

# CHAPTER 12

## HYDRONICS

### Part I – Steam and Water Piping.

#### 1201.0 General.

**1201.1 Applicability.** Steam and water piping systems that are part of a heating or cooling system shall comply with the following requirements.

**1201.2 High Pressure Systems.** Portions of piping systems in which the pressure exceeds 160 pounds-force per square inch gauge (psig) (1103 kPa) or the temperature exceeds 250°F (121°C) shall comply with nationally recognized standards and the requirements of Section 1201.3.

**1201.3 Low Pressure Systems.** Portions of piping systems in which the pressure does not exceed 160 psig (1103 kPa) and the temperature does not exceed 250°F (121°C) shall comply with the following requirements.

**1201.3.1 Standards.** Piping, tubing, and fittings materials for hydronic systems shall comply with the applicable standards referenced in Table 1201.3.1.

**1201.3.2 Materials and Construction.** Pipe shall be brass, copper, cast-iron, galvanized or black wrought iron, galvanized or black steel, or other approved materials.

**1201.3.2.1 Tubing.** Tubing shall be copper water tube.

**1201.3.2.2 Valves.** Valves no more than 2 inches (50 mm) in size shall be brass, malleable iron, or steel bodies. Each gate valve shall be a full-way type with working parts of noncorrosive metal.

**1201.3.2.3 Fittings.** Plain screwed fittings shall be brass, bronze, cast-iron, galvanized or black malleable iron, or galvanized or black steel.

**1201.3.2.4 Copper Tubing.** Fittings for copper tubing shall be wrought copper, wrought bronze, or cast brass.

**1201.3.2.5 Mechanically Formed Tee Fittings.** Mechanically extracted collars shall be formed in a continuous operation consisting of drilling a pilot hole and drawing out the tube surface to form a collar having a height not less than three times the thickness of the branch tube wall.

The branch tube shall be notched to comply with the inner curve of the run tube and have two dimple/depth stops to ensure that penetration of the branch tube into the collar is of an approved depth for brazing and that the branch tube does not obstruct the flow in the main line tube. Dimple or depth stops shall be in line with the run of the tube. The second dimple shall be ¼ of an inch (6.4 mm) above the first and shall serve as a visual point of inspection.

Joints shall be brazed in accordance with Section 212.0. Soft soldered joints shall not be allowed.

**1201.3.2.6 Welding.** Welding fittings shall be black steel.

**1201.3.2.7 Asbestos–Cement.** Fittings for asbestos-cement shall be made of cast-iron.

**1201.3.2.8 Pipe Joint Compound.** Pipe joint compound shall be noncorrosive and insoluble in the material being carried in the pipe.

**1201.3.2.9 Protective Coatings.** Protective coatings shall be watertight, durable, heat resistant, electrically nonconductive, and tightly adherent to the pipe.

**1201.3.2.10 Fluxes.** Fluxes for solder, sweat, and brazed joints shall be a noncorrosive type and intended for the use.

**1201.3.2.11 Insulation.** Coverings and insulation used for hot water pipes shall be of material approved for the operating temperature of the system. The insulation, jackets, and lap-seal adhesives, including pipe coverings and linings, shall have a flame spread index not to exceed 25 and a smoke-developed index not to exceed 50 where tested in accordance with ASTM E 84 or UL 723. The specimen preparation and mounting procedures of ASTM E 2231 shall be used. Materials used for pipe coverings and insulation (including the insulation, jacket, and lap-seal adhesives) shall have a maximum peak heat release rate of 1.02 E+06 British thermal units per hour (Btu/h) (299 kW), a maximum total heat release of 4.7 E+04 Btu (50 MJ), a maximum total smoke release of 5382 square feet (500 m<sup>2</sup>), and shall not generate flames that extend 1 foot (305 mm) or more above the top of the vertical portion of the apparatus during the test where tested in accordance with NFPA 274. Insulation coverings and linings shall not flame, glow, smolder, or smoke where tested in accordance with ASTM C 411 at the temperature to which they are exposed in service. In no case shall the test temperature be less than 250°F (121°C).

**1201.3.2.12 Flashing Material.** Flashing material shall be lead, copper, galvanized iron, or other approved materials.

**1201.3.2.13 Gaskets.** Flange gaskets shall be metal, asbestos, or other approved materials.

**1201.3.2.14 Hangers and Anchors.** Hangers and anchors shall be approved for the use intended.

**1201.3.2.15 Sleeves.** Sleeves shall be of steel, cast-iron or wrought-iron pipe, or tile.

**TABLE 1201.3.1  
MATERIALS FOR HYDRONIC SYSTEM PIPING, TUBING, AND FITTINGS**

MATERIAL	STANDARDS		INSTALLATION	
	PIPING/TUBING	FITTINGS	UNDERGROUND	ABOVEGROUND
Asbestos-Cement <sup>3</sup>	ASTM C 296	—	X	—
<b>METALLIC</b>				
Brass	ASTM B 43, ASTM B 135	ASTM F 1974	X	X
Bronze	—	ASME B16.24	X	X
Copper/Copper Alloy	ASTM B 42, ASTM B 75, ASTM B 88, ASTM B 251 <sup>2</sup> , ASTM B 302, ASTM B 447	ASME B16.15, ASME B16.18, ASME B16.22, ASME B16.23, ASME B16.26, ASME B16.29	X	X
Ductile Iron	AWWA C115/A21.15, AWWA C151/A21.51	AWWA C110/A21.10 <sup>1</sup> , AWWA C153/A21.53	X	X
Galvanized Steel/Wrought Iron	ASTM A 53, ASTM A 106, ASTM A 254	ASME B16.5, ASME B16.9, ASME B16.11, ASTM A 420	X	X
Gray Iron	—	ASTM A 126	X	X
Malleable Iron	—	ASME B16.3	X	X
<b>PLASTIC</b>				
Acrylonitrile Butadiene Styrene (ABS)	ASTM D 1527	—	X	X
Chlorinated Polyvinyl Chloride (CPVC)	ASTM D 2846, ASTM F 441, ASTM F 442	ASTM D 2846, ASTM F 437, ASTM F 438, ASTM F 439, ASTM F 1970	X	X
Polyethylene (PE) Pipe	ASTM D 1693, ASTM D 2513, ASTM D 2683, ASTM D 2837, ASTM D 3035, ASTM D 3350, ASTM F 1055	ASTM D 2609, ASTM D 2683, ASTM D 3261, ASTM F 1055, CSA B137.1	X	X
Cross-Linked Polyethylene (PEX)	ASTM F 876, ASTM F 877	ASTM F 877, ASTM F 1807, ASTM F 1960, ASTM F 1961, ASTM F 2080, ASTM F 2159, CSA B137.5	X	X
Polypropylene (PP)	ASTM F 2389	—	X	X
Polyvinyl Chloride (PVC)	ASTM D 1785, ASTM D 2241	ASTM D 2464, ASTM D 2466, ASTM D 2467, ASTM F 1970	X	X
Raised Temperature Polyethylene (PE-RT)	ASTM F 2623, ASTM F 2769	ASTM F 1807, ASTM F 2159, ASTM F 2735, ASTM F 2769	X	X
Cross-Linked Polyethylene/Aluminum/Cross-Linked Polyethylene(PEX-AL-PEX)	ASTM F 1281, CSA B137.10	ASTM F 1281, ASTM F 1974, ASTM F 2434, CSA B137.10	X	X
Polyethylene/Aluminum/Polyethylene (PE-AL-PE)	ASTM F 1282, CSA B137.9	ASTM F 1282, ASTM F 1974, CSA B137.9	X	X

**Notes:**

<sup>1</sup> Ductile and gray iron.

<sup>2</sup> Only type K, L, or M tubing allowed to be installed.

<sup>3</sup> Used only for low-pressure hydronic system with water without additives.

**1201.3.2.16 Standards.** Piping, tubing, valves, joints, fittings, devices, and materials shall be free of defects and comply with nationally recognized standards.

**1201.3.2.17 Marking.** Materials and devices shall be identified. In addition to the incised marking required in the standards, hard-drawn copper tubing shall be marked in accordance with the applicable standard found in Chapter 17. Color coding shall be as follows:

- (1) Type L – Blue
- (2) Type K – Green
- (3) Type M – Red
- (4) Type ACR – Blue
- (5) Type DWV – Yellow

**1201.3.3 Fabrication of Joints.** Joints shall be made by the use of fittings except as otherwise permitted in this chapter.

**1201.3.3.1 Screwed Joints.** Threads on iron pipe size (IPS pipe) shall be standard taper pipe threads. Burrs shall be removed. Pipe ends shall be reamed or filed out to the full size of bore, and chips shall be removed.

**1201.3.3.2 Solder Joints.** Surfaces to be joined by soldering shall be cleaned bright by manual or mechanical means. The joints shall be fluxed using a listed soldering flux. (See standards for soldering fluxes in Chapter 17). Tubing shall be reamed out to the full size of bore.

**1201.3.3.3 Welded Joints.** Welding shall be performed in accordance with nationally recognized standards by certified welders.

**1201.3.3.4 Flanged Joints.** Flanged joints shall be tightened evenly and provided with approved nuts, bolts, and gaskets.

**1201.3.3.5 Mechanical Joints.** Mechanical joints shall comply with nationally recognized standards.

#### **1201.3.4 Connections.**

**1201.3.4.1 Brass and Copper Piping.** Joints in brass and copper piping shall be threaded, brazed, welded, flanged, or mechanical type.

**1201.3.4.2 Cast-Iron Piping.** Joints in cast-iron pipe shall be threaded, flanged, or mechanical type.

**1201.3.4.3 Galvanized Wrought-Iron and Galvanized Steel Piping.** Joints in galvanized wrought-iron and galvanized steel piping shall be threaded, flanged, or mechanical type.

**1201.3.4.4 Black Wrought-Iron Piping.** Joints in black wrought-iron piping shall be threaded, brazed, welded, flanged, or mechanical type, except that joints built into or embedded in concrete or masonry shall be welded.

**1201.3.4.5 Black Steel Piping.** Joints in black steel piping shall be threaded, brazed, welded, flanged, or mechanical type.

**1201.3.4.6 Asbestos-Cement Piping.** Joints in asbestos-cement piping shall be mechanical type and approved for the service temperature intended.

**1201.3.4.7 Copper Tubing.** Joints in copper tubing shall be soldered, brazed, grooved, pressed, flared, or compression except that joints under a building and in or under a concrete slab resting on the ground shall be brazed, or equal, and fittings shall be of wrought copper. Mechanically formed tee fittings are also acceptable where brazed and installed in accordance with Section 1201.3.2.5. Solder joints shall be made with solders meeting the standard for solder metal found in Chapter 17. Where steam pressures exceed 15 psig (103 kPa) or water pressures exceed 30 psig (207 kPa), then 50 percent tin-50 percent lead solder shall not be used. Solders and fluxes with a lead content which exceeds two-tenths of 1 percent shall be prohibited in piping systems conveying potable water.

**1201.3.4.8 Piping to Tubing.** Joints connecting piping to tubing shall be made with adapter fittings connected as required in Section 1201.3.4.1 through Section 1201.3.4.7.

**1201.3.5 Changes in Direction.** Changes in direction shall be made by the approved use of fittings, except that changes in direction in copper tubing shall be permitted to be made with bends having a radius not less than six diameters of the tubing, provided that such bends

are made by the use of forming equipment that does not deform or reduce appreciably the cross-sectional area of the tubing.

**1201.3.6 Changes in Pipe Sizes.** Where different sizes of pipe or pipe and fittings are to be connected, the approved size increasers or reducer fittings shall be used between the two sizes. Where the branch is not less than two sizes smaller than the main, weldolets or threadolets shall be permitted to be used in lieu of welding tees. Bushings shall not be used. Eccentric reducing fittings shall be used wherever necessary to provide free drainage of lines.

**1201.3.7 Hangers and Supports.** Hot-water and steam piping shall be supported, anchored, and provided with swing joints, expansion loops or joints, or other means to avoid excessive strain on piping, equipment, or the building structure. Piping and tubing hangers and supports shall comply with requirements listed in Section 316.0.

**1201.3.7.1 In Ground.** Piping and tubing in the ground shall be laid on a firm bed for its entire length except where otherwise approved by the Authority Having Jurisdiction. Asbestos-cement piping shall be provided with approved thrust blocking.

**1201.3.8 Installation.** Piping materials used, except valves and similar devices, shall be of a like material, except as otherwise acceptable to the Authority Having Jurisdiction.

**1201.3.8.1 Wall Thickness.** Piping shall be not less than standard-weight brass or copper, Class 150 cast-iron, standard-weight wrought iron, ASTM Schedule 40 steel, or asbestos-cement of approved pressure rating.

**1201.3.8.1(A) Condensate Return Lines.** Tubing shall be not less than Type K, for condensate return lines; Type L, for steam condenser cooling water lines, underground water lines, and aboveground water lines; Type M, for aboveground water lines not embedded in concrete or masonry.

**1201.3.8.2 Piping Embedded in Structure.** Piping shall not be built into or embedded in concrete or masonry, except where used for radiant panel heating or cooling. Black steel pipe, wrought-iron piping, or Type L copper tubing shall be permitted to be embedded.

**1201.3.8.3 Providing for Expansion, Contraction, and Settling.** Piping shall be installed so that piping, connections, and equipment shall not be subjected to excessive strains or stresses, and provisions shall be made for expansion, contraction, shrinkage, and structural settlement.

**1201.3.8.4 Circulation.** Piping shall provide approved circulation. Piping shall be graded so that gases are capable of moving in the direction of the water flow to a vented section of the system. Where sections of a piping system cannot be installed with

the required grade, such sections shall be provided with automatic or manual air vents whose discharge is piped to an approved location. Steam traps shall be provided where required.

**1201.3.8.5 Underground Piping.** Piping passing through or under cinders or other corrosive fill materials shall be protected from corrosion.

**Exception:** Where a soil analysis by an approved testing laboratory shows the soil to be free of materials that are capable of corroding the pipe to be installed, the requirements for protective coatings shall be permitted to be waived.

**1201.3.8.5(A) Beneath Buildings.** Piping located within a building and in, or under, a concrete floor slab resting on the ground shall be installed as follows:

- (1) Ferrous piping shall be galvanized and covered with an approved protective coating.
- (2) Copper tubing shall be installed without joints.
- (3) Asbestos-cement pipe shall not be installed beneath a building.

**1201.3.8.5(B) Outside of Buildings.** Underground piping located outside of buildings shall be installed as follows:

- (1) Black wrought-iron and black steel piping shall be protected against corrosion by an approved pipe wrapping.
- (2) Asbestos-cement piping shall be installed in accordance with the manufacturer's installation instructions, but shall not be installed within 2 feet (610 mm) of a building.

**1201.3.8.5(C) Openings into Buildings.**

Voids around piping passing through concrete or masonry floors or walls shall be sealed at the opening into the building. Sleeves shall be provided at such openings.

**1201.3.8.6 Aboveground Piping.** Sleeves shall be provided to protect piping through concrete and masonry walls.

**1201.3.8.6(A) Insulation.** The temperature of surfaces within normal reach of building occupants shall not exceed 140°F (60°C) unless they are protected by insulation. Where sleeves are installed, an insulation shall continue full-sized through them.

**1201.3.8.6(B) Lining.** Combustible portions of unventilated spaces that contain piping or devices whose outside temperature, including insulation, exceeds 140°F (60°C), shall be lined with No. 24 gauge (0.021 inch) (0.53 mm) steel, or ¼ of an inch thick (6.4 mm) insulating mill-board.

**1201.3.8.6(C) Clearance.** There shall be not less than 1 inch (25.4 mm) clearance from the structure around steam pipes.

**1201.3.8.6(D) Exposed Piping.** Exposed piping subject to excessive corrosion, erosion, or mechanical damage shall be protected.

**1201.3.8.6(E) Asbestos-Cement Piping.** Asbestos-cement piping shall not be installed within a building.

**1201.3.8.6(F) Roof and Wall Openings.** Joints at the roof around pipes or appurtenances shall be made watertight by the use of approved flashings or flashing material. Exterior wall openings shall be made watertight.

**1201.3.8.6(G) Drainage.** Means shall be provided to drain all piping.

**1201.3.8.6(H) Freezing.** Where required, piping outside of a building or in an exterior wall shall be protected from freezing.

**1201.3.8.7 Trenches and Tunnels.** Trenches deeper than the footings of a building or structure and paralleling the same shall be not less than 45 degrees (0.79 rad) therefrom, or approved in accordance with Section 103.0.

**1201.3.8.7(A) Mechanical Equipment.**

Use of mechanical excavating equipment is prohibited within 2 feet (610 mm) of existing piping or appurtenances.

**1201.3.8.7(B) Tunneling and Driving.** Tunnels shall, before backfilling, have a clear height of 2 feet (610 mm) above the pipe and shall be limited in length to one-half the depth of the trench, with a maximum length of 8 feet (2438 mm). Where pipes are driven, the drive pipe shall be not less than one size larger than the pipe to be laid.

**1201.3.8.7(C) Backfilling.** Excavations shall be completely backfilled as soon after inspection as practicable. Precaution shall be taken to ensure compaction of backfill around piping without damage to such piping. Trenches shall be backfilled in thin layers to 12 inches (305 mm) above the top of the piping with clean earth that shall not contain stones, boulders, cinderfill, or other materials that are capable of damaging or breaking the pipe, or causing corrosive action. Mechanical devices, such as bulldozers, graders, etc., shall be permitted to then be used to complete backfill to grade. Fill shall be compacted. Precautions shall be taken to ensure permanent stability for pipe laid in filled or made ground.

**1201.3.9 Pressure Testing.** The equipment, material, and labor necessary for inspection or test shall be furnished by the person to whom the permit is issued or by whom inspection is requested.

**1201.3.9.1 Media.** The piping shall be tested with water.

**1201.3.9.2 Pressure Test.** Piping shall be tested with a hydrostatic pressure of not less than 100 psig (689 kPa), and 50 psig (345 kPa) more than the operating pressure. This pressure shall be maintained for not less than 30 minutes. Required tests shall be conducted by the owner or contractor in the presence of an authorized inspector. The piping being tested shall remain exposed to the inspector and shall not leak during the test.

**1201.3.9.3 Moved Structures.** Piping systems of a building and parts thereof that are moved from one foundation to another shall be completely tested as prescribed elsewhere in this section for new work, except that walls or floors need not be removed during such test where equivalent means of inspection are provided.

**1201.3.9.4 Test Waived.** No test or inspection shall be required where a system, or part thereof, is set up for exhibition purposes and has no connection with a water system.

**1201.3.9.5 Exceptions.** In cases where it is impractical to provide the aforementioned tests, or for minor installations and repairs, the Authority Having Jurisdiction shall have the authority to make such inspection as it deems necessary.

**1201.4 PEX Tubing.** Hydronic piping systems where the continuous pressure/temperature does not exceed the values in Table 1201.4 shall be permitted to be constructed of cross-linked polyethylene (PEX) tubing.

**TABLE 1201.4  
PEX TUBING PRESSURE/TEMPERATURE**

TEMPERATURE (°F)	PRESSURE (psi)
73	160
180	100
200	80

For SI units: °C = (°F-32)/1.8, 1 pound-force per square inch = 6.8947 kPa

**1201.4.1 Materials and Construction.** PEX tubing and fittings shall be installed in accordance with the manufacturer’s installation instructions.

**1201.4.1.1 Fittings.** Fittings shall be manufactured and tested in accordance with the nationally recognized standards.

**1201.4.1.2 Insulation.** Coverings and insulation used for hot water pipes shall be of material approved for the operating temperature of the system. The insulation, jackets, and lap-seal adhesives, including pipe coverings and linings, shall have a flame-spread index not to exceed 25 and a smoke-developed index not to exceed 50 where tested in accordance with ASTM E 84 or UL 723. The spec-

imen preparation and mounting procedures of ASTM E 2231 shall be used. Materials used for pipe coverings and insulation (including the insulation, jacket, and lap-seal adhesives) shall have a maximum peak heat release rate of 1.02 E+06 Btu/h (299 kW), a maximum total heat release of 4.7 E+04 Btu (50 MJ), a maximum total smoke release of 5382 square feet (500 m<sup>2</sup>), and shall not generate flames that extend 1 foot (305 mm) or more above the top of the vertical portion of the apparatus during the test where tested in accordance with NFPA 274. Insulation coverings and linings shall not flame, glow, smolder, or smoke where tested in accordance with ASTM C 411 at the temperature to which they are exposed in service. In no case shall the test temperature be less than 250°F (121°C).

**1201.4.1.3 Hangers, Sleeves, and Anchors.** Hangers, sleeves, and anchors shall be approved for the use intended as recommended by the manufacturer’s instructions.

**1201.4.1.4 Marking.** Materials and devices shall be identified.

**1201.4.2 Fabrication of Joints.** Joining methods shall comply with the performance requirements of ASTM F 877. Joints shall be made by one or more of the following methods:

- (1) Insert fittings of metal with crimp rings of copper shall be permitted to be used.
- (2) Metallic fittings utilizing compression seals shall be permitted to be used.
- (3) Cold expansion fittings utilizing a PEX reinforcing ring or metal compression sleeve shall be permitted to be used.
- (4) Connections to other piping materials shall be made of approved types of special transition fittings.

**1201.4.3 Changes in Direction.** Changes in direction shall be made by the use of fittings or with pipe bends having a radius of not less than six times the outside diameter of the tubing. No forming equipment or heating is required.

**1201.5 PEX-AL-PEX.** Hydronic piping systems where the continuous pressure/temperature does not exceed the values in Table 1201.5 shall be permitted to be constructed of cross-linked polyethylene/aluminum/cross-linked polyethylene (PEX-AL-PEX) piping.

**TABLE 1201.5  
PEX-AL-PEX PIPING PRESSURE/TEMPERATURE**

TEMPERATURE (°F)	PRESSURE (psi)
73	200
180	125
200	100

For SI units: °C = (°F-32)/1.8, 1 pound-force per square inch = 6.8947 kPa

**1201.5.1 Materials and Construction.** PEX-AL-PEX piping and fittings shall be installed in accordance with the manufacturer's installation instructions.

**1201.5.1.1 Fittings.** Fittings shall be manufactured and tested in accordance with the nationally recognized standards.

**1201.5.1.2 Insulation.** Coverings and insulation used for hot water pipes shall be of materials for the operating temperature of the system. The insulation, jackets, and lap-seal adhesives shall be tested as a composite developed rating of not exceeding 50 where tested in accordance with building code standards.

**1201.5.1.3 Hangers, Sleeves, and Anchors.** Hangers, sleeves, and anchors shall be approved for the use intended as recommended by the manufacturer's instructions.

**1201.5.1.4 Markings.** Materials and devices shall be identified.

**1201.5.2 Fabrication of Joints.** Joining methods shall comply with the performance requirements set forth in ASTM F 1281. Joints shall be made by one or more of the following methods:

- (1) Insert fittings of metal with crimp rings of copper shall be in permitted to be used.
- (2) Metallic fittings utilizing a split ring and compression nut shall be permitted to be used.
- (3) Connections to other piping materials shall be made of approved types of special transition fittings.

**1201.5.3 Changes in Direction.** Changes in direction shall be made by fittings or with pipe bends having a radius of not less than five times the outside diameter of the piping. No forming equipment or heating is required.

**1201.6 Polypropylene Pipe.** Hydronic piping systems where the continuous pressure/temperature does not exceed the values in Table 1201.6 shall be permitted to be constructed of polypropylene (PP) piping.

**TABLE 1201.6  
POLYPROPYLENE PIPING PRESSURE/TEMPERATURE**

TEMPERATURE (°F)	PRESSURE (psi)
73	200
180	100
200	40

For SI units: °C = (°F-32)/1.8, 1 pound-force per square inch = 6.8947 kPa

**1201.6.1 Materials and Construction.** Polypropylene pipe and fittings shall be installed in accordance with the manufacturer's installation instructions.

**1201.6.1.1 Fittings.** Fittings shall be manufactured and tested in accordance with the ASTM F 2389.

**1201.6.1.2 Hangers, Sleeves and Anchors.** Hangers, sleeves, and anchors shall be approved for

the use intended as recommended by the manufacturer's instructions.

**1201.6.1.3 Marking.** Materials and devices shall be identified. Polypropylene (PP) pipe and fittings shall be marked in accordance with ASTM F 2389.

**1201.6.1.4 Heat-Fusion Joints.** Heat-fusion for polypropylene (PP) pipe and fitting joints shall be installed with socket-type heat-fused polypropylene fittings, butt-fusion polypropylene fittings or pipe, or electro-fusion polypropylene fittings. Joint surfaces shall be clean and free from moisture. The joint shall be undisturbed until cool.

**1201.6.1.5 Mechanical and Compression Sleeve Joints.** Mechanical and compression sleeve joints shall be installed in accordance with the manufacturer's installation instructions.

**1201.6.1.6 Transition Fittings.** Connections to other piping materials shall be made with approved types of transition fittings.

**1201.7 PE-RT Tubing.** Hydronic piping systems where the continuous pressure/temperature does not exceed the values in Table 1201.7(1) shall be permitted to be constructed of raised temperature polyethylene (PE-RT) tubing.

**TABLE 1201.7(1)  
PE-RT TUBING PRESSURE/TEMPERATURE (ASTM F 2623)**

TEMPERATURE (°F)	PRESSURE (psi)
73	160
140	100
180	80

For SI units: °C = (°F-32)/1.8, 1 pound-force per square inch = 6.8947 kPa

Those portions of the hot water piping systems in which the continuous pressure/temperature relationship does not exceed Table 1201.7(2) shall be permitted to be constructed of raised temperature polyethylene (PE-RT) tubing in accordance with ASTM F 2769.

**TABLE 1201.7(2)  
PE-RT TUBING PRESSURE/TEMPERATURE (ASTM F 2769)**

TEMPERATURE (°F)	PRESSURE (psi)
73	160
180	100

For SI units: °C = (°F-32)/1.8, 1 pound-force per square inch = 6.8947 kPa

**1201.7.1 Materials and Construction.** PE-RT tubing and fittings shall be installed in accordance with the manufacturer's installation instructions.

**1201.7.1.1 Fittings.** Fittings shall be manufactured and tested in accordance with the Section 1201.7.2.

**1201.7.1.2 Hangers, Sleeves and Anchors.** Hangers, sleeves, and anchors shall be approved for the use intended as recommended by the manufacturer's instructions.

**1201.7.1.3 Marking.** Materials and devices shall be identified.

**1201.7.2 Fabrication of Joints.** Fittings shall be manufactured and tested in accordance with the application for which they are intended. Joints shall be made by one or more of the following methods:

- (1) Insert fittings of metal or plastic with crimp rings of copper shall be permitted to be used.
- (2) Metallic fittings utilizing compression seals shall be permitted to be used.
- (3) Connections to other piping materials shall be made of approved types of special transition fittings.

**1201.7.3 Changes in Direction.** Changes in direction shall be made by the approved use of fittings or with pipe bends having a radius of not less than six times the outside diameter of tubing. No forming equipment or heating is required.

**1201.8 PE-AL-PE.** Hydronic piping systems where the continuous pressure/temperature does not exceed the values in Table 1201.8 shall be permitted to be constructed of Polyethylene/Aluminum/Polyethylene (PE-AL-PE) piping.

**TABLE 1201.8  
PE-AL-PE PRESSURE-TEMPERATURE**

TEMPERATURE (°F)	PRESSURE (psi)
73	200
140	150
180	100

For SI units: °C = (°F-32)/1.8, 1 pound-force per square inch = 6.8947 kPa

**1201.8.1 Materials and Construction.** PE-AL-PE piping and fittings shall be installed in accordance with the manufacturer’s installation instructions.

**1201.8.1.1 Fittings.** Fittings shall be manufactured and tested in accordance with the nationally recognized standards.

**1201.8.1.2 Hangers, Sleeves, and Anchors.** Hangers, sleeves, and anchors shall be approved for the use intended as recommended by the manufacturer’s instructions.

**1201.8.1.3 Marking.** Materials and devices shall be identified.

**1201.8.1.4 Fabrication of Joints.** Joining methods shall comply with ASTM F 1282 or ASTM F 1974. Joints shall be made by one or more of the following methods:

- (1) Insert fittings of metal or plastic with crimp rings of copper shall be permitted to be used.
- (2) Metallic fittings utilizing compression seals shall be permitted to be used.
- (3) Connections to other piping materials shall be made of approved types of special transition fittings.

**1201.8.2 Changes in Direction.** Changes in direction shall be made by the approved use of fittings or with pipe bends having a radius of not less than six times the outside diameter of the piping. No forming equipment or heating is required.

**Part II – Hydronic Panel Heating Systems.**

**1202.0 Scope.**

**1202.1 General.** The purpose of this part is to establish and provide minimum standards for the protection of public health, welfare, and property by regulating and controlling the design and installation of panel heating systems.

**1203.0 Installation.**

**1203.1 Design and Installation.** Panel systems shall be designed and installed in accordance with installation standards incorporated in Chapter 17 and the requirements of this code.

**1203.2 Pressure Testing.** 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.

**1204.0 Piping Materials.**

**1204.1 Panel(s).** Piping for heating panels shall be standard-weight steel pipe, Type L copper tubing, or approved plastic pipe or tubing rated at 100 pounds-force per square inch (psi) (689 kPa) at 180°F (82°C).

**1204.2 Hot-Water Supply Lines.** Piping for hot-water supply lines shall be installed in accordance with the requirements in Chapter 10.

**1205.0 Piping Joints.**

**1205.1 General.** Joints of pipe or tubing forming the panel that are embedded in a portion of the building, for example, concrete or plaster, shall be in accordance with the following:

- (1) Steel pipe welded with electrical arc or oxygen/acetylene method.
- (2) Copper tubing joined with brazing alloys having a melting point above 1000°F (538°C).

**1206.0 Heat Sources.**

**1206.1 General.** Heat sources for generating hot water for use in hydronic panel radiant heating systems shall include conventional fossil fuel, hot water boilers, electrical-resistance heated boilers, air/water or water/water heat pumps, or solar heat collector systems. A latter system shall be permitted to include booster or backup heating units.

Systems shall be protected by pressure-temperature relief valves as outlined in this code.

## HYDRONICS

### 1207.0 Testing.

**1207.1 General.** Approved piping or tubing installed as a portion of a radiant panel system that will be embedded in the walls, floors, or ceilings of the building it is designed to heat shall be tested for leaks by the hydrostatic test method by applying not less than 100 psi (689 kPa) water pressure or one and one-half times the operating pressure, whichever is greater.

For metal piping, a pressure gauge shall be connected to the piping, and after the pressure has been raised, the hydrostatic pressure connection shall be discontinued and the systems under pressure shall remain at the test pressure for a period of time to determine whether leaks exist in the system. A leak shall be indicated by the pressure drop on the gauge. The test period shall be not less than 30 minutes.

For flexible plastic piping, the test pressure shall be applied for a period of 30 minutes. During this time, the system shall be maintained at the test pressure by the periodic addition of makeup water to compensate for the initial stretching of the pipe. The system shall be visually inspected for tightness.

Tests for tightness of radiant piping systems shall be witnessed by the Authority Having Jurisdiction.