Exchangers

1. Compact Heat Exchangers:

a. Description: Hot-water storage tank with integral heat-exchanger coil, controls, and specialties for heating domestic water with heating hot water **OR** steam, **as directed**, in coil.

b. Storage Tank Shell Construction: Steel or stainless steel with 150-psig (1035-kPa) working-pressure rating.
   1) Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
   2) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
   3) Insulation: Complying with ASHRAE/IESNA 90.1 or ASHRAE 90.2, and suitable for operating temperature. Surround entire tank except connections and controls.
   4) Jacket: Steel with enameled finish, unless otherwise indicated.
   5) Anode Rods for Steel Tanks: Factory installed, magnesium.

c. Heat-Exchanger Coil: Copper or stainless-steel coil assembly, permanently installed inside storage tank, for heating fluid. Include working-pressure rating equal to or greater than heating-fluid supply pressure.
d. Temperature Control: Adjustable thermostat.
e. Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3, for combination temperature and pressure relief valves. Include relief valve with relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of heat exchanger. Select relief valve with sensing element that extends into storage tank.

2. Storage Heat Exchangers:
   a. Description: Assembly of hot-water storage tank with separate heat-exchanger coil; controls; and specialties for heating domestic water with heating hot water **OR** steam, **as directed**, in coil.
   b. Storage Tank Construction: ASME-code steel with 125-psig (860-kPa) **OR** 150-psig (1035-kPa), **as directed**, working-pressure rating. Include nozzle and head for heat-exchanger tube coil.
      1) Configuration: Horizontal **OR** Vertical, **as directed**.
      2) Manhole: 11 by 15 inches (280 by 380 mm) in end head of horizontal **OR** sidewall of vertical, **as directed**, storage tank shell.
      3) Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing and labeling.
         a) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
         b) 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.
      4) Lining: Cement **OR** Glass **OR** Nickel plate **OR** Phenolic coating **OR** Sheet copper, **as directed**, complying with NSF 61 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.
      5) Anode Rods: Factory installed, magnesium.
      6) Insulation: Complying with ASHRAE/IESNA 90.1, unless otherwise indicated, and suitable for operating temperature. Surround entire storage tank and nozzle except connections and controls.
   c. Heat-Exchanger Coil: NPS 3/4 (DN 20) **OR** NPS 1-1/4 (DN 32), **as directed**, diameter, vented, double-wall, copper or copper-alloy, U tubes with tube sheet and supporting baffles.
      1) Heat-Exchanger Pressure Rating: Equal to or greater than heating-fluid supply pressure.
   d. Temperature Control: Adjustable temperature aquastat, mounted in storage tank shell head, unless otherwise indicated.
   e. Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3, for combination temperature and pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of heat exchanger. Select one relief valve with sensing element that extends into storage tank.
   f. Support: Factory mounted on skids.

D. Plate Heat Exchangers
   1. Brazed-Plate Heat Exchangers:
      a. Description: Assembly of heat-exchanger plates, permanently brazed together, for using heating hot water **OR** steam, **as directed**, to heat domestic water.
      b. Working-Pressure Rating: 150 psig (1035 kPa) **OR** 200 psig (1380 kPa) **OR** 250 psig (1725 kPa) **OR** 400 psig (2760 kPa), **as directed**, minimum.
      c. Plate Construction: Single **OR** Vented, double, **as directed**, wall.
      d. Plate Material: ASTM A 666, Type 316 stainless steel.
      e. Connections: Stainless steel; threaded.

2. Frame-and-Plate Heat Exchangers:
   a. Description: Assembly of nonfixed-position, heat-exchanger plates, with frame, for using heating hot water **OR** steam, **as directed**, to heat domestic water.
   b. Working-Pressure Rating: 150 psig (1035 kPa) **OR** 200 psig (1380 kPa) **OR** 250 psig (1725 kPa) **OR** 400 psig (2760 kPa), **as directed**, minimum.
   c. Frame:
      1) Carrying and Guide Bars: Carbon steel **OR** Stainless steel, **as directed**.
      2) Fixed, Frame Plate; Pressure Plate; Support Column; and Nuts and Bolts: Carbon steel.
   d. Channel Plates:
      1) Type: Single **OR** Vented, double, **as directed**, wall.
      2) Material: ASTM A 666, Type 304 or 316 stainless steel.
      3) Gasket Material: Butyl or acrylonitrile-butadiene rubber, suitable for potable water.
   e. Connections: Stainless steel suitable for potable water.
      1) NPS 2 (DN 50) and Smaller: Threaded.
      2) NPS 2-1/2 (DN 65) and Larger: Flanged.
   f. Protective Shroud: Steel, covering channel plates.
   g. Insulation: Complying with ASHRAE/IESNA 90.1, unless otherwise indicated, and suitable for operating temperature. Surround entire heat exchanger except connections.

E. Heat Reclaimers
   1. Description: Waste-heat recovery device complying with and listed according to UL 207 for heat reclaimers. Device includes vertical drainage tube with helical, domestic water preheat coil around drainage tube.
      a. Drainage Tube: ASTM B 306, Type DWV, center, copper drainage tube of size indicated.
      b. Water Preheat Coil: ASTM B 88, Type L (ASTM B 88M, Type B), copper water tube, of size indicated attached to drainage tube.
         1) Working-Pressure Rating: 150 psig (1035 kPa) on potable-water supply tubing.
      c. Capacity and Characteristics:
         1) NPS 2 (DN 50) Drainage Tube:
            a) Domestic Water Preheat Coil: NPS 3/8 (DN 10).
            b) Unit Height: 20 inches (508 mm) **OR** 24 inches (610 mm) **OR** 30 inches (762 mm), **as directed**.
         2) NPS 3 (DN 80) Drainage Tube:
            a) Domestic Water Preheat Coil: NPS 1/2 (DN 15) **OR** NPS 3/4 (DN 20), **as directed**.
            b) Unit Height: 30 inches (762 mm) **OR** 40 inches (1016 mm) **OR** 60 inches (1524 mm), **as directed**.
         3) NPS 4 (DN 100) Drainage Tube:
            a) Domestic-Water Preheat Coil: NPS 1/2 (DN 15) **OR** NPS 3/4 (DN 20), **as directed**.
            b) Unit Height: 30 inches (762 mm) **OR** 40 inches (1016 mm) **OR** 60 inches (1524 mm), **as directed**.

F. Compression Tanks
   1. 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.
      a. Construction:
         1) Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
         2) Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
         3) Air-Charging Valve: Factory installed.
      b. Capacity and Characteristics:
         1) Working-Pressure Rating: 100 psig (690 kPa) **OR** 150 psig (1035 kPa), **as directed**.

2) Capacity Acceptable: 2 gal. (7.6 L) **OR** 4 gal. (15.1 L) **OR** 7 gal. (26.5 L) **OR** 10 gal. (37.9 L), **as directed**, minimum.

G. Heat-Exchanger Accessories
1. Combination Temperature and Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of heat exchanger. Select relief valves with sensing element that extends into heat-exchanger storage tank.
2. Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include pressure setting less than working-pressure rating of heat exchanger.
3. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.
4. Source Quality Control
5. Test and inspect heat-exchanger storage tanks, specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
6. Hydrostatically test commercial heat-exchanger storage tanks before shipment to minimum of one and one-half times pressure rating.
7. Prepare test reports.

1.3 EXECUTION

A. Heat-Exchanger Installation
1. Install heat exchangers on concrete bases.
   a. Concrete base construction requirements are specified in Division 22 Section "Common Work Results For Plumbing".
2. Install heat exchangers 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.
3. Anchor heat exchangers to substrate.
4. Install seismic restraints for heat exchangers. Anchor to substrate.
5. Install temperature and pressure relief valves in top portion of storage tank shells of heat exchangers with domestic water storage. Use relief valves with sensing elements that extend into shells. Extend relief-valve outlet, with drain piping same as water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
6. Install combination temperature and pressure relief valves in water piping for heat exchangers without storage. Extend relief-valve outlet, with drain piping same as water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
7. Install heat-exchanger 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 heat exchangers that do not have tank drains. Refer to Division 22 Section "Domestic Water Piping Specialties" for hose-end drain valves.
8. Install thermometer on each heat-exchanger domestic-water inlet and outlet piping, and install thermometer on each heat-exchanger heating-fluid inlet and outlet piping. Refer to Division 22 Section "Meters And Gages For Plumbing Piping" for thermometers.
9. Install pressure gages on heat-exchanger heating-fluid piping. Refer to Division 22 Section "Meters And Gages For Plumbing Piping" for pressure gages.
10. Fill heat exchangers with water.
11. Charge compression tanks with air.

B. Connections
1. Piping installation requirements are specified in other Division 14. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to heat exchangers to allow service and maintenance. Arrange piping for easy removal of heat exchangers.

3. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
4. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

C. Field Quality Control
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
2. Perform the following field tests and inspections and prepare test reports:
   a. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
   b. Operational Test: After electrical circuitry has been energized, confirm proper operation.
   c. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Remove and replace heat exchangers that do not pass tests and inspections and retest as specified above.

D. Demonstration
1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain heat exchangers.

END OF SECTION 22 35 23 00

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Task	Specification	Specification Description
22 35 23 00	22 12 23 13	Electric, Domestic Water Heaters
22 41 39 00	10 28 19 16	Plumbing Fixtures
22 41 39 00	22 01 40 00	Emergency Plumbing Fixtures
22 42 13 00	10 28 19 16	Plumbing Fixtures
22 42 13 00	22 01 40 00	Emergency Plumbing Fixtures
22 42 16 00	10 28 19 16	Plumbing Fixtures
22 42 16 00	22 01 40 00	Emergency Plumbing Fixtures

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SECTION 22 42 19 00 - PORCELAIN STEEL BATHTUB LINERS AND SURROUNDS

DESCRIPTION OF WORK

This specification covers the furnishing and installation of materials for porcelain steel bathtub liners and surrounds. Products shall be as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

GENERAL

System Description

1. Performance Requirements: Comply with following:
   a. Porcelain Enameled Formed Steel Plumbing Fixtures: FS WWP 542b, Section 12, Porcelain Enameled Fixtures:
      1) Specular Gloss: Determined in accordance with ASTM C 346.
         a) Cover Coat: 45 degree specular gloss.
      2) Acid Resistance: Determined in accordance with ASTM C 282.
         a) Cover Coat: Rating of not less than Class A.
      3) Alkali Resistance: Determined in accordance with ASTM C 614.
         a) Cover Coat: Weight Loss: Not exceed 20 mg/square inch.
      4) Abrasion Resistance: Determined in accordance with ASTM C 448.
         a) Surface Abrasion Index of Cover Coat: 40 or higher.
      5) Warpage: Comply with US Dept. of Commerce Commercial Standard (CS) 77, Paragraph 7.1; and US Dept. of Commerce Product Standard (PS) 5, Paragraph 6.2.2.
      6) Rigidity: Comply with PS 5, Paragraph 6.6.2.

Submittals

2. Product Data:
   a. Include porcelain enamel steel samples, backer board material, and joint sealant.

3. Shop Drawings
   a. Indicate proposed method of panel securing method.
   b. Templates: Furnish plumber with templates of all openings required in porcelain enamel wall system to accommodate new plumbing trim.
4. Design Drawings: If required, prepare and submit drawings for approval to applicable governmental agencies and obtain necessary permits and certificates for compliance when required.
5. Samples:
   a. Three samples of steel proposed to be used for bathtub liner and for wall panels.
      1) Samples without porcelain enamel coating.
      2) Sample: Used to calibrate elcometer to determine amount of porcelain enamel coatings applied.
   b. Three samples of each type of porcelain enamel finish on steel for acceptance.
   c. the Owner will retain one set of approved samples.
   d. Keep one set of approved samples at site throughout construction period.
6. Quality Assurance/Control Submittals:
   a. Test Reports: Results of testing by accredited independent laboratory demonstrating compliance of porcelain enamel with Performance Requirements.
   b. Certificates: Manufacturer's written certification that bathtub liners and surrounds meet or exceed specified requirements.

Quality Assurance

7. Materials: Been in general use and satisfactorily performed for minimum of five years. Provide list of locations where such materials have been used.
8. Certifications: Comply with ANSI Z34.2.
9. Regulatory Requirements: Comply with following:
   a. Install bathtub liners and surrounds in accordance with applicable codes and regulations. Should any specified items or requirements conflict with such codes and regulations, consult with the Owner.
   b. Accessibility:
      1) Architectural Barriers Act of 1968 as amended (42 USC 4152-4157) and HUD implementing regulations (24 CFR Part 40).
         a) Uniform Federal Accessibility Standards (UFAS).
      2) Section 504 of the Rehabilitation Act of 1973 as amended (29 USC 794) and HUD implementing regulations 24 CFR Part 8.
      3) Fair Housing Accessibility Guidelines (24 CF1R Chapter 1).
      4) Americans with Disabilities Act of 1990 (ADA) (28 CFR Part 35).
10. Mock-ups: Install one complete mock-up of each typical bathtub liner and surround installation. Comply with Section _____ for bathroom renovation mock-up requirements.
    a. Locations: As directed.
    b. Approved Mock-ups: Standard for rest of work.
    c. Approved Mock-ups: May remain part of completed project.
11. Pre-Installation Meetings: Hold meeting with associated plumbing items installer. Notify the Owner of time and location of meeting.

Project Conditions

12. Existing Conditions:
    a. Existing Utilities: Protect any sewer, water, gas, electric or other pipelines or conduits uncovered during work from damage.
13. Field Measurements: Field measure each bathroom before start of fabrication.

Scheduling And Sequencing

14. Scheduling: Schedule bathtub liner and surround work in coordination with associated plumbing work installer.
15. Scheduling and Completion: Comply with requirements of Detailed Scope of Work.

PRODUCTS

Bathtub Liners And Aprons

16. Description: Prefabricated customized inserts to fit existing bathtubs and provide new, substantial units, capable of supporting bather and coordinated and integrated with bathtub/shower surround system.
    a. Bathtub Liners and Aprons: Completely and uniformly enclose existing bathtubs, obscuring them from view.
    b. New Tub Liners and Aprons: Integrate with existing bathtubs, wall conditions, floor conditions, and plumbing connections to provide complete installation subject to individual dimensional variations in bathtub.
17. Bathtub Liner and Apron Materials: Sheet steel coated with porcelain enamel.
    a. Sheet Steel Thickness: No. 16 gage through 20 gage as specified below:

Gage	No. 16	No. I8	No. 20
Standard Thickness, mm (inch)	1.52 (0.0598)	1.21 (0.0478)	1.01 (0.0398)
Minimum Thickness, mm (inch)	1.37 (0.054)	1.09 (0.043)	0.84 (0.0329)

Bathtub/Shower Surrounds

18. Panel System: Prefabricated panels in solid sections and continuous to cover back and side walls of bathtub/shower, coordinated and integrated with bathtub liners and aprons.
    a. Height of Bathtub/Shower Surround: 1 500 mm (60 inches) above bathtub ledge.
    b. Contractor's Option: One, two, or three piece back wall system.
    c. Where window is located over bathtub, install porcelain enamel on steel on full depth of returns at full length of window stool and at jambs; from window stool to top of surround.
        1) Sill and Jamb System: Not interfere with easy use of and access to window pulls, handles, screen retainers, etc.
    d. Access Panels: Provide easily removable panel to provide access to tub and shower valves. Provide panels with shallow formed edge on all four sides to receive bead of joint sealant.
    e. Method of Securing: Not visible.
19. Panels: Coated with porcelain enamel to provide bright, hard, impervious panels.
    a. Panels: Retain their surface characteristics and resist wear as result of abrasion or scouring, and staining due to use of ordinary household abrasive cleaners in popular use.
    b. Material: Special purpose enameling iron or steel or low metalloid for carbon content, especially manufactured and processed for porcelain enamel units for architectural purposes.
        1) Thickness: 18 through 22 gage steel.
    c. Panel Edges: 90 degree flange formed as part of face panel and of same finish.
20. Wall Clips Supporting Panels: Minimum 20 gage, hot-dipped galvanized.
21. Fastening Devices: As required and in accordance with panel manufacturer's instructions and accepted good industry practices and as approved.
    a. Provide expansion toggle bolts, molly bolls, nylon and other plastic anchors, lead anchors as required for existing wall conditions.

Porcelain Enamel Finish

22. Porcelain Enamel Coating: Hard, impervious arid durable, glass-like coating produced by fusing carefully compounded mixture of mineral substances such as Cryolite, Feldspar, Quartz, Borax, Silica, Tin and Zirconium Oxide Clays at temperatures up to 980 degrees C (1800 degrees F) in accordance with ANSI A112.19.4M.
23. Porcelain Enamel: Apply to all areas of each component, including backs and flanges.
    a. Initial Enamel Coating: Apply to all surfaces and apply additional separately fired coating of chemically resistant porcelain enamel as face coat.
    b. Each coat of Porcelain Enamel: 0.10 to 0.15 mm (0.004 to 0.006 inch) when measured in accordance with ASTM D1186.
    c. Two Coatings of Porcelain Enamel on Exposed Surfaces of Panels: Thickness of 0.20 to 0.05 mm (0.008 to 0.002 inch).
    d. Final Porcelain Enamel Coat: Chemically resistant, complying with Performance Requirements in this Section.
    e. Installed Liner and Surround: Uniform color.
        1) Color: White.

Accessories

24. Bracing Strips/Filler Material/Backer Board: Fire retardant perlite or molded polystyrene material providing zero capillarity water resistance, and permanent insulation properties.
    a. Bracing Strips: Fire retardant molded polystyrene material.
    b. Filler Material: Sound deadening and cushioning material.
    c. Panel Backer Board: Minimum 12.7 mm (112 inch) thick.
25. Joint Sealant: Mildew resistant one-component silicone; FS TT-S-001543A, Class A; ASTM C 920, Type S, Grade NS, Class 25, Uses NT, G, and A.
    a. Color: Match color of porcelain enamel.
26. Bath Accessories: See Division 10 Section “Bath Accessories.”

Fabrication

27. Shop Assembly: Shop assemble panels to greatest extent possible.

a. Coordinate with bath accessories provided under Division 10 Section “Bath Accessories.”

EXECUTION

Examination

28. Site Verification of Conditions:
    a. Existing Conditions: Examine bathrooms before beginning installation.
    b. Field Measurements: Verify field measurements are as indicated on Shop Drawings.
    c. Do riot proceed with installation until conditions are satisfactory.

Preparation

29. Protection: Comply with requirements of Detailed Scope of Work.
    a. Protect or repair utilities damaged by operations under this Section.
    b. Protect adjacent elements from damage and disfiguration.
    c. Repair or replace damaged elements in accordance with Detailed Scope of Work.
30. Preparation: Prepare bathtubs and surround walls as required for proper installation in accordance with Detailed Scope of Work.

Installation

31. Interface With Other Work: Coordinate installation of bathtub liner and surround wall panel system with installation of bath accessories under Division 10 Section “Bath Accessories” and plumbing work under Division 15 Section “Plumbing.”
32. Bathtub Liners and Aprons:
    a. Installation: Accomplished without removing existing bathtub fixture.
    b. Bracing Strips/Filler Material: Partially line clearance between base of existing bathtubs and tub liner with bracing strips.
    c. Insert new bathtub liner over and into existing bathtub, simultaneously bottoming on and compressing filler material and resting on and being supported by intimate contact with existing bathtub seat and rim on all four sides, to eliminate any movement.
    d. Apron: Install new apron to extension to new bathtub liner ledge or seat portion; by inserting non-corrosive locating pins and/or fasteners as required between floor and roll rim of new tub liner.
    e. Customize bathtub liner Insert in accordance with variable field dimensions into variably sized ledges and seat: both in plant fabrication and field installation as required.
        1) a. Verify dimensions and conditions by visiting each bathroom for work indicated and specified.
33. Tub Surround Wall Panel System: Integrate wall panels with installation of new tub liners.
    a. Panel System: Install as extension of bathtub in upward direction bearing configuration and function of bathtub and shower enclosure.
    b. Install window sill and jamb system where window is located over bathtub in manner not to interfere with easy use of and access to window pulls, handles, screen retainers, etc.
    c. Existing Walls: Remove obstructions, encountered for installation of porcelain enamel panels.
        1) Patch and repair damaged wall board surfaces that are exposed after panel installation in accordance with Detailed Scope of Work.
        2) Backer Board: Provide between wall panels and existing masonry walls.
    d. Method of Securing Panels: Mechanical and not visible.
        1) Provide at least two wall clips on both top and bottom flanges of each panel.
        2) Exposed bolts, screw heads, grommets, battens, channel moldings. or any other fastening devices not allowed.
    e. Access Panels: Seal perimeter with joint sealant for waterproof joint.
    f. Joint Sealing: Permanently seal perimeter edges between new panels and existing walls, joints between panels, joints at window sill and jamb system, and comer joint at juncture of back wall with side walls with joint sealant .

34. Joint Sealants: Apply in accordance with manufacturers recommendations.
    a. Surfaces to be Sealed: Clean, dry and free of any foreign matter that would degrade adhesion.
    b. Prime cleaned surfaces in accordance with sealant manufacturer's recommendations.
    c. Protect surfaces adjacent to joints by masking tape before applying sealant. Remove tape upon finishing sealing work.

Cleaning

35. Cleaning: Comply with requirements of Detailed Scope of Work.
    a. Clean bathtub liners and surrounds after installation is completed with materials compatible with porcelain enamel and having no detrimental effects on porcelain enamel.

END OF SECTION 22 42 19 00

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Task	Specification	Specification Description
22 42 19 00	10 28 19 16	Plumbing Fixtures
22 42 19 00	22 01 40 00	Emergency Plumbing Fixtures
22 42 23 00	10 28 19 16	Plumbing Fixtures
22 42 23 00	22 01 40 00	Emergency Plumbing Fixtures
22 42 33 00	10 28 19 16	Plumbing Fixtures
22 42 33 00	22 01 40 00	Emergency Plumbing Fixtures
22 42 39 00	01 22 16 00	No Specification Required
22 42 39 00	10 28 19 16	Plumbing Fixtures
22 42 39 00	22 01 40 00	Emergency Plumbing Fixtures
22 42 43 00	10 28 19 16	Plumbing Fixtures
22 42 43 00	22 01 40 00	Emergency Plumbing Fixtures
22 42 46 00	10 28 19 16	Plumbing Fixtures
22 42 46 00	22 01 40 00	Emergency Plumbing Fixtures
22 43 13 00	10 28 19 16	Plumbing Fixtures
22 43 13 00	22 01 40 00	Emergency Plumbing Fixtures
22 43 16 00	10 28 19 16	Plumbing Fixtures
22 43 16 00	22 01 40 00	Emergency Plumbing Fixtures

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SECTION 22 43 39 00 - MEDICAL PLUMBING FIXTURES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for medical plumbing fixtures. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following medical plumbing fixtures and related components:
   a. Faucets for lavatories, showers, and sinks.
   b. Laminar-flow, faucet-spout outlets.
   c. Flushometers.
   d. Toilet seats.
   e. Protective shielding guards.
   f. Fixture supports.
   g. Bedpan washers.
   h. Water closets.
   i. Lavatories.
   j. Individual showers.
   k. Patients' combination toilets.
   l. Clinical sinks.
   m. Plaster sinks.
   n. Surgeons' scrub sinks.
   o. Surgeons' instrument sinks.
   p. Bathing units.
   q. Sitz baths.
   r. Bedpan washing equipment.
   s. Hydrotherapy whirlpools.
   t. Outlet boxes.
   u. Morgue equipment.

C. Definitions
1. Accessible Medical Plumbing Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
2. Fitting: Device that controls the flow of water into or out of the medical plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads, drains and tailpieces, and traps and waste pipes.
3. FRP: Fiberglass-reinforced plastic.
4. PMMA: Polymethyl methacrylate (acrylic) plastic.

D. Submittals
1. Product Data: For each type of medical plumbing fixture indicated.
2. LEED Submittal:
   a. Product Data for Credit WE 2, 3.1, and 3.2: Documentation indicating flow and water consumption requirements.
3. Shop Drawings: Diagram power, signal, and control wiring.
4. Operation and maintenance data.

E. Quality Assurance

1. 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.
2. 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", **as directed**; for plumbing fixtures for people with disabilities.
3. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
4. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
5. Select combinations fixtures and trim, faucets, fittings, and other components that are compatible.
6. Comply with the following applicable standards and other requirements specified for medical plumbing fixtures:
   a. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
   b. Plastic Bathtubs: ANSI Z124.1.
   c. Plastic Shower Enclosures: ANSI Z124.2.
   d. Slip-Resistant Bathing Surfaces: ASTM F 462.
   e. Vitreous-China Fixtures: ASME A112.19.2M.
7. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
   a. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
   b. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
   c. Faucets: ASME A112.18.1.
   d. Hose-Connection Vacuum Breakers: ASSE 1011.
   e. Hose-Coupling Threads: ASME B1.20.7.
   f. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
   g. NSF Materials: NSF 61.
   h. Pipe Threads: ASME B1.20.1.
   i. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
   j. Supply Fittings: ASME A112.18.1.
   k. Brass Waste Fittings: ASME A112.18.2.
8. Comply with the following applicable standards and other requirements specified for bathtub and shower faucets:
   a. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
   b. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.
   c. Faucets: ASME A112.18.1.
   d. Hand-Held Showers: ASSE 1014.
   e. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
   f. Hose-Coupling Threads: ASME B1.20.7.
   g. Manual-Control Antiscald Faucets: ASTM F 444.
   h. Pipe Threads: ASME B1.20.1.
   i. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
   j. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
   k. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
9. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
   a. Atmospheric Vacuum Breakers: ASSE 1001.
   b. Brass and Copper Supplies: ASME A112.18.1.
   c. Flexible Water Connectors: ASME A112.18.6.
   d. Manual-Operation Flushometers: ASSE 1037.
   e. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.
   f. Brass Waste Fittings: ASME A112.18.2.
10. Comply with the following applicable standards and other requirements specified for miscellaneous components:

a. Grab Bars: ASTM F 446.
b. Hose-Coupling Threads: ASME B1.20.7.
c. Off-Floor Fixture Supports: ASME A112.6.1M.
d. Pipe Threads: ASME B1.20.1.
e. Plastic Toilet Seats: ANSI Z124.5.
f. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.2 PRODUCTS

A. Lavatory Faucets
1. Description: Faucet for lavatory-type medical plumbing fixture. Coordinate faucet inlets with supplies, connectors, and fixture holes; coordinate outlet with spout and fixture receptor.
a. Maximum Flow Rate: 2.2 gpm (8.3 L/min.).
b. Body Material: Solid brass.
c. Finish: Polished chrome plate.
d. Type: Single-control mixing **OR** Single-valve nonmixing **OR** Two-handle mixing, **as directed**.
e. Tempering System: Not required **OR** Thermostatic **OR** Pressure balance, **as directed**.
f. Supply Centers: Single hole **OR** 4 inches (102 mm) **OR** 6 inches (152 mm) **OR** 8 inches (203 mm) **OR** 12 inches (305 mm) **OR** Adjustable, **as directed**.
g. Mounting: Deck, exposed **OR** Deck, concealed **OR** Back/wall, exposed **OR** Back/wall, concealed, **as directed**.
h. Handle(s): Single lever **OR** Cross, four arm **OR** Wrist blade, 4 inches (102 mm) **OR** Elbow, 6 inches (152 mm) **OR** Not applicable, **as directed**.
i. Temperature Indicators: Color-coded for hot and cold water.
j. Inlet(s): NPS 3/8 (DN 10) tubing, plain end **OR** NPS 3/8 (DN 10) tubing, with NPS 1/2 (DN 15) male adaptor **OR** NPS 1/2 (DN 15) male shank **OR** NPS 1/2 (DN 15) female shank, **as directed**.
k. Spout: Rigid **OR** Swing **OR** Rigid gooseneck **OR** Swivel gooseneck, **as directed**, brass.
l. Spout Outlet: Aerator **OR** Spray **OR** Laminar flow **OR** Plain end **OR** Spray, 0.5 gpm (1.5 L/min.), **as directed**.
m. Operation: Compression, manual **OR** Noncompression, manual **OR** Automatic, hard-wired electric sensor, **as directed**.
n. Drain: Pop up **OR** See fixture, **as directed**.

B. Shower Faucets
1. Description: Faucet for shower-type medical plumbing fixtures. Include hot- and cold-water indicators; check stops; and shower head, arm, and flange. Coordinate faucet inlets with supplies.
a. Maximum Flow Rate: 2.5 gpm (9.5 L/min.), unless otherwise indicated.
b. Body Material: Solid brass.
c. Finish: Polished chrome plate.
d. Type: Thermostatic **OR** Pressure balance **OR** Thermostatic and pressure balance, **as directed**, with integral or field-installed check stops on hot- and cold-water supplies.
e. Mounting: Exposed **OR** Concealed, **as directed**.
f. Handle(s): Single lever **OR** Cross, four arm **OR** Not applicable, **as directed**.
g. Temperature Indicators: Color-coded for hot and cold water.
h. Diverter Valve: Not required **OR** Integral with mixing valve **OR** Not integral with mixing valve, **as directed**.
i. Backflow Protection Device for Hand-Held Shower: Required **OR** Not required, **as directed**.
j. Operation: Compression, manual **OR** Noncompression, manual **OR** Automatic, hard-wired electric sensor, **as directed**.
k. Antiscald Device: Integral with mixing valve **OR** Not required, **as directed**.

l. Supply Connections: NPS 1/2 (DN 15) **OR** NPS 1/2 (DN 15), union **OR** Sweat, **as directed**.
m. Shower Head Material: Brass with chrome-plated finish.
n. Head Type: Ball joint **OR** Without ball joint **OR** Hand held, slide-bar mounted **OR** Hand held, hook mounted, **as directed**.
o. Spray Pattern: Fixed **OR** Adjustable, **as directed**.
p. Integral Volume Control: Required **OR** Not required, **as directed**.
q. Shower-Arm, Flow-Control Fitting: Not required **OR** 1.5 gpm (5.7 L/min.) **OR** 2.0 gpm (7.6 L/min.), **as directed**.

C. Sink Faucets
1. Description: Faucet for sink-type medical plumbing fixtures. Coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
a. Maximum Flow Rate: 2.5 gpm (9.5 L/min.), unless otherwise indicated.
b. Body Material: Solid brass.
c. Finish: Polished chrome plate **OR** Rough chrome plate, **as directed**.
d. Type: Sink faucet **OR** Clinical-sink faucet with stops in shanks, vacuum breaker, hose-thread outlet, and pail hook, **as directed**.
e. Tempering Device: Thermostatic **OR** Pressure balance **OR** Not required, **as directed**.
f. Mixing Valve: Single control **OR** Two-lever handle, **as directed**.
g. Backflow Protection Device for Hose Outlet: Required **OR** Not required **OR** Not applicable, **as directed**.
h. Supply Centers: Single hole **OR** 4 inches (102 mm) **OR** 6 inches (152 mm) **OR** 8 inches (203 mm) **OR** Adjustable, **as directed**.
i. Mounting: Deck, exposed **OR** Deck, concealed **OR** Back/wall, exposed **OR** Back/wall, concealed, **as directed**.
j. Handle(s): Lever **OR** Knob **OR** Cross, four arm **OR** Wrist blade, 4 inches (102 mm) **OR** Elbow, 6 inches (152 mm) **OR** Not applicable, **as directed**.
k. Temperature Indicators: Color-coded for hot water on left and cold water on right.
l. Inlet(s): NPS 3/8 (DN 10) plain-end tubing **OR** NPS 3/8 (DN 10) tubing with NPS 1/2 (DN 15) male adapter **OR** NPS 1/2 (DN 15) male shank **OR** NPS 1/2 (DN 15) female shank, **as directed**.
m. Spout: Rigid, solid **OR** Swing tubular **OR** Rigid, gooseneck, solid **OR** Swivel, gooseneck, solid, **as directed**, brass with wall brace, **as directed**.
n. Spout Outlet: Aerator **OR** Swivel aerator/spray **OR** Spray **OR** Laminar flow **OR** Hose thread **OR** Plain end, **as directed**.
o. Vacuum Breaker: Required **OR** Not required, **as directed**.
p. Operation: Compression, manual **OR** Noncompression, manual **OR** Automatic, hard-wired electric sensor, **as directed**.

D. Laminar-Flow Faucet-Spout Outlets
1. Description: Chrome-plated-brass faucet-spout outlet that produces non-aerating laminar stream. Include male or female thread that mates with faucet outlet for attachment to faucets where indicated and flow-rate range that includes flow of faucet.

E. Flushometers
1. Description: Flushometer for clinical-sink-type **OR** water-closet-type, **as directed**, medical plumbing fixture. Include brass body with corrosion-resistant internal components, non-hold-open feature, **as directed**, control stop with check valve, vacuum breaker, and copper or brass tubing, and polished chrome-plated finish on exposed parts.
a. Internal Design: Diaphragm operation.
b. Style: Exposed **OR** Concealed, **as directed**.
c. Inlet Size: NPS 1 (DN 25).
d. Trip Mechanism: Oscillating, lever-handle actuator **OR** Mechanical, push-button actuator with stainless-steel access plate **OR** Hydraulic, push-button actuator **OR** Foot-pedal

actuator **OR** Hard-wired, electric-sensor actuator **OR** Battery-operated sensor actuator, **as directed**.

e. Consumption: 1.6 gal./flush (6.0 L/flush) **OR** 3.5 gal./flush (13.3 L/flush), **as directed**.

f. Tailpiece Size: NPS 1-1/4 (DN 32) **OR** NPS 1-1/2 (DN 40), **as directed**, and standard length to top of bowl.

g. Integral Bedpan Washer: Not required **OR** Factory fabricated, attached to tailpiece, and with spray head, **as directed**.

F. Toilet Seats

1. Description: Plastic toilet seat for water-closet-type medical plumbing fixture.
   a. Material: Molded, solid plastic with antimicrobial agent, **as directed**.
   b. Configuration: Closed **OR** Open, **as directed**, front with **OR** without, **as directed**, cover.
   c. Size: Elongated, unless otherwise indicated.
   d. Class: Standard **OR** Heavy-duty, **as directed**, commercial.
   e. Hinge Type: Stainless-steel CK, check **OR** SC, self-sustaining check, **as directed**.
   f. Color: White **OR** Black, **as directed**.

G. Protective Shielding Guards

1. Protective Shielding Pipe Covers:
   a. Description: Manufactured plastic wraps for covering medical plumbing fixture hot-water supply **OR** hot- and cold-water supplies, **as directed**, and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.
2. Protective Shielding Piping Enclosures:
   a. Description: Manufactured plastic enclosure for covering medical plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

H. Fixture Supports

1. Water-Closet Supports:
   a. Description: Combination carrier designed for accessible **OR** standard, **as directed**, mounting height of wall-mounting, water-closet-type medical plumbing fixture. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.
2. Lavatory Supports:
   a. Description: Type I, lavatory carrier with exposed arms and tie rods **OR** Type II, lavatory carrier with concealed arms and tie rod **OR** Type III, lavatory carrier with hanger plate and tie rod, **as directed**, for wall-mounting, lavatory-type medical plumbing fixture. Include steel uprights with feet.
   b. Accessible-Fixture Support: Include rectangular steel uprights.
3. Sink Supports:
   a. Description: Type I, sink carrier with exposed arms and tie rods **OR** Type II, sink carrier with hanger plate, bearing studs, and tie rod **OR** Type III, sink carrier with hanger plate and exposed arms, **as directed**, for sink-type medical plumbing fixture. Include steel uprights with feet.
4. Bedpan Washers
   a. Description: Wall-mounting, hand-held, hand-control **OR** single-pedal, foot-control **OR** double-pedal, hot- and cold-water control, **as directed**, medical plumbing fixture.
      1) Hose: 48-inch- (1220-mm-) long rubber or vinyl hose with spray nozzle, wall bracket, and hook.
      2) Self-closing valve.
      3) Loose-key supply stop.
      4) Vacuum Breaker: Wall mounting, atmospheric.
      5) Finish: Polished, chrome-plated finish on metal parts exposed after installation.

I. Water Closets

1. Wall-Mounting Water Closets:
   a. Description: Accessible, wall-mounting **OR** Wall-mounting, **as directed**, back-outlet, vitreous-china medical plumbing fixture designed for bedpan washing and flushometer valve operation.
      1) Style: Flushometer valve.
         a) Bowl Type: Elongated with siphon-jet design and bedpan lugs or slots.
         b) Design Consumption: 1.6 gal./flush (6 L/flush).
         c) Color: White.
2. Floor-Mounting Water Closets:
   a. Description: Accessible, floor-mounting **OR** Floor-mounting, **as directed**, floor-outlet, vitreous-china medical plumbing fixture designed for bedpan washing and flushometer valve operation.
      1) Style: Flushometer valve.
         a) Bowl Type: Elongated with siphon-jet design and bedpan lugs or slots. Include bolt caps matching fixture.
         b) Height: Standard **OR** Accessible, **as directed**.
         c) Design Consumption: 1.6 gal./flush (6 L/flush).
         d) Color: White.

J. Lavatories
1. Wall-Mounting Lavatories:
   a. Description: Accessible, wall-mounting **OR** Wall-mounting, **as directed**, vitreous-china medical plumbing fixture.
      1) Type: With back **OR** Ledge back **OR** Shelf back **OR** Slab, **as directed**.
      2) Size: 18 by 15 inches (457 by 381 mm) **OR** 19 by 16 inches (483 by 406 mm) **OR** 20 by 18 inches (508 by 457 mm) **OR** 24 by 20 inches (610 by 508 mm), **as directed**, rectangular.
      3) Faucet Hole Punching: One hole **OR** Three holes, 2-inch (51-mm) centers **OR** Three holes, 4-inch (102-mm) centers, **as directed**.
      4) Faucet Hole Location: Top **OR** Front wall **OR** Inclined panel, **as directed**.
      5) Color: White.
      6) Faucet: Lavatory with pop-up waste **OR** for separate drain, **as directed**.
      7) Supplies: NPS 3/8 (DN 10) chrome-plated copper tubes or flexible connectors, **as directed**, with stops.
      8) Drain: See faucet **OR** Grid **OR** Grid with offset, **as directed**.
         a) Location: Not applicable.
      9) Drain Piping: NPS 1-1/4 (DN 32) **OR** NPS 1-1/4 by NPS 1-1/2 (DN 32 by DN 40), **as directed**, chrome-plated, cast-brass P-trap; NPS 1-1/4 (DN 32) **OR** NPS 1-1/2 (DN 40), **as directed**, 0.032-inch- (0.8-mm-) **OR** 0.045-inch- (1.1-mm-), **as directed**, thick tubular brass waste to wall; and wall escutcheon.
      10) Protective Shielding Guard(s): Designation, as directed by the Owner.
      11) Fixture Support: Lavatory.
2. Counter-Mounting Lavatories:
   a. Description: Accessible, **as directed**, Counter-mounting **OR** Undercounter-mounting, **as directed**, vitreous-china, medical plumbing fixture.
      1) Type: Flat rim with ledge **OR** Self-rimming, **as directed**.
      2) Rectangular Lavatory Size: 18 by 15 inches (457 by 381 mm) **OR** 19 by 16 inches (483 by 406 mm) **OR** 20 by 18 inches (508 by 457 mm) **OR** 24 by 20 inches (610 by 508 mm), **as directed**.
      3) Oval Lavatory Size: 19 by 16 inches (483 by 406 mm) **OR** 20 by 17 inches (508 by 432 mm), **as directed**.
      4) Round Lavatory Size: 18 inches (457 mm) **OR** 19 inches (483 mm), **as directed**, in diameter.
      5) Faucet Hole Punching: One hole **OR** Three holes, 2-inch (51-mm) centers **OR** Three holes, 4-inch (102-mm) centers, **as directed**.

6) Faucet Hole Location: Top **OR** Front wall **OR** Inclined panel, **as directed**.
7) Color: White.
8) Faucet: Lavatory with pop-up waste **OR** for separate drain, **as directed**.
9) Supplies: NPS 3/8 (DN 10) chrome-plated copper tubes or flexible connectors, **as directed**, with stops.
10) Drain: See faucet **OR** Grid **OR** Grid with offset, **as directed**.
    a) Location: Not applicable.
11) Drain Piping: NPS 1-1/4 (DN 32) **OR** NPS 1-1/4 by NPS 1-1/2 (DN 32 by DN 40), **as directed**, chrome-plated, cast-brass P-trap; NPS 1-1/4 (DN 32) **OR** NPS 1-1/2 (DN 40), **as directed**, 0.032-inch- (0.8-mm-) **OR** 0.045-inch- (1.1-mm-), **as directed**, thick tubular brass waste to wall; and wall escutcheon.
12) Protective Shielding Guard(s): Designation, as directed by the Owner.

K. Individual Showers:
1. Description: Accessible, **as directed**, FRP **OR** PMMA, **as directed**, shower enclosure medical plumbing fixture with slip-resistant bathing surface complying with ASTM F 462. Comply with ADA requirements for use by people with disabilities.
   a. Size: 36 by 34 inches (915 by 865 mm) **OR** 42 by 36 inches (1065 by 915 mm) **OR** 43 by 39 inches (1090 by 990 mm) **OR** 48 by 34 inches (1220 by 865 mm) **OR** 52 by 36 inches (1320 by 915 mm) **OR** 60 by 36 inches (1525 by 915 mm) **OR** 72 by 36 inches (1830 by 915 mm), **as directed**.
   b. Surround: One piece.
   c. Color: White.
   d. Faucet: Shower.
   e. Drain: Grid, NPS 2 (DN 50).
      1) Location: Left side **OR** Center **OR** Right side, **as directed**.
   f. Accessories: If not furnished as integral components of specified fixture. Accessories are specified in Division 10 Section "Toilet, Bath, And Laundry Accessories".
      1) Grab bar(s).
      2) Normal-duty **OR** Heavy-duty, **as directed**, shower-curtain rod.
      3) Vinyl **OR** Duck **OR** Antibacterial, **as directed**, shower curtain.
      4) Shower-curtain hooks.
      5) Folding seat, **as directed**.

L. Patients' Combination Toilets
1. Swing-Away, Patients' Combination Toilets:
   a. Description: Factory-fabricated, combination water closet and lavatory medical plumbing fixture.
      1) Cabinet: Fixed installation with storage space and toilet paper holder.
         a) Material: Stainless steel **OR** Stainless steel, plastic laminate, or fiberglass, **as directed**, with laminated-wood or -plastic **OR** solid-plastic **OR** stainless-steel, **as directed**, top surface.
         b) Color: Not applicable.
         c) Mounting: Wall bracket.
      2) Water Closet: Swivel, floor-mounting, back-outlet **OR** floor-outlet, **as directed**, flushometer valve design.
         a) Material: Stainless steel.
         b) Orientation: Left **OR** Right, **as directed**, hand.
         c) Color: Not applicable.
         d) Toilet Seat: White, solid plastic.
         e) Flushometer: Concealed flushometer valve with push-button trip mechanism, check stop, and vacuum breaker on tailpiece.
         f) Fixture Support: Floor plate.
         g) Seal: For outlet.
      3) Lavatory: Counter mounting.
         a) Material: Stainless steel.

b) Color: Not applicable.
c) Faucet: Gooseneck type with wrist-blade handles **OR** Swing-spout type with single lever, **as directed**.
d) Drain: Grid, NPS 1-1/4 (DN 32).
e) Drain Piping: NPS 1-1/4 (DN 32) chrome-plated, cast-brass P-trap; tubular-brass waste to wall; and wall flange.

4) Bedpan Washer: On flushometer valve tailpiece or separate attachment affixed to unit.

2. Static, Patients' Combination Toilets:
a. Description: Factory-fabricated, combination water closet and lavatory fixture.
1) Cabinet: Fixed installation; swing-away cabinet or retractable, water-closet cover design with storage space and toilet paper holder.
a) Material: Stainless steel **OR** Stainless steel, plastic laminate, or fiberglass, **as directed**, with laminated-wood or -plastic **OR** solid-plastic **OR** stainless-steel, **as directed**, top surface.
b) Color: Not applicable.
c) Mounting: Wall bracket.

2) Water Closet: Floor-mounting, floor-outlet, flushometer valve design.
a) Material: Stainless steel or vitreous china.
b) Orientation: Left **OR** Right, **as directed**, hand.
c) Color: Not applicable.
d) Toilet Seat: White, solid plastic.
e) Flushometer: Concealed flushometer valve with push-button trip mechanism, check stop, and vacuum breaker on tailpiece.
f) Seal: For outlet.

3) Lavatory: Counter mounting.
a) Material: Stainless steel.
b) Color: Not applicable.
c) Faucet: Gooseneck type with wrist-blade handles **OR** Swing-spout type with single lever, **as directed**.
d) Drain: Grid, NPS 1-1/4 (DN 32).
e) Drain Piping: NPS 1-1/4 (DN 32) chrome-plated, cast-brass P-trap; tubular-brass waste to wall; and wall flange.

4) Bedpan Washer: On flushometer valve tailpiece or separate attachment affixed to unit.

M. Clinical Sinks
1. Wall-Mounting Clinical Sinks:
a. Description: Wall-mounting, back-outlet, vitreous-china, flushing-rim, service-sink-type medical plumbing fixture.
1) Size: Approximately 25 by 20 inches (635 by 510 mm).
2) Color: White.
3) Rim Guard: Stainless steel on front and also on sides if flat rim.
4) Faucet: Sink, polished, chrome-plated, solid-brass, service-sink faucet type, including integral stops in shanks, vacuum breaker, hose-thread outlet, and pail hook.

2. Floor-Mounting Clinical Sinks:
a. Description: Floor-mounting, bottom-outlet, vitreous-china, flushing-rim, service-sink-type medical plumbing fixture. Include bolt caps.
1) Size: Approximately 27 by 20 inches (685 by 510 mm).
2) Color: White.
3) Rim Guards: Stainless steel on front and sides.
4) Sink Base: 10-inch (25.4-mm) -high, cast terrazzo if required.

5) Faucet: Sink, polished, chrome-plated, solid-brass, service-sink faucet type, including integral stops in shanks, vacuum breaker, hose-thread outlet, and pail hook.

N. Plaster Sinks:
1. Description: Wall-mounting, vitreous-china medical plumbing fixture.
   a. Size: 24 by 22 inches (610 by 560 mm) **OR** 30 by 22 inches (760 by 560 mm), **as directed**, with back or ledge faucet holes.
   b. Color: White.
   c. Faucet Holes: One **OR** Two, **as directed**, in back or ledge.
   d. Faucet: Sink.
   e. Supplies: NPS 1/2 (DN 15) chrome-plated copper tubes or flexible connectors, **as directed**, with stops.
   f. Drain: Grid, NPS 1-1/2 (DN 40) with NPS 1-1/2 (DN 40) to NPS 2 (DN 50) adaptor, **as directed**.
   g. Drain Piping: NPS 1-1/2 (DN 40) **OR** NPS 2 (DN 50), **as directed**, chrome-plated brass; 0.045-inch- (1.1-mm-) thick waste to interceptor; interceptor to wall; and wall flange.
   h. Plaster Interceptor:
      1) Description: Cast-iron or steel body and removable cover with acid-resistant-enameled interior lining and outside coating; removable, corrosion-resistant metal screens or strainer; and NPS 1-1/2 (DN 40) **OR** NPS 2 (DN 50), **as directed**, inlet and outlet.
2. Fixture Support: Sink with white-enameled-steel brackets.

O. Surgeons' Scrub Sinks
1. Stainless-Steel Surgeons' Scrub Sinks:
   a. Description: Wall-mounting, sink-type medical plumbing fixture.
      1) Size: Approximately 31 by 20 inches (790 by 510 mm) with back with 1 faucet hole.
      2) Faucet: Chrome-plated-brass, gooseneck type matching fixture.
      3) Operation: Foot-pedal **OR** Knee **OR** Automatic, hard-wired electric sensor, **as directed**, control.
      4) Supplies: NPS 1/2 (DN 15) chrome-plated copper tubes or flexible connectors, **as directed**, with stops.
      5) Drain: Grid, NPS 1-1/2 (DN 40).
      6) Drain Piping: NPS 1-1/2 (DN 40) chrome-plated, cast-brass P-trap; 0.045-inch- (1.1-mm-) thick tubular-brass waste to wall; and wall flange.
      7) Fixture Support: Sink.
2. Vitreous-China Surgeons' Scrub Sinks:
   a. Description: Wall-mounting, sink-type medical plumbing fixture.
      1) Size: 28 by 22 inches (710 by 560 mm) **OR** 30 by 22 inches (760 by 560 mm), **as directed**, with back or ledge with 1 faucet hole.
      2) Color: White.
      3) Faucet: Chrome-plated-brass, gooseneck-type matching fixture.
      4) Operation: Foot-pedal **OR** Knee, **as directed**, control.
      5) Supplies: NPS 1/2 (DN 15) chrome-plated copper tubes or flexible connectors, **as directed**, with stops.
      6) Drain: Grid, NPS 1-1/2 (DN 40).
      7) Drain Piping: NPS 1-1/2 (DN 40) chrome-plated, cast-brass P-trap; 0.045-inch- (1.1-mm-) thick tubular-brass waste to wall; and wall flange.
      8) Fixture Support: Sink.

P. Surgeons' Instrument Sinks:
1. Description: Wall-mounting, stainless-steel, sink-type medical plumbing fixture. Include instrument tray on each side.
   a. Size: 28 by 20 inches (710 by 510 mm) with 1 hole for deck-mounting faucet.

b. Faucet: Chrome-plated-brass, gooseneck type matching fixture with knee **OR** foot-pedal, **as directed**, control for mixing hot- and cold-water supplies.
c. Supplies: NPS 1/2 (DN 15) chrome-plated copper tubes or flexible connectors, **as directed**, with stops.
d. Drain: Grid, NPS 1-1/2 (DN 40).
e. Drain Piping: NPS 1-1/2 (DN 40) chrome-plated, cast-brass P-trap; 0.045-inch- (1.1-mm-) thick tubular-brass waste to wall; and wall flange.
f. Fixture Support: Sink.

Q. Bathing Units
1. Institutional Bath Tubs:
a. Description: Enameled, cast-iron, island medical plumbing fixture with separate wall-mounting faucet.
1) Size: 66 by 30 by 18 inches (1680 by 765 by 455 mm).
2) Base: Enameled, cast iron to raise rim of bathtub to 28 inches (710 mm) above the floor.
3) Faucet: Shower **OR** Sink, **as directed**, modified to include tub filler spout.
4) Supplies: NPS 1/2 (DN 15) chrome-plated copper tubes or flexible connectors, **as directed**, with stops. Include atmospheric vacuum breaker.
5) Drain: NPS 1-1/2 (DN 40); chrome-plated exposed parts; brass pop-up waste and overflow.
6) Drain Piping: NPS 1-1/2 (DN 40) chrome-plated, cast-brass P-trap; 0.045-inch- (1.1-mm-) thick tubular-brass waste to wall; and wall flange.
2. Bathing Units:
a. Description: Plastic-tub, institutional side-entry bath **OR** whirlpool-bath, **as directed**, fixture with integral controls.
1) Tub Size: 60 by 30 inches (1525 by 765 mm).
2) Controls: Vacuum breakers on supplies, thermostatic mixing valve, tub fill spout, and hand-held shower head.
3) Supplies: NPS 3/4 (DN 20) **OR** NPS 1 (DN 25), **as directed**, copper tubing with ball, gate, or globe valves.
4) Drain: NPS 1-1/2 (DN 40) and NPS 2 (DN 50).
5) Drain Piping: NPS 1-1/2 (DN 40) **OR** NPS 2 (DN 50), **as directed**, cast-brass P-trap, waste to wall, and wall flange. Include combined drain piping if two drains.
3. Bathing Units:
a. Description: Plastic-tub, institutional side-entry **OR** transfer-lift-entry **OR** slide-on-entry, **as directed**, adjustable-height **OR** fixed-height, **as directed**, bath fixture with integral controls.
1) Tub Size: 60 by 30 inches (1525 by 765 mm).
2) Controls: Vacuum breakers on supplies, thermostatic mixing valve, tub fill spout, and hand-held shower head.
3) Supplies: NPS 3/4 (DN 20) **OR** NPS 1 (DN 25), **as directed**, copper tubing with ball, gate, or globe valves.
4) Drain: NPS 1-1/2 (DN 40) and NPS 2 (DN 50).
5) Drain Piping: NPS 1-1/2 (DN 40) **OR** NPS 2 (DN 50), **as directed**, cast-brass P-trap, waste to wall, and wall flange. Include combined drain piping if two drains.
6) Lift System: Not required.
4. Bathing Units:
a. Description: Plastic-tub, institutional front-entry shower fixture with integral controls.
1) Cabinet Size: 35 by 41 inches (889 by 1041 mm).
2) Controls: Vacuum breakers on supplies, thermostatic mixing valve, tub fill spout, and hand-held shower head.
3) Supplies: NPS 3/4 (DN 20) **OR** NPS 1 (DN 25), **as directed**, copper tubing with ball, gate, or globe valves.
4) Drain: NPS 2 (DN 50).
5) Drain Piping: NPS 2 (DN 50) cast-brass P-trap, waste to wall, and wall flange.

5. Residential Bath Tubs:
   a. Description: Plastic island or against-wall-installation, **as directed**, medical plumbing fixture with side door, seat, and separate wall-mounting faucet.
      1) Size 1
         a) Size: Approximately 60 by 32 by 21 inches (1525 by 815 by 535 mm).
         b) Seat: Integral.
         c) Drain Location: Left **OR** Right, **as directed**, end.
      2) Size 2
         a) Size: Approximately 60 by 42 by 24.5 inches (1525 by 1070 by 620 mm).
         b) Seat: Integral bench **OR** None, **as directed**.
         c) Drain Location: Right end.
      3) Material: PMMA.
      4) Skirt: Front only **OR** Full, on three sides, **as directed**.
      5) Door: Side opening with rubber sealing gasket.
      6) Faucet: Shower **OR** Sink, **as directed**, modified to include tub filler spout.
      7) Supplies: NPS 1/2 (DN 15) chrome-plated copper tubes or flexible connectors, **as directed**, with stops. Include atmospheric vacuum breaker.
      8) Drain: NPS 1-1/2 (DN 40); chrome-plated exposed parts; brass pop-up waste and overflow.
      9) Drain Piping: NPS 1-1/2 (DN 40) cast-brass P-trap and 0.045-inch- (1.1-mm-) thick, tubular-brass waste to wall.

R. Sitz Baths:
   1. Description: Pedestal-mounting **OR** Wall-mounting, **as directed**, vitreous-china, perineal bath medical plumbing fixture.
      a. Color: White.
      b. Drain: NPS 1-1/2 (DN 40) with removable overflow attachment.
      c. Drain Piping: NPS 1-1/2 (DN 40) chrome-plated, cast-brass P-trap; waste to wall; and wall flange.
      d. Fixture Support: Sink.
      e. Faucet:
         1) Description: Wall-mounting, single-lever-handle, thermostatic-mixing-valve faucet with concealed supplies and wall-mounting thermometer.
            a) Material: Brass body and escutcheon.
            b) Flow Rate: Modified to 1.5 gpm (5.7 L/min.) maximum, unless otherwise indicated.
            c) Finish: Polished chrome plate.
            d) Temperature Indicators: Color-coded for hot and cold water.
      f. Exposed Piping: Chrome-plated; brass pipe or copper tube.

S. Bedpan Washing Equipment
   1. Bedpan Washers/Sanitizers:
      a. Description: Recessed-mounting **OR** On-wall-mounting **OR** Pedestal-mounting, **as directed**, medical plumbing fixture for cleaning bedpans and urinals having cast-iron chamber and waste assembly with spray nozzles and enameled-steel **OR** stainless-steel, **as directed**, front panel and cover box.
         1) Controls: Electric, 120-V ac, automatic operation with timer, solenoid valves, and circuit breaker.
         2) Door Mechanism: Foot-pedal operation.
         3) Supplies: NPS 1 (DN 25) cold water and NPS 3/8 (DN 10) hot water **OR** steam, **as directed**.
         4) Drain: NPS 3 (DN 80) P-trap and soil pipe.
         5) Atmospheric Vent: NPS 2 (DN 50).
         6) Mounting Hardware: Matching fixture mounting arrangement.
         7) Accessories:
            a) Bedpan Rack(s): One **OR** Two, **as directed**.

b) Urinal Rack(s): One **OR** Two, **as directed**.
c) Drain Tray(s): One **OR** Two, **as directed**.

2. Bedpan Washers/Disinfectors:
   a. Description: Freestanding-mounting **OR** On-wall-mounting **OR** Undercounter-mounting, **as directed**, medical plumbing fixture for cleaning bedpans and urinals; with steam generator, pump, and spray nozzle.
      1) Controls: Electric, automatic operation.
      2) Cabinet: Stainless steel.
      3) Wash Chamber: Stainless steel.
      4) Supplies: NPS 1/2 (DN 15) cold water and NPS 1/2 (DN 15) hot water.
      5) Drain: NPS 4 (DN 100) P-trap and soil pipe.
      6) Mounting Hardware: Matching fixture mounting arrangement.

T. Hydrotherapy Whirlpools
1. Podiatry Whirlpools:
   a. Description: Stationary, stainless-steel tank for feet and ankles.
      1) Water Capacity: 15 gal. (57 L).
      2) Drain: Waste connection.
      3) Controls.
      4) Thermometer: Control panel or tank mounted.
      5) One electric turbine ejector.
2. Upper-Extremity Whirlpools:
   a. Description: Stationary, pedestal-mounted, stainless-steel tank for arms, hands, and elbows.
      1) Water Capacity: 25 gal. (95 L).
      2) Drain: Waste connection.
      3) One arm support.
      4) Controls.
      5) Thermometer: Control panel or tank mounted.
      6) One electric turbine ejector.
3. High-Tank Body Whirlpools:
   a. Description: Stationary, stainless-steel tank for legs, hip, and back.
      1) Water Capacity: 105 gal. (397 L).
      2) Drain: Waste connection.
      3) Controls.
      4) Thermometer: Control panel or tank mounted.
      5) One electric turbine ejector.
4. Low-Tank Body Whirlpools:
   a. Description: Stationary, extended-length stainless-steel tank for legs, hip, and lower back.
      1) Water Capacity: 105 gal. (397 L).
      2) Drain: Waste connection.
      3) Controls.
      4) Thermometer: Control panel or tank mounted.
      5) Head rest.
      6) One electric turbine ejector.
5. Small, Hubbard Immersion Tanks:
   a. Description: Stationary, butterfly-shaped tank, for full-body massage
      1) Tank Dimensions: 93 by 64 by 22 inches (2362 by 1626 by 560 mm).
      2) Overall Height: 34 to 38 inches (864 to 965 mm).
      3) Water Capacity: 268 gal. (1014 L).
      4) Material: Stainless steel.
      5) Supports: Legs or base.
      6) Controls.
      7) Thermometer: Control panel or tank rim mounted.
      8) Supply: Over-the-rim fill spout.

9) Drains: Two waste connections.
10) Electric Turbine Ejectors: Two; one rail mounted on each side.
11) Thermostatic, mixing-valve assembly.
12) Hose and hand-held shower.
13) Wash-out-hose assembly.
14) Stretcher lift.
15) Overhead electric, **as directed**, hoist.

6. Medium, Hubbard Immersion Tanks:
   a. Description: Stationary, butterfly-shaped tank, for full-body massage.
      1) Tank Dimensions: 100 by 73 by 24 inches (2540 by 1854 by 610 mm).
      2) Overall Height: 34 to 38 inches (864 to 965 mm).
      3) Water Capacity: 377 gal. (1468 L).
      4) Material: Stainless steel.
      5) Supports: Legs or base.
      6) Controls.
      7) Thermometer: Control panel or tank rim mounted.
      8) Supply: Over-the-rim fill spout.
      9) Drain: One waste connection.
      10) Electric Turbine Ejector: One, panel mounted.
      11) Thermostatic, mixing-valve assembly.
      12) Hose and hand-held shower.
      13) Wash-out-hose assembly.
      14) Stretcher lift.
      15) Overhead electric, **as directed**, hoist.
7. Large, Hubbard Immersion Tanks:
   a. Description: Stationary, butterfly-shaped tank, for full-body massage.
      1) Tank Dimensions: 106 by 77 by 22 inches (2692 by 1956 by 560 mm).
      2) Overall Height: 34 inches (864 mm).
      3) Water Capacity: 425 gal. (1609 L).
      4) Material: Stainless steel.
      5) Supports: Legs or base.
      6) Controls.
      7) Thermometer: Control panel or tank rim mounted.
      8) Supply: Over-the-rim fill spout.
      9) Drain(s): One or two waste connections.
      10) Electric Turbine Ejectors: Two; one rail mounted on each side.
      11) Thermostatic, mixing-valve assembly.
      12) Hose and hand-held shower.
      13) Wash-out-hose assembly.
      14) Stretcher lift.
      15) Overhead electric, **as directed**, hoist.
8. Full-Body Immersion Tanks:
   a. Description: Stationary, rectangular tank, for full-body massage
      1) Tank Dimensions: 90 by 32 by 19 inches (2286 by 813 by 483 mm) **OR** 95 by 41 by 22 inches (2413 by 1041 by 560 mm), **as directed**.
      2) Overall Height: 32 or 34 inches (813 or 860 mm).
      3) Water Capacity: 195 gal. (738 L) **OR** 260 gal. (984 L), **as directed**.
      4) Material: Stainless steel.
      5) Supports: Legs or base.
      6) Controls.
      7) Thermometer: Control panel or tank rim mounted.
      8) Supply: Over-the-rim fill spout.
      9) Drain(s): One or two waste connections.
      10) Electric Turbine Ejector: One, tank mounted at end **OR** on rail **OR** on side, **as directed**.
      11) Thermostatic, mixing-valve assembly.

12) Hose and hand-held shower.
13) Wash-out-hose assembly.
14) Stretcher lift.
15) Overhead electric, **as directed**, hoist.

U. Outlet Boxes
1. Dialysis Equipment Outlet Boxes:
a. Description: Recessed-mounting outlet box with water supply and drain connections.
1) Box and Faceplate: Stainless steel.
2) Supply Fitting(s): 1 **OR** 2, **as directed**, NPS 1/2 (DN 15) PVC ball valve(s) and adapter with male hose-thread outlet.
3) Drain: NPS 2 (DN 50) standpipe, P-trap, and direct waste connection to drainage piping.
b. Reinforcement: 2-by-4-inch (50-by-100-mm) fire-retardant-treated-wood blocking between studs. Fire-retardant-treated wood blocking is specified in Division 06 Section "Rough Carpentry".

V. Morgue Equipment
1. Autopsy Tables:
a. Description: Pedestal stainless-steel table with sink; designed for downdraft ventilation.
1) Material: Stainless steel.
2) Overall Size: Approximately 88 by 30 inches (2250 by 760 mm) with deck faucet holes.
3) Faucet: Deck mounted with wrist- or elbow-blade handles.
4) Aspirator: Deck mounted.
5) Removable body supports.
6) Rinse Assembly: Deck-mounted faucet with hose.
7) Disposer: Not required **OR** Required, **as directed**.
8) Fixture Support: Sink.
9) Receptacle: Duplex, hospital grade with ground-fault interruption.
10) Supplies: Chrome-plated copper tubes or flexible connectors, **as directed**, with atmospheric vacuum breakers and stops.
11) Drain: Chrome-plated, cast-brass P-trap and waste to wall.
2. Dissecting Sinks:
a. Description: Wall-mounting sink with backsplash.
1) Material: Stainless steel.
2) Overall Size: 84 by 28 inches (2134 by 711 mm) with back faucet holes.
3) Sink Size: Approximately 30 inches (763 mm) wide.
4) Equipment drawer.
5) Faucet: Back mounted with wrist- or elbow-blade handles.
6) Aspirator: Back mounted.
7) Rinse Assembly: One back-mounted faucet with hose.
8) Disposer: Not required **OR** Required, **as directed**.
9) Fixture Support: Sink.
10) Supplies: Chrome-plated copper tubes or flexible connectors, **as directed**, with atmospheric vacuum breakers and stops.
11) Drain: Chrome-plated, cast-brass P-trap and waste to wall.
12) Back-mounted, hand-held-type eye wash.

1.3 EXECUTION

A. Installation
1. Assemble medical plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

2. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
   a. Use carrier supports with waste fitting and seal for back-outlet fixtures.
   b. Use carrier supports without waste fitting for fixtures with tubular waste piping.
   c. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
3. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.
4. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.
5. Install wall-mounting fixtures with tubular waste piping attached to supports.
6. Install counter-mounting fixtures in and attached to casework.
7. Install fixtures level and plumb according to roughing-in drawings.
8. Install water-supply piping with stop on each supply to each fixture to be connected to domestic water piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
   a. Exception: Use ball, gate, or globe valve if stops are not specified with fixture. Valves are specified in Division 22 Section "General-duty Valves For Plumbing Piping".
9. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
10. Install flushometer valves for accessible water closets with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
11. Install toilet seats on water closets.
12. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
13. Install shower flow-control fittings with specified maximum flow rates in shower arms.
14. Install traps on fixture outlets.
    a. Exception: Omit trap on fixtures with integral traps.
15. Install escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results For Plumbing".
16. Set showers in leveling bed of cement grout. Grout is specified in Division 22 Section "Common Work Results For Plumbing".
17. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants".

B. Connections
1. Piping installation requirements are specified in other Division 14.. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Connect water supplies from domestic water piping to medical plumbing fixtures.
3. Connect drain piping from medical plumbing fixtures to sanitary waste and vent piping.
4. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
5. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

C. Field Quality Control
1. Verify that installed medical plumbing fixtures are categories and types specified for locations where installed.
2. Check that medical plumbing fixtures are complete with trim, faucets, fittings, and other specified components.
3. Inspect installed medical plumbing fixtures for damage. Replace damaged fixtures and components.
4. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.
5. Install fresh batteries in sensor-operated mechanisms.

D. Adjusting
   1. Operate and adjust faucets and controls. Replace damaged and malfunctioning medical plumbing fixtures, fittings, and controls.
   2. Adjust water pressure at faucets, shower valves, and flushometer valves to produce proper flow and stream.
   3. Replace washers and seals of leaking and dripping faucets and stops.

E. Cleaning
   1. Clean medical plumbing fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
      a. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
      b. Remove sediment and debris from drains.
   2. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

F. Protection
   1. Provide protective covering for installed fixtures and fittings.
   2. Do not allow use of medical plumbing fixtures for temporary facilities unless approved in writing by the Owner.

END OF SECTION 22 43 39 00

Task	Specification	Specification Description
22 43 39 00	10 28 19 16	Plumbing Fixtures
22 43 39 00	22 01 40 00	Emergency Plumbing Fixtures
22 43 43 00	10 28 19 16	Plumbing Fixtures
22 45 13 00	10 28 19 16	Plumbing Fixtures
22 45 16 00	10 28 19 16	Plumbing Fixtures

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SECTION 22 46 13 00 - SECURITY PLUMBING FIXTURES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for security plumbing fixtures. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following security plumbing fixtures and related components:
   a. Combination units.
   b. Drinking fountains.
   c. Lavatories.
   d. Service sinks.
   e. Shampoo bowls.
   f. Showers.
   g. Urinals.
   h. Water closets.
   i. Flushometer valves for vitreous-china water closets.
   j. Fixture supports for front-mounting, stainless-steel fixtures and vitreous-china, wall-mounting fixtures.

C. Definitions
1. Accessible Fixture: Security plumbing fixture that can be approached and used by people with disabilities.
2. Back-Mounting-Type Fixture: Security plumbing fixture designed to mount on wall sleeve built into wall so installation and removal of fixture and piping and other components are only accessible from service space behind wall.
3. Front-Mounting-Type Fixture: Security plumbing fixture designed to mount on fixture support with installation and removal from fixture side of wall, and piping and other components are accessible from access panels in fixture or wall.

D. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:
   a. Product Data for Credit WE 2, 3.1, and 3.2: Documentation indicating flow and water consumption requirements.
3. Shop Drawings: Diagram power, signal, and control wiring.
4. Field quality-control test reports.
5. Operation and maintenance data.

E. Quality Assurance
1. 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.
2. 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", **as directed**; about security plumbing fixtures for people with disabilities. Comply with requirements in "Energy Policy Act" about water flow and consumption rates for plumbing fixtures.
3. NSF Standard: Comply with NSF 61, "Drinking Water System Components - Health Effects," for fixture materials that will be in contact with potable water.

4. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

1.2 PRODUCTS

A. Combination Units
1. Security Combination Units:
a. Description: Back-mounting, cabinet, security plumbing fixture with integral water closet and lavatory; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
1) Water Closet: Comply with IAPMO PS 61 for water-closet component.
a) Bowl: Elongated, with back inlet, integral trap, blowout design with back **OR** siphon-jet design with back **OR** siphon-jet design with floor, **as directed**, outlet and contoured seat.
i. Seat Surface: SSINA No. 7 polished finish.
ii. Punching: Provide two holes for installation of separate toilet seat.
iii. Drain: NPS 4 (DN 100) **OR** NPS 3 (DN 80), **as directed**, horizontal with cleanout and slip joint **OR** vertical, **as directed**.
b) Toilet Seat: ANSI Z124.5, white, **OR** black, **as directed**, commercial, heavy-duty, elongated, open front with cover, **as directed**, with check **OR** self-sustaining **OR** self-sustaining, check, **as directed**, hinges.
c) Flushing Device: Concealed flushometer valve manufactured by Sloan with stainless-steel access panel, push-button mechanism, and 1.6-gal./flush (6.0-L/flush), **as directed**, consumption. Refer to "Flushometer Valves" Article.
2) Lavatory: In top of cabinet.
a) Receptor: Oval **OR** Rectangular, **as directed**, bowl with integral soap depression.
b) Hot- and Cold-Water and Bubbler, **as directed**, Supply Valves: Pneumatic **OR** Mechanical-metering **OR** Electric-solenoid, **as directed**, type with push-button actuation and individual check stop.
c) Filler Spout: Backsplash **OR** Deck, **as directed**, mounted.
d) Drain: Integral punched grid with NPS 1-1/4 (DN 32) minimum horizontal waste and trap complying with ASME A112.18.2 **OR** concealed waste piping to spill into water-closet bowl, **as directed**.
e) Toothbrush Holders: One on each **OR** left **OR** right, **as directed**, side of backsplash.
f) Towel Hooks: One **OR** Two, **as directed**, on each **OR** left **OR** right, **as directed**, side of fixture.
g) Bubbler Location: On backsplash **OR** deck, **as directed**.
3) Cabinet Configuration: Rectangular apron **OR** Five-sided apron with two angled sides **OR** Four-sided apron with angled left side **OR** Four-sided apron with angled right side, **as directed**, made for above-floor **OR** on-floor, **as directed**, installation and with backsplash.
a) Water-Closet Bowl Location: Centered on front **OR** Left of center on front **OR** Right of center on front **OR** On angled left side **OR** On angled right side, **as directed**, of apron.
b) Toilet Paper Holder: Recessed, 0.063-inch (1.6-mm) minimum thickness, stainless steel complying with ASTM A 666, Type 304 and located above water closet and centered in front **OR** in front **OR** right of center in front **OR** left of center in front **OR** in angled right side **OR** in angled left side **OR** in right side **OR** in left side, **as directed**, of apron.

4) Wall Sleeve: Galvanized-steel frame of dimensions required to match and support entire fixture. Include steel bars or other design that will prevent escape if fixture is removed.

B. Drinking Fountains
1. Security Drinking Fountains, Back-Mounting:
a. Description: Back-mounting, accessible, **as directed**, security plumbing fixture; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
1) Receptor: Bowl or depression in top and with backsplash.
2) Bubbler Location: On backsplash **OR** deck, **as directed**.
3) Bubbler Water-Supply Valve: Pneumatic type with push-button actuation.
4) Drain: Integral punched grid with NPS 1-1/4 (DN 32) minimum horizontal waste and trap complying with ASME A112.18.2.
5) Wall Sleeve: Galvanized-steel frame of dimensions required to match and support fixture.
2. Security Drinking Fountains, Front-Mounting:
a. Description: Front-mounting, accessible, **as directed**, security plumbing fixture; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
1) Receptor: Bowl or depression in top and with backsplash.
2) Bubbler Location: On backsplash **OR** deck, **as directed**.
3) Bubbler Water-Supply Valve: Pneumatic type with push-button actuation.
4) Drain: Integral punched grid with NPS 1-1/4 (DN 32) minimum tailpiece, trap, and waste, and complying with ASME A112.18.2.
5) Access to Internal Components: Vandal-resistant access panels.
6) Mounting Device: Wall bracket.
7) Support: Chair carrier. Refer to "Fixture Supports" Article.

C. Lavatories
1. Security Lavatories, Back-Mounting:
a. Description: Back-mounting, accessible, **as directed**, security plumbing fixture; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
1) Receptor: Oval **OR** Rectangular, **as directed**, bowl with integral soap depression and backsplash.
2) Hot- and Cold-Water and Bubbler, **as directed**, Supply Valves: Pneumatic **OR** Mechanical-metering **OR** Electric-solenoid, **as directed**, type with push-button actuation and individual check stop.
3) Filler Spout: Backsplash **OR** Deck, **as directed**, mounted.
4) Drain: Integral punched grid with NPS 1-1/4 (DN 32) minimum horizontal waste and trap complying with ASME A112.18.2.
5) Toothbrush Holders: One on each **OR** left **OR** right, **as directed**, side of backsplash.
6) Towel Hooks: One **OR** Two, **as directed**, on each **OR** left **OR** right, **as directed**, side of fixture.
7) Bubbler Location: On backsplash **OR** deck, **as directed**.
8) Wall Sleeve: Galvanized-steel frame of dimensions required to match and support fixture.
2. Security Lavatories, Front-Mounting:
a. Description: Front-mounting, accessible, **as directed**, security plumbing fixture; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness,

ASTM A 666, Type 304, stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.

1) Receptor: Oval **OR** Rectangular, **as directed**, bowl with integral soap depression and backsplash.
2) Hot- and Cold-Water and Bubbler, **as directed**, Supply Valves: Pneumatic **OR** Mechanical-metering **OR** Electric-solenoid, **as directed**, type with push-button actuation and individual check stop.
3) Filler Spout: Backsplash **OR** Deck, **as directed**, mounted.
4) Drain: Integral punched grid with NPS 1-1/4 (DN 32) minimum tailpiece, trap, and waste complying with ASME A112.18.2.
5) Toothbrush Holders: One on each **OR** left **OR** right, **as directed**, side of backsplash.
6) Towel Hooks: One **OR** Two, **as directed**, on each **OR** left **OR** right, **as directed**, side of fixture.
7) Bubbler Location: On backsplash **OR** deck, **as directed**.
8) Access to Internal Components: Vandal-resistant access panels.
9) Mounting Device: Wall bracket.
10) Support: Chair carrier. Refer to "Fixture Supports" Article.

3. Security Lavatories, Vitreous-China:
   a. Description: ASME A112.19.2M, vitreous-china security plumbing fixture made for institutional applications, with integral soap depression and NPS 1-1/4 (DN 32) waste outlet and with factory-installed, push-button, self-closing, chrome-plated brass faucets complying with ASME A112.18.1.
      1) Waste: NPS 1-1/4 (DN 32) minimum piping and trap complying with ASME A112.18.2.
      2) Mounting Device: Wall bracket.
      3) Support: Chair carrier. Refer to "Fixture Supports" Article.

D. Service Sinks
1. Security Service Sinks:
   a. Description: Back-mounting security plumbing fixture made for above-floor **OR** on-floor, **as directed**, installation; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
      1) Receptor: Rectangular bowl with high backsplash.
      2) Hot- and Cold-Water-Supply Valves: Pneumatic type with push-button actuation and individual check stop.
      3) Filler Spout: Backsplash mounted.
      4) Drain: Grid with NPS 2 (DN 50) waste and trap complying with ASME A112.18.2.
      5) Wall Sleeve: Galvanized-steel frame of dimensions required to match and support fixture.

E. Shampoo Bowls
1. Security Shampoo Bowls:
   a. Description: Front-mounting security plumbing fixture made for above-floor **OR** counter-mounting, **as directed**, installation; fabricated from 0.078-inch (2.0-mm) thickness, ASTM A 666, Type 304 stainless steel and corrosion-resistant metal internal piping and bracing.
      1) Receptor: Bowl with contoured neck rest.
      2) Finish: White **OR** Black, **as directed**, enamel.
      3) Exposed Surfaces without Enamel Finish: SSINA No. 4 polished finish.
      4) Faucet: Dial single-lever control with vacuum breaker, hose, and spray.
      5) Drain: Basket strainer with NPS 1-1/2 (DN 40) tailpiece, trap, and waste to wall complying with ASME A112.18.2.

6) Access to Internal Components: Vandal-resistant access panels.
7) Mounting Device: Wall bracket.
8) Support: Chair carrier. Refer to "Fixture Supports" Article.

F. Showers
1. Security Showers, Back-Mounting, Recessed:
a. Description: Back-mounting, accessible, **as directed**, recessed security plumbing fixture made with wall plate for flush installation; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
1) Configuration: Wall type with shower head and soap dish.
2) Tempered-Water-Supply **OR** Hot- and Cold-Water-Supply, **as directed**, Valves: Pneumatic **OR** Mechanical-metering **OR** Electric-solenoid, **as directed**, type with individual check stop.
3) Shower: Hose with vandal-resistant, hand-held **OR** Vandal-resistant, fixed-type **OR** Vandal-resistant, swivel-type, **as directed**, head.
4) Soap Dish: Recessed, stainless steel.
5) Wall Sleeve: Galvanized-steel frame of dimensions required to match and support fixture.
2. Security Showers, Front-Mounting, Recessed:
a. Description: Front-mounting, accessible, **as directed**, recessed security plumbing fixture made with wall plate for flush installation; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
1) Configuration: Wall type with shower head and soap dish.
2) Tempered-Water-Supply **OR** Hot- and Cold-Water-Supply, **as directed**, Valves: Pneumatic **OR** Mechanical-metering **OR** Electric-solenoid, **as directed**, type with individual check stop.
3) Shower: Hose with vandal-resistant, hand-held **OR** Vandal-resistant, fixed-type **OR** Vandal-resistant, swivel-type, **as directed**, head.
4) Soap Dish: Recessed, stainless steel.
5) Access to Internal Components: Vandal-resistant access panels.
6) Mounting Device: Wall-mounting frame.
3. Security Showers, Front-Mounting, Surface Installation:
a. Description: Front-mounting, accessible, **as directed**, security plumbing fixture made for surface installation; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
1) Configuration: Wall type with shower head and soap dish.
2) Tempered-Water-Supply **OR** Hot- and Cold-Water-Supply, **as directed**, Valves: Pneumatic **OR** Mechanical-metering **OR** Electric-solenoid, **as directed**, type with individual check stops.
3) Soap Dish: Recessed, stainless steel.
4) Access to Internal Components: Vandal-resistant access panels.
5) Mounting Device: Wall-mounting frame.
4. Security Showers, Back-Mounting, Accessible:
a. Description: Back-mounting, accessible, cabinet, security plumbing fixture; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
1) Configuration: Cabinet 42 or 44 by 36 inches (1065 or 1120 by 915 mm) **OR** 48 by 36 inches (1220 by 915 mm), **as directed**, with floor and top, **as directed**, with stainless-steel soap dish, towel hook, drain, seat, and grab bar.

2) Tempered-Water-Supply **OR** Hot- and Cold-Water-Supply, **as directed**, Valves: Pneumatic **OR** Mechanical-metering **OR** Electric-solenoid, **as directed**, type with individual check stops.
3) Shower: Hose with vandal-resistant, hand-held head.
4) Drain: NPS 2 (DN 50) strainer, waste to wall, and trap complying with ASME A112.18.2.
5) Wall Sleeve: Galvanized-steel frame of dimensions required to match and support fixture.

5. Security Showers, Back-Mounting:
   a. Description: Back-mounting, cabinet, security plumbing fixture; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
      1) Configuration: Cabinet 30 by 30 inches (760 by 760 mm) **OR** 32 by 32 inches (815 by 815 mm) **OR** 36 by 36 inches (915 by 915 mm), **as directed**, with floor and top, **as directed**, and with stainless-steel soap dish, towel hook, and drain.
      2) Tempered-Water-Supply **OR** Hot- and Cold-Water-Supply, **as directed**, Valves: Pneumatic **OR** Mechanical-metering **OR** Electric-solenoid, **as directed**, type with individual check stops.
      3) Shower: Vandal-resistant, fixed **OR** Fixed **OR** Swivel, **as directed**,-type head.
      4) Drain: NPS 2 (DN 50) strainer, waste to wall, and trap complying with ASME A112.18.2.
      5) Wall Sleeve: Galvanized-steel frame of dimensions required to match and support fixture.

G. Urinals
1. Security Urinals, Back-Mounting:
   a. Description: Back-mounting security plumbing fixture; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
      1) Type and Configuration: Blowout **OR** Washout, **as directed**, type with back inlet and extended shields.
         OR
         Type and Configuration: Washout, trough type, and 36 inches (915 mm) **OR** 48 inches (1220 mm), **as directed**, wide.
      2) Drain: Strainer with NPS 2 (DN 50) tailpiece, trap under fixture, and drain piping.
      3) Flushing Device: Concealed flushometer valve manufactured by Sloan with stainless-steel access panel, push-button mechanism, and 1.5-gal./flush (5.7-L/flush) **OR** 1.0-gal./flush (3.78-L/flush), **as directed**, consumption. Refer to "Flushometer Valves" Article.
      4) Wall Sleeve: Galvanized-steel frame of dimensions required to match and support fixture.
2. Security Urinals, Front-Mounting:
   a. Description: Front-mounting security plumbing fixture; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
      1) Type and Configuration: Blowout **OR** Washout, **as directed**, type with back **OR** top, **as directed**, inlet and extended shields.
         OR
         Type and Configuration: Washout, trough type, and 36 inches (915 mm) **OR** 48 inches (1220 mm), **as directed**, wide.
      2) Drain: Strainer with NPS 2 (DN 50) tailpiece, trap under fixture, and drain piping complying with ASME A112.18.2.

3) Flushing Device: Concealed flushometer valve manufactured by Sloan with stainless-steel access panel, push-button **OR** Exposed flushometer valve with oscillating lever-handle, **as directed**, mechanism, and 1.5-gal./flush (5.7-L/flush) **OR** 1.0-gal./flush (3.78-L/flush), **as directed** consumption. Refer to "Flushometer Valves" Article.
4) Support: Chair carrier. Refer to "Fixture Supports" Article.

3. Security Urinals, Back-Mounting, Wall-And-Floor Installation:
   a. Description: Back-mounting security plumbing fixture made for wall-and-floor installation; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
      1) Type and Configuration: Washout, stall type with back inlet.
      2) Drain: Strainer with NPS 2 (DN 50) outlet.
      3) Flushing Device: Concealed flushometer valve manufactured by Sloan with stainless-steel access panel, push-button mechanism, and 1.5-gal./flush (5.7-L/flush) **OR** 1.0-gal./flush (3.78-L/flush), **as directed**, consumption. Refer to "Flushometer Valves" Article.
4. Security Urinals, Front-Mounting, Wall-And-Floor Installation:
   a. Description: Front-mounting security plumbing fixture made for wall-and-floor installation; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
      1) Type and Configuration: Washout, stall type with back **OR** top, **as directed**, inlet.
      2) Drain: Strainer with NPS 2 (DN 50) outlet.
      3) Flushing Device: Concealed flushometer valve with stainless-steel access panel, push-button **OR** Exposed flushometer valve with oscillating lever-handle, **as directed**, mechanism, and 1.5-gal./flush (5.7-L/flush) **OR** 1.0-gal./flush (3.78-L/flush), **as directed**, consumption. Refer to "Flushometer Valves" Article.
      4) Support: Chair carrier. Refer to "Fixture Supports" Article.

H. Water Closets
1. Security Water Closets, Back-Mounting, Above Floor Installation:
   a. Description: IAPMO PS 61, back-mounting, accessible, **as directed**, security plumbing fixture made for above-floor installation; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
      1) Configuration: Compact design, with bowl on wall flange.
      2) Bowl: Elongated, with back inlet, integral trap, blowout design with back outlet and contoured seat.
         a) Seat Surface: SSINA No. 7 polished finish.
         b) Punching: Provide two holes for installation of separate toilet seat.
         c) Drain: NPS 4 (DN 100) **OR** NPS 3 (DN 80), **as directed**, horizontal with cleanout and slip joint.
      3) Flushing Device: Concealed flushometer valve manufactured by Sloan with stainless-steel access panel, push-button **OR** Exposed flushometer valve manufactured by Sloan with oscillating lever-handle, **as directed**, mechanism, and 1.6-gal./flush (6.0-L/flush) consumption. Refer to "Flushometer Valves" Article.
      4) Toilet Seat, **as directed**: ANSI Z124.5, white, **OR** black, **as directed,** commercial, heavy-duty, elongated, open front with cover, **as directed**, with check **OR** self-sustaining **OR** self-sustaining, check, **as directed**, hinges.
      5) Wall Sleeve: Galvanized-steel frame of dimensions required to match and support fixture. Include steel bars or other design that will prevent escape if fixture is removed.
2. Security Water Closets, Back-Mounting, Off Floor Installation:

a. Description: IAPMO PS 61, back-mounting, accessible, **as directed**, security plumbing fixture made for off-floor installation; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
   1) Configuration: Standard design.
   2) Bowl: Elongated, with back **OR** top, **as directed**, inlet, integral trap, blowout **OR** siphon-jet, **as directed**, design with back outlet and contoured seat.
      a) Seat Surface: SSINA No. 7 polished finish.
      b) Punching: Provide two holes for installation of separate toilet seat.
      c) Drain: NPS 4 (DN 100) **OR** NPS 3 (DN 80), **as directed**, horizontal with cleanout and slip joint.
   3) Flushing Device: Concealed flushometer valve manufactured by Sloan with stainless-steel access panel, push-button **OR** Exposed flushometer valve manufactured by Sloan with oscillating lever-handle, **as directed**, mechanism, and 1.6-gal./flush (6.0-L/flush) consumption. Refer to "Flushometer Valves" Article.
   4) Toilet Seat, **as directed**: ANSI Z124.5, white, **OR** black, **as directed,** commercial, heavy-duty, elongated, open front with cover, **as directed**, with check **OR** self-sustaining **OR** self-sustaining, check, **as directed**, hinges.
   5) Wall Sleeve: Galvanized-steel frame of dimensions required to match and support fixture. Include steel bars or other design that will prevent escape if fixture is removed.

3. Security Water Closets, Front-Mounting, Off-Floor Installation:
   a. Description: IAPMO PS 61, front-mounting, accessible, **as directed**, security plumbing fixture made for off-floor installation; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
      1) Configuration: Standard design.
      2) Bowl: Elongated, with back **OR** top, **as directed**, inlet, integral trap, blowout **OR** siphon-jet, **as directed**, design with back outlet and contoured seat.
         a) Seat Surface: SSINA No. 7 polished finish.
         b) Punching: Provide two holes for installation of separate toilet seat.
      3) Access to Internal Components: Vandal-resistant access panels.
      4) Flushing Device: Concealed flushometer valve manufactured by Sloan with stainless-steel access panel, push-button **OR** Exposed flushometer valve manufactured by Sloan with oscillating lever-handle, **as directed**, mechanism, and 1.6-gal./flush (6.0-L/flush) consumption. Refer to "Flushometer Valves" Article.
      5) Toilet Seat, **as directed**: ANSI Z124.5, white, **OR** black, **as directed**, commercial, heavy-duty, elongated, open front with cover, **as directed**, with check **OR** self-sustaining **OR** self-sustaining, check, **as directed**, hinges.
      6) Support: Combination support and waste fitting assembly. Refer to "Fixture Supports" Article.

4. Security Water Closets, Back-Mounting, On-Floor Installation:
   a. Description: IAPMO PS 61, back-mounting security plumbing fixture made for on-floor installation; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4, polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.
      1) Configuration: Standard design.
      2) Bowl: Elongated, with back **OR** top, **as directed**, inlet, integral trap, blowout **OR** siphon-jet, **as directed**, design with back outlet and contoured seat.
         a) Seat Surface: SSINA No. 7 polished finish.
         b) Punching: Provide two holes for installation of separate toilet seat.

c) Drain: NPS 4 (DN 100) **OR** NPS 3 (DN 80), **as directed**, horizontal with cleanout and slip joint.

3) Flushing Device: Concealed flushometer valve manufactured by Sloan with stainless-steel access panel, push-button **OR** Exposed flushometer valve manufactured by Sloan with oscillating lever-handle, **as directed**, mechanism, and 1.6-gal./flush (6.0-L/flush) consumption. Refer to "Flushometer Valves" Article.

4) Toilet Seat, **as directed**: ANSI Z124.5, white, **OR** black, **as directed**, commercial, heavy-duty, elongated, open front with cover, **as directed**, with check **OR** self-sustaining **OR** self-sustaining, check, **as directed**, hinges.

5. Security Water Closets, Front-Mounting, On-Floor Installation:

a. Description: IAPMO PS 61, front-mounting security plumbing fixture made for on-floor installation; fabricated from 0.078-inch (2.0-mm) minimum **OR** 0.109-inch (2.8-mm), **as directed**, thickness, ASTM A 666, Type 304 stainless steel. Include SSINA No. 4 polished finish on exposed surfaces, and corrosion-resistant metal for internal piping and bracing.

1) Configuration: Standard design.

2) Bowl: Elongated, with back **OR** top, **as directed**, inlet, integral trap, siphon-jet design with back **OR** floor, **as directed**, outlet and contoured seat.

a) Seat Surface: SSINA No. 7 polished finish.

b) Punching: Provide two holes for installation of separate toilet seat.

3) Access to Internal Components: Vandal-resistant access panels.

4) Flushing Device: Concealed flushometer valve manufactured by Sloan with stainless-steel access panel, push-button **OR** Exposed flushometer valve manufactured by Sloan with oscillating lever-handle, **as directed**, mechanism, and 1.6-gal./flush (6.0-L/flush) consumption. Refer to "Flushometer Valves" Article.

5) Toilet Seat, **as directed**: ANSI Z124.5, white, **OR** black, **as directed**, commercial, heavy-duty, elongated, open front with cover, **as directed**, with check **OR** self-sustaining **OR** self-sustaining, check, **as directed**, hinges.

6) Support: Combination support and waste fitting assembly. Refer to "Fixture Supports" Article.

6. Security Water Closets, Vitreous-China, Wall-Mounting, On-Floor Installation

a. Description: ASME A112.19.2M, vitreous-china, wall-mounting and on-floor installation, back-inlet, blowout **OR** siphon-jet, **as directed**, fixture with integral contoured seat and made for institutional applications.

1) Flushing Device: Concealed flushometer valve manufactured by Sloan with stainless-steel access panel, push-button mechanism, and 1.6-gal./flush (6.0-L/flush) consumption. Refer to "Flushometer Valves" Article.

2) Support: Combination support and waste fitting assembly. Refer to "Fixture Supports" Article.

7. Security Water Closets, Vitreous-China, Wall-Mounting:

a. Description: ASME A112.19.2M, vitreous-china, accessible, **as directed**, wall-mounting, back-inlet, blowout fixture with integral contoured seat and made for institutional applications.

1) Flushing Device: Concealed flushometer valve manufactured by Sloan with stainless-steel access panel, push-button mechanism, and 3.5-gal./flush (13.3-L/flush) consumption. Refer to "Flushometer Valves" Article.

2) Support: Combination support and waste fitting assembly. Refer to "Fixture Supports" Article.

I. Flushometer Valves

1. Flushing Devices for Vitreous-China Water Closets:

a. Description: Flushometer valves manufactured by Sloan, trim, and components complying with ASSE 1037. Include brass body, check-stop inlet, diaphragm operation, vacuum breaker, tailpiece, chrome-plated finish on exposed components, and non-hold-open feature on oscillating lever-handle trip mechanism. See fixture type for consumption.

J. Fixture Supports

1. Back-mounting fixtures are installed on wall sleeves. Front-mounting and wall-mounting fixtures are installed on supports specified herein.
2. Off-Floor, Plumbing Fixture Supports:
   a. Description: ASME A112.6.1M carriers with dimensions and trim matching fixture.
      1) Stainless-Steel, Front-Mounting Fixtures: With modifications.
         a) Drinking Fountains: Type I drinking fountain carrier.
         b) Lavatories: Type III lavatory carrier.
         c) Shampoo Bowls: Type II sink carrier.
         d) Urinals: Type I urinal carrier with inlet seal unless Type II is required.
         e) Water Closets: Combination support and waste fitting assembly.
      2) Vitreous-China, Wall-Mounting Fixtures:
         a) Lavatories: Type III lavatory carrier.
         b) Water Closets: Combination support and waste fitting assembly.
      3) Carriers: With vertical steel uprights with feet. Include tie rods, bearing plates, and mounting studs matching fixture to be supported.
      4) Combination Support and Waste Fitting Assemblies: With feet and inlet seal.
      5) Carriers for Accessible Fixtures: Include rectangular, vertical steel uprights instead of steel pipe uprights.

1.3 EXECUTION

A. Security Plumbing Fixture Installation
   1. Install back-mounting-type, stainless-steel security plumbing fixtures as follows:
      a. Install wall sleeve in wall.
      b. Install fixture on wall sleeve; mount components on or attached to wall sleeve with access from accessible service space.
      c. Extend supply piping from service space to fixture.
      d. Install soil and waste piping from fixture and extend into service space.
      e. Install fixture trap in service space instead of below fixture drain.
   2. Install front-mounting-type, stainless-steel security plumbing fixtures as follows:
      a. Install fixture support or mounting bracket.
      b. Install fixture on support; mount components inside of or attached to fixture.
      c. Extend supply piping from pipe space to fixture.
      d. Install trap below fixture and extend soil and waste piping into pipe space.
   3. Install vitreous-china security plumbing fixtures onto accessible service space as follows:
      a. Install fixture support in service space.
         1) Use combination support and waste fitting assembly for water closet.
         2) Use chair carriers for lavatory.
      b. Install fixture on support.
      c. Install components in service space.
   4. Install vitreous-china security plumbing fixtures onto accessible pipe space as follows:
      a. Install fixture support in pipe space.
         1) Use combination support and waste fitting assembly for water closet.
         2) Use carrier support for lavatory.
      b. Install fixture on support.
      c. Install components in pipe space with access panels. See Division 8 Section "Access Doors and Frames" for access panels not in this Section.
   5. Install security plumbing fixture outlets with gasket seals.
   6. Install fixtures designated "accessible" according to ICC A117.1 for heights, dimensions, and clearances.
   7. Install fixtures level and plumb.
   8. Install shutoff valves in water-supply piping to fixtures. Use ball, gate, or globe valve if specific type valve is not indicated. Install valves in locations where they can be easily reached for operation. Valves are specified in Division 15 Section "Valves."

9. Install dielectric fittings in water-supply piping to fixtures if piping and fixture connections are made of different metals. See Division 15 Section "Basic Mechanical Materials and Methods" for dielectric fittings.
10. Install toilet seats on water closets and combination units if seats are indicated.

B. Connections
1. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Connect hot- and cold-water supply piping to security plumbing fixtures. Include supply stops, if specified, or ball valve on each supply. Ball valves are specified in Division 15 Section "Valves."
3. Connect soil and waste piping to security plumbing fixtures.
4. Ground equipment according to Division 16 Section "Grounding and Bonding."
5. Connect wiring according to Division 16 Section "Conductors and Cables."

C. Field Quality Control
1. Perform the following field tests and inspections and prepare test reports:
   a. Testing: After installing security plumbing fixtures and after electrical circuitry has been energized, test for compliance with requirements.
   b. Remove and replace malfunctioning security plumbing fixtures. Retest as specified above after repairs or replacements are made.

D. Adjusting
1. Operate and adjust water-supply flushometers and flow-control valves on security plumbing fixtures.

E. Cleaning
1. Clean security plumbing fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
   a. Remove faucet spouts and strainers, remove sediment and debris, and reinstall spouts and strainers.
   b. Remove sediment and debris from drains.
2. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

F. Protection
1. Provide protective covering for installed security plumbing fixtures and fittings.
2. Do not allow use of security plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 46 13 00

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Task	Specification	Specification Description
22 46 16 00	22 46 13 00	Security Plumbing Fixtures
22 46 19 00	22 46 13 00	Security Plumbing Fixtures

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SECTION 22 47 13 00 - DRINKING FOUNTAINS AND WATER COOLERS

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for drinking fountains and water coolers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

B. Summary
1. This Section includes the following:
a. Style F, freestanding drinking fountains.
b. Style W, wall-mounting drinking fountains.
c. Type PB, pressure with bubbler, Style F, freestanding water coolers.
d. Type PB, pressure with bubbler, Style W, wall-mounting water coolers.
e. Fixture supports.

C. Definitions
1. Accessible Drinking Fountain or Water Cooler: Fixture that can be approached and used by people with disabilities.
2. Cast Polymer: Dense, cast-filled-polymer plastic.
3. Drinking Fountain: Fixture with nozzle for delivering stream of water for drinking.
4. Fitting: Device that controls flow of water into or out of fixture.
5. Fixture: Drinking fountain or water cooler unless one is specifically indicated.
6. Remote Water Cooler: Electrically powered equipment for generating cooled drinking water.
7. Water Cooler: Electrically powered fixture for generating and delivering cooled drinking water.

D. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: Diagram power, signal, and control wiring.
3. Operation and maintenance data.

E. Quality Assurance
1. 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.
2. 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.
3. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
4. ARI Standard: Comply with ARI's "Directory of Certified Drinking Water Coolers" for style classifications.
5. 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.
6. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants" for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant unless otherwise indicated.

1.2 PRODUCTS

A. Drinking Fountains
1. Description: Accessible, Style F, freestanding drinking fountain.
   a. Pedestal:
      1) Material: Concrete **OR** Painted cast iron or steel, **as directed**.
      2) Shape: Rectangular **OR** Round, **as directed,** with offset to receptor **OR** with side receptor(s), **as directed**.
   b. Receptor(s):
      1) Number: One **OR** Two **OR** Three, **as directed**.
      2) Material: Bronze **OR** Chrome-plated brass or stainless steel, **as directed**.
      3) Shape: Rectangular **OR** Round **OR** Rounded front, **as directed**.
      4) Bubbler: One for each receptor, with adjustable stream regulator, located on deck.
   c. Controls: Foot pedal **OR** Push bar **OR** Push button, **as directed,** with adjustable stream regulator.
   d. Access to Internal Components: Panel in pedestal.
   e. Supply: NPS 3/8 (DN 10) **OR** NPS 1/2 (DN 15), **as directed**, with ball, gate, or globe valve.
   f. Drain: Grid with NPS 1-1/4 (DN 32) minimum horizontal waste and trap complying with ASME A112.18.2 **OR** waste to drainage system, **as directed**.
2. Description: Accessible, Style F, antifreeze, freestanding drinking fountain designed to operate without draining into ground.
   a. Pedestal: Rectangular, painted cast iron or steel.
   b. Receptor: Rectangular, chrome-plated brass or stainless steel with bubbler.
   c. Control: Foot pedal with control valve assembly.
   d. Supply: NPS 1/2 (DN 15) with underground shutoff and flow-control valve assembly.
   e. Drain: Grid with NPS 1 (DN 25) **OR** NPS 1-1/4 (DN 32) **OR** NPS 1-1/2 (DN 40), **as directed,** minimum waste to drainage system.
   f. Bury Depth, Grade to Valve Components: 36 inches (915 mm) **OR** 48 inches (1220 mm) **OR** 60 inches (1525 mm), **as directed**.
3. Description: Accessible, Style W, wall-mounting drinking fountain.
   a. Material: Bronze **OR** Metal **OR** Cast polymer **OR** Stainless steel **OR** Vitreous china complying with ASME 112.19.2M for drinking fountains with backsplash, **as directed**.
   b. Receptor Shape: Rectangular **OR** Round **OR** Rounded front, **as directed**.
   c. Back Panel: Stainless-steel wall plate behind drinking fountain.
   d. Bubblers: One **OR** Two **OR** Three, **as directed**, with adjustable stream regulator, located on deck.
   e. Control: Push button **OR** Push bar, **as directed**.
   f. Supply: NPS 3/8 (DN 10) with ball, gate, or globe valve.
   g. Drain: Grid with NPS 1-1/4 (DN 32) minimum horizontal waste and trap complying with ASME A112.18.2.
   h. Support: Type I, water cooler carrier. Refer to "Fixture Supports" Article.
4. Description: Accessible, Style WS, wall-mounting, semirecessed drinking fountain.
   a. Material: Stainless steel **OR** Bronze **OR** Vitreous china complying with ASME A112.19.2M for semirecessed drinking fountains, **as directed**.
   b. Receptor Shape: Concave with projecting bowl.
   c. Bubbler: One, with adjustable stream regulator, located on deck.
   d. Control: Push button **OR** Push bar, **as directed**.
   e. Supply: NPS 3/8 (DN 10) with ball, gate, or globe valve.
   f. Drain: Integral punched grid with NPS 1-1/4 (DN 32) minimum horizontal waste and trap complying with ASME A112.18.2.
   g. Support: Mounting frame or brackets for attaching to substrate.
5. Description: Style RE, stainless-steel, recessed drinking fountain.
   a. Receptor Shape: Concave with flush wall flange.
   b. Bubbler: One, with adjustable stream regulator, located on deck.

c. Control: Push button **OR** bar, **as directed**.
d. Supply: NPS 3/8 (DN 10) with ball, gate, or globe valve.
e. Drain: Grid with NPS 1-1/4 (DN 32) minimum horizontal waste and trap complying with ASME A112.18.2.
f. Support: Mounting frame or brackets for attaching to substrate.

B. Water Coolers
1. Description: ARI 1010, Type PB, pressure with bubbler, Style F, freestanding or Style FW, flush-to-wall water cooler.
a. Cabinet: All stainless steel **OR** Steel with powder-coat-finish **OR** Vinyl-covered steel with stainless-steel top, **as directed**.
b. Bubbler: One, with adjustable stream regulator, located on deck.
c. Control: Push button **OR** Foot pedal, **as directed**.
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: Grid with NPS 1-1/4 (DN 32) minimum horizontal waste and trap complying with ASME A112.18.2.
g. Cooling System: Electric, with precooler, hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
1) Capacity: 5 gph (0.0053 L/s) **OR** 8 gph (0.0084 L/s) **OR** 10 gph (0.0105 L/s) **OR** 14 gph (0.0147 L/s), **as directed,** 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: 1/6 **OR** 1/5 **OR** 1/4, **as directed**, hp; 120-V ac; single phase; 60 Hz.
2. Description: ARI 1010, Type PBC, pressure with bubbler and compartment, Style F, freestanding water cooler.
a. Cabinet: All stainless steel **OR** Vinyl-covered steel with stainless-steel top, **as directed,** with refrigerated compartment in front panel.
b. Bubbler: One, with adjustable stream regulator, located on deck.
c. Control: Push button.
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: Grid with NPS 1-1/4 (DN 32) minimum horizontal waste and trap complying with ASME A112.18.2.
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: 3 gph (0.0032 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: 1/8 hp; 120-V ac; single phase; 60 Hz.
3. Description: Accessible, ARI 1010, Type PB, pressure with bubbler, Style W, wall-mounting water cooler for adult **OR** child, **as directed,**-mounting height.
a. Cabinet: Single **OR** Bilevel with two attached cabinets **OR** Bilevel with two attached cabinets and with bilevel skirt kit, **as directed**, all stainless steel **OR** vinyl-covered steel with stainless-steel top, **as directed**.
b. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
c. Control: Push button **OR** Push bar, **as directed**.
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: 5 gph (0.0053 L/s)\ **OR** 8 gph (0.0084 L/s), **as directed**, 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: 1/6 **OR** 1/5 **OR** 1/4 **OR** 1/3, **as directed,** hp; 120-V ac; single phase; 60 Hz.

h. Support: Type I **OR** II, **as directed**, water cooler carrier. Refer to "Fixture Supports" Article.

4. Description: Accessible, ARI 1010, Type PB, pressure with bubbler, Style WS, semirecessed water cooler.
   a. Cabinet: All stainless steel **OR** Vinyl-covered steel with stainless-steel top, **as directed**.
   b. Bubbler: One, with adjustable stream regulator, located on deck.
   c. Control: Push button **OR** Push bar, **as directed**.
   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: Grid with NPS 1-1/4 (DN 32) minimum horizontal waste and trap complying with ASME A112.18.2.
   g. Cooling System: Electric, with precooler, hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
      1) Capacity: 8 gph (0.0084 L/s) **OR** 12 gph (0.0126 L/s), **as directed,** 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: 1/6 **OR** 1/5, **as directed,** hp; 120-V ac; single phase; 60 Hz.
   h. Support: Mounting frame or brackets for attaching to substrate.

5. Description: ARI 1010, Type PB, pressure with bubbler, Style RE, recessed water cooler.
   a. Cabinet: All stainless steel.
   b. Bubbler: One, with adjustable stream regulator, located on deck.
   c. Control: Push button **OR** bar, **as directed**.
   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: Grid with NPS 1-1/4 (DN 32) minimum horizontal waste and trap complying with ASME A112.18.2.
   g. Cooling System: Electric, with precooler, hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
      1) Capacity: 8 gph (0.0084 L/s) **OR** 12 gph (0.0126 L/s), **as directed,** 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: 1/6 **OR** 1/5, **as directed,** hp; 120-V ac; single phase; 60 Hz.
   h. Ventilation Grille: Stainless steel, located above **OR** below, **as directed,** fountain.
   i. Support: Mounting frame for attaching to substrate.

C. Water Station Water Coolers
   1. Description: Water-station configuration, freestanding, cabinet water cooler with top-mounting glass fillers.
      a. Cabinet: All stainless steel **OR** Enameled-steel panels with stainless-steel top, **as directed**, 0.05 inch (1.3 mm) thick; and 32 inches (813 mm) **OR** 36 inches (915 mm), **as directed**, high.

b. Receptors: Two **OR** Four, **as directed,** stainless-steel bowls, with grid drain and bottom outlet in top; with two facing front and two facing back.
c. Glass Fillers: Two **OR** Four, **as directed**, push-back type **OR** pedestal type, **as directed**, on top, over receptors.
d. Tray Slides: One on front and one on back, stainless steel.
e. Supply: NPS 1/2 (DN 15) with ball, gate, or globe valve, and connected to filter, chiller, and each glass filler.
f. 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.
g. Drain: Waste piping from each receptor connected to NPS 1-1/4 (DN 32) **OR** NPS 1-1/2 (DN 40), **as directed**, trap and waste to wall **OR** indirect waste to floor receptor, **as directed,** complying with ASME A112.18.2.
h. Cooling System: Electric, complying with ARI 1010, for Type R remote water coolers.
1) Chassis: Galvanized or corrosion-resistant-coated steel.
2) Chiller: Hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, and refrigerant.
3) Storage Tank: 2 gal. (7.6 L) **OR** 4 gal. (15.1 L) **OR** 6 gal. (22.7 L) **OR** 14 gal. (53 L) **OR** 25 gal. (95 L), **as directed**, stainless steel.
4) Controls: Adjustable thermostat.
5) One-Hour Peak Capacity Rate: 8 gph (0.0084 L/s) **OR** 12 gph (0.0126 L/s) **OR** 18 gph (0.0189 L/s) **OR** 29 gph (0.0305 L/s) **OR** 50 gph (0.0526 L/s), **as directed,** 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.
6) Electrical Characteristics: 1/5 **OR** 1/4 **OR** 1/3 **OR** 1/2 **OR** 3/4, **as directed,** hp; 120 **OR** 240 **OR** 277 **OR** 480, **as directed,**-V ac; single phase; 60 Hz.

2. Description: Water-station configuration, freestanding, cabinet water cooler with front-mounting glass fillers.
a. Cabinet: All stainless steel **OR** Enameled-steel panels with stainless-steel top, **as directed**, 0.05 inch (1.3 mm) thick; and 42 inches (1067 mm) **OR** 48 inches (1219 mm), **as directed**, high.
b. Receptors: One **OR** Two, **as directed,** stainless-steel tray(s), with antisplash design, drain, and bottom outlet, in vertical panel(s), with one facing front and one facing back.
c. Glass Fillers: Two **OR** Four, **as directed**, push-back type, on vertical panel(s), over receptor(s).
d. Shelves: One **OR** Two, **as directed**, stainless steel, on each side panel.
e. Supply: NPS 1/2 (DN 15) with ball, gate, or globe valve, and connected to filter, chiller, and each glass filler.
f. 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.
g. Drain: NPS 1-1/4 (DN 32) **OR** NPS 1-1/2 (DN 40), **as directed**, trap and waste to wall **OR** indirect waste to floor receptor, **as directed,** complying with ASME A112.18.2.
h. Cooling System: Electric, complying with ARI 1010, for Type R remote water coolers.
1) Chassis: Galvanized or corrosion-resistant-coated steel.
2) Chiller: Hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, and refrigerant.
3) Storage Tank: 6 gal. (22.7 L) **OR** 14 gal. (53 L) **OR** 25 gal. (95 L) **OR** 30 gal. (113.6 L) **OR** 40 gal. (151.4 L), **as directed**, stainless steel.
4) Controls: Adjustable thermostat.
5) One-Hour Peak Capacity Rate: 18 gph (0.0189 L/s) **OR** 29 gph (0.0305 L/s) **OR** 50 gph (0.0526 L/s) **OR** 65 gph (0.0684 L/s) **OR** 85 gph (0.0894 L/s), **as directed,** 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.
6) Electrical Characteristics: 1/3 **OR** 1/2 **OR** 3/4 **OR** 1 **OR** 1-1/2, **as directed**, hp; 120 **OR** 240 **OR** 277 **OR** 480, **as directed,**-V ac; single phase; 60 Hz.

D. Remote Water Coolers

1. Description: ARI 1010, Style R, remote chiller equipment for installation separate from drinking fountains. Include filter, reverse-osmosis system and ultra-violet-disinfection equipment, **as directed**.
   a. Cooling System: Electric.
      1) Chassis: Galvanized or corrosion-resistant-coated steel.
      2) Chiller: Hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, and refrigerant.
      3) Storage Tank: 0.5 gal. (1.9 L) **OR** 4 gal. (15.1 L), **as directed**, stainless steel.
      4) Controls: Adjustable thermostat.
      5) Capacity: 5 gph (0.0053 L/s) **OR** 8 gph (0.0084 L/s) **OR** 14 gph (0.0147 L/s), **as directed,** 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.
      6) Electrical Characteristics: 1/5 **OR** 1/4 **OR** 1/3, **as directed,** hp; 120 **OR** 240 **OR** 277 **OR** 480, **as directed,**-V ac; single phase; 60 Hz.
   b. Ventilation Grille: Stainless steel.
   c. 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.

E. Fixture Supports
1. 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.
   a. Type I: Hanger-type carrier with two vertical uprights.
   b. Type II: Bilevel, hanger-type carrier with three vertical uprights.
   c. Supports for Accessible Fixtures: Include rectangular, vertical, steel uprights instead of steel pipe uprights.

1.3 EXECUTION

A. Applications
1. Use carrier off-floor supports for wall-mounting fixtures, unless otherwise indicated.
2. Use mounting frames for recessed water coolers, unless otherwise indicated.
3. Set freestanding and pedestal drinking fountains on floor.
4. Set remote water coolers on floor, unless otherwise indicated.
5. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.

B. Installation
1. Install off-floor supports affixed to building substrate and attach wall-mounting fixtures, unless otherwise indicated.
2. Install mounting frames affixed to building construction and attach recessed water coolers to mounting frames, unless otherwise indicated.
3. Install fixtures level and plumb. For fixtures indicated for children, install at height required by authorities having jurisdiction.
4. 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".
5. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
6. 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".

7. 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".

C. Connections
1. Connect fixtures with water supplies, traps, and risers, and with soil, waste, and vent piping. Use size fittings required to match fixtures.
2. Ground equipment according to Division 26 Section "Grounding And Bonding For Electrical Systems".
3. Connect wiring according to Division 26 Section "Low-voltage Electrical Power Conductors And Cables".

D. Field Quality Control
1. Water Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties.
   a. Remove and replace malfunctioning units and retest as specified above.
   b. Report test results in writing.

E. Adjusting
1. Adjust fixture flow regulators for proper flow and stream height.
2. Adjust water cooler temperature settings.

END OF SECTION 22 47 13 00

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Task	Specification	Specification Description
22 47 16 00	01 22 16 00	No Specification Required
22 47 16 00	10 28 19 16	Plumbing Fixtures
22 47 16 00	22 01 40 00	Emergency Plumbing Fixtures
22 47 16 00	22 47 13 00	Drinking Fountains And Water Coolers
22 47 23 00	22 47 13 00	Drinking Fountains And Water Coolers
22 47 26 00	10 28 19 16	Plumbing Fixtures
22 51 13 00	01 22 16 00	No Specification Required
22 51 16 00	01 22 16 00	No Specification Required
22 51 19 00	01 22 16 00	No Specification Required
22 66 53 00	07 63 00 00	Common Work Results for Fire Suppression
22 66 53 00	07 63 00 00a	Common Work Results for Plumbing
22 66 53 00	07 63 00 00b	Common Work Results for HVAC
22 66 53 00	22 11 16 00a	Sanitary Waste And Vent Piping
22 66 53 00	22 11 16 00f	General-Service Compressed-Air Piping

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SECTION 22 66 83 16 - CHEMICAL-WASTE SYSTEMS FOR LABORATORY AND HEALTHCARE FACILITIES

1.1 GENERAL

A. Description Of Work
1. This specification covers the furnishing and installation of materials for chemical-waste systems for laboratory and healthcare facilities. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the products manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

C. Summary
1. Section Includes:
a. Single-wall piping.
b. Double-containment piping.
c. Field-fabrication containment piping.
d. Piping specialties.
e. Neutralization tanks.
f. Neutralization systems.
g. Manholes.
h. Leak-detection systems.

D. Definitions
1. CR: Chlorosulfonated polyethylene synthetic rubber.
2. FPM: Vinylidene fluoride-hexafluoro propylene copolymer rubber.

E. Performance Requirements
1. Single-Wall Piping Pressure Rating: 10 feet head of water (30 kPa).
2. Double-Containment Piping Pressure Rating:
a. Carrier Piping: 5-psig (34.5-kPa) air test pressure.
b. Containment Piping: 5-psig (34.5-kPa) air test pressure.
3. Field-Fabrication Containment-Piping Pressure Rating: 5-psig (34.5-kPa) air test pressure.
4. Delegated Design: Design seismic restraints for aboveground piping, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

F. Submittals
1. Product Data: For each type of product indicated.
2. LEED Submittal:
a. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content.
3. Shop Drawings: For neutralization system and leak-detection system. Include plans, elevations, sections, details, and attachments to other work.
a. Detail neutralization-system assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
b. Detail leak-detection-system assemblies and indicate required clearances, method of field assembly, components, and location and size of each field connection.
c. Wiring Diagrams: For power, signal, and control wiring.
4. Delegated-Design Submittal: For seismic restraints of aboveground piping, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
5. Profile Drawings for Outdoor Underground Piping: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1 inch equals 50 feet (1:500) and vertical scale of not

less than 1 inch equals 5 feet (1:50). Indicate underground structures and pipes. Show types, sizes, materials, and elevations of other utilities crossing system piping.

6. Field quality-control test reports.
7. Operation and Maintenance Data: For chemical-waste specialties and neutralization tanks, neutralization systems, and leak-detection systems to include in emergency, operation, and maintenance manuals.

G. Quality Assurance
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. NFPA Compliance: Comply with NFPA 70, "National Electrical Code."

H. Delivery, Storage, And Handling
1. Deliver and store piping and specialties with sealing plugs in ends or with end protection.
2. Do not store plastic pipe or fittings in direct sunlight.
3. Protect pipe, fittings, and seals from dirt and damage.

I. Project Conditions
1. Interruption of Existing Chemical-Waste Service: Do not interrupt chemical-waste service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary chemical-waste service according to requirements indicated:
   a. Notify the Owner no fewer than two days in advance of proposed interruption of chemical-waste service.
   b. Do not proceed with interruption of chemical-waste service without the Owner's written permission.

1.2 PRODUCTS

A. Single-Wall Pipe And Fittings
1. PE Drainage Pipe and Fittings: Made of ASTM D 4976, PE resin.
   a. Pipe: ASTM F 1412, Schedule 40.
   b. Fittings: ASTM F 1412, Schedule 40, socket-fusion, drainage pattern complying with ASTM D 3311.
2. PP Drainage Pipe and Fittings: ASTM F 1412, pipe extruded and drainage-pattern fittings molded, with Schedule 40 dimensions, from PP resin with fire-retardant additive complying with ASTM D 4101; with fusion **OR** fusion- and mechanical **OR** mechanical, **as directed**,-joint ends.
   a. Exception: Pipe and fittings made from PP resin without fire-retardant additive may be used for underground installation.
3. PVC Drainage Pipe and Fittings: ASTM D 2665, pipe and drainage-pattern fittings.
4. PVDF Drainage Pipe and Fittings: ASTM F 1673, Schedule 40, pipe and drainage-pattern fittings. Include fittings with fusion **OR** fusion- and mechanical **OR** mechanical, **as directed**,-joint ends.
5. Fiberglass Pipe and Fittings, Centrifugally Cast: ASTM D 2997, Type II, Grade 1 **OR** Grade 2, **as directed**, Class A **OR** Class B **OR** Class C, **as directed**, RTRP pipe; with ASTM D 5685, Type 4, RTRF fittings matching pipe; and adhesive-bonding **OR** butt-and-wrap-joint, **as directed**, materials. Include wall thickness that will provide 160-psig (1105-kPa) minimum, sustained water test pressure rating.
6. Fiberglass Pipe and Fittings, Filament Wound: ASTM D 2996, Type I, Grade 1 **OR** Grade 2, **as directed**, Class A **OR** Class B **OR** Class C **OR** Class E **OR** Class F, **as directed**, RTRP pipe; ASTM D 5685, Type 1, RTRF fittings matching pipe; and adhesive-bonding **OR** butt-and-wrap-joint, **as directed**, materials. Include wall thickness that will provide 160-psig (1105-kPa) minimum, sustained water test pressure rating.

7. High-Silicon-Iron, Hub-and-Plain-End Pipe and Fittings: ASTM A 861, pipe and drainage-pattern fittings; acid-resistant packing; and lead calking materials.
8. High-Silicon-Iron, Mechanical-Joint Pipe and Fittings: ASTM A 861, pipe and drainage-pattern fittings; and stainless-steel clamps with TFE inner sleeve and CR outer sleeve.
9. Stainless-Steel Drainage Pipe and Fittings: ASME A112.3.1, ASTM A 666, Type 316L, stainless-steel pipe and drainage-pattern fittings; with socket and spigot ends for gasket joints; and having piping manufacturer's FPM lip-seal rubber gaskets shaped to fit socket groove, with plastic backup ring.
10. Borosilicate Glass Pipe and Fittings: ASTM C 1053, pipe and drainage-pattern fittings; with manufacturer's standard couplings.
    a. Covering: Factory-applied polystyrene for pipe installed underground.
11. Adapters and Transition Fittings: Assemblies with combination of clamps, couplings, adapters, and gaskets; compatible with piping and system liquid; made for joining different piping materials.

B. Double-Containment Pipe And Fittings
1. Description: Factory-fabricated, double-wall pipe and fittings. Sizes indicate carrier-pipe size; with carrier (inner) pipe and fittings; annular-space, carrier-pipe supports; containment (outer) pipe and fittings; and joining materials and fasteners. Include manufacturer's standard piping materials according to the following:
    a. PE, Double-Containment Drainage Pipe and Fittings: Made of ASTM D 4976, PE resin.
        1) Carrier and Containment Pipes: ASTM F 1412, Schedule 40.
        2) Fittings: ASTM F 1412, Schedule 40 drainage pattern complying with ASTM D 3311.
    b. PP, Double-Containment Drainage Pipe and Fittings: Made of ASTM D 4101, PP resin.
        1) Carrier and Containment Pipes: ASTM F 1412, Schedule 40.
        2) Fittings: ASTM F 1412, Schedule 40 drainage pattern complying with ASTM D 3311.
    c. PP/PVC, Double-Containment Drainage Pipe and Fittings:
        1) PP Carrier Pipe: ASTM F 1412, Schedule 40; made of ASTM D 4101, PP resin.
        2) PP Carrier-Pipe Fittings: ASTM F 1412, Schedule 40 drainage pattern complying with ASTM D 3311; made of ASTM D 4101, PP resin.
        3) PVC Containment Pipe: ASTM D 2665, PVC pipe.
        4) PVC Containment Pipe Fittings: ASTM D 2665, PVC drainage pattern.
    d. PVDF, Double-Containment Drainage Pipe and Fittings: Made of ASTM D 3222, PVDF resin.
        1) Carrier and Containment Pipes: ASTM F 1673, Schedule 40.
        2) Fittings: ASTM F 1673, Schedule 40 drainage pattern complying with ASTM D 3311.
    e. PVDF/PVC, Double-Containment Drainage Pipe and Fittings:
        1) PVDF Carrier Pipe: ASTM F 1673, Schedule 40; made of ASTM D 3222, PVDF resin.
        2) PVDF Carrier-Pipe Fittings: ASTM F 1673, Schedule 40 drainage pattern complying with ASTM D 3311; made of ASTM D 3222, PVDF resin.
        3) PVC Containment Pipe: ASTM D 2665, PVC pipe.
        4) PVC Containment Pipe Fittings: ASTM D 2665, PVC drainage pattern.
2. Include design and fabrication of double-containment pipe and fitting assemblies with provision for field installation of cable leak-detection system in annular space between carrier and containment piping.

C. Field-Fabrication Containment Piping
1. Description: Containment split pipe and split fittings with carrier-pipe centralizers. Include manufacturer's fastening devices and materials.
    a. Material: HDPE **OR** PP **OR** Yellow PVC **OR** Clear PVC, **as directed**, pipe and fittings.
    b. Fastening System: FPM gaskets, clamps, and pins.

c. Material: Clear PVC pipe and fittings with adhesive channels, for use with drainage-pattern carrier piping.
d. Fastening System: Adhesive.

D. Joining Materials
1. Couplings: Assemblies with combination of clamps, gaskets, sleeves, and threaded or flanged parts; compatible with piping and system liquid; and made by piping manufacturer for joining system piping.
2. Adapters and Transition Fittings: Assemblies with combination of clamps, couplings, adapters, gaskets, and threaded or flanged parts; compatible with piping and system liquid; and made for joining different piping materials.
3. Flanges: Assemblies of companion flanges and gaskets complying with ASME B16.21 and compatible with system liquid, and bolts and nuts.
4. Solvent Cement for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
   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).
5. Fiberglass-Pipe Adhesive: As furnished or recommended by pipe manufacturer.
   a. Use fiberglass adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Piping Specialties
1. Plastic Dilution Traps:
   a. Material: Corrosion-resistant PP, with removable base.
   b. End Connections: Mechanical joint.
   c. Dilution Tanks: 1-gal. (3.8-L) capacity, with clear base unless colored base is indicated; with two NPS 1-1/2 (DN 40) top inlets and one NPS 1-1/2 (DN 40) side outlet.
   d. Small Dilution Jars: 1-pint (0.5-L) capacity, with clear base unless colored base is indicated; with NPS 1-1/2 (DN 40) top inlet and NPS 1-1/2 (DN 40) side outlet.
   e. Large Dilution Jars: 1-quart (1-L) capacity; with NPS 1-1/2 (DN 40) top inlet and NPS 1-1/2 (DN 40) side outlet.
2. High-Silicon-Iron Dilution Traps:
   a. Standard: ASTM A 861.
   b. Size: NPS 1-1/2 or NPS 2 (DN 40 or DN 50) as required for fixture and waste.
   c. End Connections: Mechanical.
3. Glass, Drain-Line, Interceptor Traps:
   a. Standard: ASTM C 1053.
   b. Type: Drum trap.
   c. Size: NPS 1-1/2 (DN 40), NPS 2 by NPS 1-1/2 (DN 50 by DN 40), or NPS 2 (DN 50), as required to match connecting piping.
4. Corrosion-Resistant Traps:
   a. Type: P-trap or drum trap.
   b. Size: NPS 1-1/2 or NPS 2 (DN 40 or DN 50), as required to match connected piping.
   c. High-Silicon Iron: ASTM A 861, with horizontal outlet and hub-and-plain or plain ends to match connecting piping.
   d. PP: ASTM D 4101, with mechanical-joint pipe connections.
   e. PVDF: ASTM D 3222, with mechanical-joint pipe connections.
   f. Glass: ASTM C 1053, with coupling pipe connections.
5. High-Silicon-Iron Floor Drains:
   a. Standard: ASTM A 861.
   b. Body: With integral flashing flange and weep holes; and with flashing ring and stainless-steel strip, sediment basin and funnel attachment, **as directed**.

c. Top: 8-3/4-inch (222-mm) diameter with grate.
d. Size: NPS 2, NPS 3, NPS 4, or NPS 6 (DN 50, DN 80, DN 100, or DN 150) outlet as indicated.

6. Stainless-Steel Floor Drains:
   a. Standard: ASME A112.3.1, ASTM A 666, Type 316L.
   b. Body: With 8.5-by-8.5-inch (215-by-215-mm) **OR** 12.4-by-12.4-inch (315-by-315-mm), **as directed**, top with grate.
   c. Outlet: Bottom, of size indicated.
7. PP Floor Drains:
   a. Body: With 7- to 9-inch (178- to 230-mm) top diameter, with flashing flange and weep holes; and with flashing clamp, basket strainer, funnel attachment, and trap-primer connection, **as directed**.
   b. Outlet: Bottom, to match connecting pipe, with NPS 2, NPS 3, NPS 4, or NPS 6 (DN 50, DN 80, DN 100, or DN 150) outlet as indicated.
8. High-Silicon-Iron Cleanouts:
   a. Standard: ASTM A 861, fitting with PTFE gasket and closure plug, of design appropriate for piping application.
9. Stainless-Steel Cleanouts:
   a. Standard: ASME A112.3.1, ASTM A 666, Type 316L, stainless steel.
   b. Aboveground Piping: Cleanout tee of size matching piping.
   c. Underground and Underslab Piping: Floor access cleanout of size matching piping.
10. High-Silicon-Iron Backwater Valves:
    a. Standard: ASTM A 861.
    b. Body: Hub-and-plain end with swing-check valve; and with high-silicon-iron pipe extension of length to reach floor surface, and high-silicon-iron closure plug, **as directed**.
11. Plastic Backwater Valves:
    a. Description: Full-port NPS 3 (DN 80) check valve, PP or PVDF, matching or compatible with system piping and compatible with system liquid, with EPDM seals and flanged ends.
       1) Exception: PVC material for use with PVC piping systems.
12. High-Silicon-Iron Sink Outlets:
    a. Standard: ASTM A 861, high-silicon iron, NPS 1-1/2 (DN 40), with clamping device and 4-, 6-, or 8-inch- (100-, 150-, or 200-mm-) high overflow fitting, as indicated.
13. PP Sink Outlets:
    a. Description: NPS 1-1/2 (DN 40), with clamping device, stopper, and 7-inch- (178-mm-) high overflow fitting.
14. Glass Sink Outlets:
    a. Standard: ASTM C 1053, components for field assembly, NPS 1-1/2 (DN 40); with sink assembly of outlet, strainer, gasket, and locknut; overflow fitting of length indicated; and tailpiece assembly of borosilicate glass and locknut.

F. Neutralization Tanks
1. Plastic Neutralization Tanks:
   a. Description: Corrosion-resistant plastic materials; with removable, gastight cover; interior, sidewall, dip-tube inlet; outlet; vent; and threaded or flanged, sidewall pipe connections.
      1) Material: HDPE **OR** ASTM D 4101, PP, **as directed**.
      2) Tank Capacity: as directed by the Owner.
      3) Dip Tube: On outlet pipe instead of inlet pipe.
      4) Extension: HDPE, PE, or PP.
      5) Traffic Cover: Light-duty **OR** Heavy-duty pedestrian or light-duty vehicular, steel plate over, **as directed**, plastic, bolted.
      6) Limestone: Chips or lumps, with more than 90 percent calcium carbonate content and 1- to 3-inch (25- to 75-mm) diameter.
         OR

Dolomitic Limestone: Chips or lumps, with more than 90 percent combined magnesium carbonate and calcium carbonate content and 1- to 3-inch (25- to 75-mm) diameter.

2. Ceramic Neutralization Tanks:
   a. Description: Corrosion-resistant, cast-ceramic shell; with removable, reinforced-plastic, gastight cover; inlet; interior, sidewall, dip-tube outlet; vent; and bell, sidewall pipe connections.
      1) Extension: Ceramic, of size and length indicated, and with cast-iron manhole frame and cover.
         OR
         Extension: Steel with protective coating, 28-inch (710-mm) diameter, and cast-iron manhole frame and cover.
      2) Limestone: Chips or lumps, with more than 90 percent calcium carbonate content and 1- to 3-inch (25- to 75-mm) diameter.
         OR
         Dolomitic Limestone: Chips or lumps, with more than 90 percent combined magnesium carbonate and calcium carbonate content and 1- to 3-inch (25- to 75-mm) diameter.
3. Collection Tanks: Corrosion-resistant, cast-ceramic shell. Include removable, reinforced-plastic, gastight cover; inlet; vent; and bell, sidewall pipe connections.
   a. Extension: Ceramic **OR** Steel with protective coating, **as directed**, 28-inch (710-mm) minimum diameter, and cast-iron manhole frame and cover.

G. Neutralization Systems
1. Plastic-Tank Neutralization Systems:
   a. Description: Automatic system for neutralizing chemical waste.
      1) Controls: Factory-wired and -tested, 120-V ac, to operate probes, control valves, and metering pumps and to monitor pH of effluent; with wiring and electrical-power terminals.
      2) Panel: NEMA 250, Type 4X enclosure, unless otherwise indicated; with manufacturer's standard features, control devices, and indicators, but not less than the following:
         a) Power light and on/off switch.
         b) pH analyzer with meter and high- and low-pH indicators.
         c) Low caustic- and acid-solution level indicators.
         d) Alarm horn with silencer and reset switch.
         e) Agitator running light with on/off switch.
         f) Running lights with on/off switches for caustic- and acid-solution pumps.
      3) Strip chart recorder with capacity for 30-day record.
      4) Piping between Tanks: Same material as chemical-waste piping system unless otherwise indicated.
      5) Interceptor Tank: Same material as mixing tank; with removable, gastight cover; and sidewall inlet and outlet piping connections.
      6) Neutralization Tank: Same material as mixing tank; with removable, gastight cover; sidewall inlet and outlet piping connections; and vent connection in sidewall or top.
         a) Limestone: Chips or lumps, with more than 90 percent calcium carbonate content and 1- to 3-inch (25- to 75-mm) diameter.
            OR
            Dolomitic Limestone: Chips or lumps, with more than 90 percent combined magnesium carbonate and calcium carbonate content and 1- to 3-inch (25- to 75-mm) diameter.
      7) Mixing Tank: With removable, gastight cover; sidewall inlet and outlet piping connections; vent connection in sidewall or top; neutralizing-solution piping connections; and openings in top for probe and agitator.

a) Material: HDPE **OR** ASTM D 4101, PP, **as directed**.
b) pH Probe: Type and length suitable for mixing-tank size.
c) Agitator: Electric, with stainless-steel shaft and propeller.

8) Caustic-Solution Storage Tank: PP.
a) Caustic Chemical: Sodium hydroxide solution.

9) Acid Storage Tank: PP.
a) Acid Chemical: Sulfuric acid solution.

10) Metering Pumps: Types suitable for neutralizing solutions.

11) Sampling Tank: Same material as mixing tank; with removable, gastight cover; sidewall inlet and outlet piping connections; and opening in top for probe.
a) pH probe: Type and length suitable for sampling-tank size.

2. Ceramic-Tank Neutralization Systems:

a. Description: Automatic system for neutralizing chemical waste.

1) Controls: Factory-wired and -tested, 120-V ac, to operate probes, control valves, and metering pumps and to monitor pH of effluent; with wiring and electrical-power terminals.

2) Panel: NEMA 250, Type 4X enclosure, unless otherwise indicated; with manufacturer's standard features, control devices, and indicators, including the following:
a) Power light and on/off switch.
b) pH analyzer with meter and high- and low-pH indicators.
c) Low caustic- and acid-solution level indicators.
d) Alarm horn with silencer and reset switch.
e) Agitator running light with on/off switch.
f) Running lights with on/off switches for caustic- and acid-solution pumps.

3) Strip chart recorder with capacity for 30-day record.

4) Piping between Tanks: Same material as chemical-waste piping system unless otherwise indicated.

5) Interceptor Tank: Same material as mixing tank; with removable, gastight cover; and sidewall inlet and outlet piping connections.

6) Neutralization Tank: Same material as mixing tank; with removable, gastight cover; sidewall inlet and outlet piping connections; and vent connection in sidewall or top.
a) Limestone: Chips or lumps, with more than 90 percent calcium carbonate content and 1- to 3-inch (25- to 75-mm) diameter.
OR
Dolomitic Limestone: Chips or lumps, with more than 90 percent combined magnesium carbonate and calcium carbonate content and 1- to 3-inch (25- to 75-mm) diameter.

7) Mixing Tank: With removable, gastight cover; sidewall inlet and outlet piping connections; vent connection in sidewall or top; neutralizing-solution piping connections; and openings in top for probe and agitator.
a) Material: Clay, vitrified into ceramic unit.
b) pH Probe: Type and length suitable for mixing tank size.
c) Agitator: Electric, with stainless-steel shaft and propeller.

8) Caustic-Solution Storage Tank: PP.
a) Caustic Chemical: Sodium hydroxide solution.

9) Acid Storage Tank: PP.
a) Acid Chemical: Sulfuric acid solution.

10) Metering Pumps: Types suitable for neutralizing solutions.

11) Sampling Tank: Same material as mixing tank; with removable, gastight cover; sidewall inlet and outlet piping connections; and opening in top for probe.
a) pH probe: Type and length suitable for sampling-tank size.

H. Manholes

1. Description: ASTM F 1759, fabricated from PE components. Include bottom, sidewalls, and top sections; corrosion-resistant, manhole frame and cover; fusion or other watertight joints; and design to prohibit flotation.
    a. Construction: Single wall **OR** Double wall with interstitial space, **as directed**.
    b. Bottom: Channeled.
    c. Connections: Inlets and outlet matching or suitable for piping.
    d. Steps: Manufacturer's standard, fusion welded to sidewall. Omit steps for manholes less than 60 inches (1500 mm) deep.
    e. Top: Include 24-inch- (610-mm-) nominal-diameter frame and cover.

I. Leak-Detection Systems
1. Leak-Detection Systems:
    a. Description: Cable leak-detection system capable of detecting and annunciating fluid leaks; with controls, panel, wiring, cable sensors, probes if required, and piping.
        1) Annunciator Panel: Enclosure with visual and audible alarms and leak location indicator.
        2) Sensors: Electric cable, suitable for insertion into double-containment piping annular space, with capability of detecting fluid leaks and signaling locations of leaks.

J. Sleeves
1. Cast-Iron Wall Pipes: Cast or fabricated of cast iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
2. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
3. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
4. Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc-coated, plain ends.
5. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
    a. Underdeck Clamp: Clamping ring with set screws.

K. Sleeve Seals
1. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
    a. Sealing Elements: EPDM **OR** NBR, **as directed**, interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
    b. Pressure Plates: Carbon steel **OR** Plastic **OR** Stainless steel, **as directed**.
    c. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating **OR** Stainless steel, **as directed**, of length required to secure pressure plates to sealing elements.

L. Escutcheons
1. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and tube and OD that completely covers opening.
2. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.
3. One-Piece, Stamped-Steel Escutcheons: With set screw **OR** spring clips, **as directed**, and chrome-plated finish.
4. Split-Plate, Stamped-Steel Escutcheons: With concealed **OR** exposed-rivet, **as directed**, hinge, set screw **OR** spring clips, **as directed**, and chrome-plated finish.
5. One-Piece, Floor-Plate Escutcheons: Cast iron.
6. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

M. Grout
1. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

a. Characteristics: Post-hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
b. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
c. Packaging: Premixed and factory packaged.

1.3 EXECUTION

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

B. Concrete Bases
1. Anchor neutralization tanks and neutralization system tanks to concrete bases.
a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 19-inch (480-mm) centers around full perimeter of base.
b. For installed equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be imbedded.
d. Install anchor bolts to elevations required for proper attachment to supported equipment.
e. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
f. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-place Concrete".
g. Comply with requirements in Division 31 for cast-in-place concrete materials and placement.

C. Piping Installation
1. Chemical-Waste Sewerage Outside the Building:
a. Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground chemical-waste sewerage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
b. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.
c. Install manholes for changes in direction, unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
d. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
e. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed by tunneling, jacking, or combination of both.
f. Install drainage piping pitched down in direction of flow, at minimum slope of 1 **OR** 2, **as directed**, percent, unless otherwise indicated.
g. Install drainage piping with 36-inch (915-mm) **OR** 48-inch (1220-mm) **OR** 60-inch (1524-mm) **OR** 72-inch (1830-mm), **as directed**, minimum cover.
h. Install PE drainage piping according to ASTM D 2321 and ASTM F 1668.
i. Install PVC drainage piping according to ASTM D 2321 and ASTM F 1668.
j. Install PVDF drainage piping according to ASTM D 2321 and ASTM F 1668.
k. Install fiberglass piping according to ASTM D 3839 and ASTM F 1668.
l. Install field-fabrication containment piping over new and existing carrier piping. Use containment piping manufacturer's fastening system.

m. Clear interior of piping and structures of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

2. Chemical-Waste Piping Inside the Building:
   a. Install piping next to equipment, accessories, and specialties to allow service and maintenance.
   b. Transition and special fittings with pressure ratings at least equal to piping pressure rating may be used unless otherwise indicated.
   c. Flanges may be used on aboveground piping unless otherwise indicated.
   d. Install underground fiberglass piping according to ASTM D 3839.
   e. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
   f. 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.
   g. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
   h. Install piping at indicated slopes.
   i. Install piping free of sags and bends.
   j. Install fittings for changes in direction and branch connections.
   k. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
      1) New Piping:
         a) Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
         b) Insulated Piping: One-piece, stamped-steel type with spring clips.
         c) Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
         d) Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type **OR** Split-plate, stamped-steel type with concealed hinge **OR** One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge, **as directed**, and set screw.
         e) Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with set screw **OR** spring clips, **as directed**.
         f) Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw **OR** spring clips, **as directed**.
         g) Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
      2) Existing Piping:
         a) Insulated Piping: Split-plate, stamped-steel type with concealed **OR** exposed-rivet, **as directed**, hinge and spring clips.
         b) Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and spring clips.
         c) Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.
         d) Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed **OR** exposed-rivet, **as directed**, hinge and set screw or spring clips.
         e) Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.
         f) Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.
   l. Sleeves are not required for core-drilled holes.
   m. Permanent sleeves are not required for holes formed by removable PE sleeves.
   n. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

OR

Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

1) Cut sleeves to length for mounting flush with both surfaces.
   a) Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
2) Install sleeves in new walls and slabs as new walls and slabs are constructed.
3) Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
   a) PVC **OR** Steel, **as directed**, Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
   b) Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum board partitions.
   c) Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing And Trim" for flashing.
   d) Seal space outside of sleeve fittings with grout.
4) Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

o. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and 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) Sleeve-Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

p. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using 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) Sleeve-Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

q. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

r. Verify final equipment locations for roughing-in.

D. Piping Specialty Installation
   1. Embed floor drains in 4-inch (100-mm) minimum depth of concrete around bottom and sides. Comply with requirements in Division 03 Section "Cast-in-place Concrete" for concrete.
   2. Fasten grates to drains if indicated.
   3. Set floor drains with tops flush with pavement surface.
   4. Install cleanouts and riser extension from sewer pipe to cleanout at grade. Use fittings of same material as sewer pipe at branches for cleanouts and riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in pipe.

a. Set cleanout bodies in earth in cast-in-place concrete block, 18 by 18 by 12 inches (450 by 450 by 300 mm) deep. Set with tops 1 inch (25 mm) above surrounding grade. Set cleanout plugs in concrete pavement with tops flush with pavement surface. Comply with requirements in Division 03 Section "Cast-in-place Concrete" for formwork, reinforcement, and concrete requirements.

5. Install backwater valves in horizontal position. Include riser to cleanout at grade.

E. Joint Construction

1. Chemical-Waste Sewerage Outside the Building:
   a. Plastic-Piping, Electrofusion Joints: Make polyolefin drainage-piping joints according to ASTM F 1290.
   b. Make fiberglass-piping bonded joints according to ASTM D 3839.
   c. Make fiberglass butt-and-wrap joints according to ASTM D 3839.
   d. Join dissimilar pipe materials with adapters compatible with pipe materials being joined.
   e. Join high-silicon-iron, hub-and-plain-end piping with calked joints using acid-resistant packing and lead.
   f. Join high-silicon-iron, mechanical-joint piping with coupled joints using clamps and sleeves.
   g. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.
2. Chemical-Waste Piping Inside the Building:
   a. Plastic-Piping Electrofusion Joints: Make polyolefin drainage-piping joints according to ASTM F 1290.
   b. Fiberglass-Piping Joints: Make joints with piping manufacturer's bonded adhesive.
   c. Dissimilar-Material Piping Joints: Make joints using adapters compatible with both system materials.
   d. Join high-silicon-iron, hub-and-plain-end piping with calked joints using acid-resistant packing and lead.
   e. Join high-silicon-iron, mechanical-joint piping with coupled joints using clamps and sleeves.
   f. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

F. Hanger And Support Installation

1. Pipe sizes in this article refer to aboveground, single-wall piping and carrier piping of containment piping, **as directed**.
2. Comply with requirements in Division 22 Section "Vibration And Seismic Controls For Plumbing Piping And Equipment" for seismic-restraint devices.
3. Comply with requirements in Division 22 Section "Hangers And Supports For Plumbing Piping And Equipment" for pipe hanger and support devices. Install the following:
   a. Vertical Piping: MSS Type 8 or MSS Type 42, riser clamps.
   b. Individual, Straight, Horizontal Piping Runs:
      1) 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
      2) Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
      3) Longer Than 100 Feet (30 m), if Indicated: MSS Type 49, spring cushion rolls.
   c. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   d. Base of Vertical Piping: MSS Type 52, spring hangers.
4. Comply with requirements in Division 22 Section "Hangers And Supports For Plumbing Piping And Equipment" for installation of supports.
5. Support horizontal piping and tubing within 12 inches (300 mm) of each fitting and coupling.
6. Support vertical piping and tubing at base and at each floor.
7. Rod diameter may be reduced 1 size for double-rod hangers, to minimum of 3/8 inch (10 mm).
8. Install vinyl-coated hangers for PP piping with the following maximum horizontal spacing and minimum rod diameters:
   a. NPS 2 (DN 50): 33 inches (840 mm) with 3/8-inch (10-mm) rod.
   b. NPS 2-1/2 and NPS 3 (DN 65 and DN 80): 42 inches (1067 mm) with 1/2-inch (13-mm) rod.

c. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1220 mm) with 5/8-inch (16-mm) rod.
d. NPS 6 (DN 150): 48 inches (1220 mm) with 3/4-inch (19-mm) rod.
e. NPS 8 (DN 200): 48 inches (1220 mm) with 7/8-inch (22-mm) rod.

9. Install supports for vertical PP piping every 72 inches (1830 mm).
10. Install vinyl-coated hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
    a. NPS 1-1/4 (DN 32): 36 inches (910 mm) with 3/8-inch (10-mm) rod.
    b. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 42 inches (1067 mm) with 3/8-inch (10-mm) rod.
    c. NPS 2-1/2 and NPS 3 (DN 65 and DN 80): 42 inches (1067 mm) with 1/2-inch (13-mm) rod.
    d. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1220 mm) with 5/8-inch (16-mm) rod.
    e. NPS 6 (DN 150): 48 inches (1220 mm) with 3/4-inch (19-mm) rod.
    f. NPS 8 to NPS 12 (DN 200 to DN 300): 48 inches (1220 mm) with 7/8-inch (22-mm) rod.
11. Install supports for vertical PVC piping every 48 inches (1220 mm).
12. Install vinyl-coated hangers for PVDF piping with the following maximum horizontal spacing and minimum rod diameters:
    a. All Sizes: Install continuous support for piping with liquid waste at temperatures above 140 deg F (60 deg C).
    b. NPS 1/2 (DN 15) and Smaller: 30 inches (760 mm) with 3/8-inch (10-mm) rod.
    c. NPS 3/4 to NPS 1-1/2 (DN 20 to DN 40): 36 inches (910 mm) with 3/8-inch (10-mm) rod.
    d. NPS 2 (DN 50): 36 inches (910 mm) with 3/8-inch (10-mm) rod.
    e. NPS 2-1/2 and NPS 3 (DN 65 and DN 80): 42 inches (1067 mm) with 1/2-inch (13-mm) rod.
    f. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches (1220 mm) with 5/8-inch (16-mm) rod.
    g. NPS 6 (DN 150): 48 inches (1220 mm) with 3/4-inch (19-mm) rod.
13. Install supports for vertical PVDF piping NPS 1-1/2 (DN 40) every 48 inches (1220 mm) and NPS 2 (DN 50) and larger every 72 inches (1830 mm).
14. Install vinyl-coated hangers for fiberglass piping with the following maximum horizontal spacing and minimum rod diameters:
    a. NPS 2 (DN 50) and Smaller: 10 feet (3 m) with 3/8-inch (10-mm) rod.
    b. NPS 2-1/2 and NPS 3 (DN 65 and DN 80): 10 feet (3 m) with 1/2-inch (13-mm) rod.
    c. NPS 4 and NPS 5 (DN 100 and DN 125): 10 feet (3 m) with 5/8-inch (16-mm) rod.
    d. NPS 6 (DN 150): 10 feet (3 m) with 3/4-inch (19-mm) rod.
    e. NPS 8 to NPS 12 (DN 200 to DN 300): 12 feet (3.6 m) with 7/8-inch (22-mm) rod.
15. Install supports for vertical fiberglass piping every 12 feet (3.6 m).
16. Install hangers for stainless-steel drainage piping with the following maximum horizontal spacing and minimum rod diameters:
    a. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
    b. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
    c. NPS 3 (DN 80): 12 feet (3.6 m) with 1/2-inch (13-mm) rod.
    d. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.6 m) with 5/8-inch (16-mm) rod.
    e. NPS 6 (DN 150): 12 feet (3.6 m) with 3/4-inch (19-mm) rod.
17. Install supports for vertical stainless-steel drainage piping every 15 feet (4.5 m).
18. Install hangers for high-silicon-iron piping with the following maximum horizontal spacing and minimum rod diameters:
    a. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches (1520 mm) with 3/8-inch (10-mm) rod.
    b. NPS 3 (DN 80): 60 inches (1520 mm) with 1/2-inch (13-mm) rod.
    c. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1520 mm) with 5/8-inch (16-mm) rod.
    d. NPS 6 (DN 150): 60 inches (1520 mm) with 3/4-inch (19-mm) rod.
    e. NPS 8 to NPS 12 (DN 200 to DN 300): 60 inches (1520 mm) with 7/8-inch (22-mm) rod.
    f. NPS 15 (DN 375): 60 inches (1520 mm) with 1-inch (25-mm) rod.
    g. Spacing for horizontal pipe in 84-inch (2134-mm) lengths may be increased to 84 inches (2134 mm). Spacing for fittings is limited to 60 inches (1520 mm).

19. Install supports for vertical high-silicon-iron piping every 15 feet (4.5 m).
20. Install vinyl-coated hangers for glass piping with the following maximum horizontal spacing and minimum rod diameters:
    a. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches (1830 mm) with 3/8-inch (10-mm) rod.
    b. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2440 mm) with 3/8-inch (10-mm) rod.
    c. NPS 3 (DN 80): 96 inches (2440 mm) with 1/2-inch (13-mm) rod.
    d. NPS 4 and NPS 6 (DN 100 and DN 150): 96 inches (2440 mm) with 5/8-inch (16-mm) rod.
21. Install supports for vertical glass piping every 96 inches (2440 mm).
22. Support piping and tubing not listed above according to MSS SP-69.

G. Neutralization Tank Installation
1. Install exterior collection **OR** neutralization, **as directed**, tanks, complete with appurtenances indicated.
    a. Set tops of tank covers flush with finished surface where covers occur in pavements. Set covers 3 inches (76 mm) above finished surface elsewhere unless otherwise indicated.
    b. Include initial fill of limestone for neutralization tanks.
2. Install interior neutralization tanks on smooth and level concrete base **OR** floor surface, **as directed**. Include full initial charge of limestone.

H. Neutralization System Installation
1. Install neutralization systems on smooth and level concrete base **OR** floor surface, **as directed**. Include neutralizing solutions and full initial charge of limestone.

I. Manhole Installation
1. General: Install manholes, complete with appurtenances and accessories indicated. Comply with requirements in Division 22 Section "Facility Sanitary Sewers".
2. Set tops of manhole frames and covers flush with finished surface where manholes occur in pavements. Set tops 3 inches (76 mm) above finished surface elsewhere unless otherwise indicated.

J. Leak-Detection System Installation
1. Single-Pipe, Chemical-Waste Sewerage Piping: Install leak-detection system below piping.
2. Double-Containment Piping: Install leak-detection system in piping annular space.
3. Manholes: Install leak-detection system around bottom of exterior.
4. Install panel in location indicated.

K. Concrete Placement
1. Comply with requirements in Division 03 Section "Cast-in-place Concrete" for concrete supports.
2. Place cast-in-place concrete according to ACI 318/318R.

L. Connections
1. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Make connections to existing piping so finished Work complies as nearly as practical with requirements specified for new Work.
3. Use commercially manufactured wye fittings for sewerage piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting plus 6-inch (150-mm) overlap, with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
4. Protect existing piping to prevent concrete or debris from entering while making connections. Remove debris or other extraneous material that may accumulate.
5. Install piping adjacent to equipment to allow service and maintenance.

M. Labeling And Identification
1. Comply with requirements in Division 22 Section "Identification For Plumbing Piping And Equipment" for labeling of equipment and piping.
   a. Use warning tape **OR** detectable warning tape, **as directed**, over ferrous piping.
   b. Use detectable warning tape over nonferrous piping and over edges of underground structures.

N. Field Quality Control
1. Inspect interior of sewerage piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (610 mm) of backfill is in place and again at completion of Project.
   a. Defects requiring correction include the following:
      1) Alignment: Less than full diameter of inside of pipe is visible between inspection points.
      2) Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
      3) Crushed, broken, cracked, or otherwise damaged piping.
      4) Hydrostatic Tests for Drainage Piping:
         a) Allowable leakage is a maximum of 50 gal./inch of nominal pipe size per mile (4.6 L/mm of nominal pipe size per kilometer) of pipe, during 24-hour period.
         b) Close openings in system and fill with water.
         c) Purge air and refill with water.
         d) Disconnect water supply.
         e) Test and inspect joints for leaks.
      5) Air Tests for Drainage Piping: Comply with UNI-B-6.
   b. Leaks and loss in test pressure constitute defects that must be repaired.
   c. Submit separate reports for each test.
2. Replace leaking sewerage piping using new materials, and repeat testing until leakage is within allowances specified.
3. Perform tests and inspections.
   a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
4. Tests and Inspections:
   a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect assembled neutralization systems and leak-detection systems and their installation, including piping and electrical connections, and to assist in testing.
   b. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   c. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Chemical-waste piping will be considered defective if it does not pass tests and inspections.
6. Prepare test and inspection reports.

O. Startup Service
1. Perform startup service for neutralization systems and leak-detection systems.
   a. Complete installation and startup checks according to manufacturer's written instructions.
   b. Neutralization Systems:
      1) Verify that neutralization system is installed and connected according to the Contract Documents.
      2) Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 22.
      3) Install neutralizing solutions and limestone.
      4) Energize circuits.
      5) Start and run systems through complete sequence of operations.

6) Adjust operating controls.

c. Leak-Detection Systems:

1) Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 22.

2) Energize circuits.

3) Adjust operating controls.

P. Adjusting

1. Adjust neutralization-system set points.
2. Adjust leak-detection-system control and device settings.

Q. Cleaning

1. Use procedures prescribed by authorities having jurisdiction or, if not prescribed, use procedures described below:

a. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.

b. Clean piping by flushing with potable water.

R. Demonstration

1. Train the Owner's maintenance personnel to adjust, operate, and maintain neutralization systems and leak-detection systems.

S. Piping Schedule

1. Transition and special fittings with pressure ratings at least equal to piping pressure rating may be used in applications below unless otherwise indicated.
2. Single-Wall, Chemical-Waste Sewerage Piping: Use any of the following piping materials for each size range:

a. NPS 2 to NPS 4 (DN 50 to DN 100): High-silicon-iron, hub-and-plain-end pipe and fittings and calked **OR** High-silicon-iron, mechanical-joint pipe and fittings and coupled, **as directed**, joints.

b. NPS 2 to NPS 4 (DN 50 to DN 100): Stainless-steel drainage pipe and fittings and gasketed joints.

c. NPS 1-1/2 to NPS 4 (DN 40 to DN 100): PE drainage pipe and fittings and heat-fusion joints.

d. NPS 1-1/2 to NPS 4 (DN 40 to DN 100): PP drainage pipe and fittings and electrofusion joints.

e. NPS 1-1/2 to NPS 4 (DN 40 to DN 100): PVC drainage pipe and fittings and solvent-cemented joints.

f. NPS 1-1/2 to NPS 4 (DN 40 to DN 100): PVDF drainage pipe and fittings and electrofusion joints.

g. NPS 2 to NPS 4 (DN 50 to DN 100): Centrifugally cast **OR** Filament-wound, **as directed**, fiberglass pipe and fittings and butt-and-wrap **OR** bonded, **as directed**, joints.

h. NPS 1-1/2 to NPS 4 (DN 40 to DN 100): Glass pipe and fittings and coupled joints.

i. NPS 6 (DN 150): High-silicon-iron, hub-and-plain-end pipe and fittings and calked **OR** High-silicon-iron, mechanical-joint pipe and fittings and coupled, **as directed**, joints.

j. NPS 6 (DN 150): Stainless-steel drainage pipe and fittings and gasketed joints.

k. NPS 6 (DN 150): PE drainage pipe and fittings and heat-fusion joints.

l. NPS 6 (DN 150): PP drainage pipe and fittings and electrofusion joints.

m. NPS 6 (DN 150): PVC drainage pipe and fittings and solvent-cemented joints.

n. NPS 6 (DN 150): PVDF drainage pipe and fittings and electrofusion joints.

o. NPS 6 (DN 150): Centrifugally cast **OR** Filament-wound, **as directed**, fiberglass pipe and fittings and butt-and-wrap **OR** bonded, **as directed**, joints.

p. NPS 6 (DN 150): Glass pipe and fittings and coupled joints.

q. NPS 8 to NPS 12 (DN 200 to DN 300): High-silicon-iron, hub-and-plain-end pipe and fittings and calked joints.
r. NPS 8 to NPS 12 (DN 200 to DN 300): PP drainage pipe and fittings and electrofusion joints.
s. NPS 8 to NPS 12 (DN 200 to DN 300): PVC drainage pipe and fittings and solvent-cemented joints.
t. NPS 8 to NPS 12 (DN 200 to DN 300): PVDF drainage pipe and fittings and electrofusion joints.
u. NPS 8 to NPS 12 (DN 200 to DN 300): Centrifugally cast **OR** Filament-wound, **as directed**, fiberglass pipe and fittings and butt-and-wrap **OR** bonded, **as directed**, joints.
v. NPS 15 (DN 375): High-silicon-iron, hub-and-plain-end pipe and fittings and calked joints.
w. NPS 15 (DN 375): NPS 16 (DN 400) centrifugally cast **OR** NPS 14 (DN 350) filament-wound, **as directed**, fiberglass pipe and fittings and butt-and-wrap **OR** bonded, **as directed**, joints.

3. Underground, Double-Containment, Chemical-Waste Sewerage Piping: Use any of the following piping materials for each size range:
   a. NPS 2 to NPS 12 (DN 50 to DN 300): PE double-containment drainage pipe and fittings.
   b. NPS 2 to NPS 12 (DN 50 to DN 300): PP double-containment drainage pipe and fittings.
   c. NPS 2 to NPS 12 (DN 50 to DN 300): PP/PVC double-containment drainage pipe and fittings.
   d. NPS 2 to NPS 12 (DN 50 to DN 300): PVDF double-containment drainage pipe and fittings.
   e. NPS 2 to NPS 12 (DN 50 to DN 300): PVDF/PVC double-containment drainage pipe and fittings.
4. Aboveground Chemical-Waste Piping: Use any of the following piping materials for each size range:
   a. NPS 1-1/2 to NPS 6 (DN 40 to DN 150): PP drainage piping and electrofusion **OR** mechanical, **as directed**, joints.
   b. NPS 1-1/2 to NPS 6 (DN 40 to DN 150): PVC drainage piping and solvent-cemented joints.
   c. NPS 1-1/2 to NPS 6 (DN 40 to DN 150): PVDF drainage piping and electrofusion **OR** mechanical, **as directed**, joints.
   d. NPS 1-1/2 to NPS 6 (DN 40 to DN 150): NPS 2 to NPS 6 (DN 50 to DN 150) high-silicon-iron piping with hub-and-plain ends and calked joints.
   e. NPS 1-1/2 to NPS 4 (DN 40 to DN 100): High-silicon-iron piping with mechanical-joint ends, mechanical couplings, and coupled joints.
   f. NPS 1-1/2 to NPS 6 (DN 40 to DN 150): NPS 2 to NPS 4 (DN 50 to DN 100) stainless-steel drainage piping with socket-and-spigot ends and gasketed joints.
   g. NPS 1-1/2 to NPS 6 (DN 40 to DN 150): Borosilicate glass pipe and fittings, couplings, and coupled joints.
   h. NPS 8 to NPS 12 (DN 200 to DN 300): PVC drainage pipe and fittings and solvent-cemented joints.
   i. NPS 8 to NPS 12 (DN 200 to DN 300): High-silicon-iron piping with hub-and-plain ends and calked joints.
5. Under Slab-on-Grade, Indoor, Chemical-Waste Piping: Use any of the following piping materials for each size range:
   a. NPS 1-1/2 to NPS 6 (DN 40 to DN 150): PP drainage piping and electrofusion joints.
   b. NPS 1-1/2 to NPS 6 (DN 40 to DN 150): PVC drainage piping and solvent-cemented joints.
   c. NPS 1-1/2 to NPS 6 (DN 40 to DN 150): PVDF drainage piping and electrofusion joints.
   d. NPS 1-1/2 to NPS 6 (DN 40 to DN 150): NPS 2 to NPS 4 (DN 50 to DN 100) high-silicon-iron piping with hub-and-plain ends and calked joints.
   e. NPS 1-1/2 to NPS 6 (DN 40 to DN 150): NPS 2 to NPS 4 (DN 50 to DN 100) stainless-steel drainage piping with socket-and-spigot ends and gasketed joints.

f. NPS 1-1/2 to NPS 6 (DN 40 to DN 150): Borosilicate glass piping with covering, couplings, and coupled joints.
g. NPS 1-1/2 to NPS 6 (DN 40 to DN 150): PE **OR** PP **OR** PP/PVC **OR** PVDF **OR** PVDF/PVC, **as directed**, double-containment drainage piping and manufacturer's standard joints.
h. NPS 8 (DN 200): PVC drainage piping and solvent-cemented joints.
i. NPS 8 (DN 200): High-silicon-iron piping with hub-and-plain ends and calked joints.
j. NPS 8 (DN 200): PE **OR** PP **OR** PP/PVC **OR** PVDF **OR** PVDF/PVC, **as directed**, double-containment drainage piping and manufacturer's standard joints.
k. NPS 10 and NPS 12 (DN 250 and DN 300): PVC drainage piping and solvent-cemented joints.
l. NPS 10 to NPS 15 (DN 250 to DN 375): High-silicon-iron piping with hub-and-plain ends and calked joints.

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01 22 16 00	01 22 16 00
01 22 20 00	01 22 16 00
01 22 23 00	01 22 16 00
01 32 33 00	01 32 33 00, 01 32 33 00a, 01 32 33 00b, 01 32 33 00c, 01 32 33 00d
01 52 13 00	01 52 13 00, 01 22 16 00
01 52 19 00	01 22 16 00, 01 52 13 00
01 54 23 00	01 22 16 00
01 54 26 00	01 22 16 00
01 54 30 00	01 22 16 00
01 55 23 00	01 22 16 00
01 55 26 00	01 22 16 00
01 56 16 00	01 22 16 00
01 56 26 00	01 56 26 00, 01 56 26 00a, 01 22 16 00
01 56 29 00	01 22 16 00
01 56 33 00	01 22 16 00
01 56 39 00	01 22 16 00
01 58 13 00	01 58 13 00, 01 22 16 00
01 66 19 00	01 22 16 00
01 71 13 00	01 22 16 00
01 71 23 16	01 71 23 16
01 74 16 00	01 22 16 00
01 74 19 00	01 74 19 00
02 41 13 13	02 41 13 13
02 41 16 13	02 41 16 13, 02 41 16 13a, 02 41 13 13
02 41 19 13	01 71 23 16, 02 41 16 13, 02 41 16 13a, 02 41 13 13
02 41 19 16	02 41 16 13, 02 41 16 13a, 02 41 13 13
02 58 13 00	02 58 13 00, 02 58 13 00a
02 61 00 00	02 61 00 00
02 61 13 00	02 61 13 00, 02 61 13 00a, 02 61 13 00b, 02 41 16 13, 02 61 00 00
02 65 00 00	02 41 16 13, 02 61 00 00, 02 61 13 00, 02 61 13 00a, 02 61 13 00b
02 81 00 00	02 81 00 00, 02 61 00 00
02 82 00 00	02 82 00 00, 02 82 00 00a, 02 82 00 00b, 01 22 16 00, 02 81 00 00
02 83 19 13	02 83 19 13, 02 83 19 13a, 02 83 19 13b, 02 83 19 13c
02 83 33 13	02 83 19 13, 02 83 19 13a, 02 83 19 13b, 02 83 19 13c
02 84 16 00	02 84 16 00, 02 84 16 00a, 02 84 16 00b
02 85 00 00	02 85 00 00
02 86 00 00	02 41 16 13, 02 61 00 00, 02 61 13 00, 02 61 13 00a, 02 61 13 00b, 02 81 00 00
02 87 00 00	02 87 00 00
02 89 00 00	01 22 16 00, 02 83 19 13, 02 83 19 13a, 02 83 19 13b, 02 83 19 13c
03 01 30 71	03 01 30 71, 03 01 30 71a, 01 22 16 00
03 05 00 00	03 05 00 00
03 11 13 00	01 22 16 00, 03 05 00 00
03 11 16 00	03 11 16 00, 03 05 00 00
03 11 23 00	01 22 16 00, 03 05 00 00
03 15 13 13	03 05 00 00
03 15 13 16	03 05 00 00
03 15 16 00	03 05 00 00
03 15 19 00	05 50 00 00
03 21 11 00	03 05 00 00
03 31 13 00	03 31 13 00, 03 31 13 00a, 03 31 13 00b, 03 31 13 00c, 03 31 13 00d, 03 05 00 00, 03 11 16 00
03 35 16 00	03 05 00 00
03 35 23 00	03 35 23 00, 03 05 00 00
03 35 26 00	03 05 00 00
03 35 33 00	03 05 00 00

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03 35 39 00	03 35 39 00
03 35 63 00	03 05 00 00
03 35 66 00	03 05 00 00
03 35 83 00	03 05 00 00
03 37 13 00	03 37 13 00, 03 37 13 00a
03 39 13 00	03 05 00 00
03 39 23 23	03 05 00 00
03 39 33 00	03 05 00 00
03 48 29 00	03 48 29 00
03 48 49 00	03 48 29 00
03 51 13 00	03 51 13 00
03 51 16 00	03 51 16 00, 03 51 16 00a, 03 51 16 00b
03 52 16 00	03 52 16 00
03 53 00 00	03 53 00 00
03 54 16 00	03 54 16 00
03 61 16 00	01 22 16 00
03 62 13 00	03 48 29 00
03 62 16 00	03 48 29 00
03 64 23 00	03 48 29 00
03 64 26 00	01 22 16 00
04 01 20 52	04 01 20 52
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04 01 50 52	04 01 20 52
04 05 13 26	04 01 20 91
04 05 16 26	04 01 20 91
04 05 19 13	04 01 20 91
04 05 19 16	04 01 20 91
04 05 19 26	04 01 20 91
04 05 23 13	04 01 20 91
04 05 23 16	01 22 16 00, 07 62 00 00
04 05 26 00	04 05 26 00, 04 01 20 91
04 21 13 00	04 01 20 91
04 21 19 00	04 01 20 91
04 21 26 00	04 01 20 91
04 21 29 00	04 01 20 91
04 22 23 13	04 01 20 91
04 22 23 23	04 01 20 91
04 22 23 26	04 01 20 91
04 22 23 29	04 01 20 91
04 22 23 31	04 01 20 91
04 23 13 00	04 23 13 00, 04 01 20 91
04 26 13 00	04 01 20 91
04 41 00 00	04 41 00 00, 04 41 00 00a
04 42 43 00	04 41 00 00, 04 01 40 91, 04 41 00 00a
04 43 00 00	01 22 16 00, 04 41 00 00, 04 01 40 91, 04 41 00 00a
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05 05 19 00	05 50 00 00
05 05 23 00	05 05 23 00, 01 22 16 00, 05 50 00 00
05 12 23 00	05 12 23 00, 05 05 23 00, 05 50 00 00
05 13 00 00	05 50 00 00
05 14 16 00	05 14 16 00, 01 22 16 00

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05 41 00 00	05 12 23 00
05 43 00 00	01 22 16 00, 05 12 23 00, 05 50 00 00
05 50 00 00	05 50 00 00
05 51 13 00	05 51 13 00, 05 51 13 00a, 05 50 00 00
05 51 19 00	05 50 00 00, 05 51 13 00, 05 51 13 00a
05 51 33 13	05 50 00 00, 05 52 13 00
05 51 33 16	05 50 00 00
05 51 33 23	05 50 00 00, 05 52 13 00
05 52 13 00	05 52 13 00, 05 50 00 00
05 53 13 00	05 53 13 00, 01 22 16 00, 05 50 00 00
05 54 00 00	05 50 00 00
05 55 13 00	05 50 00 00, 05 51 13 00, 05 51 13 00a
05 55 16 00	05 50 00 00, 05 51 13 00, 05 51 13 00a
05 56 00 00	05 50 00 00
05 58 16 00	05 58 16 00, 05 58 16 00a
05 58 23 00	05 50 00 00
05 59 65 00	01 22 16 00
05 73 00 00	05 73 00 00, 05 73 00 00a, 05 58 16 00
05 75 00 00	05 58 16 00, 05 58 16 00a
06 05 23 00	06 05 23 00, 06 05 23 00a, 06 05 23 00b, 06 05 23 00c
06 11 13 00	06 05 23 00a, 06 05 23 00b
06 11 16 00	06 11 16 00, 01 22 16 00, 06 05 23 00a, 06 05 23 00b
06 15 13 00	06 15 13 00, 06 15 13 00a, 06 05 23 00a, 06 05 23 00b, 06 11 16 00
06 16 23 00	06 16 23 00, 06 05 23 00a, 06 05 23 00b
06 16 33 00	06 05 23 00a, 06 05 23 00b, 06 16 23 00
06 16 43 00	06 05 23 00a, 06 05 23 00b, 06 16 23 00, 06 11 16 00
06 17 13 00	06 17 13 00, 06 05 23 00, 06 05 23 00a
06 17 23 00	06 05 23 00a, 06 05 23 00b, 06 11 16 00
06 17 43 00	06 05 23 00, 06 05 23 00a, 06 17 13 00
06 18 13 00	06 15 13 00a, 06 17 13 00
06 18 16 00	06 05 23 00, 06 05 23 00a, 06 17 13 00
06 22 13 00	06 22 13 00, 06 22 13 00a, 06 05 23 00b
06 25 16 00	06 25 16 00
06 41 13 00	06 41 13 00, 06 41 13 00a
06 41 93 00	08 71 21 00
06 42 13 00	06 25 16 00
06 42 16 00	06 25 16 00
06 42 19 00	06 42 19 00, 06 25 16 00
06 43 16 00	06 41 13 00
06 44 39 00	06 41 13 00
06 46 13 00	06 05 23 00b, 06 22 13 00, 06 22 13 00a
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06 46 23 00	06 41 13 00
06 46 26 00	06 41 13 00
06 46 29 00	06 46 29 00, 06 41 13 00
06 46 36 00	06 41 13 00
06 48 13 00	06 48 13 00
06 48 16 00	06 48 13 00
06 65 00 00	06 05 23 00b
06 71 13 00	06 05 23 00, 06 05 23 00a, 06 17 13 00
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