

# CHAPTER 21

## HYDRONIC PIPING

**User notes:**

**About this chapter:** Chapter 21 is specific to hydronic piping, which includes steam, hot water and ground-source heat-pump system loop piping. This chapter addresses piping materials, joining methods, support, protection of the structure, testing, protection of potable water and general installation requirements.

**Code development reminder:** Code change proposals to this chapter will be considered by the IRC—Plumbing/Mechanical Code Development Committee during the 2021 (Group A) Code Development Cycle.

### SECTION M2101 HYDRONIC PIPING SYSTEMS INSTALLATION

**M2101.1 General.** Hydronic piping shall conform to Table M2101.1. *Approved* piping, valves, fittings and connections shall be installed in accordance with the manufacturer’s instructions. Pipe and fittings shall be rated for use at the operating temperature and pressure of the hydronic system. Used pipe, fittings, valves or other materials shall be free of foreign materials.

**TABLE M2101.1  
HYDRONIC PIPING AND FITTING MATERIALS**

| MATERIAL  | USE CODE <sup>a</sup> | STANDARD <sup>b</sup>   | JOINTS  | NOTES  |
|---|-----------------------|---|---|--|
| Acrylonitrile butadiene styrene (ABS) plastic pipe                                      | 1, 5                  | ASTM D1527, ASTM F2806, ASTM F2969  | Solvent cement joints   | —  |
| Chlorinated poly (vinyl chloride) (CPVC) pipe and tubing                                | 1, 2, 3               | ASTM D2846  | Solvent cement joints, compression joints and threaded adapters                               | —  |
| Copper and copper-alloy pipe  | 1                     | ASTM B42, ASTM B43, ASTM B302   | Brazed, soldered and mechanical fittings threaded, welded and flanged                         | —  |
| Copper and copper-alloy tubing (Type K, L or M)   | 1, 2                  | ASME B16.51, ASTM B75, ASTM B88, ASTM B135, ASTM B251, ASTM B306                  | Brazed, soldered, press-connected and flared mechanical fittings                              | Joints embedded in concrete shall be brazed            |
| Cross-linked polyethylene (PEX)   | 1, 2, 3               | ASTM F876; ASTM F3253   | (See PEX fittings)  | Install in accordance with manufacturer’s instructions |
| Cross-linked polyethylene/aluminum/cross-linked polyethylene (PEX-AL-PEX) pressure pipe | 1, 2                  | ASTM F1281 or CAN/CSA B137.10   | Mechanical, crimp/insert  | Install in accordance with manufacturer’s instructions |
| PEX fittings  | —                     | ASTM F877, ASTM F1807, ASTM F1960, ASTM F2098, ASTM F2159, ASTM F2735, ASTM F3253 | Copper crimp/insert fittings, cold expansion fittings, stainless steel clamp, insert fittings | Install in accordance with manufacturer’s instructions |
| Polybutylene (PB) pipe and tubing   | 1, 2, 3               | ASTM D3309  | Heat-fusion, crimp/insert and compression   | Joints in concrete shall be heat-fused                 |
| Polyethylene/aluminum/polyethylene (PE-AL-PE) pressure pipe                             | 1, 2, 3               | ASTM F1282, CSA B137.9  | Mechanical, crimp/insert  | —  |
| Polypropylene (PP)  | 1, 2, 3               | ISO 15874, ASTM F2389   | Heat-fusion joints, mechanical fittings, threaded adapters, compression joints                | —  |
| Raised temperature polyethylene (PE-RT)   | 1, 2, 3               | ASTM F2623, ASTM F2769, CSA B137.18   | Copper crimp/insert fitting, stainless steel clamp, insert fittings                           | —  |

**TABLE M2101.1—continued  
HYDRONIC PIPING AND FITTING MATERIALS**

| MATERIAL   | USE CODE <sup>a</sup> | STANDARD <sup>b</sup>   | JOINTS  | NOTES  |
|--|-----------------------|---|---|--|
| Raised temperature polyethylene (PE-RT) fittings | 1, 2, 3               | ASTM D3261, ASTM F1807, ASTM F2098, ASTM F2159, ASTM F2735, ASTM F2769, CSA B137.18 | Copper crimp/insert fitting, stainless steel clamp, insert fittings | —  |
| Steel pipe                                       | 1, 2                  | ASTM A53, ASTM A106   | Brazed, welded, threaded, flanged and mechanical fittings           | Joints in concrete shall be welded. Galvanized pipe shall not be welded or brazed. |
| Steel tubing                                     | 1                     | ASTM A254   | Mechanical fittings, welded   | —  |

For SI: °C = [(°F) – 32]/1.8.

a. Use code:

1. Above ground.
2. Embedded in radiant systems.
3. Temperatures below 180°F only.
4. Low-temperature (below 130°F) applications only.
5. Temperatures below 160°F only.

b. Standards as listed in Chapter 44.

**M2101.2 System drain down.** Hydronic piping systems shall be installed to permit draining of the system. Where the system drains to the plumbing drainage system, the installation shall conform to the requirements of Chapters 25 through 32 of this code.

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

**[W] M2101.3 Protection of potable water.** The potable water system shall be protected from backflow in accordance with the provisions listed in Section ((~~P2902~~) 603 of the *State Plumbing Code*.

**M2101.4 Pipe penetrations.** Openings through concrete or masonry building elements shall be sleeved.

**M2101.5 Contact with building material.** A hydronic piping system shall not be in direct contact with any building material that causes the piping material to degrade or corrode.

**M2101.6 Drilling and notching.** Wood-framed structural members shall be drilled, notched or altered in accordance with the provisions of Sections R502.8, R602.6, R602.6.1 and R802.7. Holes in load-bearing members of cold-formed steel *light-frame construction* shall be permitted only in accordance with Sections R505.2.6, R603.2.6 and R804.2.6. In accordance with the provisions of Sections R505.3.5, R603.3.4 and R804.3.3, cutting and notching of flanges and lips of load-bearing members of cold-formed steel *light-frame construction* shall not be permitted. Structural insulated panels (SIPs) shall be drilled and notched or altered in accordance with the provisions of Section R610.7.

**[W] ((~~M2101.7 Prohibited tee applications.~~))** Fluid in the supply side of a hydronic system shall not enter a tee fitting through the branch opening.)

**M2101.8 Expansion, contraction and settlement.** Piping shall be installed so that piping, connections and *equipment* shall not be subjected to excessive strains or stresses. Provisions shall be made to compensate for expansion, contraction, shrinkage and structural settlement.

**M2101.9 Piping support.** Hangers and supports shall be of material of sufficient strength to support the piping, and shall be fabricated from materials compatible with the piping material. Piping shall be supported at intervals not exceeding the spacing specified in Table M2101.9.

**TABLE M2101.9  
HANGER SPACING INTERVALS**

| PIPING MATERIAL               | MAXIMUM HORIZONTAL SPACING (feet) | MAXIMUM VERTICAL SPACING (feet) |
|-------------------------------|-----------------------------------|---------------------------------|
| ABS                           | 4                                 | 10 <sup>a</sup>                 |
| CPVC ≤ 1-inch pipe or tubing  | 3                                 | 5 <sup>a</sup>                  |
| CPVC ≥ 1-1/4 inches           | 4                                 | 10 <sup>a</sup>                 |
| Copper or copper-alloy pipe   | 12                                | 10                              |
| Copper or copper-alloy tubing | 6                                 | 10                              |
| PB pipe or tubing             | 2.67                              | 4                               |
| PE pipe or tubing             | 2.67                              | 4                               |
| PE-RT ≤ 1 inch                | 2.67                              | 10 <sup>a</sup>                 |
| PE-RT ≥ 1-1/4 inches          | 4                                 | 10 <sup>a</sup>                 |

**TABLE M2101.9—continued  
HANGER SPACING INTERVALS**

| PIPING MATERIAL            | MAXIMUM HORIZONTAL SPACING<br>(feet) | MAXIMUM VERTICAL SPACING<br>(feet) |
|----------------------------|--------------------------------------|------------------------------------|
| PEX tubing ≤ 1 inch        | 2.67                                 | 4                                  |
| PEX tubing ≥ 1-1/4 inches  | 4                                    | 10 <sup>a</sup>                    |
| PP < 1-inch pipe or tubing | 2.67                                 | 4                                  |
| PP > 1-1/4 inches          | 4                                    | 10 <sup>a</sup>                    |
| PVC                        | 4                                    | 10 <sup>a</sup>                    |
| Steel pipe                 | 12                                   | 15                                 |
| Steel tubing               | 8                                    | 10                                 |

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

a. For sizes 2 inches and smaller, a guide shall be installed midway between required vertical supports. Such guides shall prevent pipe movement in a direction perpendicular to the axis of the pipe.

**M2101.10 Tests.** Hydronic piping systems shall be tested hydrostatically at a pressure of one and one-half times the maximum system design pressure, but not less than 100 pounds per square inch (689 kPa). The duration of each test shall be not less than 15 minutes.

**Exception:** For PEX piping systems, testing with a compressed gas shall be an alternative to hydrostatic testing where compressed air or other gas pressure testing is specifically authorized by all of the manufacturers' instructions for the PEX pipe and fittings products installed at the time the system is being tested, and compressed air or other gas testing is not otherwise prohibited by applicable codes, laws, or regulations outside of this code.

**M2101.11 Used materials.** Used pipe, fittings, valves and other materials shall not be reused in hydronic systems.

**M2101.12 Material rating.** Pipe and tubing shall be rated for the operating temperature and pressure of the system. Fittings shall be suitable for the pressure applications and recommended by the manufacturer for use with the pipe and tubing material installed. Where used underground, materials shall be suitable for burial.

**M2101.13 Joints and connections.** Joints and connections shall be of an *approved* type. Joints and connections shall be tight for the pressure of the system. Joints used underground shall be *approved* for such applications.

**M2101.13.1 Joints between different piping materials.** Joints between different piping materials shall be made with *approved* transition fittings.

**M2101.14 Preparation of pipe ends.** Pipe shall be cut square and shall be free of burrs and obstructions. Pipe ends shall have full-bore openings and shall be prepared in accordance with the pipe manufacturer's instructions.

**M2101.15 Joint preparation and installation.** Where required by Sections M2101.16 through M2101.18, the preparation and installation of mechanical and thermoplastic-welded joints shall comply with Sections M2101.15.1 and M2101.15.2.

**M2101.15.1 Mechanical joints.** Mechanical joints shall be installed in accordance with the manufacturer's instructions.

**M2101.15.2 Thermoplastic-welded joints.** Joint surfaces for thermoplastic-welded joints shall be cleaned by an *approved* procedure. Joints shall be welded in accordance with the manufacturer's instructions.

**M2101.16 CPVC plastic pipe.** Joints between CPVC plastic pipe or fittings shall be solvent cemented in accordance with Section P2906.9.1.2. Threaded joints between fittings and CPVC plastic pipe shall be in accordance with Section M2101.16.1.

**M2101.16.1 Threaded joints.** Threads shall conform to ASME B1.20.1 The pipe shall be Schedule 80, 40 or heavier plastic pipe and 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.

**M2101.17 Cross-linked polyethylene (PEX) plastic tubing.** Joints between cross-linked polyethylene plastic tubing and fittings shall comply with Sections M2101.17.1 and M2101.17.2. Mechanical joints shall comply with Section M2101.15.1.

**M2101.17.1 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.

**M2101.17.2 Plastic-to-metal.** Solder joints in a metal pipe shall not occur within 18 inches (457 mm) of a transition from such metal pipe to plastic pipe or tubing.

**M2101.18 Polyethylene plastic pipe and tubing.** Joints between polyethylene plastic pipe and tubing or fittings for systems shall be heat-fusion joints complying with Section M2101.18.1, electrofusion joints complying with Section M2101.18.2, or stab-type insertion joints complying with Section M2101.18.3.

**M2101.18.1 Heat-fusion joints.** Joints shall be of the socket-fusion, saddle-fusion or butt-fusion type, and joined in accordance with ASTM D2657. Joint surfaces shall be clean and free from moisture. Joint surfaces shall be heated to melt

temperatures and joined. The joint shall remain undisturbed until cool. Fittings shall be manufactured in accordance with ASTM D2683 or ASTM D3261.

**M2101.18.2 Electrofusion joints.** Joints shall be of the electrofusion type. Joint surfaces shall be clean and free from 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 remain undisturbed until cool. Fittings shall be manufactured in accordance with ASTM F1055.

**M2101.18.3 Stab-type insert fittings.** Joint surfaces shall be clean and free from moisture. Pipe ends shall be chamfered and inserted into the fittings to full depth. Fittings shall be manufactured in accordance with ASTM F1924.

**M2101.19 Polypropylene (PP) plastic.** Joints between PP plastic pipe and fittings shall comply with Sections M2101.19.1 and M2101.19.2.

**M2101.19.1 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 remain undisturbed until cool. Joints shall be made in accordance with ASTM F2389.

**M2101.19.2 Mechanical and compression sleeve joints.** Mechanical and compression sleeve joints shall be installed in accordance with the manufacturer's instructions.

**M2101.20 Raised temperature polyethylene (PE-RT) plastic tubing.** Joints between raised temperature poly-ethylene tubing and fittings shall comply with Sections M2101.20.1 through M2101.20.4. Mechanical joints shall comply with Section M2101.15.1.

**M2101.20.1 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.

**M2101.20.2 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 or tubing.

**M2101.20.3 Heat-fusion joints.** Heat-fusion joints shall be of the socket-fusion, saddle-fusion or butt-fusion type, and shall be joined in accordance with ASTM D2657. Joint surfaces shall be clean and free from moisture. Joint surfaces shall be heated to melt temperatures and joined. The joint shall remain undisturbed until cool. Fittings shall be manufactured in accordance with ASTM D2683 or ASTM D3261.

**M2101.20.4 Electrofusion joints.** Joints shall be of the electrofusion type. Joint surfaces shall be clean and free from moisture and scoured to expose virgin resin. Joint surfaces shall be heated to melt temperatures for the period of time specified by the manufacturer and joined. The joint shall remain undisturbed until cool. Fittings shall be manufactured in accordance with ASTM F1055.

**M2101.21 PVC plastic pipe.** Joints between PVC plastic pipe or fittings shall be solvent cemented in accordance with Section P2906.9.1.4. Threaded joints between fittings and PVC plastic pipe shall be in accordance with Section M2101.16.1.

**M2101.22 Shutoff valves.** Shutoff valves shall be installed in ground-source loop piping systems in the locations indicated in Sections M2101.22.1 through M2101.22.6.

**M2101.22.1 Heat exchangers.** Shutoff valves shall be installed on the supply and return sides of a heat exchanger.

**Exception:** Shutoff valves shall not be required where 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 required by Section M2001.3.

**M2101.22.2 Central systems.** Shutoff valves shall be installed on the building supply and return of a central utility system.

**M2101.22.3 Pressure vessels.** Shutoff valves shall be installed on the connection to any pressure vessel.

**M2101.22.4 Pressure-reducing valves.** Shutoff valves shall be installed on both sides of a pressure-reducing valve.

**M2101.22.5 Equipment and appliances.** Shutoff valves shall be installed on connections to mechanical equipment and *appliances*. This requirement does not apply to components of ground-source loop systems such as pumps, air separators, metering devices, and similar equipment.

**M2101.22.6 Expansion tanks.** Shutoff valves shall be installed at connections to nondiaphragm-type expansion tanks.

**M2101.23 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 M2002.

**M2101.24 Installation.** Piping, valves, fittings and connections shall be installed in accordance with the manufacturer's instructions.

**M2101.25 Protection of potable water.** Where hydronic systems have a connection to a potable water supply, the potable water system shall be protected from backflow in accordance with Section P2902.

**M2101.26 Pipe penetrations.** Openings for pipe penetrations in walls, floors and 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 Section P2606.1.

**M2101.27 Clearance from combustibles.** A pipe in a piping system having an exterior surface temperature exceeding 250°F (121°C) shall have a clearance of not less than 1 inch (25 mm) from *combustible materials*.

**M2101.28 Contact with building material.** A piping system shall not be in direct contact with building materials that cause the piping or fitting material to degrade or corrode, or that interfere with the operation of the system.

**M2101.29 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.

**M2101.29.1 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.

**M2101.30 Chemical compatibility.** Antifreeze and other materials used in the system shall be chemically compatible with the pipe, tubing, fittings and mechanical systems.

**M2101.31 Makeup water.** The transfer fluid shall be compatible with the makeup water supplied to the system.

## SECTION M2102 BASEBOARD CONVECTORS

**M2102.1 General.** Baseboard convectors shall be installed in accordance with the manufacturer's instructions. Convectors shall be supported independently of the hydronic piping.

## SECTION M2103 FLOOR HEATING SYSTEMS

**M2103.1 Piping materials.** Piping for embedment in concrete or gypsum materials shall be standard-weight steel pipe, copper and copper-alloy pipe and tubing, cross-linked polyethylene/aluminum/cross-linked polyethylene (PEX-AL-PEX) pressure pipe, chlorinated polyvinyl chloride (CPVC), cross-linked polyethylene (PEX) tubing, polyethylene of raised temperature (PE-RT) or polypropylene (PP) with a rating of not less than 80 pounds per square inch at 180°F (552 kPa at 82°C).

**M2103.2 Thermal barrier required.** Radiant floor heating systems shall have a thermal barrier in accordance with Sections M2103.2.1 and M2103.2.2. Insulation *R*-values for slab-on-grade and suspended floor installations shall be in accordance with Chapter 11.

**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.

**M2103.2.1 Thermal break required.** A thermal break consisting of asphalt expansion joint materials or similar insulating materials shall be provided at a point where a heated slab meets a foundation wall or other conductive slab.

**M2103.2.2 Thermal barrier material marking.** Insulating materials used in thermal barriers shall be installed so that the manufacturer's *R*-value mark is readily observable upon inspection.

**[W] M2103.3 Piping joints.** Copper and copper-alloy systems shall be soldered (~~(, brazed, or press connected)~~) in accordance with ASTM B828. (~~(Soldering shall be in accordance with ASTM B828.)~~) Fluxes for soldering shall be in accordance with ASTM B813. Brazing fluxes shall be in accordance with AWS A5.31. (~~(Press-connect joints shall be in accordance with ASME B16.51.)~~) Piping joints that are embedded shall be installed in accordance with the following requirements:

1. Steel pipe joints shall be welded.
2. Copper tubing shall be joined by brazing complying with Section (~~(P3003-6.1)~~) 605 of the *State Plumbing Code*.
3. Polybutylene pipe and tubing joints shall be installed with socket-type heat-fused polybutylene fittings.
4. CPVC tubing shall be joined using solvent cement joints.
5. Polypropylene pipe and tubing joints shall be installed with socket-type heat-fused polypropylene fittings.
6. Cross-linked polyethylene (PEX) tubing shall be joined using cold expansion, insert or compression fittings.
7. Raised temperature polyethylene (PE-RT) tubing shall be joined using insert or compression fittings.

**M2103.4 Testing.** Piping or tubing to be embedded shall be tested by applying a hydrostatic pressure of not less than 100 psi (690 kPa). The pressure shall be maintained for 30 minutes, during which the joints shall be visually inspected for leaks.

**SECTION M2104  
LOW TEMPERATURE PIPING**

**M2104.1 Piping materials.** Low temperature piping for embedment in concrete or gypsum materials shall be as indicated in Table M2101.1.

**M2104.2 Piping joints.** Piping joints that are embedded, other than those in Section M2103.3, shall comply with the following requirements:

1. Cross-linked polyethylene (PEX) tubing shall be installed in accordance with the manufacturer's instructions.
2. Polyethylene tubing shall be installed with heat-fusion joints.
3. Polypropylene (PP) tubing shall be installed in accordance with the manufacturer's instructions.
4. Raised temperature polyethylene (PE-RT) shall be installed in accordance with the manufacturer's instructions.

**M2104.3 Raised temperature polyethylene (PE-RT) plastic tubing.** Joints between raised temperature polyethylene tubing and fittings shall conform to Sections M2104.3.1 through M2104.3.3. Mechanical joints shall be installed in accordance with the manufacturer's instructions.

**M2104.3.1 Compression-type fittings.** Where compression-type fittings include inserts and ferrules or O-rings, the fittings shall be installed without omitting such inserts and ferrules or O-rings.

**M2104.3.2 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.

**M2104.3.3 PE-RT insert fittings.** PE-RT insert fittings shall be installed in accordance with the manufacturer's instructions.

**M2104.4 Polyethylene/aluminum/polyethylene (PE-AL-PE) pressure pipe.** Joints between polyethylene/aluminum/polyethylene pressure pipe and fittings shall conform to Sections M2104.4.1 and M2104.4.2. Mechanical joints shall be installed in accordance with the manufacturer's instructions.

**M2104.4.1 Compression-type fittings.** Where compression-type fittings include inserts and ferrules or O-rings, the fittings shall be installed without omitting such inserts and ferrules or O-rings.

**M2104.4.2 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.

**SECTION M2105  
GROUND-SOURCE HEAT-PUMP SYSTEM LOOP PIPING**

**M2105.1 Plastic ground-source heat-pump loop piping.** Plastic piping and tubing material used in water-based ground-source heat-pump ground-loop systems shall conform to the standards specified in this section.

**M2105.2 Used materials.** Reused pipe, fittings, valves, and other materials shall not be used in ground-source heat-pump loop systems.

**M2105.3 Material rating.** Pipe and tubing shall be rated for the operating temperature and pressure of the ground-source heat-pump loop system. Fittings shall be suitable for the pressure applications and recommended by the manufacturer for installation with the pipe and tubing material installed. Where used underground, materials shall be suitable for burial.

**M2105.4 Piping and tubing materials standards.** Ground-source heat-pump ground-loop pipe and tubing shall conform to the standards listed in Table M2105.4.

**TABLE M2105.4  
GROUND-SOURCE LOOP PIPE**

| MATERIAL  | STANDARD  |
|---|---|
| Chlorinated polyvinyl chloride (CPVC)                       | ASTM D2846; ASTM F437; ASTM F438; ASTM F439; ASTM F441; ASTM F442; CSA B137.6             |
| Cross-linked polyethylene (PEX)                             | ASTM F876; CSA B137.5; ANSI/CSA/IGSHPA C448; NSF 358-3                                    |
| High-density polyethylene (HDPE)                            | ASTM D2737; ASTM D3035; ASTM F714; AWWA C901; CSA B137.1; ANSI/CSA/IGSHPA C448; NSF 358-1 |
| Polyethylene/aluminum/polyethylene (PE-AL-PE) pressure pipe | ASTM F1282; AWWA C903; CSA B137.9   |
| Polypropylene (PP-R)  | ASTM F2389; CSA B137.11; NSF 358-2  |
| Polyvinyl chloride (PVC)                                    | ASTM D1785; ASTM D2241; CSA B137.3  |
| Raised temperature polyethylene (PE-RT)                     | ASTM F2623; ASTM F2769; CSA B137.18; ANSI/CSA/IGSHPA C448; NSF 358-4                      |

**M2105.5 Fittings.** Ground-source heat-pump pipe fittings shall be *approved* for installation with the piping materials to be installed, shall conform to the standards listed in Table M2105.5 and, where installed underground, shall be suitable for burial.

**TABLE M2105.5  
GROUND-SOURCE LOOP PIPE FITTINGS**

| PIPE MATERIAL                                 | STANDARD   |
|---|--|
| Chlorinated polyvinyl chloride (CPVC)         | ASTM D2846; ASTM F437; ASTM F438; ASTM F439; ASTM F1970; CSA B137.6  |
| Cross-linked polyethylene (PEX)               | ASTM F877; ASTM F1807; ASTM F1960; ASTM F2080; ASTM F2159; ASTM F2434; CSA B137.5; ANSI/CSA/IGSHPA C448; NSF 358-3                                       |
| High-density polyethylene (HDPE)              | ASTM D2683; ASTM D3261; ASTM F1055; CSA B137.1; ANSI/CSA/IGSHPA C448; NSF 358-1  |
| Polyethylene/aluminum/polyethylene (PE-AL-PE) | ASTM F1282; ASTM F2434; CSA B137.9   |
| Polypropylene (PP-R)                          | ASTM F2389; CSA B137.11; NSF 358-2   |
| Polyvinyl chloride (PVC)                      | ASTM D2464; ASTM D2466; ASTM D2467; ASTM F1970; CSA B137.2; CSA B137.3   |
| Raised temperature polyethylene (PE-RT)       | ASTM D2683; ASTM D3261; ASTM F1055; ASTM F1807; ASTM F2098; ASTM F2159; ASTM F2735; ASTM F2769; CSA B137.1; CSA B137.18; ANSI/CSA/IGSHPA C448; NSF 358-4 |

**M2105.6 Joints and connections.** Joints and connections shall be of an *approved* type. Joints and connections shall be tight for the pressure of the ground-source loop system. Joints used underground shall be *approved* for such applications.

**M2105.6.1 Joints between different piping materials.** Joints between different piping materials shall be made with *approved* transition fittings.

**M2105.7 Preparation of pipe ends.** Pipe shall be cut square and shall be free of burrs and obstructions. Pipe ends shall have full-bore openings and shall be prepared in accordance with the pipe manufacturer's instructions.

**M2105.8 Joint preparation and installation.** Where required by Sections M2105.9 through M2105.11, the preparation and installation of mechanical and thermoplastic-welded joints shall comply with Sections M2105.8.1 and M2105.8.2.

**M2105.8.1 Mechanical joints.** Mechanical joints shall be installed in accordance with the manufacturer's instructions.

**M2105.8.2 Thermoplastic-welded joints.** Joint surfaces for thermoplastic-welded joints shall be cleaned by an *approved* procedure. Joints shall be welded in accordance with the manufacturer's instructions.

**[W] M2105.9 CPVC plastic pipe.** Joints between CPVC plastic pipe or fittings shall be solvent-cemented in accordance with Section ((P2906.9.1.2)) 605 of the *State Plumbing Code*. Threaded joints between fittings and CPVC plastic pipe shall be in accordance with Section M2105.9.1.

**M2105.9.1 Threaded joints.** Threads shall conform to ASME B1.20.1. The pipe shall be Schedule 80 or heavier plastic pipe and 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.

**M2105.10 Cross-linked polyethylene (PEX) plastic tubing.** Joints between cross-linked polyethylene plastic tubing and fittings shall comply with Sections M2105.10.1 and M2105.10.2. Mechanical joints shall comply with Section M2105.8.1.

**M2105.10.1 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.

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**M2105.10.2 Plastic-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 plastic pipe or tubing.

**M2105.11 Polyethylene plastic pipe and tubing.** Joints between polyethylene plastic pipe and tubing or fittings for ground-source heat-pump loop systems shall be heat-fusion joints complying with Section M2105.11.1, electrofusion joints complying with Section M2105.11.2, or stab-type insertion joints complying with Section M2105.11.3.

**M2105.11.1 Heat-fusion joints.** Joints shall be of the socket-fusion, saddle-fusion or butt-fusion type, and joined in accordance with ASTM D2657. Joint surfaces shall be clean and free from moisture. Joint surfaces shall be heated to melt temperatures and joined. The joint shall remain undisturbed until cool. Fittings shall be manufactured in accordance with ASTM D2683 or ASTM D3261.

**M2105.11.2 Electrofusion joints.** Joints shall be of the electrofusion type. Joint surfaces shall be clean and free from 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 remain undisturbed until cool. Fittings shall be manufactured in accordance with ASTM F1055.

**M2105.11.3 Stab-type insert fittings.** Joint surfaces shall be clean and free from moisture. Pipe ends shall be chamfered and inserted into the fittings to full depth. Fittings shall be manufactured in accordance with ASTM F1924.

**M2105.12 Polypropylene (PP) plastic.** Joints between PP plastic pipe and fittings shall comply with Sections M2105.12.1 and M2105.12.2.

**M2105.12.1 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 remain undisturbed until cool. Joints shall be made in accordance with ASTM F2389.

**M2105.12.2 Mechanical and compression sleeve joints.** Mechanical and compression sleeve joints shall be installed in accordance with the manufacturer's instructions.

**M2105.13 Raised temperature polyethylene (PE-RT) plastic tubing.** Joints between raised temperature polyethylene tubing and fittings shall comply with Sections M2105.13.1 through M2105.13.4. Mechanical joints shall comply with Section M2105.8.1.

**M2105.13.1 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.

**M2105.13.2 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 or tubing.

**M2105.13.3 Heat-fusion joints.** Heat-fusion joints shall be of the socket-fusion, saddle-fusion or butt-fusion type, and shall be joined in accordance with ASTM D2657. Joint surfaces shall be clean and free from moisture. Joint surfaces shall be heated to melt temperatures and joined. The joint shall remain undisturbed until cool. Fittings shall be manufactured in accordance with ASTM D2683 or ASTM D3261.

**M2105.13.4 Electrofusion joints.** Joints shall be of the electrofusion type. Joint surfaces shall be clean and free from moisture and scoured to expose virgin resin. Joint surfaces shall be heated to melt temperatures for the period of time specified by the manufacturer and joined. The joint shall remain undisturbed until cool. Fittings shall be manufactured in accordance with ASTM F1055.

**[W] M2105.14 PVC plastic pipe.** Joints between PVC plastic pipe or fittings shall be solvent-cemented in accordance with Section ((P2906.9.1.4) 605 of the State Plumbing Code). Threaded joints between fittings and PVC plastic pipe shall be in accordance with Section M2105.9.1.

**M2105.15 Shutoff valves.** Shutoff valves shall be installed in ground-source loop piping systems in the locations indicated in Sections M2105.15.1 through M2105.15.6.

**M2105.15.1 Heat exchangers.** Shutoff valves shall be installed on the supply and return side of a heat exchanger.

**Exception:** Shutoff valves shall not be required where 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 required by Section M2001.3.

**M2105.15.2 Central systems.** Shutoff valves shall be installed on the building supply and return of a central utility system.

**M2105.15.3 Pressure vessels.** Shutoff valves shall be installed on the connection to any pressure vessel.

**M2105.15.4 Pressure-reducing valves.** Shutoff valves shall be installed on both sides of a pressure-reducing valve.

**M2105.15.5 Equipment and appliances.** Shutoff valves shall be installed on connections to mechanical equipment and *appliances*. This requirement does not apply to components of ground-source loop systems such as pumps, air separators, metering devices, and similar equipment.

**M2105.15.6 Expansion tanks.** Shutoff valves shall be installed at connections to nondiaphragm-type expansion tanks.

**M2105.16 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 M2002.

**M2105.17 Installation.** Piping, valves, fittings, and connections shall be installed in accordance with the manufacturer's instructions.

[W] **M2105.18 Protection of potable water.** Where ground-source heat-pump ground-loop systems have a connection to a potable water supply, the potable water system shall be protected from backflow in accordance with Section ((P2902)) 603 of the State Plumbing Code.

[W] **M2105.19 Pipe penetrations.** Openings for pipe penetrations in walls, floors and 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 Section ((P2606.1)) 312 of the State Plumbing Code.

**M2105.20 Clearance from combustibles.** A pipe in a ground-source heat pump piping system having an exterior surface temperature exceeding 250°F (121°C) shall have a clearance of not less than 1 inch (25 mm) from *combustible materials*.

**M2105.21 Contact with building material.** A ground-source heat-pump ground-loop piping system shall not be in direct contact with building materials that cause the piping or fitting material to degrade or corrode, or that interfere with the operation of the system.

**M2105.22 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.

**M2105.22.1 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*.

**M2105.23 Pipe support.** Pipe shall be supported in accordance with Section M2101.9.

**M2105.24 Velocities.** Ground-source heat-pump ground-loop systems shall be designed so that the flow velocities do not exceed the maximum flow velocity recommended by the pipe and fittings manufacturer. Flow velocities shall be controlled to reduce the possibility of water hammer.

**M2105.25 Labeling and marking.** Ground-source heat-pump ground-loop system piping shall be marked with tape, metal tags or other methods where it enters a building. The marking shall state the following words: "GROUND-SOURCE HEAT-PUMP LOOP SYSTEM." The marking shall indicate if antifreeze is used in the system and shall indicate the chemicals by name and concentration.

**M2105.26 Chemical compatibility.** Antifreeze and other materials used in the system shall be chemically compatible with the pipe, tubing, fittings and mechanical systems.

**M2105.27 Makeup water.** The transfer fluid shall be compatible with the makeup water supplied to the system.

**M2105.28 Testing.** Before connection header trenches are backfilled, the assembled loop system shall be pressure tested with water at 100 psi (689 kPa) for 15 minutes without 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 cause shall be identified and corrective action taken.

**M2105.29 Embedded piping.** Ground-source heat-pump ground-loop 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.

