Design Standard

Hydronic Piping for Utility Plants (CHW, HHW) and Domestic Hot and Cold Water

Detailed specifications follow.

PART 1 – GENERAL

1.01 SUMMARY:

A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:

1. Hot-water heating piping.
2. Chilled-water piping.
3. Condenser-water piping.
4. Makeup-water piping.
5. Domestic Hot and Cold Water Piping
7. Instrument compressed air piping.

1.02 REFERENCES:

A. Applicable Standards (Latest Edition):

1. American Welding Society (AWS):
2. ASME International (ASME):
3. ASTM International (ASTM):
4. Copper Development Association, Inc. (CDA):
5. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):

1.03 PERFORMANCE REQUIREMENTS:

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:

1. Hot-Water Heating Piping: 150 psig at 200ºF
2. Chilled-Water Piping: 150 psig at 200ºF
3. Condenser-Water Piping: 150 psig at 200ºF
4. Makeup-Water Piping: 150 psig at 200ºF
5. Safety-valve-inlet and -outlet piping: Equal to the pressure of the piping system to which it is attached.


PART 2 – PRODUCTS

2.01 COPPER TUBE AND FITTINGS:

A. Drawn-Temper Copper Tubing: ASTM B88, Type L.

B. Wrought-Copper Fittings: ASME B16.22.

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

   a. Anvil International, Inc.
   b. S. P. Fittings; a division of Star Pipe Products.
   c. Victaulic Company.
   d. Approved Equal.

C. Copper Grooved Mechanical – Joint Couplings and Fittings: ASTM B 75 (ASTM B 75M), copper tube or ASTM B 584, bronze casting.

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

   a. Victaulic Company.
   b. Approved Equal.

2. Grooved-End-Tube Couplings: Rigid pattern, angular bolt pads and installation ready coupling, unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, pre-lubricated EPDM gasket rated for minimum 230 deg F for use with housing, and steel bolts and nuts. NSF 61 rated for hot and cold water services. Victaulic Style 607 or approved equivalent.

2.02 STEEL PIPE AND FITTINGS:

A. Steel Pipe: ASTM A53/A53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.


E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; flat ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.

F. Wrought-Steel Fittings: ASTM A234/A234M, wall thickness to match adjoining pipe.

G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

2. End Connections: Butt welding.
3. Facings: Raised face and flat face. Flat face forged steel flanges shall be used to connect to all classes of cast iron flange.

H. Grooved Mechanical - Joint Fittings and Couplings: 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.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Victaulic Company.
   b. Approved Equal.

2. Grooved-End Couplings: Ductile-iron housing and synthetic EPDM gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings. NSF 61 rated for hot and cold water services.
   a. Rigid Type IPS ¾" - 12": Two segment coupling housings with offsetting, angle pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1, B31.9, and NFPA 13. Pre-lubricated EPDM gasket rated for minimum -30 deg F and maximum 250 deg F for use with ductile-iron housing, and steel bolts and nuts. Victaulic Style 07 / Style 107 Installation Ready Coupling or approved equal.
   b. Rigid Type IPS 14" - 72": Two segment, wedge-shaped Advanced Groove System key profile coupling housings shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1, B31.9, and NFPA 13. EPDM gasket rated for minimum...
-30 deg F and maximum 230 deg F for use with ductile-iron housing, and steel bolts and nuts. Victaulic Style W07 Zero-Flex Coupling or approved equal.

3. Flexible Type: Use in locations where vibration attenuation and thermal expansion / contraction are accommodated. Three flexible couplings may be used in lieu of flexible connectors at equipment connections. Couplings shall be placed in close proximity to the vibration source. Victaulic Style 177 Installation Ready Standard or Style 77 / W77 Flexible Coupling or approved equal.

4. Flange Adapters: For use with copper grooved end tubing and fittings, for mating to ANSI Class 125 / 150 flanges. Victaulic Style 741 / W741 Flange Adapter or approved equal.

2.03 STAINLESS STEEL PIPE AND FITTINGS:

A. Stainless Steel Pipe: ASTM A312 316; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article. Wall thickness to be approved for use with fitting manufacturer.

B. Stainless Steel Fittings: ASTM A312 316:

1. O-rings integral to Press Fit components: EPDM.
2. Connection Type: Press Fittings
3. Pressure Class: 150.
4. Schedule: Same as pipe.

C. Stainless Steel Flanges and Flanged Fittings: ASTM A312 316:

1. Type: Press Fit flange adapter with isolation kit when connecting to steel pipe or equipment.
2. Pressure Class: 150.
3. Gaskets: Nylon reinforced rubber for flat faced or non-asbestos for raised face.

2.04 POLYPROPYLENE PIPE AND FITTINGS:

A. Pipe: ASTM2389 polypropylene pipe and fittings

B. Pipe shall have NSF certification to meet NSF 14 and 61 and shall be ICC listed

C. Joints: Socket fusion, electrofusion or butt fusion as applicable

D. Standard grade hydrostatic pressure ratings from Plastic Pipe Institute in accordance with TR-3 as listed in TR-4. The following three standard-grade hydrostatic ratings are required:

Hydronic Piping for Utility Plants (CHW, HHW)

and Domestic Hot and Cold Water

Version 1.1.2020
1. 200 Degrees F at 80 psi
2. 180 Degrees F at 100 psi
3. 73.4 Degrees F at 160 psi

E. Certification of flame spread/smoke development rating in accordance with ASTM E84 when wrapped with standard pipe insulation, field installed

F. Where installed in systems with pumps in excess of 7.5 HP, piping shall be protected from excessive heat generated by operating the pump at shut-off conditions. Where the possibility exists that the pump will operate with no flow, the protection method shall be a temperature relief valve or comparable level of protection, set to a maximum temperature of 185 degrees F.

G. When used in any application where it will be exposed to sunlight, the piping shall have a factory applied UV protective coating

H. Select proper pipe system for the water application CW, HHW or domestic

I. Acceptable suppliers.
   1. Aquatherm.
   2. Approved equal.

2.05 JOINING MATERIALS:

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness, unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

D. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.
E. 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.

F. Welding Filler Metals: Comply with ASME Section IX for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

G. Gasket Material: EPDM

2.06 DIELECTRIC FITTINGS:

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Description:
   b. Pressure Rating: 125 psig minimum at 180°F.
   c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Description:
   b. Factory-fabricated, bolted, companion-flange assembly.
   c. Pressure Rating: 150 psig.
   d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

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

E. Dielectric Nipples:
1. Description:

   a. Standard: IAPMO PS 66
   c. Pressure Rating: 300 psig at 225ºF.
   d. End Connections: Male threaded or grooved.
   e. Lining: Inert and noncorrosive, propylene.

2.07 VALVES:

A. Ball Valves:

   1. Body: Two piece CPVC or PVC to match piping.
   2. Ball: Full-port CPVC or PVC to match piping.
   3. Seats: PTFE.
   4. Seals: EPDM.
   5. End Connections: Socket, union, or flanged.
   6. Handle Style: Tee shape.
   7. CWP Rating: Equal to piping service.
   8. Maximum Operating Temperature: Equal to piping service.
   9. Comply with MSS SP-122.

B. Butterfly Valves:

   1. Body: PVC or CPVC to match piping wafer type for installation between flanges.
   3. Seats: PTFE.
   4. Handle Style: Locking lever.
   5. CWP Rating: Equal to piping service.

C. Check Valves:

   1. Body: One-, two-, or three-piece PVC or CPVC to match piping.
   2. Ends: Socket or flanged.
   3. Seats: PTFE.
   4. Check Style: Swing or ball type.
   5. CWP Rating: Equal to piping service.

D. Bronze, Calibrated-Orifice, Balancing Valves:

   1. Body: Bronze, ball or plug type with calibrated orifice or venturi.
   2. Ball: Brass or stainless steel.
   3. Plug: Resin.
4. Seat: PTFE.
5. End Connections: Threaded or socket.
7. Handle Style: Lever, with memory stop to retain set position.
8. CWP Rating: Minimum 125 psig.
9. Maximum Operating Temperature: 250°F.

E. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

1. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
2. Ball: Brass or stainless steel.
4. Disc: Glass and carbon-filled PTFE.
5. Seat: PTFE.
6. End Connections: Flanged or grooved.
8. Handle Style: Lever, with memory stop to retain set position.
10. Maximum Operating Temperature: 250°F.

2.08 AIR CONTROL DEVICES:

A. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2.
7. Maximum Operating Temperature: 225°F.

B. Automatic Air Vents:

1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.
4. Inlet Connection: NPS 1/2.
7. Maximum Operating Temperature: 240°F.

2.09 HYDRONIC PIPING SPECIALTIES:
A. Y-Pattern Strainers:

1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged or grooved ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50% free area.

B. Basket Strainers:

1. Body: ASTM A126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged or grooved ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50% free area.

C. Stainless-Steel Bellow, Flexible Connectors:

2. End Connections: Threaded or flanged to match equipment connected.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250ºF.

D. Spherical, Rubber, Flexible Connectors:

2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250ºF.

PART 3 – EXECUTION

3.01 PIPING APPLICATIONS:

A. Hot-water heating piping, aboveground, NPS 4 and smaller, shall be any of the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and brazed joints.
2. Schedule 40 steel pipe; Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

B. Hot-water heating piping, aboveground, NPS 6 and larger shall be any of the following:

1. Schedule 40 steel pipe, wrought-steel fittings and wrought-forged-steel flanges and flange fittings, grooved joints, and welded and flanged joints.
2. ASTM 2389 polypropylene pipe and fittings

C. Chilled-water piping, aboveground, NPS 4 and smaller, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and brazed joints.

D. Chilled-water piping, aboveground, NPS 6 and larger, shall be the following:

1. Schedule 40 steel pipe, wrought-steel fittings and wrought-forged-steel flanges and flange fittings, grooved joints, and welded and flanged joints.
2. ASTM 2389 polypropylene pipe and fittings

E. Condenser-water piping, aboveground, NPS 2-1/2 and larger, shall be either of the following:

1. Schedule 40 steel pipe, wrought-steel fittings and wrought-forged-steel flanges and flange fittings, grooved joints, and welded and flanged joints.
2. Fiberglass as indicated on drawings.
3. ASTM 2389 polypropylene pipe and fittings

F. Makeup-water piping installed aboveground shall be the following:

1. Schedule 40 steel pipe, wrought-steel fittings and wrought-forged-steel flanges and flange fittings, grooved joints, and welded and flanged joints.
2. ASTM 2389 polypropylene pipe and fittings

G. Domestic Hot and Cold Water Piping, NPS 4 and smaller

1. Type L, drawn-temper copper tubing, wrought-copper fittings and brazed joints.
H. Domestic Hot and Cold Water Piping, NPS 6 and larger
   1. ASTM 2389 polypropylene pipe and fittings

I. Air-Vent Piping:
   1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.
   2. Outlet: Type L, annealed-temper copper tubing with soldered or flared joints.

J. Instrument Compressed Air Piping:
   1. Schedule 5S seamless stainless steel pipe, stainless steel fittings and stainless steel flanges and flange fittings.
   2. Stop Valves: type 411.

3.02 VALVE APPLICATIONS:

A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.

B. Install check valves at each pump discharge and elsewhere as required to control flow direction.

3.03 PIPING INSTALLATIONS:

A. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

B. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited, unless specifically indicated otherwise.

C. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

D. Install piping to permit valve servicing.

E. Install piping free of sags and bends.

F. Install fittings for changes in direction and branch connections.

G. Install piping to allow application of insulation.
H. Select system components with pressure rating equal to or greater than system operating pressure.

I. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

J. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

K. Install piping at a uniform grade of 0.2% upward in direction of flow.

L. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

M. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

N. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

3.04 HANGERS AND SUPPORTS:

A. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

B. Install hangers for steel piping with the maximum spacing and minimum rod sizes per drawings.

C. Install hangers for drawn-temper copper piping with the maximum spacing and minimum rod sizes.

D. Support vertical runs at each floor.
3.05 PIPE JOINT CONSTRUCTION:

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.


E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

   1. Apply appropriate tape or thread compound to external pipe threads, unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.


G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

H. 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. Pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. All grooved components (couplings, fittings, valves, gaskets, and specialties) shall be of one manufacturer. Grooved manufacturer shall provide on-site training for contractor's field personnel by a factory trained representative in the proper use of grooving tools, application of groove, and product installation. Factory trained representative shall periodically visit the job site and inspect installation. Contractor shall remove and replace any improperly installed products. All fittings shall be insulated with pre-molded insulation per system requirements.
I. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.


3.06 TERMINAL EQUIPMENT CONNECTIONS:

A. Install control valves in accessible locations close to connected equipment.

B. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

3.07 PIPING AND EQUIPMENT FLUSHING AND CLEANING:

A. Verify materials in system. If there is aluminum or galvanized components in the system this procedure should not be used.

B. Verify or calculate system volume. Verify system is isolated and closed.

C. Begin filling system with raw water (i.e.; raw water with minimal chlorination).

D. As the system is being filled, inject the Ferroquest FQ710/Chemtreat CT-38 or approved equal product into the water. Proper mixing is necessary if mixing cannot be established through circulation.

E. Begin to circulate the water. The higher the water velocity in the system the more effective cleaning and passivation will be. Target flow velocity is 2-3 ft/sec for optimal cleaning results.

F. After two hours of circulation, record conductivity and pH.

G. Circulate the water in the system for 24 to 72 hours depending on concentration of product. With a 2% solution, ambient temperatures, and good flow (i.e.; flow velocity 2-3 ft/sec), the target is 24 hours. With minimal or no flow conditions, the target is 72 hours.

H. When precleaning time is complete, record conductivity and pH, drain the system to remove product, iron and any scale that is dissolved.

I. Refill with clean raw water, circulate for 30 minutes, and drain. Continue filling and draining until the iron content of the water inside the pipe is within 1 ppm of the city water supply and conductivity is within +/- 10 mmhos of city makeup conductivity. This process can take a very long time if there are areas that will trap water (no low point drains). Alternatively, you can use a “bleed and feed” method in which
you feed raw water into the system while at the same time circulate with pumps and have a blowdown open. The larger the bleed and feed lines, the faster this process will go.

J. Fill the system with TAMU chilled or condenser water, put into service with regular treatment as soon as possible.

3.08 POST CLEANING REQUIREMENTS:

A. Place the system on line immediately or bypass enough chilled water through the system to maintain a flow velocity of 3 ft/sec in the piping. If it is not possible to place the system online or maintain flow velocity, the water in the pipe should be exchanged with fresh treated chilled water every 2 to 3 days.

3.09 FIELD QUALITY CONTROL:

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium, unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. 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.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. 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% of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. 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.

6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.