SECTION 221000 - PLUMBING PIPING, VALVES AND SPECIALTIES

PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, Section 220500 - Basic Plumbing Materials and Methods, and other Sections in Division 22 specified herein.

1.2 SCOPE

A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to the following:

1. Pipe and Fittings
    a. Sanitary waste and vent
    b. Potable Cold water
    c. Potable Hot water
2. Valves
    a. Water valves
    b. Backflow prevention valves
    c. Thermostatic mixing valves
3. Thermometers and gauges
4. Piping specialties
5. Pipe escutcheons
6. Strainers
7. Drip pans
8. Air vent
9. Dielectric unions
10. Unions
11. Flanges
12. Pipe sleeves
13. Sleeve seals
14. Pipe coating

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 220500: Basic Plumbing Materials and Methods, including:

1. Hangers and supports.
2. Water hammer arrestors.
3. Trap primers.
4. Cleanouts.
5. Access panels.

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6. Identification.

B. Section 224000: Plumbing Fixtures.

C. Division 21: Fire Suppression.

D. Division 26: Electrical.

E. Division 09: Finishes/Painting.

1.4 FIRE PROTECTION VALVES:

A. Refer to Section 211000.

1.5 REFERENCE STANDARDS

A. Comply with requirements of latest standard or as required by local AHJ.

B. This is a comprehensive list of standards, not all standards are applicable to this project. Refer to product listings within Part 2 of this specification for approved pipe and fittings. Approved pipe and fittings shall comply with the applicable standards listed herein.

C. American National Standards Institute (ANSI)/American Welding Society (AWS)/National Sanitation Foundation (NSF):

1. ANSI/AWS A5.8: Specification for Filler Metals for Brazing.
2. ANSI/AWS A5.31: Specification for Fluxes for Brazing and Braze Welding.
3. ANSI/AWS B2.2: Standard for Brazing Procedure and Performance Qualification.
4. ANSI/AWS C3.4: Specification for Torch Brazing.
5. ANSI LC4: Press-Connect Metallic Fittings for use in Fuel Gas Distribution System.
6. ANSI/NSF 14: Plastics Piping System Components and Related Materials.

D. American National Standards Institute (ANSI)/American Water Works Association (AWWA):

1. ANSI/AWWA A21.10: Ductile-Iron and Gray-Iron Fittings.

E. American Society of Mechanical Engineers (ASME):

1. ASME Boiler and Pressure Vessel Code.
2. ASME B1.20.1: Pipe Threads, General Purpose.
3. ASME B16.18: Cast Copper Alloy Solder Joint Pressure Fittings.
4. ASME B16.22: Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
5. ASME B16.23: Cast Copper Alloy, Solder-Joint, DWV Drainage Fittings.
6. ASME B16.24: Cast Copper Alloy Pipe Flanges and Flanged Fittings, Class 150 and 300.
7. ASME B16.29: Wrought Copper, and Wrought Copper Alloy Solder-Joint Drainage Fittings, DWV.
8. ASME B16.26: Cast Copper Alloy Fittings for Flare Copper Tubes.
9. ASME B16.50: Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings.

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10. ASME B16.51: Cast and Wrought Copper and Copper Alloy Press-Connect Pressure Fittings.
11. ASME B31.8: Gas Transmission and Distribution Piping Systems.
12. ASME A112.6.4: Roof, Deck, and Balcony Drains.
13. ASME A112.6.9: Siphonic Roof Drains.

F. American Society for Testing and Materials (ASTM):

1. Mechanical Couplings: ASTM A 536, ductile iron, or ASTM A 47, malleable iron coupling housing fabricated to manufacturer's specifications.
2. ASTM B584: Cast Copper Alloy for Grooved-End Fittings.
3. ASTM B75: Seamless Copper Tube for Grooved-End Fittings.
4. ASTM B32: Standard Specification for Solder Metal.
5. ASTM B88: Standard Specification for Seamless Copper Water Tube.
6. Hard Copper Tube: (Drawn Temper):
    a. ASTM B75: UNS Number C12200, drawn temper, seamless copper tube, wall thickness as specified.
    b. ASTM B88: Types K, L, and M, drawn temper, seamless copper tube.
    c. ASTM B306: Type DWV, drawn temper, seamless copper tube.
    d. ASTM B819: Type K and L, drawn temper, seamless copper tube.
    e. ASTM B837: Type GAS, drawn temper, seamless copper tube.
7. Soft Copper Tube:(Annealed Temper):
    a. ASTM B75: UNS Number C12200, annealed temper, seamless copper tube, wall thickness as specified.
    b. ASTM B88: Types K and L, annealed temper, seamless copper tube.
    c. ASTM B280: Type ACR, annealed temper, seamless copper tube.
    d. ASTM B837: Type GAS, annealed temper, seamless copper tube.
8. ASTM B306: Copper Drainage Tube (DWV).
9. ASTM B584: Copper Alloy Sand Castings for General Applications.
10. ASTM B813: Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube.
11. ASTM B819: Seamless Copper Tube for Medical Gas Systems.
12. ASTM B828: Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.
13. ASTM B837: Seamless Copper Tube for Natural Gas and Liquefied Petroleum (LP) Gas Fuel Distribution Systems.
14. ASTM D3311: Standard Specification for Drain, Waste, and Vent (DWV) Plastic Fittings Patterns.
15. ASTM D2513: Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings.
16. ASTM A47: Ferritic Malleable Iron Castings.
17. ASTM A536: Ductile Iron Castings.
18. ASTM D1784: Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.

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19. ASTM E84: Standard Test Method for Surface Burning Characteristics of Building Materials.
20. ASTM F2014: Standard Specification for Non-Reinforced Extruded Tee Connections for Piping Applications.
21. ASTM F2023 – Standard Test Method for Evaluating the Oxidative Resistance of Crosslinked Polyethylene (PEX) Tubing and Systems to Hot Chlorinated Water
22. ASTM F2080 – Standard Specification for Cold-Expansion Fittings with Metal Compression-Sleeves for Crosslinked Polyethylene (PEX) Pipe
23. ASTM F1807 – Standard Specification for Metal Insert Fittings Utilizing a Copper Crimp Ring for SDR9 Crosslinked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing
24. ASTM F2159 – Standard Specification for Plastic Insert Fittings Utilizing a Copper Crimp Ring for SDR9 Crosslinked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing
25.
26. ASTM F2389: Standard Specification for Pressure-Rated Polypropylene (PP) Piping Systems.
27. ASTM F2618: Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Fittings for Chemical Waste Drainage Systems.
28. ASTM F441: Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
29. ASTM F493: Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
30. ASTM C 1460 Standard Specification for Shielded Transition Couplings for use with Dissimilar DWV Pipe and Fittings Above Ground
31. ASTM D 2321 Underground Installation of Thermoplastic Pipe (non-pressure applications)
32. ASTM F 1668 Procedures for Buried Plastic Pipe

G. American Society of Plumbing Engineers (ASPE)/American National Standards Institute (ANSI):

1. ASPE/ANSI 45: Siphonic Roof Drainage.

H. Cast Iron Soil Pipe Institute (CISPI):

1. CISPI 301: Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications (ASTM B 888)
2. CISPI 310: Specification for Coupling for Use in Connection with Hubless Cast iron Soil Pipe and Fittings for Sanitary and Storm Drain Waste, and Vent Piping

I. Factory Mutual (FM):

1. FM-1680: Standard to evaluate intended application for long-term connection to hubless cast iron soil pipe aboveground and underground. Class I for Industrial/Commercial and Residential to 15 psi working pressure.

J. National Fire Prevention Association (NFPA):

1. NFPA-54/ANSI-Z223.1: National Fuel Gas Code.

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2. NFPA-58: Liquefied Petroleum Gas Code.

K. Joining Materials

1. Pipe Flange Gasket Materials: Suitable for the chemical and thermal conditions of the piping system contents and exterior environment.
    a. ASME B16.21, nonmetallic, flat, asbestos-free, full-face type for Class 150 and 300 cast copper alloy flanges. 1/8-inch maximum thickness, except where thickness or specific material is indicated.
2. Mechanical Coupling Gasket Materials: Suitable for the chemical and thermal conditions of the piping system contents and exterior environment.
    a. Gasket design shall be such that the entire coupling housing is isolated from the system contents to prevent galvanic action and inhibit galvanic corrosion.
3. Proprietary filler metals having compositions not conforming to the exact ANSI/AWS A5.8 classifications for BCuP and BAg Series filler metals shall be permitted when used according to the manufacturer's written instructions.
4. Soldering and Brazing Fluxes: Soldering and brazing fluxes shall not exceed 0.20 percent Lead (Pb) content for any work in potable water systems.
    a. Soldering Fluxes: ASTM B813, liquid or paste type.
    b. Brazing Fluxes: ANSI/AWS A5.31, Type FB3-A or FB3-C.
    c. The use of brazing flux is not necessary if the components being joined are wrought copper tube, wrought copper fittings and the filler metal being used is of the BCuP series.
    d. Solder flux should not exceed any VOC regulatory limitations at the time of installation. Flux is currently considered a low emitting material with no VOC regulations, but must be confirmed with prior to installation.
5. ASTM B32 Solder Filler Metal:
    a. Alloy Sn95 or Alloy Sn94: Tin (Sn) approximately 95%, and Silver (Ag) approximately 5%, having 0.10% maximum Lead (Pb) content.
    b. Alloy Sb5: Tin (Sn) 95%, and Antimony (Sb) 5%, having 0.20% maximum Lead (Pb) content.
    c. Alloy E: Tin (Sn) approximately 95%, and Copper (Cu) approximately 5%, having 0.10% maximum Lead (Pb) content.
6. ANSI/AWS A5.8 Brazing Filler Metals:
    a. BCuP Series: Copper-Phosphorus alloys. The following brazing filler metals shall be used. Brazing filler metals shall conform to the requirements of the individual piping systems.
        1) BCuP - 2: Copper (Cu) and Phosphorus (P) 7.0 - 7.5%.
        2) BCuP - 3: Copper (Cu), Phosphorus (P) 5.8 - 6.2%, and Silver (Ag) 4.8 - 5.2%.
        3) BCuP - 4: Copper (Cu), Phosphorus (P) 7.0 - 7.5%, and Silver (Ag) 5.8 - 6.2%.

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4) BCuP - 5: Copper (Cu), Phosphorus (P) 4.8 - 5.2%, and Silver (Ag) 14.5 - 15.5%.

1.6 QUALITY ASSURANCE

A. Manufacturers Qualifications:

1. Manufactured items furnished shall be the current, cataloged product of the manufacturer.
2. Replacement parts shall be readily available and stocked in the USA.

B. Codes and Standards:

1. All work shall be in full accordance with all applicable codes, ordinances and code rulings.
2. The Contractor shall furnish without any extra charge the labor and material required for compliance of codes.
3. Perform all tests required by governing authorities and as required under all Division 22 Sections. Provide written reports on all tests.
4. Electrical devices and wiring shall confirm to the latest standards of NEC; all devices shall be UL listed and so identified.
5. All plumbing work shall comply with the Americans with Disabilities Act (ADA).
6. All excavation work must comply with all provisions of state laws including notification to all owners of underground utilities at least 48 business day hours, but not more than 10 business days, before commencing an excavation.
7. Provide thermostatic mixing valves and fixtures conforming to ASSE 1070 to limit the maximum water temperature to 110°F for all public lavatories and 120°F for all other public fixtures served with hot water. Handle position stops and temperature mixing valves shall be used as required to limit maximum temperature to prevent scalding. Water heater thermostats shall not be considered a suitable control

C. All materials (such as piping, insulation, wiring, controls, etc.) located within air plenum spaces, air shafts, and occupied spaces shall be noncombustible or shall have a flame-spread index of not more than 25 and smoke-developed index of not more than 50 when tested in accordance with ASTM E84 or UL 723. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing, or satisfactory certified test report from an approved testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified elsewhere in the construction drawings. Contractor shall review all mechanical and architectural plans and be fully aware of all building design criteria prior to installation of any work. Any work installed that does not comply with applicable life/safety requirements of all codes and standards shall be replaced and/or repaired at no additional cost to the Owner.

D. Welding Standards:

1. Welding Qualifications:

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a. Certification: Each welder shall have a current AWS QC7 welding certification with successful completion of written test and welding samples in compliance with AWS D1.1. The Owner's Representative reserves the right to request sample coupon test welds of each welder to validate quality of welding work.

2. Welding Procedures:

a. Steel Support Welding: All work shall be performed in compliance with American Welding Society AWS D1.1/D1.1M-Structural Welding Code-Steel.
b. Pipe Welding: All work shall be performed to meet or exceed the requirements of the American Welding Society AWS B2.1 Specification for Welding Procedure and Performance Qualification and ASME Boiler & Pressure Vessel Code: Section IX "Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators."

E. Pressure Piping Standards

a. Comply with ASME B31.1 Power Piping, ASME B31.3-Process Piping and ASME B31.9-Building Services Piping standards for materials, products, and installation per pressure and temperature operating class.
b. Comply with ASME B31.9 Building Services Piping standard for the following services:

1) Conveying fluid between 0°F (-18°C) to 250°F (121°C).
2) Fluid pressure less than 350 psig.

c. Comply with ASME B31.3 Process Piping standard for the following services:

1) Conveying fluid above 250°F (121°C).
2) Toxic or flammable fluids.

F. Press Joint Fittings

1. Installer shall be a qualified installer, licensed within the jurisdiction, and familiar with the installation of applicable press joint systems.
2. Press fittings shall be installed using the proper tool, actuator, jaws and rings as instructed by the press fitting manufacturer.
3. The installation of press joint fittings shall conform to all local code requirements.
4. ASME Compliance: ASME B31.9 for building services piping valves.

1.7 DEFINITIONS

A. AHJ: Authority Having Jurisdiction

B. CSA: Formerly known as the Canadian Standards Association (CSA). CSA Group is a member of ISO. CSA is accredited by US OSHA as a Nationally Recognized Testing Laboratory (NRTL).

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C. Lead Free: Materials containing not more than 0.2 percent lead when used with respect to solder and flux and not more than a weighted average of 0.25 percent when used with respect to the wetted surfaces of pipes and pipe fittings, plumbing fittings, and fixtures, providing a specified definition and formula for determining “weighted average”.

D. NRTL: Nationally Recognized Testing Laboratory, including UL, CSA and/or ETL.

1.8 WORKING PRESSURES

A. All fittings, valves, pipe, specialties equipment shall be rated for the working pressure subjected in the installed locations.

B. Drawings indicate working pressure in each system. The rating of the equipment and material shall not be less than that of the system pressures.

1.9 SUBMITTALS

A. Product Data: Submit manufacturer’s technical product data for all piping, valves and specialties indicating dimensions, valve CV, tolerances etc.

B. Shop Drawings: Submit shop drawings indicating piping installation showing all fittings with inverts. Indicate all footings and grade beams.

C. Maintenance Data: Submit maintenance instructions on accordance with requirements of Division 01.

D. Delegated-Design Submittal for each vibration isolation and seismic-restraint device.

1. Seismic restraint calculations must be provided for all connections to the structure.
2. Include design calculations and details for selecting vibration isolators, seismic restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
3. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system was examined for excessive stress and that none exists.
4. Provide flexible joints, supports and piping joints as required to accommodate movement across seismic expansion joints and vertical building drift between floors.

1.10 WARRANTY

A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.

B. Refer to Section 220500 for additional warranty and Substantial Completion requirements.

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PART 2 - PRODUCTS

2.1 GENERAL

A. Furnish and install all new material, equipment, and apparatus hereinafter specified unless specifically noted otherwise. All material, equipment, and apparatus shall be identified by the manufacturer's name, nameplate, and pertinent data.

1. All pipe, pipe fittings and valves shall be manufactured in North America, or may be import products where manufacturers are specifically identified below. Alternatives may be acceptable, but must be submitted and approved by the Owner’s Representative prior to bidding.

B. Type M copper piping is not acceptable for any pressure water piping unless specifically noted otherwise.

C. For all Grade B piping specified belowground provide a mill report with production identification numbers for piping submitted to permit tracking of pipe by mill and production lot.

D. All materials, equipment, and apparatus are mentioned as standards unless noted otherwise. The words "or approved equal" shall be considered to be subsequent to all manufacturer's names used herein, unless specifically noted that substitutes are not allowed.

2.2 STANDARD PIPE AND FITTING

A. Domestic Hot and Cold Water Pipe & Fittings – COPPER (Aboveground):

1. Copper Piping. pipe sizes 1/2” to 8”:

a. Piping

1) ASTM B88 or B75, Type K or L, annealed (soft) temper.
2) ASTM B88 or B75, Type K or L, hard temper.
3) Manufacturers: Mueller Streamline, or Cerro Flow Products.

b. Fittings-Soldered:

1) ASME B16.22 wrought copper alloy.
2) ASME B16.18 cast copper alloy.
3) Manufacturers: Nibco, or Mueller.

c. Fittings-Brazed:

1) ASME B16.50 wrought or copper alloy.
2) Manufacturers: Nibco, or Mueller.

d. Joints-Soldered:

1) ASTM B32 filler metals. Manufacturers: Canfield #Silverflo or #Watersafe, or Lucas Milhaupt #Silvabrite 100.

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2) Water soluble, lead free flux. Manufacturers: Oatey #H-20-95, JW Harris #Bridgit, La-CO #FLUX-RITE 90, Rectorseal #Nokorode, or LucasMilhaupt #Silvabrite 100 or #95/5.

e. Joints-Brazed:

1) ANSI/AWS A5.8 filler metals. Manufacturers: Canfield #Sil-Can 5 or #Sil-Can 15, or LucasMilhaupt #Sil-Fos.
2) Water soluble, lead free flux. Manufacturers: JW Harris #Safety-Silv, or LucasMilhaupt #Handy Flux.

B. Trap Primer Piping:

1. Seamless copper tube:

a. Piping

1) ASTM B88 or B75, Type K, annealed (soft) temper.
2) Manufacturers: Mueller Streamline, Cerro Flow Products.

b. Fittings (underground):

1) No joints allowed underground or bottom slab level.

c. Fittings (aboveground):

1) ASME B16.22 wrought copper alloy.
2) ASME B16.18 cast copper alloy.
3) Manufacturers: Nibco.

d. Joints-Soldered:

1) ASTM B32 filler metals. Manufacturers: Canfield #Silverflo or #Watersafe, or Lucas Milhaupt #Silvabrite 100.
2) Water soluble, lead free flux.
3) Manufacturers: Oatey #H-20-95, JW Harris #Bridgit, La-CO #FLUX-RITE 90, Rectorseal #Nokorode, or LucasMilhaupt #Silvabrite 100 or #95/5.

e. For all copper piping installed underground wrap pipe with two layers of 20 mil PVC tape, minimum 2” wide, with 50% overlap and no exposed pipe surface. Manufacturers: 3M Scotchrap #51, or Pasco Specialty #9000 Series.

2. PEX tubing (Underground):

a. Piping

1) PEX A

b. Fittings

1) No Joints Allowed

C. Sanitary Sewer, Vent Pipe & Fittings up to 15” – CAST IRON (Aboveground)

1. Cast Iron Piping

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a. Pipe and Fittings:

1) Cast iron, bituminous coated “No-Hub” fittings complying with ASTM A74, ASTM A888, CISPI 301.
2) Manufactured by AB&I, Charlotte, Tyler, or New Age.

b. Couplings Aboveground:

1) Type 301 or 304 stainless steel couplings conforming to ASTM C1540 with heavy-duty shield and neoprene sealing sleeve conforming to ASTM C-564, CISPI 310 and FM-1680.
2) Manufacturers: Anaco Husky #HD-2000, Clamp-All (Norma Group) #Hi-Torq 80, Mission #HeavyWeight, or Ideal TridonHeavy Duty.

2.3 VALVES: GENERAL

A. General: Valve ratings shall exceed respective system operating pressures by 50% (minimum). All valves shall be line size unless otherwise noted. Use ball valves, butterfly valves or angle stop valves for manual shut-off. Gate valves may be used in backflow preventer assemblies.

B. Product Data: Submit manufacturer’s technical product data, including installation instructions for each type of valve. At a minimum, include pressure drop curve or chart for each type and size for each types of valve listed below. Submit valve schedule showing manufacturer’s figure number, size, location, and valve features for each required valve.

1. Balancing valves
2. Backflow prevention valves

C. Shop Drawings: Submit manufacturer’s assembly-type (exploded view) shop drawings for each type of valve, indicating dimensions, weights, materials, and methods of assembly of components.

D. Acceptable manufacturers (manufacturer and model number listed for individual valves indicates minimum acceptable by all manufacturers):

1. Manual Ball or Butterfly Shutoff: Apollo, Hammond, Nibco (commercial grade, US manufacturer only), Milwaukee, Victaulic, or Watts.
2. Check: Apollo, Hammond, Nibco (commercial grade, US manufacturer only), Milwaukee, Victaulic, or Watts.
3. Backflow Preventors: Apollo, Ames, Febco, Cla-Val, Watts, or Zurn.

E. Valve Identification: Provide valves with manufacturer’s name (or trademark) and pressure rating clearly marked on the valve body.

F. Operators: Provide handwheels, fastened to valve stem, for valves other than quarter-turn. Provide lever handle for quarter-turn valves, other than plug valves. Provide one wrench for every 10 plug valves, and one in each size. Provide extended levers/stems for valves on insulated lines. For manual valves 2-1/2” and larger located seven (7) feet above the floor in mechanical rooms provide chain operator to permit operating the valve from four (4) feet above floor.

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G. Valve Features:

1. General: Provide valves with features indicated and, where not otherwise indicated, provide proper valve features. Comply with ASME B31.9 for building services piping, and ASME B31.1 for power piping.
2. Lead-Free Construction: NSF Standard 61 compliant. California AB1953 and Vermont S512 compliant for valves conveying water for human consumption.
3. Drain: Comply with MSS SP-45 and provide threaded pipe plugs.
4. Flanged: Valve flanges complying with ASME B16.1 (cast iron), ASME B16.5 (steel), or ASME B16.24 (bronze).
5. Threaded: Valve ends complying with ANSI B2.1.
6. Solder-Joint: Valve ends complying with ASME B16.18.
7. Flangeless: Valve bodies manufactured to fit between flanges complying with ASME B16.1 (cast iron), ASME B16.5 (steel), or ASME B16.24 (bronze).

2.4 DOMESTIC PLUMBING SERVICE VALVES

A. Ball Valves:

1. 2" and Smaller: 600 psi, 2-piece, bronze body, soldered ends for copper pipe and threaded ends for iron pipe, chrome plated brass ball, Teflon seat, brass stem, steel handle, full port, low lead compliant. Manufacturers: Milwaukee #UPBA-400 Series (Threaded), Milwaukee #UPBA-450 Series (Sweat), Apollo #APXV1212 (PEX Connector), or Apollo Lead Free #77CLF Series.

B. Butterfly Valves:

1. 2-1/2” and Larger: MSS SP-67, lug wafer, ductile iron body, stainless steel or aluminum bronze disc, stainless steel stem, EPDM seat, low lead compliant, memory stop control, lever handle thru 5" size and worm gear operator for 6" and larger. Mount stem in horizontal position. Manufacturers: Milwaukee #ML-233E/MW-233 Series, or Apollo #LD141/WD141 Series.

C. Check Valves:

1. 2" and Smaller: Class 125, MSS SP-80, ASTM B62 and ASTM B16, cast bronze body, soldered ends for copper pipe, screwed cap, swing type, Teflon bronze disc, low lead compliant. Manufacturers: Milwaukee #UP1509/#UP509 Series, or Apollo Lead Free #163LF Series.
2. 2-1/2" and Larger: Class 125, MSS SP-71, ASTM A126 class B cast iron body, bolted bonnet flanged ends, bolted cap, swing type, cast iron disc with bronze face rings, low lead compliant. Manufacturers: Milwaukee #F-2974M26 Series, or Apollo Lead Free #910F Series.
3. Vertical or High Flow: Class 125, cast bronze, high-flow body, TFE seat, brass check, low lead compliant, stainless steel guide and spring. Manufacturers: Milwaukee #UP1548T Series (Sweat), Milwaukee #UP548T Series (Threaded), or Apollo Lead Free #61LF Series.

D. Angle Stop Valves:

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1. Heavy duty 1/4 turn commercial stop, brass body, chrome plated, 125 psi working pressure, compliant with ASME A112.18.1, low lead compliant. Provide with loose key handle in public access spaces for vandal resistance. Select outlet diameter size to match fixture connection size. Manufacturers: Chicago Faucets #ST Series, Brasscraft #KT Series, or McGuire.

E. Angle Stop Valves with Integral Check Valve:

1. For installation on critical sinks and equipment with hot and colder connections, including each janitor/service sink. Provide on sinks and equipment connections in healthcare facilities and food service areas as a minimum provision.
2. Chrome plated brass supply stop with spring actuated integral check valve and full turn brass stem, 125 psi working pressure, compliant with ASME A112.18.1, low lead compliant. IPS, seat or compression connections. Provide with loose key handle in public access spaces. Select outlet diameter size to match fixture connection size. Manufacturers: McGuire #LFCK Series.

2.5 BACKFLOW PREVENTION VALVES

A. General: All backflow prevention valves shall be State approved and listed.

B. Reduced Pressure Principal Backflow Prevention Assembly for High Hazard Applications:

1. 2" and Smaller: Assembly shall consist of shutoff ball valves in inlet and outlet, and strainer on inlet. Assemblies shall be lead free and include test cocks and pressure-differential relief valve located between two positive seating check valves and shall comply with requirements of ASSE Standard 1013 and AWWA C511. Bronze construction, threaded ends, stainless steel internal parts, and air gap fitting. Route pipe from air gap fitting to approved waste receptor. Apollo #RP4ALF Series valve with #AGD4A air gap fitting, or Watts #LF009 Series with #909 air gap fitting.
2. 2-1/2" and Larger: Assembly shall consist of shutoff OS&Y gate valves in inlet and outlet, and strainer on inlet. Assemblies shall be lead free and include test cocks and pressure-differential relief valve located between two positive seating check valves and shall comply with requirements of ASSE Standard 1013 and AWWA C511. Stainless Steel body construction, flanged ends, center stem guided check valves, and air gap fitting. Route pipe from air gap fitting to approved waste receptor. Apollo Lead Free #RP4ALF-OS&Y valve with #AGD4A air gap fitting, or Watts #LF9090 Series with #909 air gap fitting.

C. Double Check Valve for Low Hazard Applications:

1. 2" and Smaller: Assembly shall consist of shutoff ball valves in inlet and outlet, and strainer on inlet. Assemblies shall include test cocks and two positive seating check valves and shall comply with requirements of ASSE Standard 1015 and AWWA C510. Bronze construction, threaded ends, and stainless steel internal parts. Apollo Lead Free #DC4ALF Series.
2. 2-1/2" and Larger: Assembly shall consist of shutoff OS&Y gate valves in inlet and outlet, and strainer on inlet. Assemblies shall include test cocks and two

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positive seating check valves and shall comply with requirements of ASSE Standard 1015 and AWWA C506. Epoxy coated cast iron body construction, flanged ends, and stainless steel internal parts. Apollo Lead Free #DC4ALF Series.

D. Atmospheric Vacuum Breaker: Assembly shall consist of a bronze vacuum breaker body with silicone disc, and full size orifice. Device shall be IAPMO listed, lead free and comply with ASSE 1011. Chrome plated in finished occupied areas. Apollo #HB Series.

E. Pressure Vacuum Breaker: Assembly shall consist of a bronze or stainless steel body, with stainless steel spring loaded check, lead free, atmospheric vent and ASSE 102 compliant. Chrome plated in finished occupied areas. Apollo #PVB Series .

2.6 PRESSURE RELIEF VALVES

A. Pressure Relief Valve: Lead free bronze body construction, thermostat and test lever, and initial pressure relief set at 125 psi (adjust for system requirements). Certified to meet ASME low pressure heating boiler code.

B. Manufacturers: Watts #LF3L, or Cash Acme #LFF-95 Series.

2.7 THERMOSTATIC MIXING VALVE – LAVATORIES

A. Mixing valve shall be ASSE 1070 (Performance Requirements for Water Temperature Limiting Devices) compliant with adjustable and lockable means to limit the hot water temperature setting for individual fixtures such as lavatories and bathtubs. Where fixtures have integral ASSE 1070 compliant valves there is no additional requirement for upstream temperature limitation control. Provide valve for individual fixtures or combined flows up to 6 gpm.

B. Refer to drawings for locations, capacities, pressure drops, flow rates, and models.

C. Thermostatic valve constructed of brass, bronze or stainless steel body, with screwdriver locking temperature regulators, check stops, removable/replaceable cartridge, stainless steel piston, brass pipe fittings, and unions. Interior parts in standard rough bronze, nickel or chrome finish. Valve shall be lead-free. Include cold water bypass fitting where required by faucet.

D. Provide chrome or nickel plated body where installed exposed under a lavatory. Provide stainless steel cabinet with wall mounting bracket for valve when installed inside the concealed cabinet.

E. Manufacturers: Chicago Faucet #131 Series, Symmons #Maxline 7 Series, Apollo #34 Series, Leonard #LF Series, Cash Acme #HG Series, Caleffi #5212, or Nibco/Webstone #H-77200 Series.

2.8 THERMOMETERS AND GAUGES

A. General:

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1. Certification: Provide meters and gauges whose accuracies, under specified operating conditions, are certified by manufacturer.
2. No mercury shall be used in thermometers due to hazardous material classification.
3. Manufacturers: Weksler, Winters, Trerice, Marshalltown or US Gauge.

B. Thermometers:

1. Bi-Metal Type: Provide bi-metal glass thermometers of materials, capacities, and ranges indicated, designed and constructed in service indicated. Accuracy shall be 1% +/- full scale with adjustable recalibration.
    a. Case: Type 300 series stainless steel, hermetically sealed, glass window, 3" diameter dial, with adjustable angle.
    b. Adjustable Joint: Die cast aluminum, finished to match case, 180° adjustment in vertical plane, 360° adjustment in horizontal plane, with locking device.
    c. Scale: Satin faced, non-reflective aluminum, permanently etched markings.
    d. Stem: Stainless steel, adjustable angle socket, length to suit installation.
2. Glass Thermometer: Provide adjustable angle 9” thermometer of materials, capacities and ranges as appropriate to medium being measured and designed and constructed for service indicated. Accuracy to be 1% +/- of full scale.
    a. Case: Aluminum or reinforced plastic.
    b. Temperature Sensitive Gage Liquid: Organic non-toxic. No mercury permitted.
    c. Scale: Aluminum painted white with black markings.
    d. Connection: 1/2” NPT with thermowell or 1-1/4” UNF swivel nut without thermowell.
3. Photovoltaic Cell Powered LCD Thermometer
    a. Case: ABS Plastic
    b. Accuracy: 1% of full scale.
    c. Display: 16 LUX rating LCD display. Switchable Fahrenheit and Celsius.
    d. Connection: 3/4” NPT with thermowell or 1-1/4” UNF swivel nut without thermowell.
4. Conform to the following temperature ranges:
    a. Hot Water: 20°F - 240°F with 2°F scale divisions.
    b. Cold Water: -40°F - 160°F with 2°F scale divisions.

C. Thermometer Test Wells:

1. Provide thermometer test wells as indicated, constructed of brass or stainless steel, pressure rated to match piping system design pressure. Provide 2" extension for insulated piping. Provide cap nut with chain fastened permanently to thermometer well.

D. Temperature Gauge Connector Plugs:

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1. Provide temperature gauge connector plugs pressure rated for 500 psi and 200°F (93°C). Construct of brass and finish in nickel-plate, equip with 1/2" NPS fitting, with self-sealing valve core type neoprene gasketed orifice suitable for inserting 1/8" OD probe assembly from dial type insertion thermometer. Equip orifice with gasketed screw cap and chain. Provide extension, length equal to insulation thickness, for insulated piping.

E. Pressure Gauges:

1. General: Provide pressure gauges of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.
2. Type: General use, 1% accuracy ANSI B40.1 grade A, phosphor bronze bourbon type, bottom connection.
3. Case: Drawn steel or brass, glass lens, 4-1/2" diameter.
4. Connector: Brass with 1/4" male NPT.
5. Scale: White coated aluminum, with permanently etched markings.
6. Pressure differential range shall be 100 psig minimum for the appropriate application with maximum 1 psig divisions.

F. Pressure Gauge Cocks:

1. General: Provide pressure gauge cocks/valves between pressure gauges and gauge tees on piping systems. Two-piece bronze body ball valve with threaded ends. Manufacturers: Milwaukee #BA-100.
2. Snubber: 1/4" brass or stainless steel bushing with corrosion resistant porous metal disc, through which pressure fluid is filtered. Select disc material for fluid served and pressure rating. Manufacturers: Wika #910.12, or Ashcroft #1112.

G. Pressure Gauge Connector Test Plugs:

1. Provide pressure gauge connector plugs pressure rated for 500 psi and 200°F (93°C). Constructed of lead-free brass, with 1/4” or 1/2" NPT fitting, with self-sealing valve core type neoprene or Buna-N gasketed orifice suitable for inserting 1/8" O.D. probe assembly from dial type insertion pressure gauge. Equip orifice with gasketed screw cap and chain. Provide extension, length equal to insulation thickness, for insulated piping.

2.9 PIPING SPECIALTIES

A. General:

1. Provide factory-fabricated piping specialties recommended by manufacturer for use in service indicated. Provide piping specialties of types and pressure ratings indicated for each service or provide proper selection to comply with installation requirements. Provide sizes as indicated, and connections, which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is installer's option.

B. Pipe Escutcheons:

1. Provide pipe escutcheons as specified herein with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated.

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Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas. Prime zinc base paint finish is allowed for unoccupied areas.

2. Pipe Escutcheons for Moist Areas: For waterproof floors, and areas where water and condensation can be expected to accumulate, provide stainless steel, cast brass or sheet brass escutcheons, solid or split hinged.
3. Pipe Escutcheons for Dry Areas: Provide stainless steel escutcheons, solid or split hinged.

C. Automatic Air Vent

1. For automatic air venting at all high points in hot and cold piping where air can be trapped, particularly at the top each pipe riser (supply and return), other high points in piping where air binding may occur, and other locations shown on drawing and as required for complete air venting of piping system during startup and during normal operation. Air vents shall be tightly sealed against loss of system water and prevent entrance of air in negative pressure situations.
2. Body: Low-lead brass.
3. Float: Stainless steel or polyethylene.
4. Inlet Connection: Minimum 1/4” NPT. Extended stem, minimum 2” long, to terminate above insulation/jacket surface where required. Provide with manual ball valve on inlet side to allow for future maintenance.
5. Outlet Connection: Minimum 1/4” discharge pipe routed to nearest floor drain or floor sink or other approved drainage location.
6. Maximum operating pressure: 150 psig.
7. Maximum operating temperature: 220°F.
8. Manufacturers: Watts #FV-4, or Caleffi #Plumbvent.

D. Unions:

1. Unions shall be of type specified in following schedule:
    a. Black Steel, 2" and smaller: 250 lb. screwed malleable iron, ground joint, brass to iron seat.
    b. Black Steel, 2-1/2" and larger: 150 lb. cast iron screwed flanged, flat faced, full faced gasket.
    c. Soldered Copper or Brass Pipe, 2" and smaller: 150 lb. cast bronze or copper, ground joint, non-ferrous seat with soldered ends.
    d. Screwed Copper or Brass Pipe, 2" and smaller: 150 lb. cast brass, ground joint, brass to brass seat, with threaded ends.
    e. Flanged Copper or Brass Pipe, 2-1/2" and larger: two (2) 150 lb. cast bronze flanges.
2. Manufacturers: EPCO, Mueller, Stanley G. Flagg, or Watts.

E. Flanges:

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1. Provide flanges at flanged connections to equipment, tanks and valves. Faces of flanges being connected shall be alike in all cases. Connection of raised-face flange to flat-faced flange not permitted.
2. Use ASTM A307, Grade B, bolts and nuts for cast iron flanges and ASTM A193 for steel flanges. Regular square head unfinished bolts with heavy semi-finished hex nuts ASTM A194. Cadmium plated where exposed to weather.
3. Ratings: 150 lb. or 300 lb. in high pressure portions.
4. Type of pipe and corresponding flanges as follows:
    a. Screwed Black Steel Pipelines: 125 lb. black cast iron screwed flange, flat faces.
    b. Welded Steel Pipe, 150 lb. black forges steel welding flanges, 1/16" raised face ASTM A181 Grade I. Use flat face when connected to flat faced companion flange.

F. Dielectric Fittings:

1. Dielectric Unions:
    a. Provide standard products recommended by manufacturer for use in service indicated to effectively isolate steel, galvanized steel, and zinc plated steel from non-ferrous piping to prevent galvanic action and related corrosion.
    b. Manufacturers: Watts #LF3000 Series, or Zurn #DUX Series.
2. Dielectric Waterways/Nipples:
    a. Comply with standard IAPMO PS 66.
    b. Electroplated steel waterway/nipple complying with ASTM F1545 or ASTM F492.
    c. Pressure Rating: 300 psig (2070 kPa) at 225°F (107°C).
    d. End Connections: Male threaded or grooved.
    e. Lining: Inert and noncorrosive, propylene.
    f. Manufacturers: Mifab #MI-DE Series, or Victaulic #Series 647.
3. Dielectric Flanges:
    a. Comply with standard ASSE 1079.
    b. Factory-fabricated, bolted, companion-flange assembly.
    c. Pressure Rating: 125 psig (860 kPa) minimum at 180°F (82°C).
    d. End Connections: Solder or brazed joint copper alloy and threaded ferrous; or threaded solder-joint copper alloy and threaded ferrous.
    e. Dielectric-Flange Insulating Kits:
        1) Nonconducting materials for field assembly of companion flanges.
        2) Gasket: Neoprene or phenolic.
        3) Bolt Sleeves: Phenolic or polyethylene.
        4) Washers: Phenolic with steel backing washers.
    f. Manufacturers: Watts #LF3100 Series.

G. Transition Couplings:

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1. Coupling connection for grooved end AWWA ductile iron pipe to grooved end IPS stainless steel pipe, including valves or fittings of the same nominal size. Use grooved dielectric nipple for transition to copper tubing.
    a. Housing: Ductile iron conforming to ASTM A-536, grade 65-45-12 or ductile iron conforming to ASTM A-395, grade 65-45-15.
    b. Coating: Coal tar epoxy coating, 3 mils minimum thickness, for buried piping transition.
    c. Gasket: Grade “M” FlushSeal, halogenated butyl (brown color code). Temperature range –20°F to +200°F (–29°C to 93°C). Specially compounded to conform to ductile pipe surfaces. UL classified in accordance with ANSI/NSF 61 for cold potable water service.
    d. Bolts/Nuts: Heat-treated plated carbon steel or stainless steel 316 for buried applications, compliant with the physical and chemical requirements of ASTM A-449 and physical requirements of ASTM A-183.
    e. Manufacturers: Victaulic #Style 307.

H. Pipe Sleeves:

1. Provide fire proof sleeve assemblies utilizing UL rated sealant systems at all fire rated penetrations. For non-rated sleeve penetrations pack the annular space between the pipe and sleeve with fiberglass and/or mastic.
2. Sleeves shall provide a minimum 1/2" annular clearance around pipe. Where pipes cross through/ below footings or footing walls provide a minimum 1” annular clearance between sleeve and pipe.
3. Sheet metal: Fabricate from 0.025” (0.64 mm) minimum, sheet metal; round tube closed with snap lock joint, welded spiral seams, or welded longitudinal joint.
4. Steel pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.
5. Iron pipe: Fabricate from cast iron or ductile-iron pipe; remove burrs.
6. Plastic and copper pipe: Fabricate from Schedule 80 PVC plastic pipe; remove burrs.
7. Sleeves through interior concrete walls and floors: Telescopic, submerged, adjustable sleeves to extend a minimum of 1” above finished floor. Manufacturers: Adjust-to-Crete, or Crete-Sleeve, Hilti.
8. Through exterior walls and floor on grade: 150-pound class cast-iron pipe sleeve. Where waterproof membranes are used, provide membrane clamps. For insulated piping, sleeve diameter shall not be less than diameter of insulated pipe.
9. Cast-in-place watertight device for protecting penetrating objects from expansion and contraction of concrete. Factory-assembled for use in cast-in-place concrete floors and walls and consisting of two outer sleeves and a one-piece radial extended-flange waterstop gasket, with mid-body seal for embedment and sealing to concrete slab and continuous water seal extending to the penetrating pipe.
    a. Outer Sleeves: EPDM attached to the mid-body seal forming an area with which to attach the device to the structural reinforcing rod determining the position of sleeve in the wall.

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b. Water Stop Mid-Body Seal: Flexible polymer seal with radial extended flange consisting of one to three concentric raised rings which lock into concrete, maintaining seal over time as concrete contracts from sleeve.
c. Manufacturers: HoldRite #HydroFlame.

I. Mechanical Sleeve Seals-Aboveground Penetrations:

1. Aboveground: For sleeves passing through walls or floors provide a non-toxic 3-hour rated fire resistant silicone foam sealant with a Flame Spread Rating of 20. Sealant to be tested and approved under UL 263, ASTM E119, and NFPA 251 Standards. All fire rated penetrations shall be sealed with approved UL System.
2. Local Approvals: All seals to be provided shall be in accordance with the regulations of all governing agencies of the city, county, and State Fire Marshal's Office.
3. Wood Decking Description: Cast-in-place, factory-assembled, one-piece watertight firestop device for use in concrete floors formed with wood decking to protect penetrating objects from expansion and contraction of concrete, thermal and seismic movement, and the passage of air, smoke, fire, and hot gasses.

    a. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbard Enterprises/HOLDRITE, Hydroflame Sleeve.
    b. Consists of an outer sleeve lined with an intumescent strip, and a radial extended flange attached to one end of the sleeve for fastening to concrete formwork.
    c. Include a waterstop gasket and mid-body seal consisting of one to three concentric raised rings for embedment and sealing to the concrete slab.
    d. Provide one-hour, two-hour and/or three-hour fire-resistance rated assemblies as required and tested according to ASTM E 814 or ANSI/UL 1479.

4. Steel Decking Description: Cast-in-place, factory-assembled, one-piece watertight firestop device for use in floors formed with steel decking to protect penetrating objects from expansion and contraction of concrete, thermal and seismic movement, and the passage of air, smoke, hot gasses and fire.

    a. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbard Enterprises/Holdrite; Hydroflame CMD Metal Deck Device.
    b. Consists of an outer sleeve lined with an intumescent strip, and wide outside wings attached to one end of the sleeve for fastening to metal deck concrete formwork and span deck corrugations.
    c. Includes a cone attached to the base for extending the device through the metal deck and a water stop gasket and mid-body seal consisting of one to three concentric raised rings for embedment and sealing to the concrete slab.
    d. Provide one-hour, two-hour and/or three-hour fire-resistance rated assemblies as required and tested per ASTM E 814 or ANSI/UL 1479.

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5. Concrete Description: Cast-in-place, watertight tub box drain block out firestop device for use in floors formed with wood decking to protect penetrating objects from expansion and contraction of concrete, thermal and seismic movement, and the passage of air, smoke and fire, and hot gasses.
    a. Basis-of-Design Product: Subject to compliance with requirements, provide Hubbard Enterprises/Holdrite, Hydroflame Tub Box.
    b. Consists of a reinforced polymer box containing a 2-1/2-inches (63.5 mm) thick polystyrene foam insert with an upper water seal consisting of absorbent material and a pitched water trough.
    c. Include a sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork.
    d. Include two support legs each with a radial extended flange for balance and for fastening to concrete formwork, and a lower water-seal and radial extended flange attached to the lower end of the sleeve for fastening to concrete formwork and a water stop gasket with three concentric raised rings for embedment and sealing to the concrete slab.
    e. Provide one-hour, two-hour and/or three-hour fire-resistance rated assemblies as required and tested per ASTM E 814 or ANSI/UL 1479.

J. Low Pressure Y-Type Pipeline Strainers:

1. Provide strainers full line size of connecting piping, with ends matching piping system materials. Select strainers for 125% of the working pressure of piping system, with Type 304 stainless steel screens, with 3/64" perforations (233 @ 0.045" perforations per square inch).
2. Threaded ends, 2" and smaller: Cast-iron body, screwed screen retainer with centered blowdown fitted with hose bibb. Manufacturers: Sarco, Wheatley, or Mueller.
3. Flanged ends, 2-1/2" and larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted with hose bibb. Manufacturers: Sarco, Wheatley, or Mueller.
4. Grooved ends 2-1/2” and larger: Ductile iron body, bolted screen retainer with off center blowdown fitted with hose bibb. Manufacturers: Victaulic, or Gustin-Bacon.

K. Drip Pans:

1. Provide drip pans fabricated from 16-gauge galvanized sheet metal with watertight joints, and with edges turned up 2-1/2". Reinforce top by structural angles. Provide hole, gasket, and flange at low point for watertight joint and 1" copper drain line connection. Extend 1” drain to nearest approved receptor.

L. Air Gaps:

1. Drainage Applications: Indirect drainage discharging into a receptor, drain, or similar device shall be provided with a minimum of 1” separation between the drain outlet and device receiving drainage.
2. Supply Applications: Supply and makeup water applications utilizing an air gap for backflow protection shall be provided with a minimum of 2-times the diameter

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of the supply pipe (but not less than 1”) separation between the supply pipe and fixture, equipment, or nonfood equipment.

2.10 EXPANSION COMPENSATORS

A. General: Pipe expansion, in general, is to be absorbed in bends, swing joints, expansion loops, and offsets. All piping mains, branches and runouts shall be installed to allow for free expansion and contraction without developing leaks or undue stressing of pipe. Stresses shall be within allowable limits of ASME B31.1 for pressure piping. Vertical piping shall be provided with expansion joints at each floor. Expansion products to conform to the standards of the Expansion Joint Manufacturer's Association. Expansion joints shall not require packing. Installer shall select materials and pressure/temperature ratings to suit intended service. Select packless expansion joints to provide 150% absorption capacity of calculated maximum piping expansion between anchors. All connections shall have ends to match piping system application.

B. Pressure piping compensators:

1. Expansion Compensators (Pipe Compression and Extension): Multiple stainless steel bellows and stainless steel liner with shroud and end fittings. Manufacturers: Keflex #311 series.
2. Flexible Expansion Joint/Seismic Connector for Steel Pipe: Steel hose and braid, 180° return, CSA approved, and end fittings. For flammable liquid or gas service up to 4”, flexible expansion loops shall be CSA / AGA certified. Manufacturers: Metraflex #Metraloop.
3. Flexible Expansion Joint/Seismic Connector for Copper Pipe: Copper hose and braid, 180° return, CSA approved, and end fittings. NSF 61 and NSF 372 certification. Manufacturers: Metraflex #Metraloop.
4. Flexible Connection for Steel Pipe (Piping and Equipment Located Outside the Building): Stainless steel hose and braid, with threaded or flanged ends. NSF 372 certification. For flammable liquid or gas service up to 4”, flexible hose connector shall be CSA / AGA certified. Manufacturers: Metraflex #SST.
5. Flexible Connection for Copper Pipe: Bronze hose and braid, copper tube ends. NSF 61 and NSF 372 certification and suitable for potable water systems. Manufacturers: Metraflex #BBS.
6. For non-critical pump connections. Furnish with fluorelastomer tube and cover to ASTM D2000 Grade 1HK710. The body shall be reinforced with rectangular body rings and six bias plies of fiberglass/Kevlar fabric rated 190#/26" vacuum at 250°F. Provide galvanized flat (not L shaped) back up rings and control rods to limit maximum axial extension. Manufacturers: Garlock #206 EZ-FLO.
7. Flexible Ball Pipe Joints: Provide ductile iron flexible ball pipe joints for piping systems, with materials and pressure/temperature ratings selected by installer to suit intended service. Each flexible expansion joint shall be pressure tested prior to shipment against its own restraint to a minimum of 350 psi (250 psi for flexible expansion joints 2 inch and 30 inches diameter and larger.) A minimum 2:1 safety factor, determined from the published pressure rating, shall apply. Factory Mutual Approval for the 3 inch through 12 inch sizes is required. Each flexible expansion joint shall consist of an expansion joint designed and cast as an

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integral part of a ball and socket type flexible joint, having a minimum per ball deflection of: 20º, 2” - 12”; 15º, 14” - 36”; 12º, 42”-48” and 4-inches minimum expansion. All internal surfaces (wetted parts) shall be lined with a minimum of 15 mils of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C213. Sealing gaskets shall be constructed of EPDM. The coating shall meet ANSI/NSF-61. 5. Exterior surfaces shall be coated with a minimum of 6 mils of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C116/A21.16. EBAA Flex-Tend.

C. Gravity piping compensators:

1. Single Axis Slip Joint for DWV Applications: Expansion joints shall consist of two (2) telescoping PVC or CPVC (1) tubes conforming to ASTM D1784 with triple (3) EPDM (3) O-ring seals including a center pressure seal and outer debris seals. Expansion joints ends shall be of a socket weld design conforming to ASTM D2467. Expansion Joints shall be designed to meet the pressures and temperatures for the system and be capable of 6 inch or 12 inch axial movement. Flexicraft Industries, Model C & CP.
2. Multi Axis Bellow Joint for DWV Applications: Expansion joints shall consist of a corregated neoprene rubber sleeve with two (2) stainless steel clamps and be capable of connecting to standard cast iron or plastic pipe sizes. Expansion joint shall be suitable for 1-3/4" of compression, 3/4" extension, 3/4" of lateral offset, and 15° rotation. Expansion joint shall be rated for pressures up to 5psig. Expansion Joints shall be designed to meet the pressures and temperatures for the system. Flexicraft Industries, Model DWV-Plus.
3. Flexible Ball Pipe Joints: Provide PVC flexible ball pipe joints for piping systems, with materials and pressure/temperature ratings selected by installer to suit intended service. Design joints for 15° deflection per ball for sizes 3" to 8" and temperatures up to 140°F. Provide two composition gaskets for each joint. EBAA DWV Flex-Tend.

D. Pipe Alignment Guides: Provide pipe alignment guides on both sides of expansion joints, and elsewhere as indicated on drawings. Guide shall be of carbon steel construction with split guiding cylinder and integral anchor base and internal four finger two-piece spider. Cylinder wall thickness shall be equal to schedule 40 wall thickness of pipe being guided. Spider shall be capable of clamping directly to pipe and moving only in an axial direction while inside cylinder. Anchoring directly to building substrate. Manufacturers: Metraflex #Style IV, or Flexicraft Spider Pipe Guide.

E. Expansion Loops: Provide field fabricated pipe expansion loops as an alternate to mechanical expansion joints.

PART 3 - EXECUTION

3.1 GENERAL

A. Workmanship shall be performed by licensed journeymen or master mechanics and shall result in an installation consistent with the best practices of trades.

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B. Install water piping and fixtures uniform, level plumb, in relationship to lines of building. Do not install any diagonal, or otherwise irregular work, unless so indicated on Drawings or approved by Architect or Owner’s Representative.

C. Pipe showing rust or cracks in coating shall be removed and replaced.

D. Follow manufacturers' directions and recommendations in all cases where the manufacturers of articles used on this Contract furnish directions covering points not shown on the Drawings or covered in these Specifications.

E. Coordinate the work between the various Plumbing Sections and with the work specified under other Divisions of the work or contracts toward rapid completion of the entire project. If any cooperative work must be altered due to lack of proper supervision or failure to make proper provisions in time, then the work hereunder shall include all expenses of such changes as are necessary in the work under other contracts, and such changes shall be directly supervised by and made to the satisfaction of the Owner’s Representative.

F. The cooperative work not included in the Plumbing Division related to the general construction work is as follows:

1. All formed concrete work.
2. Framed openings in masonry and other Architectural and Structural elements.
3. Wood grounds and nailing strips in masonry and concrete.
4. Sloping of floors to drains and floor sinks.
5. Sloping of roof surfaces to roof drains and overflow drains.

G. Inspect all material, equipment, and apparatus upon delivery and do not install any that may be subject to rejection as a result of damage or other defects. Provide tarps (waterproof membrane) to protect equipment and piping delivered to and stored at the site.

H. Piping in connection with a plumbing system shall be so installed that piping or connections will not be subject to undue strains or stresses, and provisions shall be made for expansion, contraction, and structural settlement. No plumbing piping shall be directly installed or embedded in concrete or masonry. No structural member shall be seriously weakened or impaired by cutting or notching. Sleeves, sealants and/or gasketing shall be utilized where penetrating through concrete or masonry assemblies.

I. All backflow preventers require adequate access clearance for future testing and maintenance. The backflow prevention device shall be installed with not less than 12 inches of clearance between the lowest portion of the assembly and grade, floor or platform. Installation of backflow prevention devices mounted more than five (5) feet above the floor shall be provided with a permanent platform capable of supporting a tester or maintenance person. The measurement is taken from the centerline of the device to the floor or platform.

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3.2 PIPES SIZES TO EQUIPMENT

A. General: Pipe sizes indicated shall be carried full size to equipment served. Any change of size to match equipment connection shall be made within one foot of equipment.

B. At temperature control valves with sizes smaller than connected lines, reduction shall be made immediately adjacent to valve.

3.3 PIPING INSTALLATION

A. Install pipes and pipe fittings in accordance with recognized industry practices which will achieve permanently leakproof piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints or couplings, but with adequate and accessible unions for disassembly and maintenance or replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, within 1/16" misalignment tolerance. Comply with ASME B31 Code for Pressure Piping.

B. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain)and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details, and notations or, if not otherwise indicated, run piping in shortest route which does not obstruct space or block access for servicing building and its equipment. Hold piping close to walls, overhead construction, and other structural and permanent-enclosure elements of building. Limit clearance to 1/2" where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1" clearance outside insulation. Whenever possible in finished and occupied spaces, conceal piping from view, by locating in column enclosures, in hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as indicated.

C. Where vents connect to a horizontal drainage pipe, each vent shall have its invert taken off above the drainage centerline of such pipe downstream of the trap being serve. Each vent shall rise vertically to a point not less than 6” above the flood-level rim of the fixture served before offsetting horizontally.

D. Elevator Machine Rooms, Switchgear, Generator, Telecommunications, Telephone Rooms, and Electrical Equipment Spaces: Special precautions must be adhered to in such rooms and in the vicinity of such critical equipment. Do not run piping through these electrical equipment spaces and enclosures unless unavoidable. Where, unavoidable, install drip pan, with 2” high sides, under water piping and drainage piping that must be run through electrical spaces. Route 3/4" drip pan drain piping to floor drain, floor sink or other approved receptor. All copper water piping in such rooms must use brazed joints. Soldered or mechanical joints are not allowed at joint in water piping within these locations.

E. Install automatic air vents, with shutoff valves, at high points in cold and hot pipe where air pockets can form and at any other point necessary to free system of air. An automatic air vent, a minimum of one, shall also be installed at the highest point in

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each piping system where air is likely to migrate. Additional automatic air vents shall be provided as necessary if piping is installed with air pockets. A shut-off valve shall be provided in riser to each vent valve to facilitate servicing. A 1/4” or 3/8" type "L" copper tubing drain line shall be run to drain receptor to carry away water that valve discharges.

3.4 CONDENSATE DISPOSAL

A. Condensate piping shall be type L or M copper tubing with wrought copper fittings.

B. Primary drain pan shall be provided with cooling coil and extend beyond the leaving side of the coil and underneath the cooling coil connections.

C. All air conditioning condensate drain lines from each air handling unit and rooftop unit shall be piped full size of the unit drain outlet, with “P” trap or manufactured Air Trap, and piped to nearest drain. See details shown on the drawings or the manufacturer’s instructions for depth of air conditioning condensate trap to exceed unit static pressure. Condensate drain lines shall not be less than 3/4" internal diameter and shall not decrease in size from the outlet of the equipment to the place of condensate disposal.

D. Equipment manufacturer shall provide outlet size to align with condensate drain sizing tables in the mechanical and plumbing codes. Unit outlet size shall be 3/4" for equipment capacity to 20 ton of refrigeration and 1” for equipment capacity over 20 tons to 40 tons of refrigeration.

E. Run horizontal indirect waste condensate drainage piping at uniform pitch of not less than 1/8" per foot (1%).

F. Where mechanical cooling equipment is located in a space where damage is capable of resulting from condensate overflow, including damage to replaceable lay-in ceiling tiles, secondary protection shall be provided by one of the following methods:

1. Install a secondary drain pipe at a level that is higher than the primary drain pipe connection of the drain pan for mechanical equipment above rigid ceilings and route to visible location or approved receptor.
2. Install a water level detecting device that will shut off the equipment or appliance in the even the primary drain is blocked. Coordinate with mechanical design for this option to be provided with mechanical equipment.
3. Install an additional watertight pan of corrosion-resistant material, with a separate drain pipe, installed beneath the cooling coil, unit, or appliance to catch overflow condensate due to a clogged primary condensate drain and route to visible location or approved receptor.

3.5 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls and for pipes passing below footings.

B. Pipes passing through foundation walls or grade beams shall be provided with a relieving arch or a pipe sleeve built into the foundation wall or grade beam. The sleeve shall be a minimum of two (2) pipe sizes larger than the pipe passing through the wall

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or beam. Coordinate specific sleeve penetration locations with structural design for placement of sleeves.

C. Perpendicular pipes passing under footings shall be located at a depth 1-foot (minimum) below the bottom of the footing and continuously sleeved through the zone of influence. In no case shall the sleeve start or terminate less than 1’ from each vertical edge of the footing. The sleeve shall be a minimum of two (2) pipe sizes larger than the pipe. Coordinate specific sleeve locations with structural design for placement of sleeves.

D. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch (25-mm) minimum annular clear space between piping and concrete slabs and walls.

1. When cast-in-place watertight sleeve seals are required, select sleeve size to match the size and type of pipe to be installed.
2. Sleeves are not required for core-drilled holes.

E. Install sleeves in concrete floors, concrete roof slabs, and concrete/masonry walls as new slabs and walls are constructed.

1. Cut sleeves to length for mounting flush with both surfaces.
    a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2” (50 mm) minimum above finished floor level.
2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

F. Install sleeves for pipes passing through fire rated interior partitions as required by assembly construction.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4” (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 Section "Joint Sealants."
4. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping." Exception: When fire-resistance-rated cast-in-place watertight sleeve seals are required for floor penetrations, additional firestopping is not necessary.

3.6 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in

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penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

C. Aboveground, Cast-in-Place Watertight Sleeves. Select sleeve size based on pipe size and material to be inserted, and thickness of wall.

1. Install cast-in-place watertight sleeves for pipes NPS 6” (DN 150) and smaller in diameter.
2. Position cast-in-place watertight sleeve in wall space securing sleeve to reinforcing steel using tie wire.

D. Underground, Exterior-Wall, Cast-in-Place Watertight Penetrations. Select sleeve size based on pipe size and material to be inserted, and thickness of wall.

1. Install cast-in-place watertight sleeves for pipes NPS 6” (DN 150) and smaller in diameter.
2. Secure sleeve to the reinforcing steel using tie wire.

E. Fire-Resistance Rated, Cast-in-Place Sleeve Installation: Select sleeve size based on size and type of pipe and thickness of the floor. Position and secure sleeve to concrete form using nails or staples.

3.7 PIPING SYSTEM JOINTS

A. All piping shall be cut squarely, free of rough edges/burrs, and reamed to full bore. Piping shall be mechanically cleaned prior to make-up of joints and fully inserted into fittings. Bevel plain ends of steel pipe.

B. Piping shall be capped during construction to prevent entry of foreign material.

C. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

D. Provide joints of type indicated in each piping system and as required to meet the maximum allowable working pressure and maximum testing pressures.

E. Thread pipe in accordance with ANSI/ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Remove excess cutting oil from piping prior to assembly.

1. Apply appropriate (Teflon) tape or thread compound to external pipe threads. on male threads at each joint and tighten joint to leave not more than three (3) threads exposed.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

F. Soldered and brazed copper water tube and fittings: Comply with maximum allowable rated internal working pressures as defined in ASME B31.9, and matching table in ASHRAE Handbook-HVAC Systems and Equipment, based on maximum service temperature and pipe diameter. Soldered and brazed joints shall only be installed where complete access is available on all sides of the pipe to assure that visual inspection can occur for 360° circumference. Blind soldering or brazing is not allowed

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ASME B31.9-2008 Table 917.3 Rated Internal Working Pressure of Joints Made With Copper Water Tube and Solder Joint Fittings (psig)					
Solder or Brazing	Maximum Service Temperature (°F)	Types K, L, M Copper Water Tube in Nominal Sizes (inches) Liquids and Gases			
		1/4" to 1”	1-1/4” to 2”	2-1/2” to 4”	Up to 8”
Tin Alloys ASTM B32	100	500	400	300	270
	150	400	350	275	250
	200	300	250	200	180
	250	200	175	150	135
Brazing Alloys	200	Tube Rating	Tube Rating	Tube Rating	Tube Rating
	250	300	210	170	150
	350	270	190	150	150

G. Solder copper tube and fitting joints with lead free nickel/silver bearing solder meeting ASTM B-32, in accordance with plumbing code requirements, ASTM B828 and Copper Development Association (CDA) recommended procedures. Joints shall be cleaned by other than chemical means prior to assembly. "Shock" cooling is prohibited. Fluxes shall be applied liberally to the outside of the pipe and the solder cup of the fitting. Fluxes shall be water soluble for copper and brass potable water applications and shall meet CDA standard test method 1.0 and ASTM B813. Solder shall be applied until a full fillet is present around the joint. Solder and flux shall not be applied in such excessive quantities as to run down interior of pipe. Lead solder or corrosive flux shall not be present at the jobsite.

H. Braze copper tube and fitting socket or mechanically formed tee fittings with BCUP series filler metal without flux. Listed brazing flux shall be used for joining of copper tube to brass or bronze fittings and shall meet AWS FB3A or FB3C. "Shock" cooling is prohibited. A continuous fillet shall be visible around the completed joint. After cooling, flux residue shall be thoroughly removed with warm water and a brush prior to testing. Do not use BCUP filler on copper alloys containing over 10% nickel.

1. Brazing fittings may use a mechanically limited depth that is not less than the minimum cup depth (overlap) specified by ANSI/ASME B16.50 for Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings. Manufacturer of mechanical dimpler: Brazing Dimpler Corp.

I. Depth of solder joint and braze joint fitting:

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Depth of Solder Joint and Braze Joint Fittings		
Pipe Size (inches)	ASME 16.22 Solder Joint Socket Depth (inches)	ASME B16.50 Brazed Joint Socket Depth (inches)
1/2	0.50	0.22
3/4	0.62	0.25
1	0.75	0.28
1-1/4	0.97	0.31
1-1/2	1.09	0.34
2	1.34	0.40
2-1/2	1.47	0.47
3	1.66	0.53
4	2.16	0.64
5	2.66	0.73
6	3.09	0.83
8	4.09	1.28

J. Cast-Iron Sanitary Sewer Joints: Comply with coupling manufacturer's Cast Iron Soil Pipe Institute Standards and installation instructions.

K. Joint Construction for grooved fittings, where allowed and approved: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting if recommended by manufacturer. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.

L. Joint Construction for Grooved-End, Ductile-Iron Water Piping to Copper Tubing: For transition site piping to building copper piping make joints according to AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting if recommended by manufacturer. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.

M. 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. Match flanges within piping system, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.

N. Weld pipe joints in accordance with recommendations of American Welding Society AWS D1.1 and ASME Boiler and Pressure Vessel Code Section IX.

1. Weld pipe joints only when ambient temperature is above 0°F.
2. Bevel pipe ends at a 37.5° angle where possible, smooth rough cuts, and clean to remove slag, metal particles, and dirt.
3. Use pipe clamps or tack-weld joints with 1" long welds, 4 welds for pipe sizes to 10", 8 welds for pipe sizes 12" and larger.

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4. Build up welds with stringer-bead pass, followed by hot pass, followed by cover or filler pass. Eliminate valleys at center and at edges of each weld. Weld by procedures which will ensure elimination of unsound or unfused metal, cracks, oxidation, blow-holes, and non-metallic inclusions.
5. Do not weld out piping system imperfections by tack-welding procedures. Refabricate to comply with requirements.
6. At Installer's option, install forged branch-connection fittings whenever branch pipe is indicated, or install regular T-fitting.

3.8 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping Outside of Building Footprint:

1. Fittings for NPS 1-1/2” (DN 40) and Smaller: Fitting-type coupling.
2. Fittings for NPS 2” (DN 50) and Larger: Sleeve-type coupling or grooved type fitting.

C. Transition Fittings in Aboveground Domestic Water Piping: Unions, flanges, grooved fittings, or connect to isolation valve to meet field conditions and maintain pressure testing requirements.

3.9 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing such as copper to zinc plated equipment fittings or copper to galvanized steel or black steel equipment.

1. Dielectric Fittings for NPS 2” (DN 50)] and Smaller: Use dielectric couplings, nipples, unions.
2. Dielectric Fittings for NPS 2-1/2” to NPS 4” (DN 65 to DN 100): Use dielectric flange kits or threaded nipples.
3. Dielectric Fittings for NPS 5” (DN 125) and Larger: Use dielectric flange kits.

B. Dielectric couplings are not required in the following locations:

1. Unions in a copper piping system with connections to brass/bronze valves and devices.
2. Unions in a copper piping system with connections to stainless steel valves and devices.
3. Connections to water hammer arrestors.

3.10 VALVES

A. General: Except as otherwise indicated, comply with the following requirements:

1. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves to be accessible. Provided separate support as necessary.

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2. Install manual shutoff valves to isolate cold and hot water services to each restroom group. Back-to-back or adjacent men's and women's restrooms are considered a group. Shutoff valves shall be located immediately above or adjacent to the restroom(s) for easy maintenance access.
3. Install valves, except butterfly valves, with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane without prior written approval. Install valve drains with hose-end adapter for each valve that must be installed with stem below horizontal plane.
4. Install butterfly valves with stems mounted horizontally.
5. All valves, 2-1/2" and larger, mounted higher than seven (7) feet above floor in mechanical rooms and where indicated shall be installed with stem horizontal and equipped with chain wheels and chains extending to four (4) feet above floor.

B. Insulation: Where insulation is indicated, install extended-stem valves, arranged in proper manner to receive insulation.

C. Selection of Valve Ends (Pipe Connections): Except as otherwise indicated, select and install valves with the following ends of types of pipe/tube connections:

1. Copper Pipe, 2-1/2" and Smaller: Soldered-joint valves.
2. Steel Pipe, 2" and Smaller: Threaded joint valves.
3. Larger Pipe Sizes: One of the following, at installer's option:

a. Flanged valves.
b. Lug valves.

D. Non-Metallic Disc: Limit selection and installation of valves with non-metallic discs to locations indicated and where foreign material in piping system can be expected to prevent tight shutoff of metal seated valves.

E. Renewable Seats: Select and install valves with renewable seats, except where otherwise indicated.

F. Fluid Control: Except as otherwise indicated, install gate, ball, plug, circuit setter, globe, and butterfly valves to comply with ASME B31.9.

G. Swing Check Valves: Install in horizontal position with hinge pin horizontally perpendicular to center line of pipe. Install for proper direction of flow.

H. Wafer Check: Install between 2 flanges in horizontal or vertical position.

I. Valve Adjustment: After piping systems have been tested and put into service, but before final testing, adjusting, and balancing, inspect each valve for possible leaks. Adjust or replace packing to stop leaks, replace valve if leak persists.

J. Valve Identification: Tag each valve in accordance with Section 220500.

K. Cleaning: Clean factory-finished surfaces. Repair marred or scratched surfaces with manufacturer's touch-up paint.

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3.11 TEMPERATURE GAUGES AND THERMOMETERS

A. General: Install temperature gauges/thermometers in vertical upright position and tilted to be easily read by observer standing on floor without supplemental illumination.

B. Install in the following locations and elsewhere as indicated:

1. At outlet of hot water heaters/boilers over 100,000 Btuh (30 kW) input.

3.12 MECHANICAL SLEEVE SEALS

A. Loosely assemble rubber links around pipe with bolts and pressure plates located under each bolt head and nut. Push into sleeve and center. Tighten bolts until links have expanded to form a watertight seal.

B. Fire Barrier Penetration Seals: Fill entire opening with sealing compound in compliance approved and listed UL system number. Adhere to manufacturer's installation instructions.

3.13 SUPPORTS AND HANGERS

A. Refer to Section 220500 – Basic Plumbing Materials and Methods.

3.14 EQUIPMENT RAILS AND PIPE PORTALS

A. Install per manufacturer's instructions.

B. Coordinate with other trades so units are installed when roofing is being installed.

C. Verify roof insulation thickness and adjust raise of cant to match.

3.15 EXPANSION COMPENSATION

A. Expansion Loops/Connectors at Expansion Joints:

1. Provide flexible hose expansion loop(s) or connectors as indicated on the contract drawings or as required to accommodate any thermal expansion, contraction, building settlement, or seismic movement of the piping system.
2. Flexible hose expansion loops shall be manufactured complete with two parallel sections of corrugated metal house, compatible braid, 180 deg return bend, with inlet and outlet connections. Field fabricated loops shall not be acceptable.
3. Flexible loops shall be capable of movement in the ±X, ±Y, and ±Z planes to meet or exceed the limits identified in the structural design.
4. Flexible hose expansion loops and connectors shall impart no thrust loads to system support, anchors or building structure.
5. Provide pipe anchors and pipe alignment guides as indicated, and elsewhere as determined by installer to properly anchor piping in relationship to expansion loops.
6. Where plans do not indicate spacing of guides or other pertinent information, install per manufacturer's recommendations.

B. Expansion Compensation for Risers and Terminals:

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1. Install connection between horizontal piping mains and vertical piping risers with at least five pipe fittings including tee in main. Install connections between piping risers and terminal units with at least four pipe fittings including tee in riser.
2. Expansion compensators and connectors shall impart no thrust loads to system support, anchors or building structure.
3. Provide pipe anchors and pipe alignment guides as indicated, and elsewhere as determined by installer to properly anchor piping in relationship to expansion compensators.

C. Thermal Expansion Compensation:

1. Provide piping U-Bend, Z-Bend, L-Bend or flexible devices to accommodate thermal expansion and contraction in piping system where shown on drawings and as required to impart minimal stress in water piping and building structure.
2. Expansion compensators and connectors shall impart no thrust loads to system support, anchors or building structure.
3. Provide pipe anchors and pipe alignment guides as indicated, and elsewhere as determined by installer to properly anchor piping in relationship to expansion compensators.

3.16 PIPE INSPECTIONS

A. Inspections shall be performed at each phase while under tests required for administrative authorities, and prior to concealment, i.e. “rough-in”, “top-out” and “final”.

B. Inspection – Underground: All piping installed underground shall be inspected prior to burial by the Owner’s Representative. Contractor must notify Owner’s Representative no less than 24 working hours prior to inspection time. Should the piping be buried prior to inspection the contractor may be requested to uncover the piping at no delay to the project and at no additional cost to the Owner.

C. Inspection – Aboveground: All piping installed Aboveground shall be made available for inspection upon completion and prior to finish of walls and ceilings. Contractor must notify Owner’s Representative no less than 24 working hours prior to the desired inspection time. Should the piping be hidden within the structure prior to inspection the contractor may be requested to uncover the piping at no delay to the project and at no additional cost to the Owner.

3.17 CLEANING, FLUSHING, DISINFECTING

A. General: Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specified coatings (if any).

B. Flush out piping systems with clean water before proceeding with required tests. Inspect each run of each system for completion of joints, supports, and accessory items.

C. Inspect pressure piping in accordance with procedures of ASME B31.

D. Disinfect water mains and water service piping in accordance with Section 220500.

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3.18 TESTING

A. Provide all tests specified hereinafter. All tests shall meet or exceed the minimum requirements of applicable codes and local ordinances. Provide all test equipment, including test pumps, gauges, instruments, and other equipment required. Test all rotational equipment for proper direction of rotation. Upon completion of testing, certify to the Architect, in writing, that the specified tests have been performed and that the installation complies with the specified requirements and provide a report of the test observations signed by qualified inspector.

B. Piping: Remove from the system, during testing, all equipment which would be damaged by test pressure. Replace removed equipment when testing has been accomplished. The system may be tested in sections as the work progresses; however, any previously tested portion shall become a part of any latter test of a composite system. Correct leaks by remaking joints with new material.

C. Test time will be accrued only while full test pressure is on the system, unless indicated otherwise. “Tolerance” shall be no pressure drop, except that due to temperature change in a 24-hour period. Inspect and test all work prior to burying or concealing. Test pressure shall be one and one-half times the system operating pressure or the listed test pressure below, whichever is greater:

System	Test Medium	Test Pressure	Tolerance-Test Period
Domestic Water	Water	150 psig	None – 8 hours
Sanitary Sewer and Gravity Condensate (non-plastic)	Water	10 ft head (or 5 psi air)	No leaks – 8 hours
Vent (non-plastic)	Air	5 psi	No leaks – 8 hours

D. Valves: Test all valve bonnets for tightness. Test operate all valves at least once from closed-to-open-to-closed position while valve is under test pressure. Test all automatic valves, including solenoid valves, and temperature and pressure relief valves, safety valves, and temperature and pressure relief valves not less than three (3) times.

E. Piping Specialties: Test all thermometers, pressure gauges, and water meters for accurate indication; automatic water feeders, air vents, trap primers, and vacuum breakers for proper performance. Test all air vent points to ensure that all air has been vented.

F. Backflow Preventers: Each testable backflow prevention device shall be tested and approved by certified testers after installation. Submit test results.

END OF SECTION 221000

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