

# CHAPTER 12

## HYDRONIC PIPING

### SECTION 1201 GENERAL

**1201.1 Scope.** The provisions of this chapter shall govern the construction, installation, *alteration* and repair of hydronic piping systems. This chapter shall apply to hydronic piping systems that are part of heating, ventilation and air-conditioning systems. Such piping systems shall include steam, hot water, chilled water, steam condensate and ground source heat pump loop systems. Potable cold and hot water distribution systems shall be installed in accordance with the *Plumbing Code*.

**1201.2 Sizing.** Piping and piping system components for hydronic systems shall be sized for the demand of the system.

**1201.3 Standards.** As an alternative to the provisions of Sections 1202 and 1203, piping shall be designed, installed, inspected and tested in accordance with ASME B31.9.

### SECTION 1202 MATERIAL

**1202.1 Piping.** Piping material shall conform to the standards cited in this section.

**Exception:** Embedded piping regulated by Section 1209.

**1202.2 Used materials.** Reused pipe, fittings, valves or other materials shall be clean and free of foreign materials and shall be *approved* by the code official for reuse.

**1202.3 Material rating.** Materials shall be rated for the operating temperature and pressure of the hydronic system. Materials shall be suitable for the type of fluid in the hydronic system.

**1202.4 Piping materials standards.** Hydronic pipe shall conform to the standards listed in Table 1202.4. The exterior of the pipe shall be protected from corrosion and degradation.

**TABLE 1202.4  
HYDRONIC PIPE**

MATERIAL	STANDARD (see Chapter 15)
Acrylonitrile butadiene styrene (ABS) plastic pipe	ASTM D 1527; ASTM D 2282
Brass pipe	ASTM B 43
Brass tubing	ASTM B 135
Copper or copper-alloy pipe	ASTM B 42; ASTM B 302
Copper or copper-alloy tube (Type K, L or M)	ASTM B 75; ASTM B 88; ASTM B 251
Chlorinated polyvinyl chloride (CPVC) plastic pipe	ASTM D 2846; ASTM F 441; ASTM F 442
Cross-linked polyethylene/aluminum/cross-linked polyethylene (PEX-AL-PEX) pressure pipe	ASTM F 1281; CSA CAN/CSA-B-137.10

(continued)

**TABLE 1202.4—continued  
HYDRONIC PIPE**

MATERIAL	STANDARD (see Chapter 15)
Cross-linked polyethylene (PEX) tubing	ASTM F 876; ASTM F 877
Ductile iron pipe	AWWA C151/A21.51; AWWA C115/A21.15
Lead pipe	FS WW-P-325B
Polybutylene (PB) plastic pipe and tubing	ASTM D 3309
Polyethylene/aluminum/polyethylene (PE-AL-PE) pressure pipe	ASTM F 1282; CSA B137.9
Polyethylene (PE) pipe, tubing and fittings (for ground source heat pump loop systems)	ASTM D 2513; ASTM D 3035; ASTM D 2447; ASTM D 2683; ASTM F 1055; ASTM D 2837; ASTM D 3350; ASTM D 1693
Polypropylene (PP) plastic pipe	ASTM F 2389
Polyvinyl chloride (PVC) plastic pipe	ASTM D 1785; ASTM D 2241
Raised temperature polyethylene (PE-RT)	ASTM F 2623
Steel pipe	ASTM A 53; ASTM A 106
Steel tubing	ASTM A 254

**1202.5 Pipe fittings.** Hydronic pipe fittings shall be *approved* for installation with the piping materials to be installed, and shall conform to the respective pipe standards or to the standards listed in Table 1202.5.

**TABLE 1202.5  
HYDRONIC PIPE FITTINGS**

MATERIAL	STANDARD (see Chapter 15)
Brass	ASTM F 1974
Bronze	ASME B16.24
Copper and copper alloys	ASME B16.15; ASME B16.18; ASME B16.22; ASME B16.23; ASME B16.26; ASME B16.29
Ductile iron and gray iron	ANSI/AWWA C110/A21.10
Ductile iron	ANSI/AWWA C153/A21.53
Gray iron	ASTM A 126
Malleable iron	ASME B16.3
Plastic	ASTM D 2466; ASTM D 2467; ASTM D 2468; ASTM F 438; ASTM F 439; ASTM F 877; ASTM F 2389
Steel	ASME B16.5; ASME B16.9; ASME B16.11; ASME B16.28; ASTM A 420

**1202.6 Valves.** Valves shall be constructed of materials that are compatible with the type of piping material and fluids in the system. Valves shall be rated for the temperatures and pressures of the systems in which the valves are installed.

**1202.7 Flexible connectors, expansion and vibration compensators.** Flexible connectors, expansion and vibration control devices and fittings shall be of an *approved* type.

## SECTION 1203 JOINTS AND CONNECTIONS

**1203.1 Approval.** Joints and connections shall be of an *approved* type. Joints and connections shall be tight for the pressure of the hydronic system.

**1203.1.1 Joints between different piping materials.** Joints between different piping materials shall be made with *approved* adapter fittings. Joints between different metallic piping materials shall be made with *approved* dielectric fittings or brass converter fittings.

**1203.2 Preparation of pipe ends.** Pipe shall be cut square, reamed and chamfered, and shall be free of burrs and obstructions. Pipe ends shall have full-bore openings and shall not be undercut.

**1203.3 Joint preparation and installation.** When required by Sections 1203.4 through 1203.14, the preparation and installation of brazed, mechanical, soldered, solvent-cemented, threaded and welded joints shall comply with Sections 1203.3.1 through 1203.3.7.

**1203.3.1 Brazed joints.** Joint surfaces shall be cleaned. An *approved* flux shall be applied where required. The joint shall be brazed with a filler metal conforming to AWS A5.8.

**1203.3.2 Mechanical joints.** Mechanical joints shall be installed in accordance with the manufacturer's instructions.

**1203.3.3 Soldered joints.** Joint surfaces shall be cleaned. A flux conforming to ASTM B 813 shall be applied. The joint shall be soldered with a solder conforming to ASTM B 32.

**1203.3.4 Solvent-cemented joints.** Joint surfaces shall be clean and free of moisture. An *approved* primer shall be applied to CPVC and PVC pipe-joint surfaces. Joints shall be made while the cement is wet. Solvent cement conforming to the following standards shall be applied to all joint surfaces:

1. ASTM D 2235 for ABS joints.
2. ASTM F 493 for CPVC joints.
3. ASTM D 2564 for PVC joints.

CPVC joints shall be made in accordance with ASTM D 2846.

**1203.3.5 Threaded joints.** Threads shall conform to ASME B1.20.1. Schedule 80 or heavier plastic pipe shall be threaded with dies specifically designed for plastic pipe. Thread lubricant, pipe-joint compound or tape shall be applied on the male threads only and shall be *approved* for application on the piping material.

**1203.3.6 Welded joints.** Joint surfaces shall be cleaned by an *approved* procedure. Joints shall be welded with an *approved* filler metal.

**1203.3.7 Grooved and shouldered mechanical joints.** Grooved and shouldered mechanical joints shall conform to the requirements of ASTM F 1476 and shall be installed in accordance with the manufacturer's installation instructions.

**1203.3.8 Mechanically formed tee fittings.** Mechanically extracted outlets shall have a height not less than three times the thickness of the branch tube wall.

**1203.3.8.1 Full flow assurance.** Branch tubes shall not restrict the flow in the run tube. A dimple/depth stop shall be formed in the branch tube to ensure that penetration into the outlet is of the correct depth. For inspection purposes, a second dimple shall be placed  $\frac{1}{4}$  inch (6.4 mm) above the first dimple. Dimples shall be aligned with the tube run.

**1203.3.8.2 Brazed joints.** Mechanically formed tee fittings shall be brazed in accordance with Section 1203.3.1.

**1203.4 ABS plastic pipe.** Joints between ABS plastic pipe or fittings shall be solvent-cemented or threaded joints conforming to Section 1203.3.

**1203.5 Brass pipe.** Joints between brass pipe or fittings shall be brazed, mechanical, threaded or welded joints conforming to Section 1203.3.

**1203.6 Brass tubing.** Joints between brass tubing or fittings shall be brazed, mechanical or soldered joints conforming to Section 1203.3.

**1203.7 Copper or copper-alloy pipe.** Joints between copper or copper-alloy pipe or fittings shall be brazed, mechanical, soldered, threaded or welded joints conforming to Section 1203.3.

**1203.8 Copper or copper-alloy tubing.** Joints between copper or copper-alloy tubing or fittings shall be brazed, mechanical or soldered joints conforming to Section 1203.3, flared joints conforming to Section 1203.8.1 or push-fit joints conforming to Section 1203.8.2.

**1203.8.1 Flared joints.** Flared joints shall be made by a tool designed for that operation.

**1203.8.2 Push-fit joints.** Push-fit joints shall be installed in accordance with the manufacturer's instructions.

**1203.9 CPVC plastic pipe.** Joints between CPVC plastic pipe or fittings shall be solvent-cemented or threaded joints conforming to Section 1203.3.

**1203.10 Polybutylene plastic pipe and tubing.** Joints between polybutylene plastic pipe and tubing or fittings shall be mechanical joints conforming to Section 1203.3 or heat-fusion joints conforming to Section 1203.10.1.

**1203.10.1 Heat-fusion joints.** Joints shall be of the socket-fusion or butt-fusion type. Joint surfaces shall be clean and free of moisture. Joint surfaces shall be heated to melt temperatures and joined. The joint shall be undisturbed until cool. Joints shall be made in accordance with ASTM D 3309.

**1203.11 Cross-linked polyethylene (PEX) plastic tubing.** Joints between cross-linked polyethylene plastic tubing and fittings shall conform to Sections 1203.11.1 and 1203.11.2. Mechanical joints shall conform to Section 1203.3.

**1203.11.1 Compression-type fittings.** When compression-type fittings include inserts and ferrules or O-rings, the fittings shall be installed without omitting the inserts and ferrules or O-rings.

**1203.11.2 Plastic-to-metal connections.** Soldering on the metal portion of the system shall be performed at least 18 inches (457 mm) from a plastic-to-metal adapter in the same water line.

**1203.12 PVC plastic pipe.** Joints between PVC plastic pipe and fittings shall be solvent-cemented or threaded joints conforming to Section 1203.3.

**1203.13 Steel pipe.** Joints between steel pipe or fittings shall be mechanical joints that are made with an *approved* elastomeric seal, or shall be threaded or welded joints conforming to Section 1203.3.

**1203.14 Steel tubing.** Joints between steel tubing or fittings shall be mechanical or welded joints conforming to Section 1203.3.

**1203.15 Polyethylene plastic pipe and tubing for ground source heat pump loop systems.** Joints between polyethylene plastic pipe and tubing or fittings for ground source heat pump loop systems shall be heat fusion joints conforming to Section 1203.15.1, electrofusion joints conforming to Section 1203.15.2, or stab-type insertion joints conforming to Section 1203.15.3.

**1203.15.1 Heat-fusion joints.** Joints shall be of the socket-fusion, saddle-fusion or butt-fusion type, joined in accordance with ASTM D 2657. Joint surfaces shall be clean and free of moisture. Joint surfaces shall be heated to melt temperatures and joined. The joint shall be undisturbed until cool. Fittings shall be manufactured in accordance with ASTM D 2683 or ASTM D 3261.

**1203.15.2 Electrofusion joints.** Joints shall be of the electrofusion type. Joint surfaces shall be clean and free of moisture, and scoured to expose virgin resin. Joint surfaces shall be heated to melt temperatures for the period of time specified by the manufacturer. The joint shall be undisturbed until cool. Fittings shall be manufactured in accordance with ASTM F 1055.

**1203.15.3 Stab-type insert fittings.** Joint surfaces shall be clean and free of moisture. Pipe ends shall be chamfered and inserted into the fittings to full depth. Fittings shall be manufactured in accordance with ASTM F 1924.

**1203.16 Polypropylene (PP) plastic.** Joints between PP plastic pipe and fittings shall comply with Sections 1203.16.1 and 1203.16.2.

**1203.16.1 Heat-fusion joints.** Heat-fusion joints for polypropylene (PP) pipe and tubing joints shall be installed with socket-type heat-fused polypropylene fittings, electrofusion polypropylene fittings or by butt fusion. Joint surfaces shall be clean and free from moisture. The joint shall

be undisturbed until cool. Joints shall be made in accordance with ASTM F 2389.

**1203.16.2 Mechanical and compression sleeve joints.** Mechanical and compression sleeve joints shall be installed in accordance with the manufacturer's instructions.

**1203.17 Raised temperature polyethylene (PE-RT) plastic tubing.** Joints between raised temperature polyethylene tubing and fittings shall conform to Sections 1203.17.1 and 1203.17.2. Mechanical joints shall conform to Section 1203.3.

**1203.17.1 Compression-type fittings.** Where compression-type fittings include inserts and ferrules or O-rings, the fittings shall be installed without omitting the inserts and ferrules or O-rings.

**1203.17.2 PE-RT-to-metal connections.** Solder joints in a metal pipe shall not occur within 18 inches (457 mm) of a transition from such metal pipe to PE-RT pipe.

**1203.18 Polyethylene/aluminum/polyethylene (PE-AL-PE) pressure pipe.** Joints between polyethylene/aluminum/polyethylene pressure pipe and fittings shall conform to Sections 1203.18.1 and 1203.18.2. Mechanical joints shall comply with Section 1203.3.

**1203.18.1 Compression-type fittings.** Where compression-type fittings include inserts and ferrules or O-rings, the fittings shall be installed without omitting the inserts and ferrules or O-rings.

**1203.18.2 PE-AL-PE-to-metal connections.** Solder joints in a metal pipe shall not occur within 18 inches (457 mm) of a transition from such metal pipe to PE-AL-PE pipe.

**1203.19 Cross-linked polyethylene/aluminum/cross-linked polyethylene (PEX-AL-PEX) pressure pipe.** Joints between cross-linked polyethylene/aluminum/cross-linked polyethylene pressure pipe and fittings shall conform to Sections 1203.19.1 and 1203.19.2. Mechanical joints shall comply with Section 1203.3.

**1203.19.1 Compression-type fittings.** Where compression-type fittings include inserts and ferrules or O-rings, the fittings shall be installed without omitting the inserts and ferrules or O-rings.

**1203.19.2 PEX-AL-PEX-to-metal connections.** Solder joints in a metal pipe shall not occur within 18 inches (457 mm) of a transition from such metal pipe to PEX-AL-PEX pipe.

## SECTION 1204 PIPE INSULATION

**1204.1 Insulation characteristics.** Pipe insulation installed in buildings shall conform to the requirements of the *Building Code*; shall be tested in accordance with ASTM E 84 or UL 723, using the specimen preparation and mounting procedures of ASTM E 2231; and shall have a maximum flame spread index of 25 and a smoke-developed index not exceeding 450.

Insulation installed in an air *plenum* shall comply with Section 602.2.1.

**Exception:** The maximum flame spread index and smoke-developed index shall not apply to one- and two-family dwellings.

**1204.2 Required thickness.** Hydronic piping shall be insulated to the thickness required by the *Building Code*.

## SECTION 1205 VALVES

**1205.1 Where required.** Shutoff valves shall be installed in hydronic piping systems in the locations indicated in Sections 1205.1.1 through 1205.1.6.

**1205.1.1 Heat exchangers.** Shutoff valves shall be installed on the supply and return side of a heat exchanger.

**Exception:** Shutoff valves shall not be required when heat exchangers are integral with a boiler; or are a component of a manufacturer's boiler and heat exchanger packaged unit and are capable of being isolated from the hydronic system by the supply and return valves.

**1205.1.2 Central systems.** Shutoff valves shall be installed on the building supply and return of a central utility system.

**1205.1.3 Pressure vessels.** Shutoff valves shall be installed on the connection to any pressure vessel.

**1205.1.4 Pressure-reducing valves.** Shutoff valves shall be installed on both sides of a pressure-reducing valve.

**1205.1.5 Equipment and appliances.** Shutoff valves shall be installed on connections to mechanical *equipment* and appliances. This requirement does not apply to components of a hydronic system such as pumps, air separators, metering devices and similar *equipment*.

**1205.1.6 Expansion tanks.** Shutoff valves shall be installed at connections to nondiaphragm-type expansion tanks.

**1205.2 Reduced pressure.** A pressure relief valve shall be installed on the low-pressure side of a hydronic piping system that has been reduced in pressure. The relief valve shall be set at the maximum pressure of the system design. The valve shall be installed in accordance with Section 1008.

## SECTION 1206 PIPING INSTALLATION

**1206.1 General.** Piping, valves, fittings and connections shall be installed in accordance with the conditions of approval.

**1206.2 System drain down.** Hydronic piping systems shall be designed and installed to permit the system to be drained. Where the system drains to the plumbing drainage system, the installation shall conform to the requirements of the *Plumbing Code*.

**Exception:** The buried portions of systems embedded underground or under floors.

**1206.3 Protection of potable water.** The potable water system shall be protected from backflow in accordance with the *Plumbing Code*.

**1206.4 Pipe penetrations.** Openings for pipe penetrations in walls, floors or ceilings shall be larger than the penetrating pipe. Openings through concrete or masonry building elements shall be sleeved. The annular space surrounding pipe penetrations shall be protected in accordance with the *Building Code*.

**1206.5 Clearance to combustibles.** A pipe in a hydronic piping system in which the exterior temperature exceeds 250°F (121°C) shall have a minimum *clearance* of 1 inch (25 mm) to combustible materials.

**1206.6 Contact with building material.** A hydronic piping system shall not be in direct contact with building materials that cause the piping material to degrade or corrode, or that interfere with the operation of the system.

**1206.7 Water hammer.** The flow velocity of the hydronic piping system shall be controlled to reduce the possibility of water hammer. Where a quick-closing valve creates water hammer, an *approved* water-hammer arrestor shall be installed. The arrestor shall be located within a range as specified by the manufacturer of the quick-closing valve.

**1206.8 Steam piping pitch.** Steam piping shall be installed to drain to the boiler or the steam trap. Steam systems shall not have drip pockets that reduce the capacity of the steam piping.

**1206.9 Strains and stresses.** Piping shall be installed so as to prevent detrimental strains and stresses in the pipe. Provisions shall be made to protect piping from damage resulting from expansion, contraction and structural settlement. Piping shall be installed so as to avoid structural stresses or strains within building components.

**1206.9.1 Flood hazard.** Piping located in a flood hazard area shall be capable of resisting hydrostatic and hydrodynamic loads and stresses, including the effects of buoyancy, during the occurrence of flooding to the *design flood elevation*.

**1206.10 Pipe support.** Pipe shall be supported in accordance with Section 305.

**1206.11 Condensation.** Provisions shall be made to prevent the formation of condensation on the exterior of piping.

## SECTION 1207 TRANSFER FLUID

**1207.1 Flash point.** The flash point of transfer fluid in a hydronic piping system shall be a minimum of 50°F (28°C) above the maximum system operating temperature.

**1207.2 Makeup water.** The transfer fluid shall be compatible with the makeup water supplied to the system.

## SECTION 1208 TESTS

**1208.1 General.** Hydronic piping systems shall be tested hydrostatically at one and one half times the maximum system design pressure, but not less than 100 psi (689 kPa). The duration of each test shall be not less than 15 minutes. Ground-source heat pump loop systems and cross-linked poly-

ethylene (PEX) tubing systems shall be tested in accordance with Sections 1208.1.1 and 1208.1.2.

**1208.1.1 Ground source heat pump loop systems.** Before connection (header) trenches are backfilled, the assembled loop system shall be pressure tested with water at 100 psi (689 kPa) for 30 minutes with no observed leaks. Flow and pressure loss testing shall be performed and the actual flow rates and pressure drops shall be compared to the calculated design values. If actual flow rate or pressure drop values differ from calculated design values by more than 10 percent, the problem shall be identified and corrected.

**1208.1.2 Cross-linked polyethylene (PEX) tubing systems.** Before a continuous looped systems using PEX tubing is embedded or concealed the assembled system shall be pressure tested at 100 psi (689 kPa) for 30 minutes with no observed leaks.

## SECTION 1209 EMBEDDED PIPING

**1209.1 Materials.** Piping for heating panels shall be standard-weight steel pipe, Type L copper tubing, cross-linked polyethylene (PEX) tubing, cross-linked polyethylene/aluminum/cross-linked polyethylene (PEX-AL-PEX) pressure pipe or polybutylene rated at 100 psi (689 kPa) at 180°F (82°C).

**1209.2 Pressurizing during installation.** Piping to be embedded in concrete shall be pressure tested prior to pouring concrete. During pouring, the pipe shall be maintained at the proposed operating pressure.

**1209.3 Embedded joints.** Joints of pipe or tubing that are embedded in a portion of the building, such as concrete or plaster, shall be in accordance with the requirements of Sections 1209.3.1 through 1209.3.3.

**1209.3.1 Steel pipe joints.** Steel pipe shall be welded by electrical arc or oxygen/acetylene method.

**1209.3.2 Copper tubing joints.** Copper tubing shall be joined by brazing with filler metals having a melting point of not less than 1,000°F (538°C).

**1209.3.3 Polybutylene joints.** Polybutylene pipe and tubing shall be installed in continuous lengths or shall be joined by heat fusion in accordance with Section 1203.10.1.

**1209.3.4 Cross-linked polyethylene joints.** PEX pipe shall be joined using cold expansion, insert or compression fittings.

**1209.3.5 Cross-linked polyethylene/aluminum/cross-linked polyethylene.** PEX-AL-PEX pipe shall be joined by mechanical, crimp/insert fittings.

**1209.4 Not embedded related piping.** Joints of other piping in cavities or running exposed shall be joined by *approved* methods in accordance with manufacturer's installation instructions and related sections of this code.

**1209.5 Thermal barrier required.** Radiant floor heating systems shall be provided with a thermal barrier in accordance with Sections 1209.5.1 through 1209.5.4.

**Exception:** Insulation shall not be required in engineered systems where it can be demonstrated that the insulation will decrease the efficiency or have a negative effect on the installation.

**1209.5.1 Slab-on-grade installation.** Radiant piping utilized in slab-on-grade applications shall be provided with insulating materials installed beneath the piping having a minimum *R*-value of 5.

**1209.5.2 Suspended floor installation.** In suspended floor applications, insulation shall be installed in the joist bay cavity serving the heating space above and shall consist of materials having a minimum *R*-value of 11.

**1209.5.3 Thermal break required.** A thermal break shall be provided consisting of asphalt expansion joint materials or similar insulating materials at a point where a heated slab meets a foundation wall or other conductive slab.

**1209.5.4 Thermal barrier material marking.** Insulating materials utilized in thermal barriers shall be installed such that the manufacturer's *R*-value mark is readily observable upon inspection.

