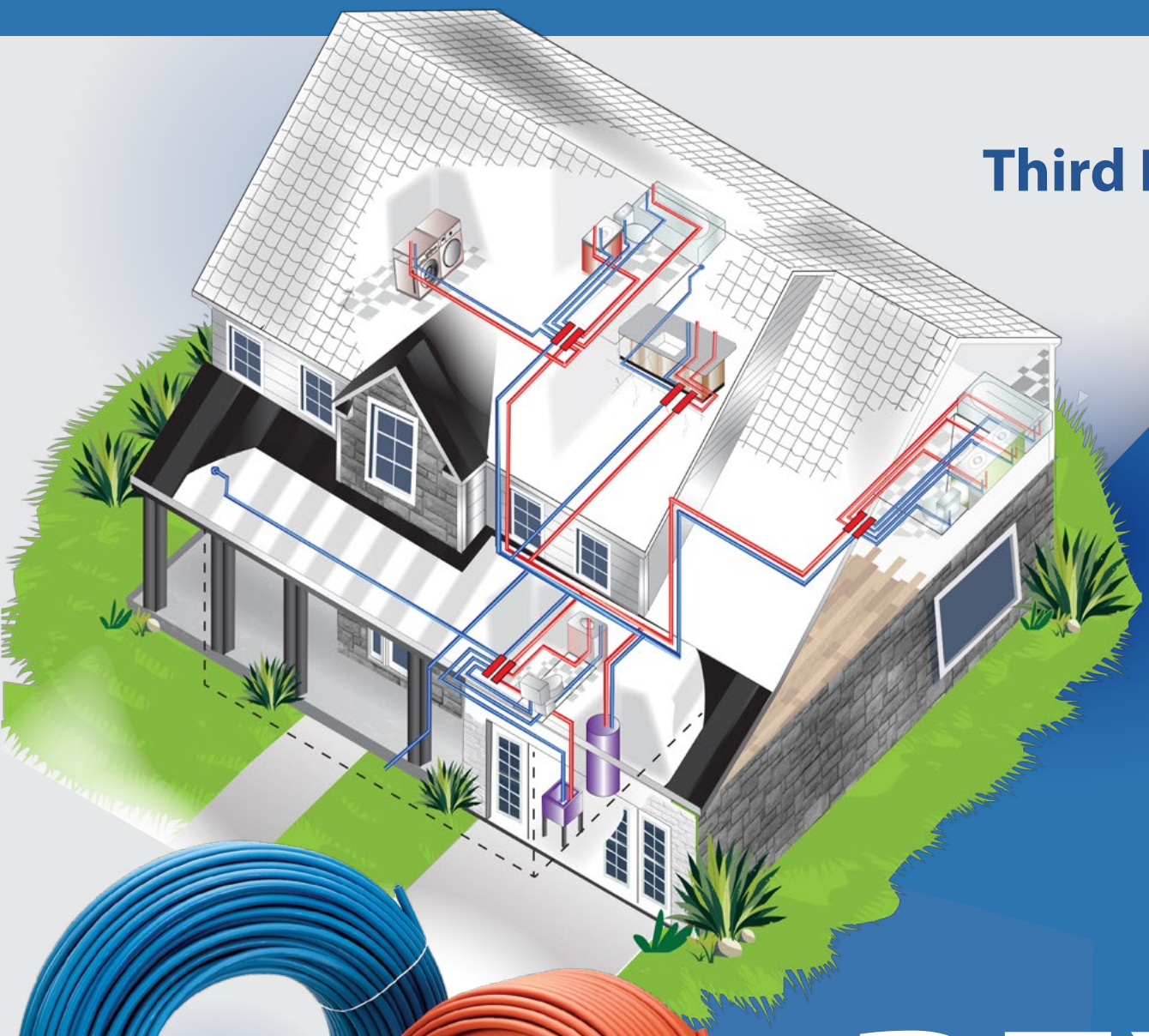
Third Edition



PEX

Plumbing Distribution Systems Design and Installation Guide

Advantages | Material Properties | Codes & Standards

Joining Methods | PEX Plumbing Layouts | Optimizing Design

Installation Guidelines | Water Service Line | Other Applications

IAPMO

PPI Plastics Pipe Institute The Voice of an Industry.

Home Innovation RESEARCH LABS™

PPFA Plastic Pipe and Fittings Association

ES ICC EVALUATION SERVICE®

PEX

Plumbing Distribution Systems Design and Installation Guide

Third Edition

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5 Joining Methods

There are several types of joining methods or fittings used with PEX tubing in plumbing systems. Each of these fitting styles utilizes mechanical compression forces to make the seal on the inside or the outside of the PEX tubing wall. PEX tubing cannot be joined by solvent cementing or typical heat fusion methods.

Several PEX tubing manufacturers have developed a unique fitting system, but each of these technologies must deliver the same minimum performance as specified in PEX system standards ASTM F877 and CSA B137.5. Many of these fitting systems are also described in their own ASTM standard specifications, covering everything from materials to dimensions to assembly to performance testing. Each of these standards requires fittings and joints to be 100% leak-free under a wide range of pressures and temperatures.

Note: Not all fittings are compatible with all PEX tubing. Consult your tubing manufacturer for acceptable joining methods or review the markings on the tubing which indicate which fitting system type or types have been approved for use with that tubing.

The method of connection should comply with the tubing manufacturer's recommendations and instructions. Fittings are regulated to comply with performance and material criteria from recognized standards. They should be marked by a certified third-party agency such as NSF, IAPMO, CSA, ICC, UL, or other third-party testing and listing agency. The most common types of PEX fitting systems used are shown in the following pages.

In all cases, it is important that the appropriate tool is used and that the manufacturer's installation instructions are followed.

See **Chapter 3 *Material Properties*** for detailed information about the types of brass, bronze, stainless steel, and polymer materials which are permitted to be utilized for PEX fittings.

ASTM F1807: Standard Specification for Metal Insert Fittings Utilizing a Copper Crimp Ring, or Alternate Stainless Steel Clamps, for SDR9 Crosslinked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing

These types of fittings are inserted into the PEX tubing and use a copper crimp ring or a stainless-steel clamp that is compressed around the PEX tubing to produce a tight seal. ASTM F1807 fittings may be produced from copper, stainless steel, lead-free brass, or bronze (see **Figures 5.1**, **5.2**, and **5.3**).

Prior to making the connection, the crimp ring or clamp is slid over the end of the PEX tube. The fitting has a barbed or ribbed annular end which is inserted into the tubing. The crimp ring is positioned over the fitting ribs and a manual or electric tool is used to compress the crimp ring around the assembly to produce a tight seal. Alternatively, the clamp is positioned over the fitting ribs and a tool is used to tighten the clamp to produce a tight seal.

Figure 5.1 ASTM F1807 Metal Insert Fittings with a Copper Crimp Ring

Figure 5.2 ASTM F1807 Metal Insert Fittings in Various Diameters with Copper Crimp Rings

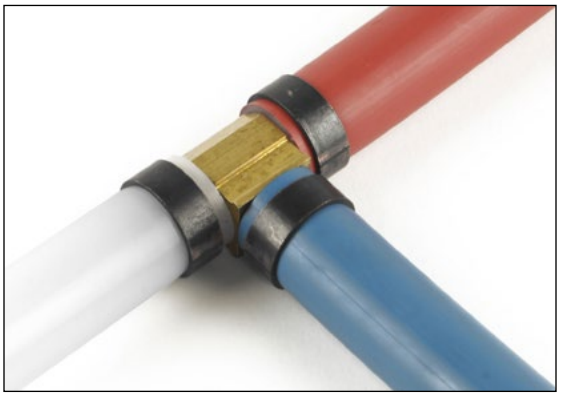

Figure 5.3 ASTM F1807 Metal Insert Fitting Assembled with Copper Crimp Rings

ASTM F1960: Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Crosslinked Polyethylene (PEX) and Polyethylene of Raised Temperature (PE-RT) Tubing

This type of fitting requires that the PEX tubing with a reinforcing PEX ring placed over the end of the tube is expanded before the fitting is inserted into the tube end. The tube is not heated before this expansion, so it is referred to as a "cold expansion" system (see **Figures 5.4**, **5.5**, and **5.6**).

The expanded tube end will naturally retract onto the fitting to form the seal—the "memory" of the tube with the PEX ring allows it to tighten over the fitting to produce a tight seal. A manual or electric expander tool is required to expand the PEX tubing and the PEX ring together. These fittings are produced from lead-free brass, Stainless Steel, and polymer materials.

Figure 5.4 ASTM F1960 Cold Expansion Fittings, Metal and Polymer, with PEX Reinforcing Rings

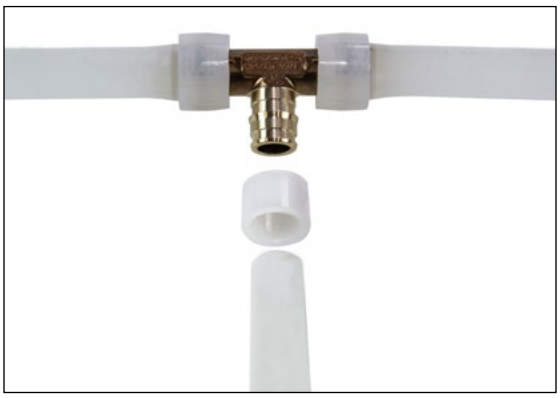

Figure 5.5 ASTM F1960 Cold Expansion Brass Fitting with PEX Reinforcing Ring

Figure 5.6 ASTM F1960 Cold Expansion Polymer Fitting with PEX Reinforcing Ring

ASTM F2080: Standard Specification for Cold Expansion Fittings with Metal Compression Sleeves for Crosslinked Polyethylene (PEX) Pipe and SDR9 Polyethylene of Raised Temperature (PE-RT) Pipe

This type of fitting requires that the PEX tubing is cold expanded before the fitting is inserted into the end of the tubing. The tubing is not heated before this expansion, so it is referred to as a "cold-expansion" system (see **Figures 5.7** and **5.8**).

The tube shrinks down over the fitting insert, then a metal compression sleeve is pulled over the connection axially, compressing the tube over the fitting to produce a tight seal. A manual or electric tool is required to expand the tube and to pull the compression-sleeve over the tube. These fittings are produced from lead-free brass materials.

Figure 5.7 ASTM F2080 Cold Expansion Fitting

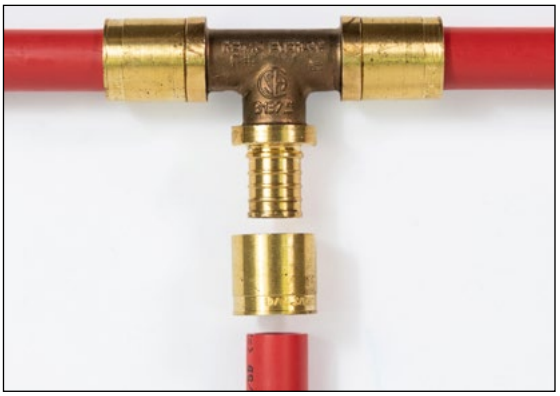

Figure 5.8 ASTM F2080 Cold Expansion Fitting with Metal Compression Sleeve

ASTM F2159: Standard Specification for Plastic Insert Fittings Utilizing a Copper Crimp Ring, or Alternate Stainless Steel Clamps, for SDR9 Crosslinked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing

These types of fittings are inserted into the PEX tubing and use a copper crimp ring or a stainless-steel clamp that is compressed around the PEX tubing to produce a tight seal. ASTM F2159 fittings are produced from polymer (see **Figures 5.9** and **5.10**).

Prior to making the connection, the crimp ring or clamp is slid over the end of the PEX tube. The fitting has a barbed or ribbed annular end which is inserted into the tubing. The crimp ring is positioned over the fitting ribs and a manual or electric tool is used to compress the crimp ring around the assembly to produce a tight seal. Alternatively, the clamp is positioned over the fitting ribs and a tool is used to tighten the clamp to produce a tight seal.

Figure 5.9 ASTM F2159 Plastic Insert Fittings

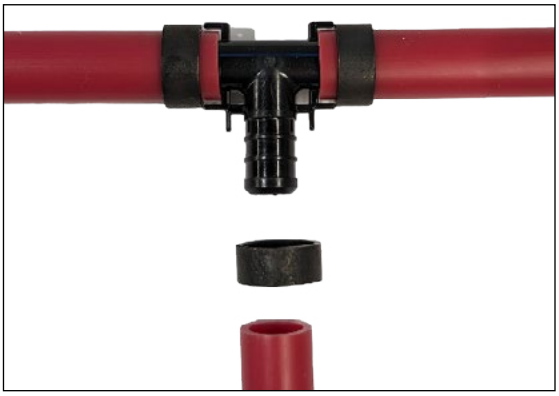

Figure 5.10 ASTM F2159 Plastic Insert Fittings with Copper Crimp Ring

ASTM F2098: Standard Specification for Stainless Steel Clamps for Securing SDR9 Crosslinked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) to Metal Insert and Plastic Insert Fittings

The stainless steel clamp is used with ASTM F1807 or ASTM F2159 insert fittings and in place of a copper crimp ring. The clamp is tightened onto PEX tubing using a ratcheting tool which only releases once a tight seal is achieved (see **Figure 5.11**).

Figure 5.11 ASTM F2098 Stainless Steel Clamps with ASTM F1807 Brass Insert Fittings

ASTM F3347: Standard Specification for Metal Press Insert Fittings with Factory Assembled Stainless Steel Press Sleeve for use with SDR9 Crosslinked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing

These types of fittings are inserted into the PEX tubing and use a stainless steel press sleeve that is compressed around the PEX tubing to produce a tight seal. ASTM F3347 fittings are produced from lead-free bronze (see **Figures 5.12** and **5.13**).

The fitting has a barbed or ribbed annular end which is inserted into the tubing. The sleeve is attached to the fitting and slides over the tubing as the fitting is inserted. A manual or electric press tool is used to compress the sleeve onto the tubing.

Figure 5.12 ASTM F3347 Metal Insert Tee with Stainless Steel Press Sleeve

Figure 5.13 ASTM F3347 Metal Insert Elbow with Stainless Steel Press Sleeve

ASTM F3348: Standard Specification for Plastic Press Insert Fittings with Factory Assembled Stainless Steel Press Sleeve for use with SDR9 Crosslinked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing

These types of fittings are inserted into the PEX tubing and use a stainless steel press sleeve that is compressed around the PEX tubing to produce a tight seal. ASTM F3348 fittings are produced from polymer (see **Figures 5.14**, **5.15**, and **5.16**).

The fitting has a barbed or ribbed annular end which is inserted into the tubing. The sleeve is attached to the fitting and slides over the tubing as the fitting is inserted. A manual or electric press tool is used to compress the sleeve onto the tubing.

Figure 5.14 ASTM F3348 Plastic Insert Fittings with Stainless Steel Press Sleeve

Figure 5.15 ASTM F3348 Plastic Insert Tee with Stainless Steel Press Sleeve

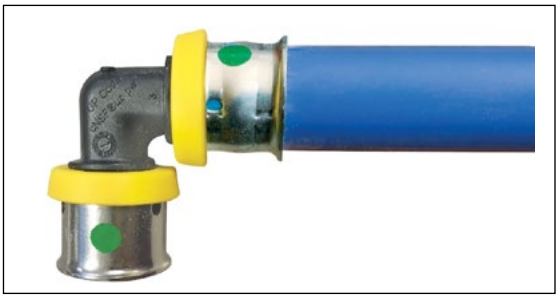

Figure 5.16 ASTM F3348 Plastic Insert Elbow with Stainless Steel Press Sleeve

ASSE 1061: Performance Requirements for Push-fit Fittings

These types of fittings use an interlocking mechanism to connect the PEX tubing to the fitting. The tubing is inserted or pushed into the fitting and locked into place with a fastening device that keeps it from being backed-out or disconnected. A support liner is inserted into the tubing and a fastening system with a locking component, such as a snap ring or twist collar, is used to ensure that the connection remains secure (see **Figures 5.17**, **5.18**, **5.19**, **5.20**, and **5.21**).

Push-fit fittings typically use an O-ring or gasket to form a tight seal on the exterior of the PEX tubing. ASSE 1061 fittings are produced from lead-free brass or polymer.

Figure 5.17 ASSE 1061 Brass Push-Fit Fitting

Figure 5.18 ASSE 1061 Polymer Push-Fit Fitting

Figure 5.19 ASSE 1061 Polymer Push-Fit Fitting

Figure 5.20 ASSE 1061 Polymer Push-Fit Fitting

Figure 5.21 ASSE 1061 Fittings in Brass and Polymer

Standard Specifications for Fittings

Each of these fitting systems are categorized in accordance with ASTM or ASSE specifications as follows, with the formal scopes of each of these standards copied verbatim from the specifications:

Note: ASTM Standard Titles and Scopes were extracted, with permission, from ASTM F877, ASTM F1807, ASTM F1960, ASTM F2080, ASTM F2098, ASTM 2159, ASTM F3347, and ASTM F3348, copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428. A copy of the complete standards may be purchased from ASTM International at www.astm.org.

ASTM F877: Standard Specification for Crosslinked Polyethylene (PEX) Hot- and Cold-Water Distribution Systems

This specification covers requirements, test methods, and marking requirements for system components when tested with nominal SDR9 crosslinked polyethylene (PEX) tubing as a system. Systems are intended for 100 psi (0.69 MPa) water service up to and including a maximum working temperature of 180°F (82°C). Requirements and test methods are included for materials, workmanship, dimensions, and tolerances, burst pressure, hydrostatic sustained pressure, excessive temperature and pressure, corrosion resistance, and thermocycling tests. The components covered by this specification are intended for use in, but not limited to, residential and commercial hot and cold potable water distribution systems or other applications such as municipal water service lines, radiant heating and cooling systems, hydronic distribution systems, snow and ice melting systems, geothermal ground loops, district heating, turf conditioning, compressed air distribution, and building services pipe.

ASTM F1807: Standard Specification for Metal Insert Fittings Utilizing a Copper Crimp Ring, or Alternate Stainless Steel Clamps, for SDR9 Crosslinked Polyethylene (PEX) Tubing and SDR 9 Polyethylene of Raised Temperature (PE-RT) Tubing

This specification covers metal insert fittings and copper crimp rings, or alternate stainless steel clamps, for use with cross-linked polyethylene (PEX) tubing in Nominal Tubing Size (NTS) 3/8, 1/2, 5/8, 3/4, 1, 1 1/4, 1 1/2, and 2 nominal sizes that meet requirements for Specification ASTM F876 or Specification F3253 or for use with polyethylene of raised temperature (PE-RT) tubing in NTS 3/8, 1/2, 5/8, 3/4, 1, 1 1/4, 1 1/2, and 2 nominal sizes that meets the requirements of Specification F2623 or Specification F2769. These fittings are intended for use in 100 psi (689.5 kPa) cold- and hot-water distribution systems operating at temperatures up to, and including, 180°F (82°C).

ASTM F1960: Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Crosslinked Polyethylene (PEX) Tubing and Polyethylene of Raised Temperature (PE-RT) Tubing

This specification covers cold expansion fittings and cross-linked (PEX) reinforcing rings for use with cross-linked polyethylene (PEX) plastic tubing in nominal tubing sizes of 3/8, 1/2, 5/8, 3/4, 1, 1 1/4, 1 1/2, 2, 2 1/2, and 3 that meet the requirements of Specification F876 or F3253 and for use with Polyethylene of Raised Temperature (PE-RT) pipe in nominal tubing sizes of 3/8, 1/2, 5/8, 3/4, 1, 1 1/4, 1 1/2, 2, 2 1/2, and 3 that meet the requirements of Specification F2769. These fittings are intended for use in 100 psi (690 kPa) cold- and hot-water distribution systems operating at temperatures up to and including 180 °F (82 °C). The system is comprised of a PEX reinforcing ring and a cold expansion fitting. Included are the requirements for materials, workmanship, dimensions, and markings to be used on the fitting components. The

components covered by this specification are intended for use in residential and commercial, hot and cold, potable water distribution systems as well as sealed central heating, including under-floor-heating systems.

ASTM F2080: Standard Specification for Cold Expansion Fittings with Metal Compression Sleeves for Crosslinked Polyethylene (PEX) Pipe and SDR9 Polyethylene of Raised Temperature (PE-RT) Pipe

This specification covers cold-expansion fittings using metal compression-sleeves for use with crosslinked polyethylene (PEX) plastic pipe in 3/8, 1/2, 5/8, 3/4, 1, 1 1/4, 1 1/2, and 2 nominal diameters, meeting the requirements of Specification F876 or F3253, and for use with Polyethylene of Raised Temperature (PE-RT) pipe in 3/8, 1/2, 5/8, 3/4, 1, 1 1/4, nominal diameters meeting the requirements of Specification F2769, whereby the pipe is cold-expanded before fitting assembly. The components covered by this specification are intended for use in residential and commercial, hot and cold, potable water distribution systems or other applications such as municipal water service lines, building supply lines, radiant panel heating systems, hydronic baseboard heating systems, snow and ice melting systems, geothermal underground pipe systems and building services pipe with continuous operation at pressures up to and including 100 psi (690 kPa), and at temperatures up to and including 180 °F (82 °C).

ASTM F2098: Standard Specification for Stainless Steel Clamps for Securing SDR9 Crosslinked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) to Metal Insert and Plastic Insert Fittings

This specification covers stainless steel clamps for use with five sizes of insert fittings that comply with F1807 or F2159, and cross-linked polyethylene (PEX) plastic tubing that complies with F876 and for use with polyethylene of raised temperature (PE-RT) tubing that complies with Specification F2769. These clamps are intended as an alternative to the copper-alloy crimp-rings of Specifications F1807 or F2159 for use in 100 psi (689.5 kPa) cold- and hot-water distribution systems operating at temperatures up to and including 180°F (82°C). Included are requirements for materials, workmanship, dimensions, and marking of the stainless steel clamps; requirements for deforming the clamps; which apply to assemblies of PEX tubing and Specifications F1807 and F2159, insert fittings secured with deformed clamps per this specification.

ASTM F2159: Standard Specification for Plastic Insert Fittings Utilizing a Copper Crimp Ring, or Alternative Stainless Steel Clamps, for SDR9 Crosslinked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing

This specification establishes requirements for sulfone plastic insert fittings and copper crimp rings, or alternate stainless steel clamps for four sizes Nominal Tubing Sizes (NTS) (3/8, 1/2, 3/4, and 1) of cross-linked polyethylene (PEX) tubing that meet the requirements for Specification F876 or Specification F3253, or polyethylene of raised temperature (PE-RT) tubing that meet the requirements of Specification F2623 or Specification F2769. These fittings are intended for use in 100 psi (690 kPa) cold- and hot-water distribution systems operating at temperatures up to and including 180 °F (82 °C). Included are the requirements for material, molded part properties, performance, workmanship, dimensions, and markings to be used on the fittings and rings.

ASTM F3347: Standard Specification for Metal Press Insert Fittings with Factory Assembled Stainless Steel Press Sleeve for SDR9 Cross-linked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing

This specification covers copper alloy metal press insert fittings with factory assembled stainless steel press sleeves incorporating 3 view holes and tool locator ring. These fittings are for use with cross-linked polyethylene (PEX) tubing in nominal sizes 5/16, 3/8, 1/2, 5/8, 3/4, 1, 1 1/4, 1 1/2, and 2 that meet the requirements for Specification F876 or F3253 and for use with polyethylene of raised temperature (PE-RT) tubing in nominal sizes 3/8, 1/2 , 3/4, 1, 1 1/4, 1 1/2, and 2 that meet the requirements of Specification F2769. These fittings are intended for use in 100 psi (689.5 kPa) hot and cold water distribution systems operating at temperatures up to, and including, 180 °F (82 °C). The requirements for materials, workmanship, dimensions, and markings to be used on the fittings and sleeves are also included.

ASTM F3348: Standard Specification for Plastic Press Insert Fittings with Factory Assembled Stainless Steel Press Sleeve for SDR9 Cross-linked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing

This specification covers plastic press insert fittings with factory assembled stainless steel press sleeves incorporating 3 view holes and a tool locator ring. These fittings are for use with cross-linked polyethylene (PEX) tubing in nominal sizes 3/8, 1/2, 3/4, 1, 1 1/4, 1 1/2, and 2 that meet the requirements for Specification F876 or F3253 and for use with polyethylene of raised temperature (PE-RT) tubing in nominal sizes 3/8, 1/2, 3/4, 1, 1 1/4, 1 1/2, and 2 that meet the requirements of Specification F2769. These fittings are intended for use in 100 psi (690 kPa) cold- and hot-water distribution systems operating at temperatures up to and including 180 °F (82 °C). Included are the requirements for material, molded part properties, performance, workmanship, dimensions, and markings to be used on the fittings and sleeves.

ASSE Standard 1061 *Performance Requirements for Push-Fit Fittings*

This standard applies to push-fit fittings up to 2 in. that can be used with one or more of the following materials:

1. PEX tubing complying with ASTM F876 or CSA B137.5;
2. Type K, L and M copper tubing complying with ASTM B88;
3. CPVC tubing complying with ASTM D2846 or CSA B137.6; and
4. PE-RT tubing complying with ASTM F2769.

Push-fit fittings may be designed to be used with one or more types of tubing that conform to the dimensions as specified in their respective standard. This standard serves to supplement ASTM F877, ASTM D2846 and ASTM B88 in describing a test method for a specific type of push-fit fitting system to be used with PEX, Copper, CPVC and PE-RT tubing. This standard covers minimum temperature and pressure ratings, markings, and identification.

Other PEX Joining/Fitting Systems

Some PEX tubing manufacturers offer fitting systems for which ASTM standards have not yet been written. These systems are typically listed as meeting the performance requirements of ASTM F877 or CSA B137.5 for PEX systems, which is allowed by standards and model codes, but their fitting dimensions and materials are not specified in a standard published by ASTM, for example.

These fittings are typically available only through a single manufacturer and the components of the system may not interchange with similar-looking parts from a different manufacturer. When using these systems, users are cautioned not to mix components from different manufacturers, even if they appear the same.

Note: The content included in this Guide is based on the latest versions of standards as of the publication date. All referenced standards are subject to change.

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