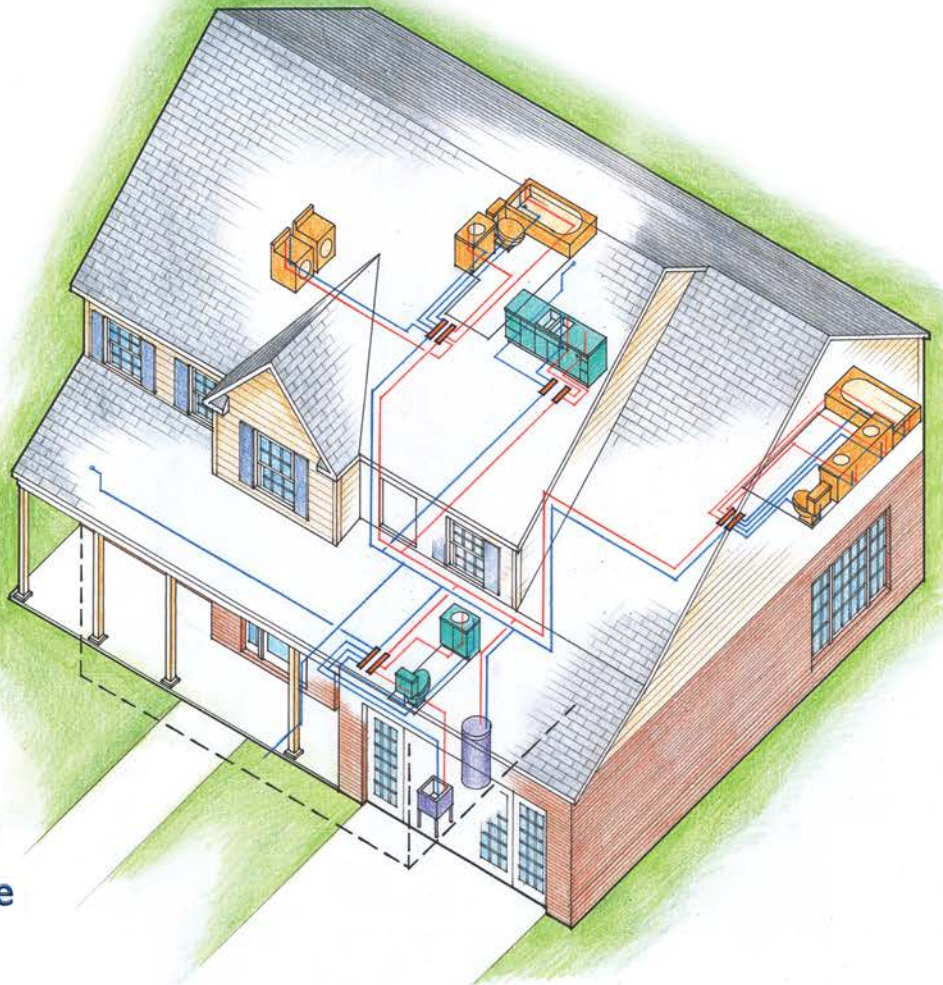


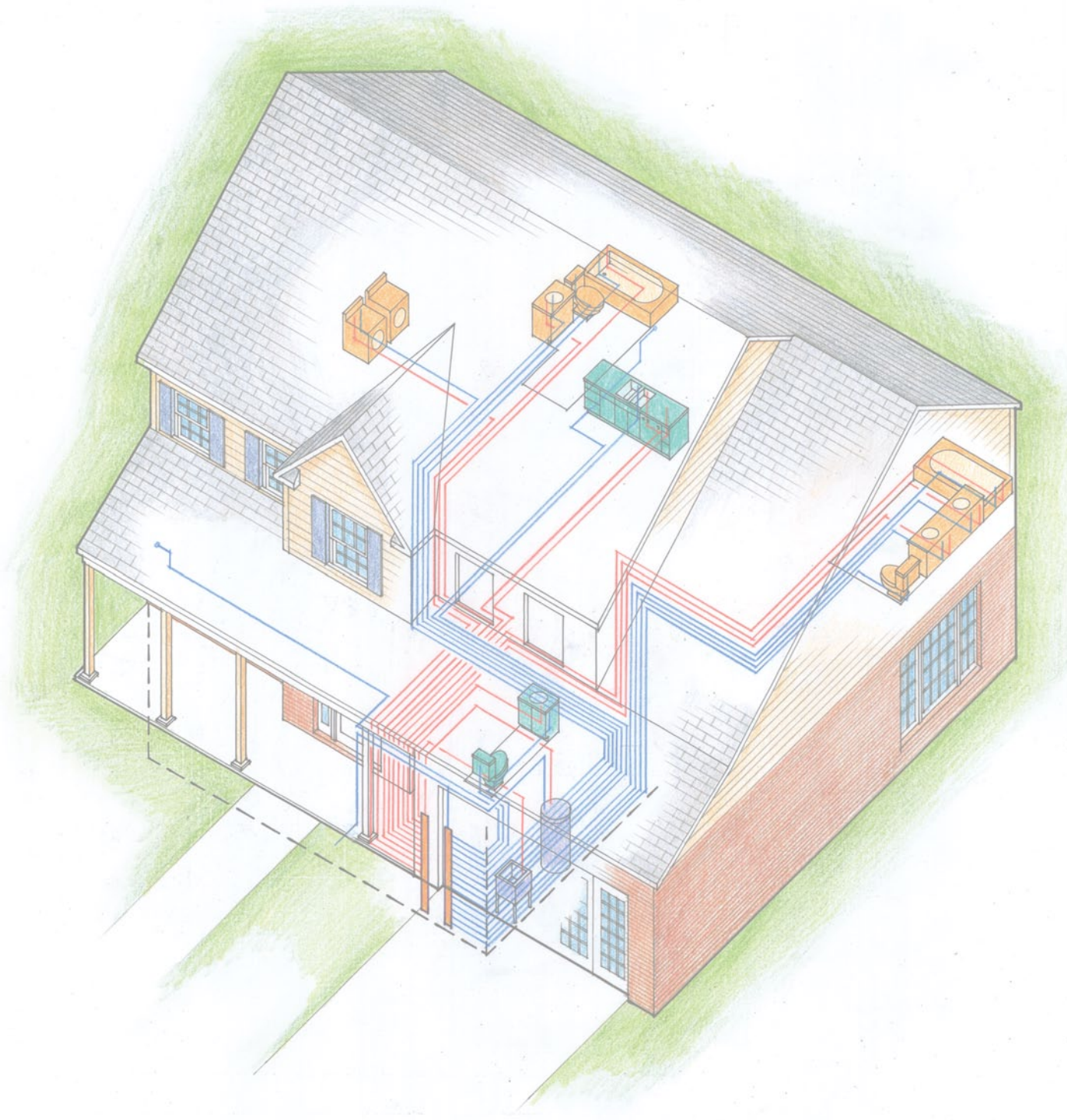
# DESIGN GUIDE

## Residential PEX Water Supply Plumbing Systems

Second Edition

Applications  
Advantages  
Material Properties  
Joining Methods  
Code Acceptance  
System Design  
Installation  
and more





# DESIGN GUIDE

## Residential PEX Water Supply Plumbing Systems

Second Edition

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## JOINING METHODS

There are several types of joining methods or fittings used with PEX plumbing systems. All are mechanical fittings that are either directional or transitional. PEX piping cannot be joined by solvent cementing.

Most PEX piping manufacturers have their own mechanical fitting system. The method of connection should comply with the 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.

Not all fittings are applicable with all PEX pipe. Consult your manufacturer for acceptable methods.

The most common types of fitting systems used are shown in the following pages.



## Cold Expansion Fittings with PEX Reinforced Rings

This type of fitting requires that the PEX piping, with a reinforcing PEX ring placed over the end of the pipe, is expanded before the fitting is inserted into the pipe end. The expanded pipe end is allowed to retract onto the fitting to form the seal—the “memory” of the pipe allows it to tighten over the fitting. An expander tool is required to expand the pipe and the PEX ring together. ASTM F1960 is applicable to fittings that use a PEX reinforcing ring.



Figure 5.1 – Cold Expansion Polymer Fitting with PEX Reinforced Ring



Figure 5.2 – Cold Expansion Metal Fitting with PEX Reinforced Ring

## Cold Expansion Fittings with Metal Compression Sleeves

This type of fitting requires that the PEX piping is expanded before it is placed over the oversized fitting. The pipe shrinks down over the fitting insert, then a metal compression sleeve is pulled over the connection, compressing the pipe over the fitting. A tool is required to expand the pipe and to pull the sleeve over the pipe. ASTM F2080 is applicable to cold expansion fittings that use a metal compression sleeve.



Figure 5.3 – Cold Expansion Fitting with Metal Compression Sleeve

## Metal or Plastic Insert Fittings

This type of fitting uses a metal crimp ring that is compressed around the PEX piping to secure it to the fitting. The crimp ring can be copper or stainless steel. Fittings can be made of copper, brass, bronze, or plastic. The fitting will typically have a barbed or ribbed annular end.

The PEX pipe slides over the barbed or ribbed annular section. Prior to making the connection, the metal crimp ring is slid over the PEX piping and away from the end of the pipe. The piping is pushed over the fitting, the crimp ring is slid down over that section and aligned over the fitting ribs, and a tool is used to compress the crimp ring around the assembly.

### Copper Crimp Ring

The copper ring is crimped equally around the fitting. The go-no-go gauge ensures a proper crimp. Some manufacturers use o-rings on their metal fittings to make the seal with the pipe. ASTM F1807 is the applicable standard for metal insert fittings. ASTM F2159 is the applicable standard for plastic fittings. ASTM F2434 is the applicable standard for metal insert fittings with o-rings.

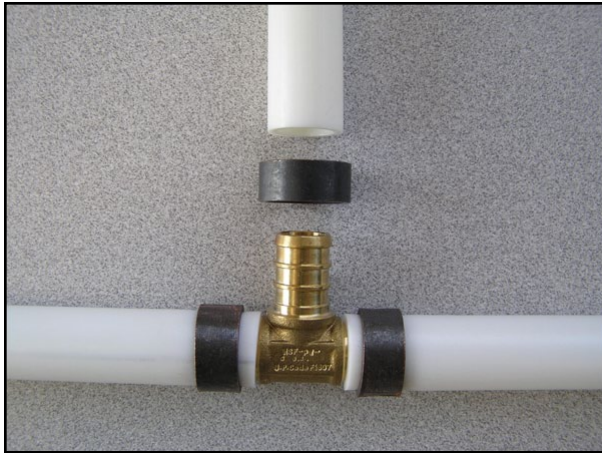


Figure 5.4 – Metal Insert Fitting with Copper Crimp Ring



Figure 5.5 – Plastic Insert Fitting with Copper Crimp Ring



Figure 5.6 – Metal Insert Fitting with O-rings and Copper Crimp Ring

## Stainless Steel Clamp

The stainless steel ring is crimped using a ratcheting tool, which only releases once a proper crimp is achieved. ASTM F2098 is the applicable standard for stainless steel clamps as shown in Figure 5.7.



Figure 5.7 – Metal Insert Fitting with Stainless Steel Clamp Band

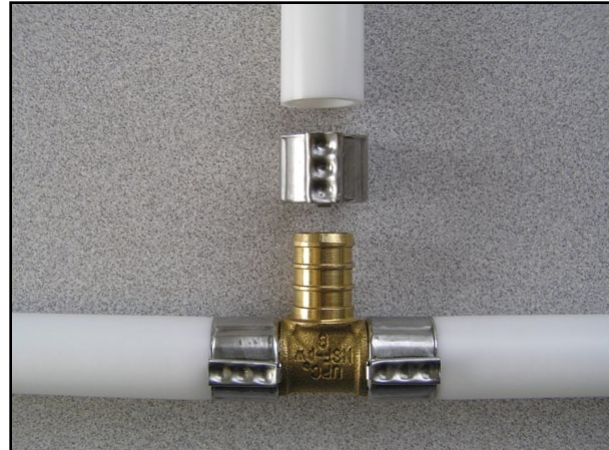


Figure 5.8 – Metal Insert Fitting with Stainless Steel Clamp Sleeve

## Stainless Steel Press Sleeve

This type of fitting is made of metal and uses a press sleeve or cap to secure the PEX pipe to the fitting. These fittings have ribbed annular ends that are inserted into the PEX pipe. A sleeve or cap slides over the outer part of the piping and the fitting is inserted into the pipe. The pipe must be fully inserted. A press tool is used to make the final connection. It is important that the appropriate tool is used per manufacturer's instructions.



Figure 5.9 – Metal Insert Fitting with Stainless Steel Press Sleeve

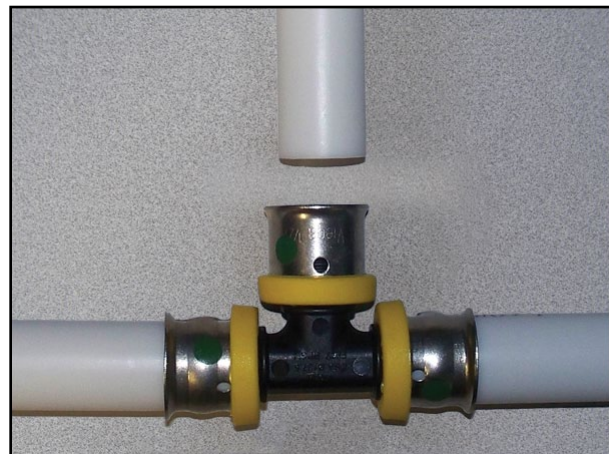


Figure 5.10 – Plastic Insert Fitting with Stainless Steel Press Sleeve

## Push Type Fittings

This type of fitting uses an interlocking mechanism to connect the PEX pipe to the fitting. The pipe is inserted, or pushed, into the fitting, and locked into place with a fastening device that keeps the pipe from being backed-out or disconnected. Push type fittings typically use some type of o-ring or gasket to form a seal around the PEX pipe. A support liner is inserted into the pipe, and a fastening system with a locking component, such as a snap ring or twist collar, is used to ensure that the connection remains permanent. ASSE 1061 is the applicable standard for push type fittings.

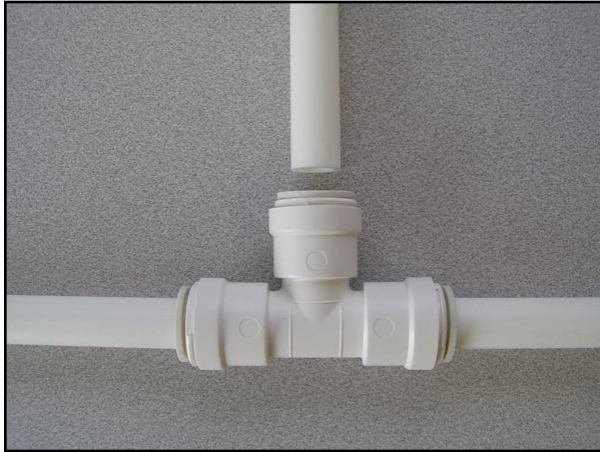


Figure 5.11 – Plastic Push Type Fitting



Figure 5.12 – Metal Push Type Fitting

### Standard Specifications for Fittings

Fittings are categorized in accordance with ASTM<sup>9</sup>, or ASSE specifications, as follows:

#### **ASTM F877: Standard Specification for Cross-Linked 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 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, sustained pressure, excessive temperature and pressure, and thermo-cycling tests. 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, radiant panel heating systems, hydronic baseboard heating systems, snow and ice melting systems, and building services pipe.

#### **ASTM F1807: Standard Specification for Metal Insert Fittings Utilizing a Copper Crimp Ring for SDR9 Cross-Linked Polyethylene (PEX) Tubing and SDR 9 Polyethylene of Raised Temperature (PE-RT) Tubing**

This specification covers metal insert fittings and copper crimp rings for use with PEX tubing that meet requirements in ASTM F876 and F877 and for use with raised temperature (PE-RT) tubing that meets the requirements of in ASTM F2623 and 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). Requirements for materials, workmanship, dimensions, and markings to be used on fittings and rings are also included. Size range is 3/8 to 2 inches.

#### **ASTM F1960: Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-Linked Polyethylene (PEX) Tubing**

This specification covers cold expansion fittings and PEX reinforcing rings for use with PEX plastic tubing that meet requirements of ASTM F876 and F877. 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 requirements for materials, workmanship, dimensions, and markings to be used on fitting components. Size range is 3/8 to 2 inches.

#### **ASTM F2080: Standard Specification for Cold Expansion Fittings with Metal Compression Sleeves for Use with PEX Pipe**

This specification covers cold-expansion fittings using metal compression sleeves for use with PEX plastic pipe that meet requirements of ASTM F876 and F877, whereby the PEX pipe is cold-expanded before fitting assembly. These cold expansion fittings and metal compression sleeves are intended for use in residential and commercial, hot and cold, potable water

<sup>9</sup> ASTM Standard Titles and Scopes were extracted, with permission, from [ASTM F877, ASTM F1807, ASTM F1960, ASTM F2080, ASTM F2098, ASTM 2159, and ASTM F2434], copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428. A copy of the complete standard may be purchased from ASTM International, [www.astm.org](http://www.astm.org).



distribution systems, with continuous operation at pressures up to and including 100 psi (690 kPa), and at temperatures up to and including 180°F (82°C). Included in the specification are requirements for materials, workmanship, dimensions, and markings to be used on fittings and compression sleeves. Performance requirements are as referenced in ASTM F877. Size range is 3/8 to 2 inches.

#### **ASTM F2098: Standard Specification for Stainless Steel Clamps for Securing SDR9 Cross-Linked Polyethylene (PEX) Tubing to Metal Insert and Plastic Insert Fittings**

This specification covers stainless steel clamps for use with four sizes of insert fittings that comply with F1807, and cross-linked polyethylene (PEX) plastic tubing that complies with F876 or F877. 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 for SDR9 Cross-Linked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing**

This specification covers plastic insert fittings and copper crimp rings for use with PEX pipe that meets requirements in ASTM F876 and F877 and for use with raised temperature (PE-RT) tubing that meets the requirements of in ASTM F2623 and F2769. It establishes requirements for sulfone plastic insert fittings and copper crimp rings for PEX plastic tubing. 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 requirements for material, molded part properties, performance, workmanship, dimensions, and markings to be used on fittings and rings. Size range is 3/8 to 1 inch.

#### **ASTM F2434: Standard Specification for Metal Insert Fittings Utilizing a Copper Crimp Ring for SDR9 PEX Tubing and SDR9 PEX-AL-PEX Tubing**

This specification covers metal insert fittings with o-ring seals and copper crimp rings for use with cross-linked polyethylene (PEX) tubing that meet the requirements for ASTM F876 and F877 and for use with cross-linked polyethylene –aluminium-cross-linked polyethylene (PEX-AL-PEX) tubing that meet the requirements for ASTM F2262. 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). Included are the requirements for materials, workmanship, dimensions, performance, and markings to be used on the fittings and rings. Size range is 1/2 to 1 1/4 inches.

### **ASSE Standard I06I**

#### ***Performance Requirements for Push-Fit Fittings***

This standard applies to push-fit fittings up to 2” 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 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/or PE-RT tubing. This standard covers minimum temperature and pressure ratings, marking, and identification.



# GLOSSARY

**ASTM:** American Society for Testing and Materials

**Corrosion:** deterioration in metals caused by oxidation or chemical action

**Crosslinked polyethylene:** a polyethylene material which has undergone a change in molecular structure using a chemical or a physical process whereby the polymer chains are chemically linked. Crosslinking of polyethylene into PEX for pipes results in improved properties such as elevated temperature strength and performance, chemical resistance, and resistance to slow crack growth.

**Elasticity:** a measure of material stiffness or the ability of the material to stretch or deform temporarily under a load

**Fitting:** a device or connection that allows the PEX pipe to change direction or size, such as a tee, elbow, or coupling

**Fixture:** a device or appliance at the end of a water supply distribution pipe line. Example: lavatory, water closet, tub/shower, dishwasher

**IAPMO:** International Association of Plumbing and Mechanical Officials

**ICC:** International Code Council

**IPC:** International Plumbing Code

**IRC:** International Residential Code

**Joint:** the connection of the PEX pipe to a fitting, fixture, or manifold

**Manifold:** a device having a series of ports that are used to connect distribution lines for several fixtures

**NSPC:** National Standard Plumbing Code



**Outlet:** see fixture

**Parallel:** a plumbing design that utilizes a central manifold and distribution piping to each hot and cold water fixture

**pH:** a scale ranging from 0 to 14 that ranks how acidic or alkaline a liquid is; water with a pH below 7 is considered acidic and water with a pH above 7 is considered alkaline

**PPFA:** Plastic Pipe and Fittings Association

**PPI:** Plastics Pipe Institute

**Scaling:** process of mineral buildup on the interior of a pipe

**Test fixture:** the tub-shower unit farthest from the water source that was instrumented to measure flow rate, flowing pressure, and mixed water temperature in the lab tests

**Thermoplastic:** having the property of becoming soft when heated and hard when cooled

**Thermoset:** having the property of becoming permanently hard and rigid when heated or cured

**Trunk and branch:** a plumbing design that has a large main line that feeds smaller pipes to each fixture

**Ultraviolet:** high energy light waves found in sunlight that lead to the degradation of many plastics and materials (UV)

**UPC:** Uniform Plumbing Code

**Wait time:** the time it takes for hot water to be delivered to the Test Fixture; delivery time

**Water hammer:** a banging noise heard in a water pipe following an abrupt alteration of the flow with resultant pressure surges

**Zone:** a plumbing system that uses trunk lines from the water source to small manifolds at grouped fixtures, such as a bathroom; can be flow-through or closed end

