**ICC PLUMBING CODE SECTION 605 MATERIALS, JOINTS AND CONNECTIONS

605.1 Soil and ground water.**
The installation of a water service or water distribution pipe shall be prohibited in soil and ground water contaminated with solvents, fuels, organic compounds or other detrimental materials causing permeation, corrosion, degradation or structural failure of the piping material. Where detrimental conditions are suspected, a chemical analysis of the soil and ground water conditions shall be required to ascertain the acceptability of the water service or water distribution piping material for the specific installation. Where detrimental conditions exist, *approved* alternative materials or routing shall be required.  **605.2 Lead content of water supply pipe and fittings.**
Pipe and pipe fittings, including valves and faucets, utilized in the water supply system shall have a maximum of 8-percent lead content.  **605.3 Water service pipe.**
Water service pipe shall conform to NSF 61 and shall conform to one of the standards listed in Table 605.3. Water service pipe or tubing, installed underground and outside of the structure, shall have a working pressure rating of not less than 160 psi (1100 kPa) at 73.4ºF (23ºC). Where the water pressure exceeds 160 psi (1100 kPa), piping material shall have a working pressure rating not less than the highest available pressure. Water service piping materials not third-party certified for water distribution shall terminate at or before the full open valve located at the entrance to the structure. All ductile iron water service piping shall be cement mortar lined in accordance with AWWA C104.  **TABLE 605.3 WATER SERVICE PIPE**

|  |  |
| --- | --- |
| **MATERIAL**  | **STANDARD**  |
| Acrylonitrile butadiene styrene (ABS) plastic pipe | ASTM D 1527; ASTM D 2282 |
| Asbestos-cement pipe | ASTM C 296 |
| Brass pipe | ASTM B 43 |
| Chlorinated polyvinyl chloride (CPVC) plastic pipe | ASTM D 2846; ASTM F 441; ASTM F 442; CSA B137.6 |
| Copper or copper-alloy pipe | ASTM B 42; ASTM B 302 |
| Copper or copper-alloy tubing (Type K, WK, L, WL, M or WM) | ASTM B 75; ASTM B 88; ASTM B 251; ASTM B 447 |
| Cross-linked polyethylene (PEX) plastic pipe and tubing | ASTM F 876; ASTM F 877; AWWA C904; CSA B137.5 |
| Cross-linked polyethylene/aluminum/cross-linked polyethylene(PEX-AL-PEX) pipe | ASTM F 1281; ASTM F 2262; CSA B137.10M |
| Cross-linked polyethylene/aluminum/high-density polyethylene(PEX-AL-HDPE) | ASTM F 1986 |
| Ductile iron water pipe | AWWA C151/A21.51; AWWA C115/A21.15 |
| Galvanized steel pipe | ASTM A 53 |
| Polyethylene (PE) plastic pipe | ASTM D 2239; ASTM D 3035; AWWA C901; CSA B137.1 |
| Polyethylene (PE) plastic tubing | ASTM D 2737; AWWA C901; CSA B137.1 |
| Polyethylene/aluminum/polethylene (PE-AL-PE) pipe | ASTM F 1282; CSA B137.9 |
| Polyethylene of raised temperature (PE-RT) plastic tubing | ASTM F 2769 |
| Polypropylene (PP) plastic pipe or tubing | ASTM F 2389; CSA B137.11 |
| Polyvinyl chloride (PVC) plastic pipe | ASTM D 1785; ASTM D 2241; ASTM D 2672; CSA B137.3 |
| Stainless steel pipe (Type 304/304L) | ASTM A 312; ASTM A 778 |
| Stainless steel pipe (Type 316/316L) | ASTM A 312; ASTM A 778 |

**605.3.1 Dual check-valve-type backflow preventer.**
Dual check-valve backflow preventers installed on the water supply system shall comply with ASSE 1024 or CSA B64.6.

**605.4 Water distribution pipe.**
Water distribution pipe shall conform to NSF 61 and shall conform to one of the standards listed in Table 605.4. Hot water distribution pipe and tubing shall have a pressure rating of not less than 100 psi (690 kPa) at 180ºF (82ºC).  **TABLE 605.4 WATER DISTRIBUTION PIPE**

|  |  |
| --- | --- |
| **MATERIAL**  | **STANDARD**  |
| Brass pipe | ASTM B 43 |
| Chlorinated polyvinyl chloride (CPVC) plastic pipe and tubing | ASTM D 2846; ASTM F 441; ASTM F 442; CSA B137.6 |
| Copper or copper-alloy pipe | ASTM B 42; ASTM B 302 |
| Copper or copper-alloy tubing (Type K, WK, L, WL, M or WM) | ASTM B 75; ASTM B 88; ASTM B 251; ASTM B 447 |
| Cross-linked polyethylene (PEX) plastic tubing | ASTM F 876; ASTM F 877; CSA B137.5 |
| Cross-linked polyethylene/aluminum/cross-linked polyethylene(PEX-AL-PEX) pipe | ASTM F 1281; ASTM F 2262; CSA B137.10M |
| Cross-linked polyethylene/aluminum/high-density polyethylene(PEX-AL-HDPE) | ASTM F 1986 |
| Ductile iron pipe | AWWA C151/A21.51; AWWA C115/A21.15 |
| Galvanized steel pipe | ASTM A 53 |
| Polyethylene/aluminum/polyethylene (PE-AL-PE) composite pipe | ASTM F 1282 |
| Polyethylene of raised temperature (PE-RT) plastic tubing | ASTM F 2769 |
| Polypropylene (PP) plastic pipe or tubing | ASTM F 2389; CSA B137.11 |
| Stainless steel pipe (Type 304/304L) | ASTM A 312; ASTM A 778 |
| Stainless steel pipe (Type 316/316L) | ASTM A 312; ASTM A 778 |

 **605.5 Fittings.**
Pipe fittings shall be *approved* for installation with the piping material installed and shall comply with the applicable standards listed in Table 605.5. Pipe fittings utilized in water supply systems shall also comply with NSF 61. Ductile and gray iron pipe fittings shall be cement mortar lined in accordance with AWWA C104.  **TABLE 605.5 PIPE FITTINGS**

|  |  |
| --- | --- |
| **MATERIAL**  | **STANDARD**  |
| Acrylonitrile butadiene styrene (ABS) plastic | ASTM D 2468 |
| Cast-iron | ASME B16.4; ASME B16.12 |
| Chlorinated polyvinyl chloride (CPVC) plastic | ASSE 1061; ASTM D 2846; ASTM F 437; ASTM F 438;ASTM F 439; CSA B137.6 |
| Copper or copper alloy | ASSE 1061; ASME B16.15; ASME B16.18; ASME B16.22; ASME B16.23; ASME B16.26; ASME B16.29 |
| Cross-linked polyethylene/aluminum/high-density polyethylene(PEX-AL-HDPE) | ASTM F 1986 |
| Fittings for cross-linked polyethylene (PEX) plastic tubing | ASSE 1061, ASTM F 877; ASTM F 1807; ASTM F 1960; ASTM F 2080; ASTM F 2098, ASTM F 2159; ASTM F 2434; ASTM F 2735; CSA B137.5 |
| Fittings for polyethylene of raised temperature (PE-RT) plastic tubing | ASTM F 1807; ASTM F 2098; ASTM F 2159; ASTM F 2735 |
| Gray iron and ductile iron | AWWA C110/A21.10; AWWA C153/A21.53 |
| Insert fittings for polyethylene/aluminum/polyethylene (PE-AL-PE) and cross-linked polyethylene/aluminum/cross-linked polyethylene(PEX-AL-PEX) | ASTM F 1974; ASTM F 1281; ASTM F 1282; CSA B137.9;CSA B137.10M |
| Malleable iron | ASME B16.3 |
| Metal (brass) insert fittings forpolyethylene/aluminum/polyethylene (PE-AL-PE) and cross-linkedpolyethylene/aluminum/cross-linked polyethylene (PEX-AL-PEX) | ASTM F 1974 |
| Polyethylene (PE) plastic pipe | ASTM D 2609; ASTM D 2683; ASTM D 3261;ASTM F 1055; CSA B137.1 |
| Polypropylene (PP) plastic pipe or tubing | ASTM F 2389; CSA B137.11 |
| Polyvinyl chloride (PVC) plastic | ASTM D 2464; ASTM D 2466; ASTM D 2467; CSA B137.2;CSA B137.3 |
| Stainless steel (Type 304/304L) | ASTM A 312; ASTM A 778 |
| Stainless steel (Type 316/316L) | ASTM A 312; ASTM A 778 |
| Steel | ASME B16.9; ASME B16.11; ASME B16.28 |

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

**605.5.1.1 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 collar is of the correct depth. For inspection purposes, a second dimple shall be placed 1/4 inch (6.4 mm) above the first dimple. Dimples shall be aligned with the tube run.

**605.5.1.2 Brazed joints.**
Mechanically formed tee fittings shall be brazed in accordance with Section 605.14.1.

**605.6 Flexible water connectors.**
Flexible water connectors exposed to continuous pressure shall conform to ASME A112.18.6/CSA B125.6. *Access* shall be provided to all flexible water connectors.  **605.7 Valves.**
All valves shall be of an *approved* type and compatible with the type of piping material installed in the system. Ball valves, gate valves, globe valves and plug valves intended to supply drinking water shall meet the requirements of NSF 61.  **605.8 Manufactured pipe nipples.**
Manufactured pipe nipples shall conform to one of the standards listed in Table 605.8.  **TABLE 605.8 MANUFACTURED PIPE NIPPLES**

|  |  |
| --- | --- |
| **MATERIAL**  | **STANDARD**  |
| Brass-, copper-, chromium-plated | ASTM B 687 |
| Steel | ASTM A 733 |

 **605.9 Prohibited joints and connections.**
The following types of joints and connections shall be prohibited:

1. Cement or concrete joints.

2. Joints made with fittings not approved for the specific installation.

3. Solvent-cement joints between different types of plastic pipe.

4. Saddle-type fittings.

**605.10 ABS plastic.**
Joints between ABS plastic pipe or fittings shall comply with Sections 605.10.1 through 605.10.3.

**605.10.1 Mechanical joints.**
Mechanical joints on water pipes shall be made with an elastomeric seal conforming to ASTM D 3139. Mechanical joints shall only be installed in underground systems, unless otherwise *approved.* Joints shall be installed only in accordance with the manufacturer’s instructions.

**605.10.2 Solvent cementing.**
Joint surfaces shall be clean and free from moisture. Solvent cement that conforms to ASTM D 2235 shall be applied to all joint surfaces. The joint shall be made while the cement is wet. Joints shall be made in accordance with ASTM D 2235. Solvent-cement joints shall be permitted above or below ground.

**605.10.3 Threaded joints.**
Threads shall conform to ASME B1.20.1. Schedule 80 or heavier pipe shall be permitted to be threaded with dies specifically designed for plastic pipe. *Approved* thread lubricant or tape shall be applied on the male threads only.

**605.11 Asbestos-cement.**
Joints between asbestos-cement pipe or fittings shall be made with a sleeve coupling of the same composition as the pipe, sealed with an elastomeric ring conforming to ASTM D 1869.  **605.12 Brass.**
Joints between brass pipe and fittings shall comply with Sections 605.12.1 through 605.12.4.

**605.12.1 Brazed joints.**
All 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.

**605.12.2 Mechanical joints.**
Mechanical joints shall be installed in accordance with the manufacturer’s instructions.

**605.12.3 Threaded joints.**
Threads shall conform to ASME B1.20.1. Pipe-joint compound or tape shall be applied on the male threads only.

**605.12.4 Welded joints.**
All joint surfaces shall be cleaned. The joint shall be welded with an *approved* filler metal.

**605.13 Gray iron and ductile iron joints.**
Joints for gray and ductile iron pipe and fittings shall comply with AWWA C111 and shall be installed in accordance with the manufacturer’s instructions.  **605.14 Copper pipe.**
Joints between copper or copper-alloy pipe or fittings shall comply with Sections 605.14.1 through 605.14.5.

**605.14.1 Brazed joints.**
All 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.

**605.14.2 Mechanical joints.**
Mechanical joints shall be installed in accordance with the manufacturer’s instructions.

**605.14.3 Soldered joints.**
Solder joints shall be made in accordance with the methods of ASTM B 828. Cut tube ends shall be reamed to the full inside diameter of the tube end. 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. The joining of water supply piping shall be made with lead-free solder and fluxes. "Lead free&rdquo; shall mean a chemical composition equal to or less than 0.2-percent lead.

**605.14.4 Threaded joints.**
Threads shall conform to ASME B1.20.1. Pipe-joint compound or tape shall be applied on the male threads only.

**605.14.5 Welded joints.** Joint surfaces shall be cleaned.
The joint shall be welded with an *approved* filler metal.

**605.15 Copper tubing.**
Joints between copper or copper-alloy tubing or fittings shall comply with Sections 605.15.1 through 605.15.4.

**605.15.1 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.

**605.15.2 Flared joints.**
Flared joints for water pipe shall be made by a tool designed for that operation.

**605.15.3 Mechanical joints.**
Mechanical joints shall be installed in accordance with the manufacturer’s instructions.

**605.15.4 Soldered joints.**
Solder joints shall be made in accordance with the methods of ASTM B 828. All cut tube ends shall be reamed to the full inside diameter of the tube end. All 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. The joining of water supply piping shall be made with lead-free solders and fluxes. "Lead free&rdquo; shall mean a chemical composition equal to or less than 0.2-percent lead.

**605.16 CPVC plastic.**
Joints between CPVC plastic pipe or fittings shall comply with Sections 605.16.1 through 605.16.3.

**605.16.1 Mechanical joints.**
Mechanical joints shall be installed in accordance with the manufacturer’s instructions.

**605.16.2 Solvent cementing.**
Joint surfaces shall be clean and free from moisture, and an *approved* primer shall be applied. Solvent cement, orange in color and conforming to ASTM F 493, shall be applied to joint surfaces. The joint shall be made while the cement is wet, and in accordance with ASTM D 2846 or ASTM F 493. Solvent-cement joints shall be permitted above or below ground.  **Exception:** A primer is not required where all of the following conditions apply:

1. The solvent cement used is third-party certified as conforming to ASTM F 493.

2. The solvent cement used is yellow in color.

3. The solvent cement is used only for joining 1/2 inch (12.7 mm) through 2 inch (51 mm) diameter CPVC pipe and fittings.

4. The CPVC pipe and fittings are manufactured in accordance with ASTM D 2846.

**605.16.3 Threaded joints.**
Threads shall conform to ASME B1.20.1. Schedule 80 or heavier pipe shall be permitted to be threaded with dies specifically designed for plastic pipe, but the pressure rating of the pipe shall be reduced by 50 percent. Thread by socket molded fittings shall be permitted. *Approved* thread lubricant or tape shall be applied on the male threads only.

**605.17 Cross-linked polyethylene plastic.**
Joints between cross-linked polyethylene plastic tubing or fittings shall comply with Sections 605.17.1 and 605.17.2.

**605.17.1 Flared joints.**
Flared pipe ends shall be made by a tool designed for that operation.

**605.17.2 Mechanical joints.**
Mechanical joints shall be installed in accordance with the manufacturer’s instructions. Fittings for cross-linked polyethylene (PEX) plastic tubing shall comply with the applicable standards listed in Table 605.5 and shall be installed in accordance with the manufacturer’s instructions. PEX tubing shall be factory marked with the appropriate standards for the fittings that the PEX manufacturer specifies for use with the tubing.

**605.18 Steel.**
Joints between galvanized steel pipe or fittings shall comply with Sections 605.18.1 and 605.18.2.

**605.18.1 Threaded joints.**
Threads shall conform to ASME B1.20.1. Pipe-joint compound or tape shall be applied on the male threads only.

**605.18.2 Mechanical joints.**
Joints shall be made with an *approved* elastomeric seal. Mechanical joints shall be installed in accordance with the manufacturer’s instructions.

**605.19 Polyethylene plastic.**
Joints between polyethylene plastic pipe and tubing or fittings shall comply with Sections 605.19.1 through 605.19.4.

**605.19.1 Flared joints.**
Flared joints shall be permitted where so indicated by the pipe manufacturer. Flared joints shall be made by a tool designed for that operation.

**605.19.2 Heat-fusion joints.**
Joint surfaces shall be clean and free from moisture. All joint surfaces shall be heated to melt temperature and joined. The joint shall be undisturbed until cool. Joints shall be made in accordance with ASTM D 2657.

**605.19.3 Mechanical joints.**
Mechanical joints shall be installed in accordance with the manufacturer’s instructions.

**605.19.4 Installation.**
Polyethylene pipe shall be cut square, with a cutter designed for plastic pipe. Except where joined by heat fusion, pipe ends shall be chamfered to remove sharp edges. Kinked pipe shall not be installed. The minimum pipe bending radius shall not be less than 30 pipe diameters, or the minimum coil radius, whichever is greater. Piping shall not be bent beyond straightening of the curvature of the coil. Bends shall not be permitted within 10 pipe diameters of any fitting or valve. Stiffener inserts installed with compression-type couplings and fittings shall not extend beyond the clamp or nut of the coupling or fitting.

**605.20 Polypropylene (PP) plastic.**
Joints between PP plastic pipe and fittings shall comply with Section 605.20.1 or 605.20.2.

**605.20.1 Heat-fusion joints.**
Heat-fusion joints for polypropylene pipe and tubing joints shall be installed with socket-type heat-fused polypropylene fittings, butt-fusion polypropylene fittings or electrofusion polypropylene fittings. 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.

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

**605.21 Polyethylene/aluminum/polyethylene (PE-AL-PE) and cross-linked polyethylene/aluminum/cross-linked polyethylene (PEX-AL-PEX).**
Joints between PE-AL-PE and PEX-AL-PEX pipe and fittings shall comply with Section 605.21.1.

**605.21.1 Mechanical joints.**
Mechanical joints shall be installed in accordance with the manufacturer’s instructions. Fittings for PE-AL-PE and PEX-AL-PEX as described in ASTM F 1974, ASTM F 1281, ASTM F 1282, CSA B137.9 and CSA B137.10M shall be installed in accordance with the manufacturer’s instructions.

**605.22 PVC plastic.**
Joints between PVC plastic pipe or fittings shall comply with Sections 605.22.1 through 605.22.3.

**605.22.1 Mechanical joints.**
Mechanical joints on water pipe shall be made with an elastomeric seal conforming to ASTM D 3139. Mechanical joints shall not be installed in above-ground systems unless otherwise *approved.* Joints shall be installed in accordance with the manufacturer’s instructions.

**605.22.2 Solvent cementing.**
Joint surfaces shall be clean and free from moisture. A purple primer that conforms to ASTM F 656 shall be applied. Solvent cement not purple in color and conforming to ASTM D 2564 or CSA B137.3 shall be applied to all joint surfaces. The joint shall be made while the cement is wet and shall be in accordance with ASTM D 2855. Solvent-cement joints shall be permitted above or below ground.

**605.22.3 Threaded joints.**
Threads shall conform to ASME B1.20.1. Schedule 80 or heavier pipe shall be permitted to be threaded with dies specifically designed for plastic pipe, but the pressure rating of the pipe shall be reduced by 50 percent. Thread by socket molded fittings shall be permitted. *Approved* thread lubricant or tape shall be applied on the male threads only.

**605.23 Stainless steel.**
Joints between stainless steel pipe and fittings shall comply with Sections 605.23.1 and 605.23.2.

**605.23.1 Mechanical joints.**
Mechanical joints shall be installed in accordance with the manufacturer’s instructions.

**605.23.2 Welded joints.**
All joint surfaces shall be cleaned. The joint shall be welded autogenously or with an *approved* filler metal as referenced in ASTM A 312.

**605.24 Joints between different materials.**
Joints between different piping materials shall be made with a mechanical joint of the compression or mechanical-sealing type, or as permitted in Sections 605.24.1, 605.24.2 and 605.24.3. Connectors or adapters shall have an elastomeric seal conforming to ASTM D 1869 or ASTM F 477. Joints shall be installed in accordance with the manufacturer’s instructions.

**605.24.1 Copper or copper-alloy tubing to galvanized steel pipe.**
Joints between copper or copper-alloy tubing and galvanized steel pipe shall be made with a brass fitting or dielectric fitting or a dielectric union conforming to ASSE 1079. The copper tubing shall be soldered to the fitting in an *approved* manner, and the fitting shall be screwed to the threaded pipe.

**605.24.2 Plastic pipe or tubing to other piping material.**
Joints between different grades of plastic pipe or between plastic pipe and other piping material shall be made with an *approved* adapter fitting.

**605.24.3 Stainless steel.**
Joints between stainless steel and different piping materials shall be made with a mechanical joint of the compression or mechanical sealing type or a dielectric fitting or a dielectric union conforming to ASSE 1079.

**605.25 Polyethylene of raised temperature plastic.**
Joints between polyethylene of raised temperature plastic tubing and fittings shall be in accordance with Sections 605.25.1 and 605.25.2.

**605.25.1 Flared joints.**
Flared pipe ends shall be made by a tool designed for that operation.

**605.25.2 Mechanical joints.**
Mechanical joints shall be installed in accordance with the manufacturer’s instructions. Fittings for polyethylene of raised temperature plastic tubing shall comply with the applicable standards listed in Table 605.5 and shall be installed in accordance with the manufacturer’s instructions. Polyethylene of raised temperature plastic tubing shall be factory marked with the applicable standards for the fittings that the manufacturer of the tubing specifies for use with the tubing.