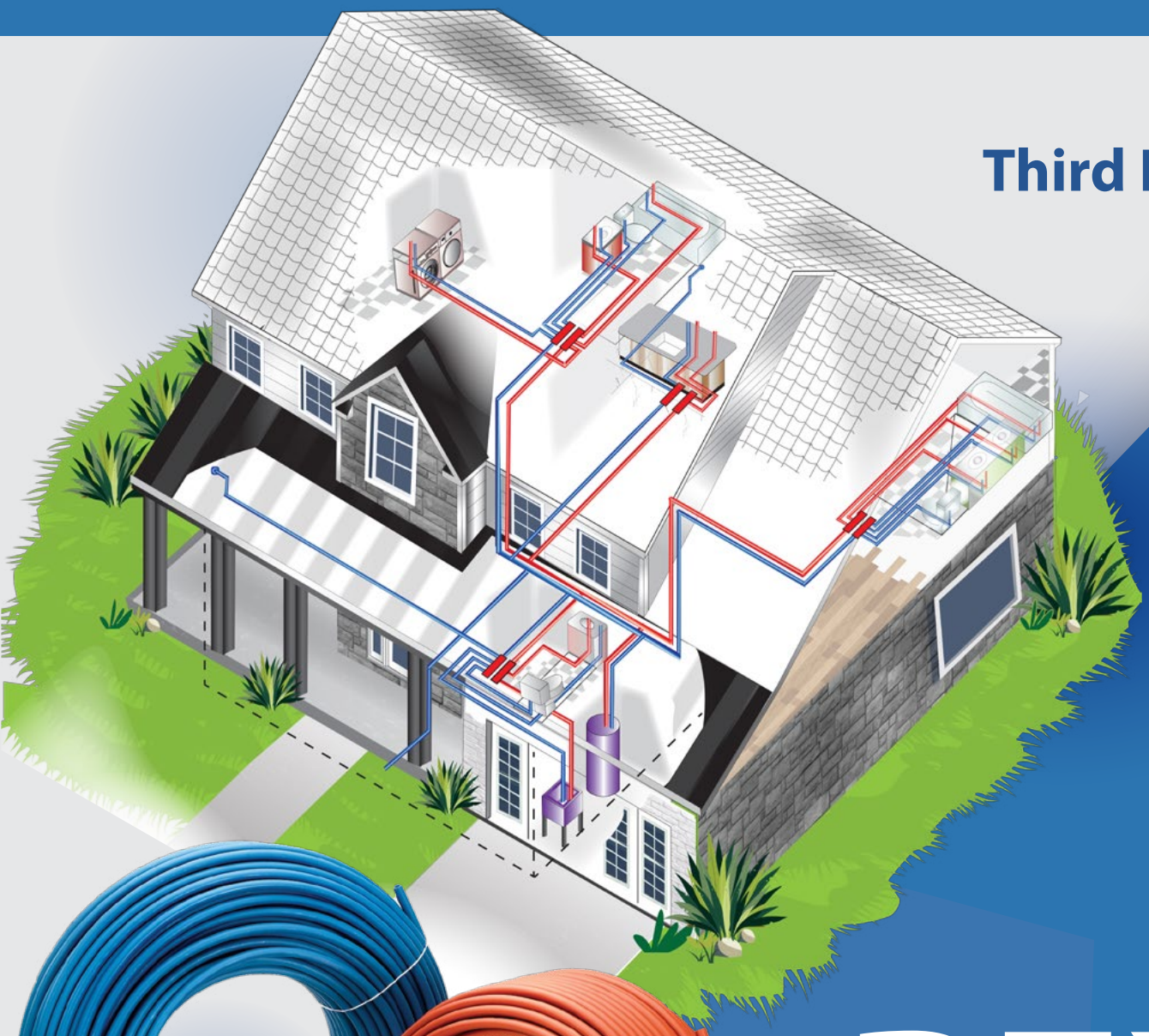
Third Edition



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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Please consult the following websites for the latest version of this publication, reference publications, and other related information:

- Plastics Pipe Institute
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Installation of PEX Plumbing Systems

9

Limitations on Use and Applications of Crosslinked Polyethylene (PEX)

This chapter begins with a list of DOs and DO NOTs and then provides many important installation details for various types of PEX plumbing systems.

- DO store fittings in protective packaging so that they do not get nicked, dented, or otherwise damaged during transportation and storage.
- DO store fittings in containers that are free of oil, grease, lubricants, solder flux, or other chemicals and away from corrosive atmospheres (e.g., ammonia). Refer to **PPI TR-19 *Chemical Resistance of Plastic Piping Materials*** for chemical compatibility of pipe and fitting materials.
- DO NOT use PEX systems in applications outside of the manufacturer's recommended installation practices (e.g., beyond approved temperature or pressure ratings).
- DO NOT use tubing with gouges, cuts, cracks, abrasions, evidence of chemical attack, or other defects, or tubing that has been crushed or kinked. See manufacturer's instructions for dealing with damaged tubing before or during installation.
- DO NOT store or use PEX tubing or fittings where it will be exposed to direct or reflected sunlight.
- DO NOT allow PEX tubing or plastic fittings to come in contact with the construction materials listed below (this list is not all-inclusive):
  - Pipe thread sealing compounds (e.g., "pipe dope")
  - Solder Flux
  - Open flame
  - Fire wall penetration sealing compounds. *Exception: water soluble, gypsum-based caulking or other sealants approved by the PEX tube manufacturer. Consult PEX manufacturer for an approved list.*
  - Petroleum-based materials or sealants such as kerosene, benzene, gasoline, ABS/PVC/CPVC primer and solvent cements, fuel oils, cutting oils, asphaltic paint, and asphaltic road materials, acetone, toluene, and/or xylene or any other solvents. Consult your tubing manufacturer if you have questions about these or any other materials not listed.

- DO NOT install PEX tubing in heavily contaminated soil or other heavily contaminated environments.
- DO NOT use PEX systems in swimming pool, spa or hot tub piping systems unless approved by the system manufacturer.

PEX Tubing Installation Practices

Preparation

Review all limitations and guidance provided by local codes and regulations, as well as by the PEX system manufacturer (i.e., tubing, fittings, valves, fasteners, tools), prior to beginning installation.

Storage & Handling

PEX tubing is typically supplied in continuous coils of 100 ft, 300 ft, 500 ft or more. Coils are easy to transport and handle, and reduce the number of couplings used during installation, reducing installation time and potentially, the pressure drop through fittings. PEX tubing may also be supplied in straight lengths (a.k.a. "sticks") of 10 ft or 20 ft length which some installers prefer to avoid having to straighten the tubing.

Straight lengths may be more difficult to transport and store and may require additional fittings (e.g., couplings) due to their shorter lengths. **Using coils maximizes the benefits and flexibility of using PEX**.

Like most plastics, the long-term performance of PEX will be affected by ultraviolet (UV) radiation from sunlight. Although most PEX tubing has good UV resistance (see **Chapter 3 *Material Properties***), PEX tubing should not be stored outdoors where it is exposed to the sun, or interior locations (i.e., indoors) directly exposed to sunlight (see **Figure 9.1**).

PEX tubing should not be installed outdoors, unless buried in earth or properly protected from UV exposure, either direct or indirect. Indirect (diffused) and reflected sunlight also emit UV energy.

If PEX will be exposed to sunlight continuously after installation, such as in an unfinished basement, installers should cover the pipe with a UV-blocking sleeve or pipe insulation that is approved by the PEX manufacturer.

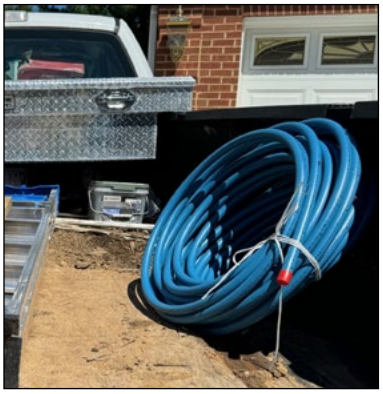


Figure 9.1 PEX Tubing Stored Outdoors

Figure 9.2 Sharp Objects Can Damage PEX

Figure 9.3 Objects that Can Damage PEX

Each PEX tubing manufacturer publishes the maximum recommended UV exposure time limit based on the UV resistance as determined in accordance with ASTM Test Method F2657 and the requirements published in ASTM F876. Central Arizona is used as the basis of the exposure time limits, as it represents the worst-case known North American location for UV energy.

PEX tubing and fittings shall be stored in a way to protect them from mechanical damage (cuts, puncture, nicks, dents, etc.; see **Figure 9.2**). PEX should be stored in original packaging or similar protection for cleanliness. Inspect all tubing and fittings before installation and do not use components that are damaged or suspected of damage or that have been exposed to excessive sunlight.

When transporting or installing, do not drag PEX tubing over rough terrain, rocks, sharp masonry or metals or any surface that can cut, puncture, or damage the tubing wall (see **Figure 9.3**).

Do not crush or kink the tubing during handling or installation.

Bending & Flexibility

Crosslinked polyethylene remains a flexible material even at temperatures well below freezing. In fact, PEX tubing remains flexible and can still be bent at temperatures as low as -40°F (-40°C).

The flexibility and low stiffness of PEX allows it to be bent gently around obstructions and installed as one continuous run without fittings, if desired. Slight changes in direction are made easily by cold-bending the tubing by hand; snap-on bend supports can hold the tubing in 90-degree sweeps in place of elbow fittings (see **Figure 9.4**).

Minimizing joints and connections can result in quicker installations, less potential for leaks at fittings, and less resistance by reducing pressure drop through fittings. Bend supports should be used to facilitate rigid bends and to alleviate stress on PEX joints when bends are needed in close proximity to such joints.

The free (unsupported) bending radius for PEX tubing, measured at the mid-point of the bend, shall be not less (i.e., no tighter than) than six times the actual outside diameter of the tubing, unless otherwise specified by the PEX manufacturer (see **Figure 9.5**).

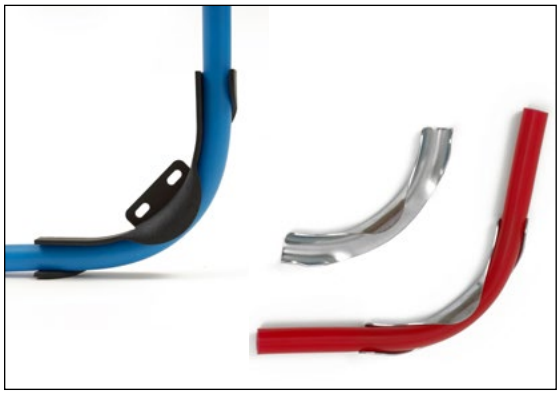


Figure 9.4 Plastic and Metal PEX Bend Supports

Figure 9.5 Tubing at its Minimum Bend Radius

Refer to **Table 9.1** for a list of bend radii based on tubing diameter and allowed minimum bend radius.

Note: For certain types of PEX tubing in coils, when bending the tubing **against** the coil direction, the minimum bending radius is three times the "6 times Bend Radius" given in **Table 9.1** (e.g., 1/2 tubing = 3.8 x 3 = 11.4 inches).

Despite this excellent flexibility, elbows may still be necessary in certain confined spaces (see **Figure 9.6**).

Table 9.1 Minimum Bend Radii of PEX Tubing

Nominal Tubing Size	Tubing OD (Actual) in.	6 times Bend Radius in.
3/8	0.500	3.0
1/2	0.625	3.8
3/4	0.875	5.3
1	1.125	6.8
1 1/4	1.375	8.3
1 1/2	1.625	9.8
2	2.125	12.8
2 1/2	2.625	15.8
3	3.125	18.8
4	4.125	24.8

Figure 9.6 Elbow Fittings in a Confined Joist Cavity

Fasteners & Supports

Horizontal runs of PEX tubing in nominal diameters up to 1 should be supported at intervals not to exceed 32 inches (80 cm) or as per local code. For most wood-frame construction, the joists can serve as the supports (see **Figure 9.7**).

For nominal diameters 1 1/4 and larger, horizontal PEX should be supported at intervals not to exceed 48 inches (120 cm) or as per local code.

Vertical tubing shall be supported each story height and at midstory, with a maximum of 60 inches (150 cm) between supports, or per local code.

Pipe support channel, typically manufactured of galvanized steel in a round or u-shape and supplied in lengths slightly less than 10 ft or 20 ft, can be used to support PEX tubing in between fittings to reduce hanger spacing and to hold the tubing straight, without drooping (see **Figure 9.8**). Be sure to use a pipe support channel that is approved by the tubing manufacturer (see **Figures 9.9** and **9.10**).

PEX tubing installed horizontally in a pipe support channel can use the following hanger spacing:

- Nominal 3/4 PEX and smaller – 6 ft (183 cm)
- Nominal 1 PEX – 8 ft (244 cm)
- Nominal PEX 1 1/4 and larger – 10 ft (305 cm)

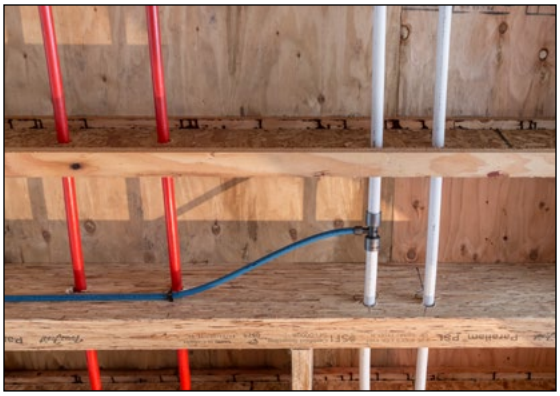


Figure 9.7 Wood Joists Serving as Horizontal Supports for PEX Tubing

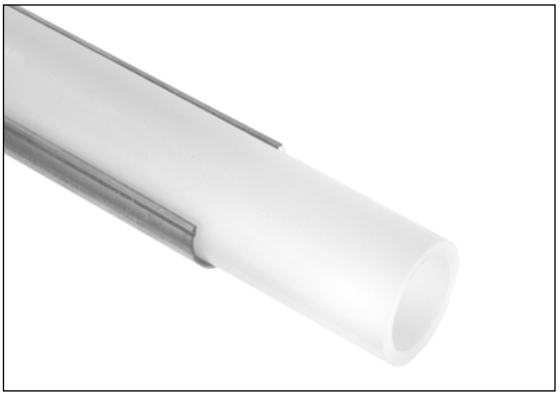
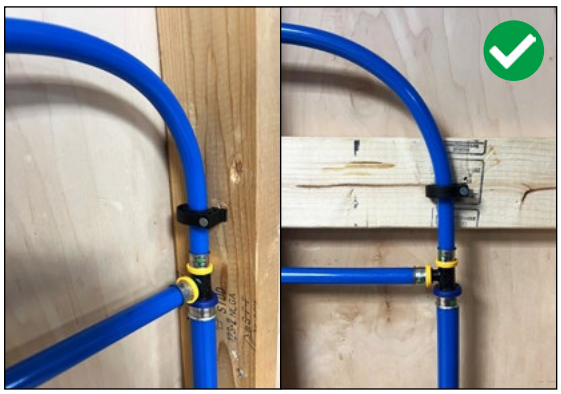


Figure 9.8 Pipe Support Channel

Figure 9.9 Pipe Support Channel

Figure 9.10 Pipe Support Channel

Tubing and fittings shall be installed without placing stress on joints or connections. Stress on connections may occur when tubing is not properly fastened at changes of direction and has the potential to cause leaks at fittings. See **Figures 9.11** and **9.12** for both recommended and incorrect fastening locations, respectively.



Figures 9.11a & 9.11b RECOMMENDED Fastening Locations to Minimize Stress on Joints

Figures 9.12a & 9.12b INCORRECT Fastening Locations that will Cause Excessive Stress on Joints at Fittings

Table 9.2 Recommended Minimum Hole Diameters for PEX tubing

Nominal Tubing Size	Minimum Hole Diameter
3/8	0.750 in. (3/4 in.) / 19 mm
1/2	0.875 in. (7/8 in.) / 22 mm
3/4	1.125 in. (1 1/8 in.) / 29 mm
1	1.375 in. (1 3/8 in.) / 35 mm
1 1/4	1.625 in. (1 5/8 in.) / 41 mm
1 1/2	1.875 in. (1 7/8 in.) / 48 mm
2	2.375 in. (2 3/8 in.) / 60 mm
2 1/2	2.875 in. (2 7/8 in.) / 73 mm
3	3.375 in. (3 3/8 in.) / 86 mm
4	4.375 in. (4 3/8 in.) / 111 mm
6	6.375 in. (6 3/8 in.) / 162 mm

Figure 9.13 PEX tubing Installed in Wood Studs

Protection

When passing through wood studs, joists, and beams, drill the hole a minimum of 1/4 inch (6 mm) larger than the outside diameter of the tubing (not the nominal diameter) to allow for slight movement (see **Table 9.2**). Tubing supports are not needed in wood (see **Figure 9.13**).

When passing through studs, joists, and beams of metal, concrete or masonry, use approved plastic pipe isolators, brackets, or hangers to prevent scratching of the tubing as it moves against sharp surfaces (see **Figure 9.14**).

Tubing supports should allow free tubing movement to accommodate thermal expansion and contraction (see **Figure 9.15a**). Do not use supports that pinch or cut the tubing (see **Figure 9.15b**).

Inspect all supports prior to installation to ensure that sharp edges do not exist that can damage the tubing.

Protect tubing from nail or screw damage where appropriate through the use of nailing plates/stud guards (see **Figure 9.16**) per local codes and manufacturer's guidelines.

Figure 9.14 Plastic Pipe Isolators, Brackets, and Hangers

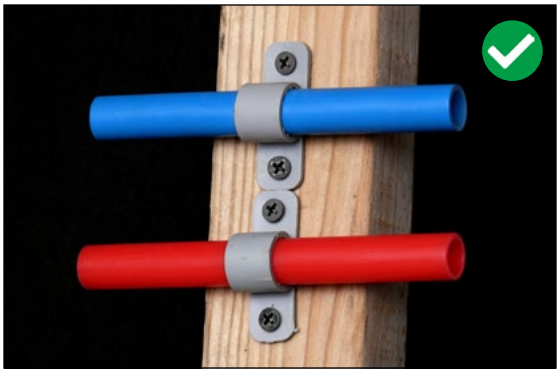


Figure 9.15a Tubing Supports that Allow Free Tubing Movement

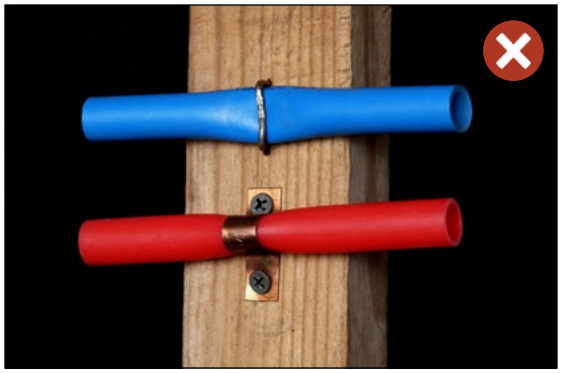


Figure 9.15b Tubing Supports that Do Not Allow Free Tubing Movement

Figure 9.16 Nailing Plate Installed on Wood Stud to Protect PEX Tubing

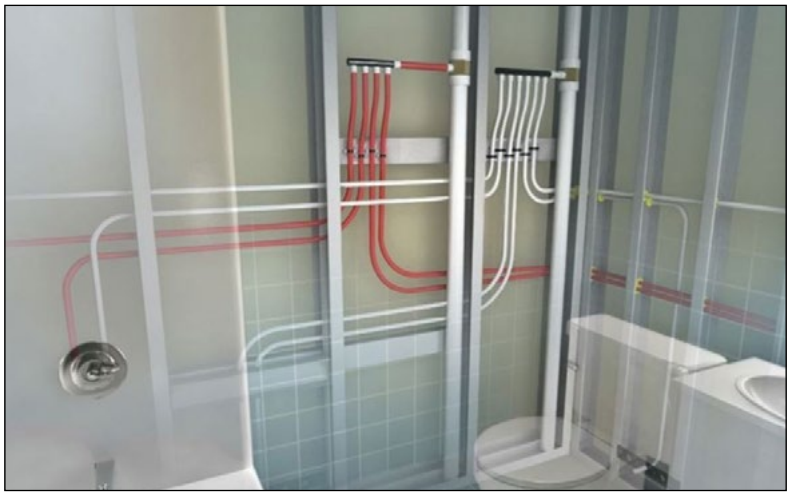


Figure 9.17 Properly Installed PEX Plumbing System within a Bathroom

Summary

A correctly installed PEX plumbing system is protected from damage, takes advantage of the material flexibility to avoid unnecessary use of fittings, is restricted from movement to prevent noise, and delivers long-term reliability (see **Figure 9.17**).

Protection from Artificial Lighting

Artificial light is primarily used for illumination of indoor living and work areas. Apart from visible light, many forms of artificial light also produce some ultraviolet (UV) light in their spectra. PEX tubing may be adversely affected by UV emissions from artificial light sources over decades of operation, and while different artificial light sources emit different levels of UV radiation, UV must be considered where PEX tubing is installed near all artificial light sources.

While it is difficult to address all types of artificial light and all installations from the perspective of possible impacts of artificial light on PEX, fluorescent lights, either tubular versions or single-envelope compact fluorescent lights (CFLs) are of most concern in residential and commercial applications as these lights have the highest component of UV emissions. Other types of lights, such as incandescent or LED lights, are of less concern.

UV irradiance and its harmful effects diminish with distance, so setback distance is a critical consideration. **PPI TN-72** ***Potential Effects of Artificial Lighting on Crosslinked Polyethylene (PEX) Pipe and Tubing and Recommended Installation Practices*** explains that minimum setback distances of 36 inches (91 cm) for residential and light commercial applications (see **Figure 9.18**) and 30 feet (9.1 m) for industrial/ manufacturing, warehousing, and large commercial applications (see **Figure 9.19**) are considered reasonable for all types of artificial light sources.

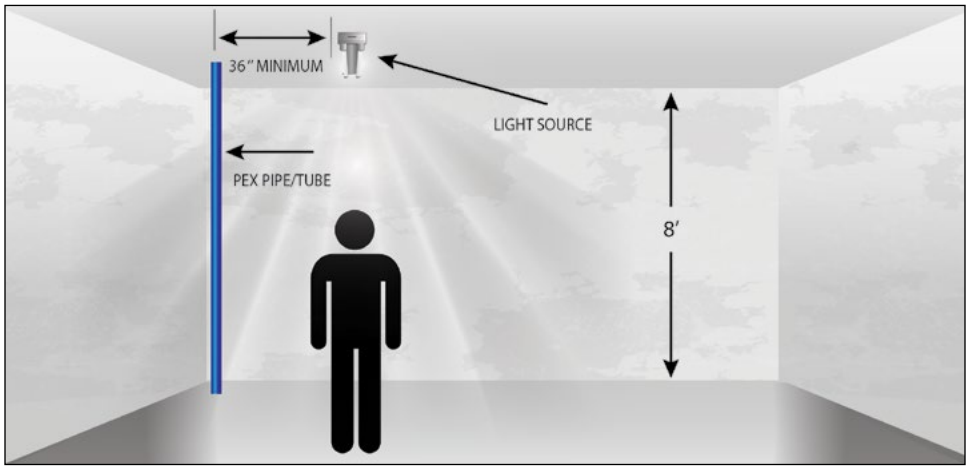


Figure 9.18 Recommended Setback Distance between Artificial Light Source (non-LED) in a Typical Residential Or Light Commercial Setting

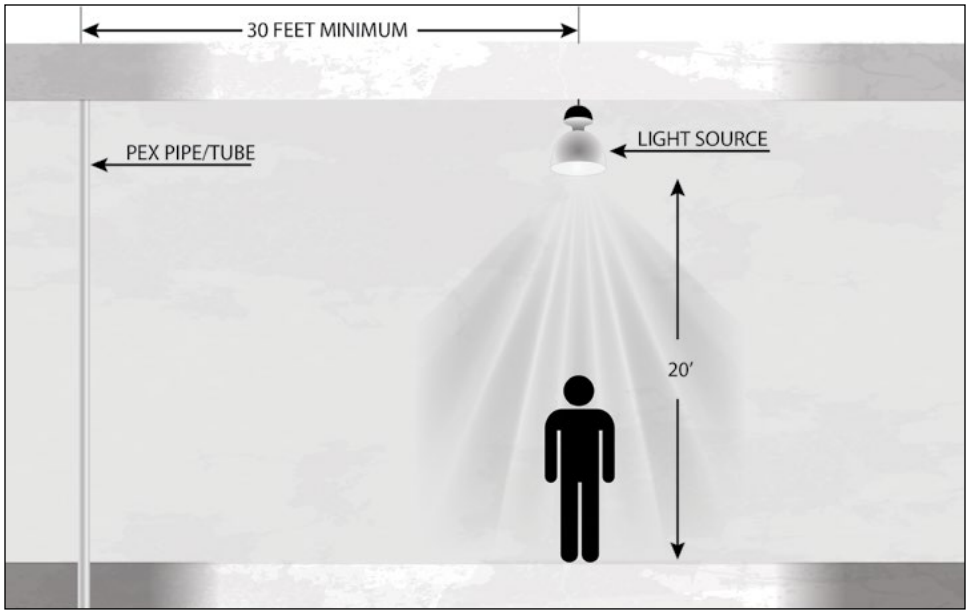


Figure 9.19 Recommended Setback Distance between Artificial Light Source (non-LED) in a Typical Industrial Setting

Recessed Lighting

Recessed lighting fixtures are typically classed as insulation contact (IC-rated) or no insulation contact (non-IC-rated). Light fixtures that are evaluated to the UL 1598 standard for an IC-rating may have exterior temperatures as high as 194°F (90°C) and recessed light fixtures that are not IC-rated may have surface temperatures as high as 300°F (150°C). It is imperative that plastic pipes be protected from exposure to these temperatures.

PEX tubing will not melt at 194°F. However, frequently repeated or long-term exposure to air or surface temperatures above 180°F (82°C) may have negative effects, potentially leading to premature tubing failure. It is recommended that, even with IC-rated recessed light fixtures, the tubing installer should ensure that adequate spacing exists so that the surface temperature of the PEX is kept to 180°F or less when lights are in operation and the environment surrounding the pipes represents a typical situation of the building when occupied (e.g., after construction is complete and the space is heated) (see **Figure 9.20**).

If the available air space is not sufficient to ensure that the surface temperature of the tubing is 180°F or less, then the PEX installer should protect the pipe with adequate thickness of insulation of a type that is approved by the tubing manufacturer and recommended by the insulation manufacturer for that type of installation, to ensure that the surface temperature of the pipe is 180°F or less when lights are in operation and the environment surrounding the pipes represents a typical situation of the building when occupied (e.g., after construction is complete and the space is heated) (see **Figure 9.21**).

CAUTION: If any plumbing supply pipe is installed too closely to a hot light fixture, the ambient heat from the fixture may increase the temperature of the water within the pipe, potentially delivering a short burst of excessively hot water to a user of the plumbing system when a valve is opened, for example, and potentially scalding the user. This is a potentially dangerous situation, regardless of which type of plumbing pipe material (e.g., plastic, metal) is used.

See **PPI TN-56** ***Installation of Plastic Pressure Piping Materials Near Insulation Contact-Rated and Non-IC-Rated Recessed Lighting Fixtures*** for more information.

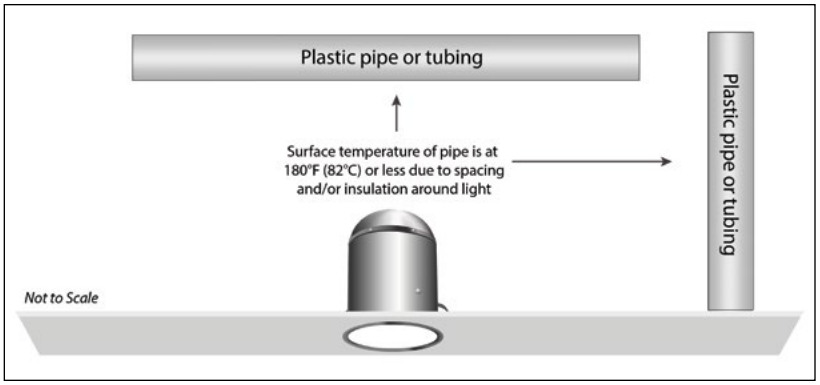


Figure 9.20 Protecting PEX Tubing against Excessive Air Temperature with Distance

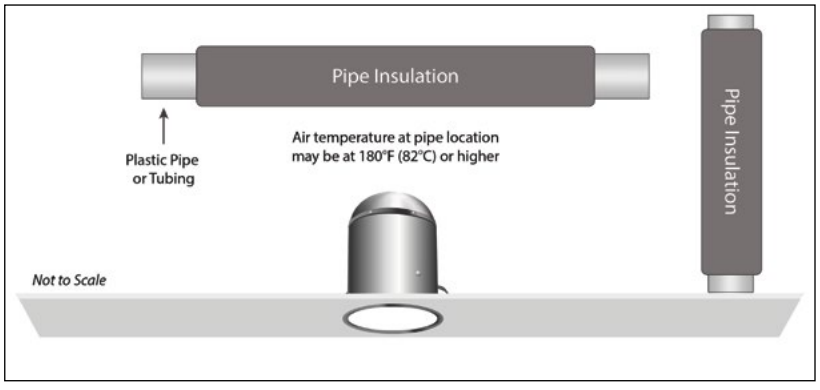


Figure 9.21 Protecting PEX Tubing against Excessive Air Temperature with Approved Insulation

Protection from Excessive Temperatures

If PEX tubing is installed too closely to an external source of heat (e.g., combustion water heater flue pipe), frequently repeated or long-term exposure to air or surface temperatures above 180°F (82°C) may have negative effects, potentially leading to premature tubing failure. It is recommended that the tubing installer should ensure that adequate spacing exists so that the surface temperature of the PEX tubing is kept to 180°F (82°C) or less when equipment is in operation and the environment surrounding the tubing represents a typical situation of the building when occupied (e.g. after construction is complete and the space is heated) (see **Figure 9.20**).

If the available air space is not sufficient to ensure that the surface temperature of the tubing is 180°F (82°C) or less, then the tubing installer should protect it with adequate thickness of insulation of a type that is approved by the tubing manufacturer for use with the specific type of PEX and recommended by the insulation manufacturer for that type of installation to ensure that the surface temperature of the PEX is 180°F or less when equipment is in operation and the environment surrounding the tubing represents a typical situation of the building when occupied (e.g. after construction is complete and the space is heated) (see **Figure 9.21**).

CAUTION: If any plumbing supply pipe is installed too close to a hot appliance, the ambient heat from the device may increase the temperature of the water within the pipe, potentially delivering a short burst of excessively hot water to a user of the plumbing system when a valve is opened, for example, and potentially scalding the user. This is a potentially dangerous situation, regardless of which type of plumbing pipe material (e.g., plastic, metal) is used.

Do not install PEX tubing where the pressure/temperature rating of the tubing could be exceeded.

Cutting PEX Tubing

For all types of PEX connections, it is important to have a clean, square cut at the end of the tubing without burrs or shavings to prevent the risk of leakage at fittings and connections (see **Figure 9.22**).

Use only a PEX tubing cutter that is intended for this purpose and approved by the tubing manufacturer (see **Figure 9.23**).

Figure 9.22 PEX Tubing with Clean Square Ends

Figure 9.23 Typical PEX Tubing Cutter

Linear (Longitudinal) Expansion & Contraction

The typical rate of linear or longitudinal expansion of PEX tubing is 1.1 inch per 10°F per 100 ft. length. For example, a 100 ft. long section of PEX tubing which undergoes a temperature increase from 70°F to 120°F (a 50°F temperature increase) will see linear expansion of 1.1 x 5 = 5.5 inches.

For nominal tubing size (NTS) of 1 and smaller, temperature changes in typical plumbing systems are usually accommodated by the tubing's flexibility and its ability to bend to accommodate expansion and contraction. During installation, do not pull tubing tightly, as this can cause excessive tensile force on fittings and connections when tubing cools and contracts due to a colder operating temperature.

It is recommended to allow 1/8 inch of slack per ft. of installed tubing (0.3 cm slack per 30 cm length) to allow for contraction when tubing cools (see **Figure 9.24**). When the tubing gets warmer, it will simply expand within the available space. PEX tubing should not be rigidly anchored to allow for free longitudinal movement of the tubing to accommodate thermal expansion.

Figure 9.24 PEX Tubing Installed with 1/8 inch Slack Per Foot

Expansion loops and offsets (see **Figure 9.25**) can also be used to accommodate high rates of tubing expansion and contraction when needed. When creating expansion loops, be sure to follow minimum tubing bend radius, measured at the mid-point of the bend, per **Table 9.1**, and for both expansion loops and offsets, fasten tubing appropriately to prevent unwanted movement that could result in noise. Refer to the PEX tubing manufacturer's installation instructions for more detailed information on thermal expansion and contraction compensation techniques.

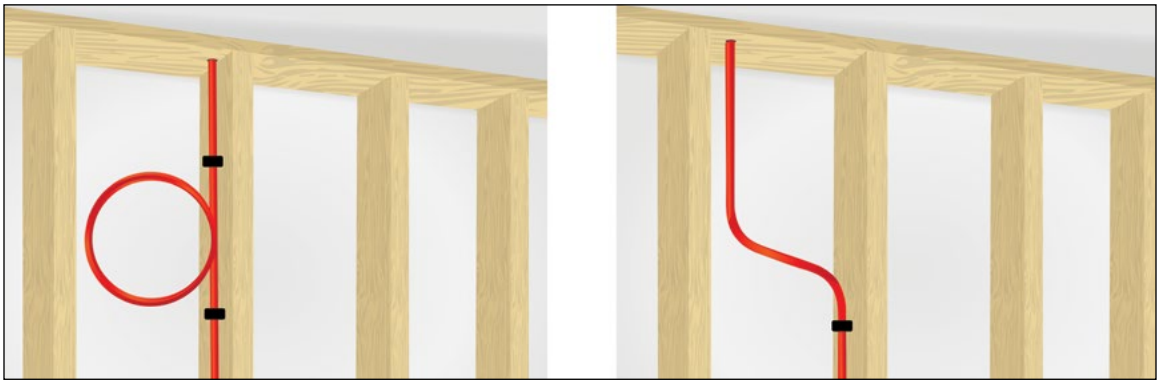


Figure 9.25 PEX Illustration of Thermal Expansion Loop (left) and Offset (right)

Larger PEX diameters (e.g., nominal tubing size 1 or larger) are not as flexible, so when installed as hot-water lines, expansion loops, arms, or legs may be needed to accommodate longitudinal thermal expansion, depending on the installation type and the expected temperature changes (see **Figure 9.26** and **Figure 9.27** for illustrations of an expansion arm and loop, respectively).

The **ASHRAE Handbook – Fundamentals** Ch. 22 *Pipe Design*, the **PPI Plastic Pipe Design Calculator**, and PEX tubing manufacturers' instructions can assist with calculations for thermal expansion and contraction and design of expansion arms and loops. www.plasticpipecalculator.com.

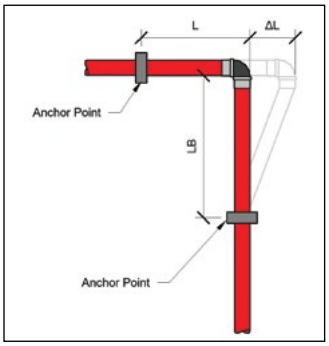


Figure 9.26 Expansion Arm Using One Elbow and Two Anchors

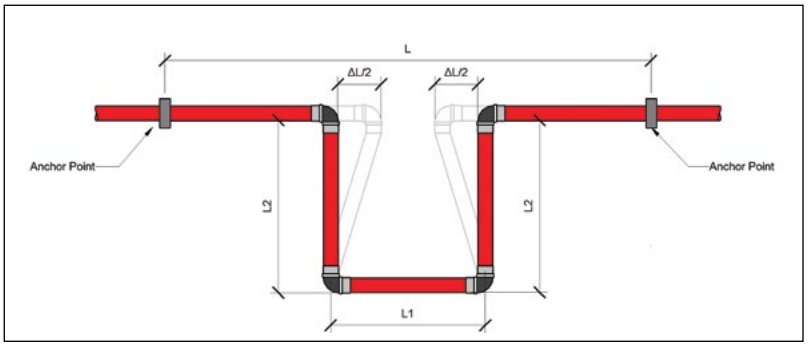


Figure 9.27 PEX Expansion Loop Using Four Elbows and Two Anchors

Installation Under Slabs

PEX tubing is recommended for hot- and cold-water distribution piping under slabs in most applications.

Laying and Supporting Tubing under Slab

For slab-on-grade installations, PEX tubing shall be completely buried by a suitable, easily compacted, backfill material such as sand or pea gravel, such that the tubing cannot come in contact with rebar, reinforcing wire mesh, or tensioning cables in the slab, or the slab itself (see **Figure 9.28**). Other soil materials without rocks or sharp edges may also be allowed, based on local building practices.

Figure 9.28 PEX Installed in Ground Below a Future Slab

Unless required by local code, it is not required to sleeve PEX tubing over its entire length where it lies beneath a slab, but tubing must be protected against abrasion with the slab by using a non-metallic sleeve or guide (e.g., PVC bend guides, PE sleeving) where it passes through and emerges from the slab (see **Figure 9.29** and **Figure 9.30**). This will serve to protect the PEX tubing from accidental damage as the slab is poured, leveled, and smoothed and from subsequent framing and construction work.

Figure 9.29 PVC Bend Guide for Protecting PEX when Emerging from a Slab

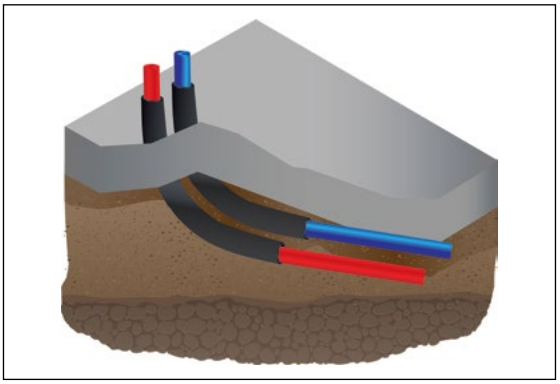


Figure 9.30 PEX Tubing Protected with Sleeving when Emerging from a Slab

PEX tubing emerging from a slab may need support to keep it vertical and prevent it from falling back onto the slab. To support the tubing in these cases, PEX can be carefully tied to a vertical piece of re-bar, wood stakes, or a rigid drainpipe for support. Some manufacturers also provide special guides for this purpose (see **Figure 9.31**).

Local codes may require insulation of PEX tubing under slabs. Follow the tubing manufacturer's recommendations for approved insulation materials.

Figure 9.31 PEX Tubing Held Vertically when Emerging from a Slab Using Special Guides

Termiticides or Pesticides

If termiticides or pesticides are applied to the soil or structure, all ends of the tubing must be closed or capped to prevent entry of chemicals into the pipe. Also, it is important to ensure that no pooling or puddling of the termiticide or pesticide occurs in the spacing between any sleeving and PEX tubing at the slab penetration. This spacing should be filled with sealants that are compatible with PEX. Please reference **PPI TN-39** ***Recommended Practices Regarding Application of Pesticides and Termiticides Near PEX Tubing*** for additional information.

Protection of Tubing and Fittings from UV Exposure after the Pour

Due to the nature of slab-on-grade installations, tubing and fittings might be exposed to sunlight for unspecified periods of time before or after a slab is poured and before the structure is framed and enclosed. To prevent damage from excessive UV exposure, PEX tubing and fittings that are exposed above the slab must be wrapped with an opaque covering such as black polyethylene bags or sheeting immediately after the pouring of the slab, per manufacturer's instructions. This covering should extend down to the surface of the slab to protect the entire tubing surface above the slab from excessive UV exposure. For specific limitations on UV exposure, consult the PEX tube manufacturer.

It is recommended to not wrap tubing in duct tape for protection from sunlight or any other reason. Check with the tubing manufacturer for proper methods of protection from sunlight in these locations.

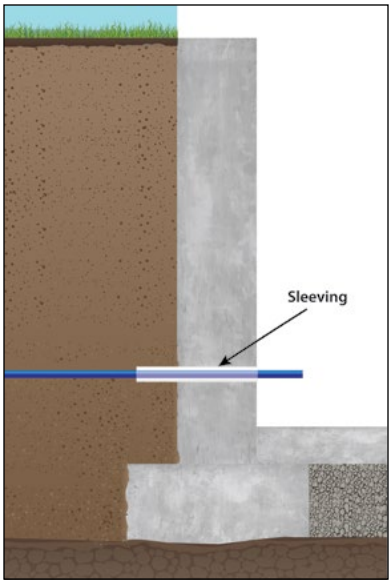


Figure 9.32 PEX Tubing Protected Against Pinching or Shearing at a Foundation Wall Penetration

Penetrating Foundation or Basement Walls

When PEX tubing passes through a basement or foundation wall, it must be protected by a rigid sleeve that spans the distance from within the wall out to the undisturbed soil in the pipe trench (see **Figure 9.32**). The purpose of this protective sleeve is to prevent pinching or shearing of the PEX tubing at the wall in the event there is settlement in the backfill around the wall.

At the point where the sleeve terminates inside the foundation or wall, the space between the PEX and the sleeve should be sealed with an approved caulking material to prevent leakage into the building.

Note: Petroleum-based caulks or sealants should not come in direct contact with PEX. Contact the tubing manufacturer for approved sealant and caulking materials.

Spray Foam Insulation

The spray polyurethane foam (SPF) curing reaction is exothermic, which means that heat is generated during the foam reaction. The heat of reaction is highly dependent on the SPF formulation and is also based upon the overall intended application or lift (i.e., layer) thickness installed. Peak temperature within the layer of foam typically occurs within 5 to 15 minutes of application, followed by gradual cooling.

The installation of spray polyurethane foam insulation on or around PEX tubing is typically acceptable when allowed by the pipe and fitting manufacturer and when the SPF installer strictly follows the recommendations of **PPI TN-69 *Recommendations When Applying Spray Polyurethane Foam Insulation On and Around Plastic Pressure Pipes & Fittings***, as well as the installation recommendations published by the Spray Polyurethane Foam Alliance (SPFA). www.sprayfoam.org.

To avoid excessive temperatures, Do Not encase PEX tubing and fittings in a single pass of SPF (see **Figure 9.33**).

SPFA recommends that when there are plastic pipes in a wall, ceiling, or floor cavity, the SPF installer should apply the first layer of foam until it just barely touches or encases the tubing, but keeping portions of the tubing exposed (see **Figure 9.34**).

SPF installers should let the first layer of foam cure for a sufficient amount of time while the heat is released and the tubing remains partially exposed. Typically, this is when the surface of the SPF has cooled to approximately 100°F (38°C). Then, they may apply the second layer or lift. This way, the tubing is never in the middle of a thick layer of foam insulation during curing. If tubing is installed at different depths, installers should continue this process for each depth of tubing.

Incorrect Installation

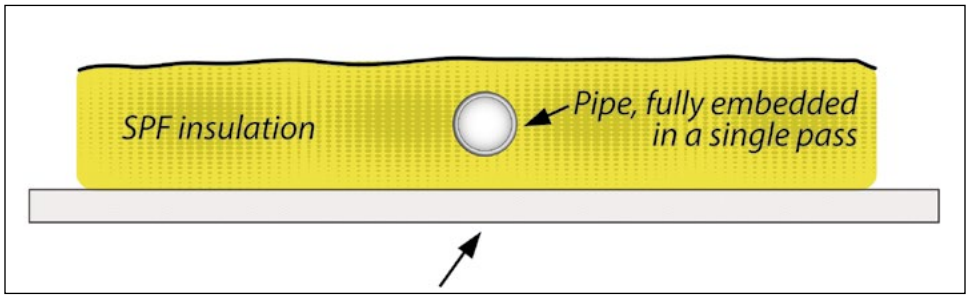


Figure 9.33 Incorrect Procedure for Installing SPF Insulation in a Single Pass, Potentially Damaging PEX Tubing and Fittings

Correct Installation

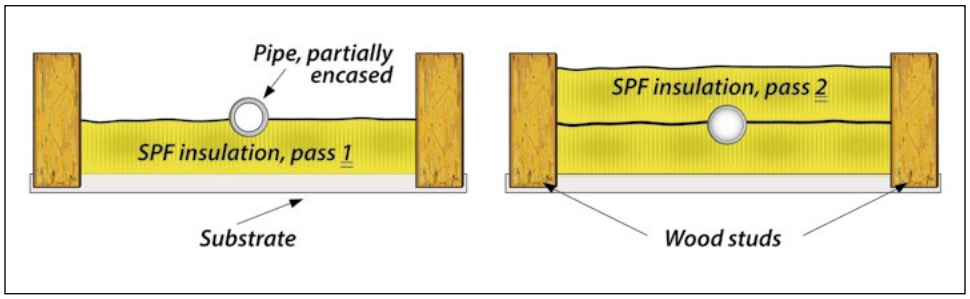


Figure 9.34 Correct Procedure for Installing SPF Insulation in Multiple Steps to Protect PEX Tubing

Protection of Polymer Fittings

Certain polymer fitting materials (e.g., polysulfone or PSU, polyphenlysulfone or PPSU) may be incompatible with spray foam insulation and might have chemical-compatibility issues if the fittings are encased directly in SPF (see **Figure 9.35**). Direct encasement of polymer fittings in spray foam is not recommended.

It is strongly recommended to completely wrap polymer fittings in aluminum foil, linerless tape, or other approved protective methods to provide a chemical barrier prior to foam application. Metallic fittings should be considered an alternative in situations where this protection is not possible.

When using polymer fittings, consult the fitting manufacturer to confirm chemical compatibility and the appropriate use of any protective materials.

Figure 9.35 Incorrect Placement of Spray Foam Insulation Directly on Polymer Fitting

Connection to Water Heaters and Other Heat Sources

When connecting PEX tubing to storage-type water heaters (oil, gas), the tubing must be kept at least six (6) inches (15 cm) away from the exhaust or flue pipe to prevent overheating. Flexible metal water heater connectors of at least 18 inches (457 mm) in length may be used to allow PEX tubing to be positioned away from flue pipes. This recommendation (18-inch metal connector) also applies to electric storage-type water heaters.

Per **PPI Recommendation H** ***Recommendation on Direct Connection of Plastic Piping Materials to Tankless Water Heaters for Domestic (i.e., residential) Applications***, PEX tubing may be connected directly to tankless or instantaneous water heaters which are intended for domestic (i.e., residential) applications, unless prohibited by local plumbing code or the specific water heater manufacturer.

For any type of water heater (e.g., storage tank, tankless, heat pump, indirect storage tank), if the inlet or outlet water piping connection positions the piping so that it might be exposed to sources of heat (e.g., vent or exhaust heat) other than the water being discharged by the water heater, the installer should use an appropriate metallic connector of sufficient length to separate the PEX tubing from the heat source so that it is not exposed to temperatures in excess of 180°F (82°C).

Connection/Transition to Other Piping Materials

PEX manufacturers offer a wide variety of transition fittings to allow direct connection of PEX tubing to copper, chlorinated polyvinyl chloride (CPVC), polybutylene (PB), polypropylene (PP), steel, or other piping materials. These fittings may transition PEX to other piping materials via tapered threads, flanges, press connections, push-fit fittings, solvent cement, or soldering (see **Figure 9.36** for examples of PEX transition fittings).

In most cases, the transition fitting should be attached to the other material (e.g., copper, steel, CPVC) before the connection to PEX is made. Be sure to solder copper transition fittings onto copper tubing first and allow them to cool before connecting to PEX tubing, because the high heat of soldering (e.g., greater than 180°F) may damage the PEX tubing and its connection.

Be sure to prevent contact with solder flux or ABS, PVC, or CPVC primer and solvent cement with plastic fittings (see **Figure 9.37**).

Push-fit fittings per ASSE 1061 are available to adapt PEX to other tubing materials directly (see **Figures 9.38**, **9.39**, and **9.40** for examples of PEX transition fittings).

Figure 9.36 Examples of PEX Transition Fittings for Sweat, Press, and Threaded Connections

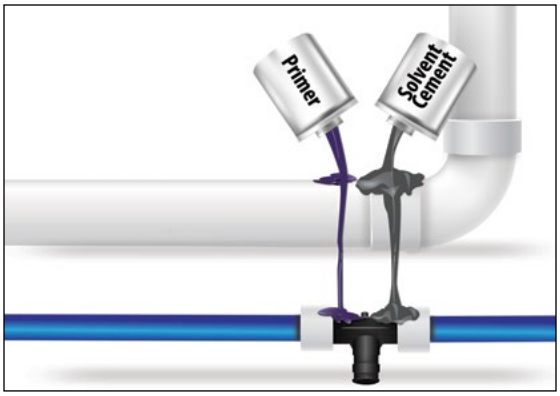


Figure 9.37 Prevent Contact with ABS, PVC, or CPVC Primer and Solvent Cement with Plastic Fittings

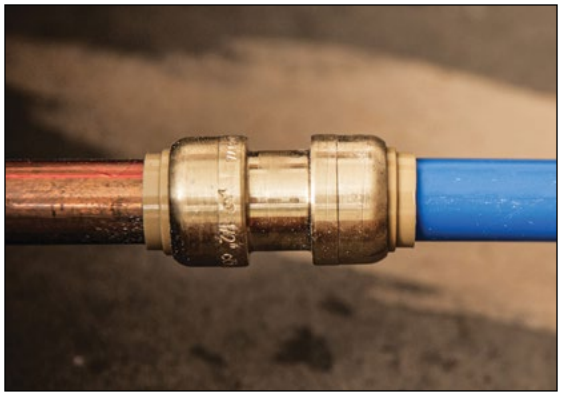


Figure 9.38 Push-Fit PEX Transition Fitting to Copper

Figure 9.39 Push-Fit PEX Transition Fitting to CPVC

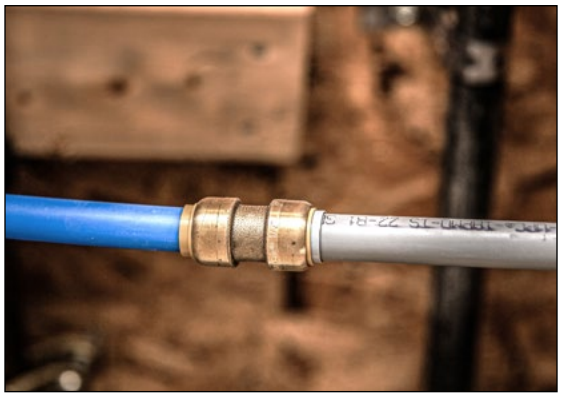


Figure 9.40 Push-Fit PEX Transition Fitting to PB

Do not use standard female plastic tapered (NPT) threaded fittings with metallic male tapered threaded fittings, since this may split the plastic female fitting. However, female plastic tapered (NPT) threaded fittings with metal reinforcements (e.g., a brass liner) may be connected to metallic male tapered threaded fittings when approved by the fitting manufacturer for that purpose.

Connections to Basin or Toilet Valves

Several options are available for supplying a basin or toilet valve below a sink or toilet with PEX tubing within the wall.

- PEX tubing may be run continuously to the exposed valve supported by a fastener on a nearby stud within the wall for rigidity (see **Figures 9.41**, **9.42** and **9.43**).
- A 90-degree support with a mounting plate may be used for this purpose (see **Figure 9.44**).
- Push-fit valves produced according to ASSE 1061 and intended for direct connection to PEX tubing may be used.
- PEX tubing may transition to a copper stub ell within the wall (see **Figure 9.45**) so that only the copper stub is visible in the room. In these cases, a standard solder, push-fit, or compression valve may be attached to the copper stub.

Figure 9.41 PEX Tubing Run Through the Wall to a Plumbing Fixture

Figure 9.42 PEX Tubing Run Through the Wall to a Plumbing Fixture

Figure 9.43 PEX Tubing Run Through the Wall to a Plumbing Fixture

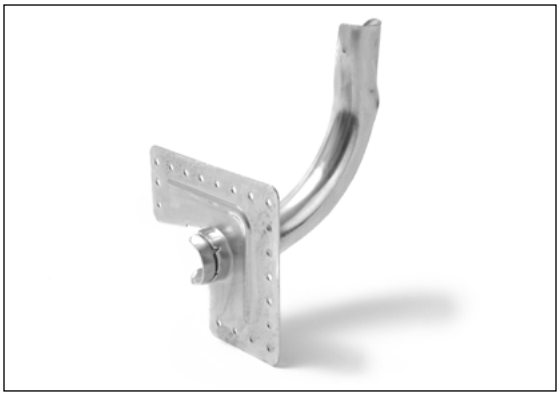


Figure 9.44 90-Degree PEX Support with Mounting Plate

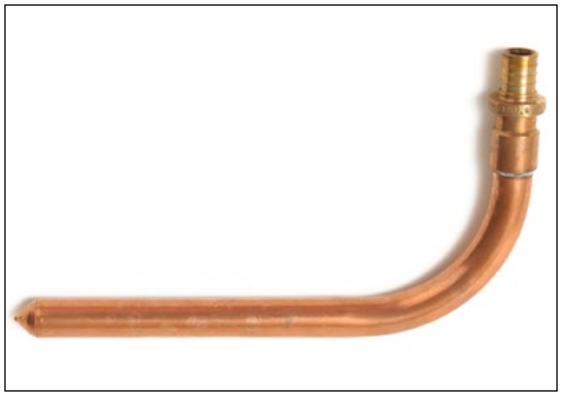


Figure 9.45 PEX/Copper Stub Ell

Hose Bibbs/Wall Hydrants/Sillcocks

PEX tubing may be used to supply hose bibbs, wall hydrants, and sillcocks and may be connected to standard hose bibbs by using a PEX transition fitting (see **Figure 9.46**. Several hose bibb manufacturers produce their assemblies with PEX connections as part of the assembly.

Hose bibbs should be protected from freezing using insulation (see **Figure 9.47**). Hose bibbs shall be anchored to prevent strain on PEX tubing and shall be supported with appropriate brackets and shall not be supported by PEX tubing alone.

Figure 9.46 PEX Connected to a Hose Bibb/Wall Hydrant

Figure 9.47 Insulated Hydrant to Prevent Freezing

Shower Valves

PEX tubing may be connected directly to shower valves using adapter fittings provided by the tubing manufacturer or using a shower valve with built-in PEX tubing connections (see **Figure 9.48**).

It is recommended to use PEX tubing for the hot- and cold-water supply lines to shower valves and for the supply line from the shower valve to the shower head or body sprays. However, it is not recommended to use PEX tubing for the connection from the valve to a tub valve/outlet, due to the potential for imbalanced flow to tub valves, which may prevent proper action of the valve (see **Figure 9.49**).

Figure 9.48 PEX Tubing Connected to a Shower Valve in 3 Locations

Figure 9.49 PEX Tubing Connected to a Shower Valve in 3 Locations

Other Valves

Many styles of valves may be used with PEX tubing systems, including ball valves which are manufactured directly with PEX connections on one or both ends (see **Figure 9.50**). When required by local code or regulations, thermostatic mixing valves (see **Figure 9.51**) and pressure regulating valves (see **Figure 9.52**) are also available with integrated PEX connections. Transition fittings may also be used to connect PEX tubing to standard threaded, solder, plastic, or flanged valves.

Figure 9.50 Ball Valve with F1960 PEX Connections

Figure 9.51 Thermostatic Mixing Valve with F1807 PEX Connections

Figure 9.52 Pressure Reducing Valve with F1960 PEX Connections

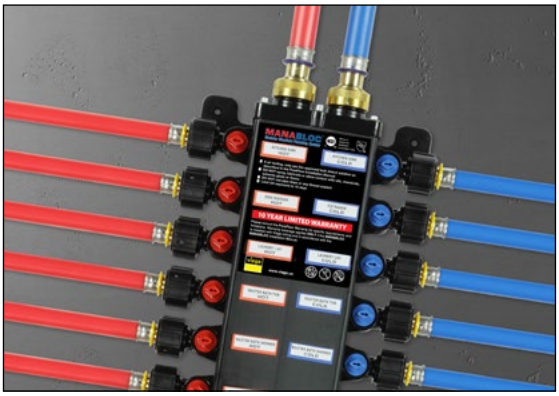


Figure 9.53 Integrated Hot- and Cold-Water Manifold Assembly

Parallel Piping (Home-run) Manifold Installations

As described in **Chapter 6 *Layouts & Design***, in a parallel or "home-run" plumbing system all outlets to fixtures are individually fed from a common manifold or two central manifolds serving hot and cold fixtures (see **Figure 9.53**). The hot water manifold should be located in close proximity to the hot water source (e.g., water heater) to minimize wait time for hot water to fixtures, ensuring efficient delivery and water conservation.

- Manifolds can be installed in a horizontal or vertical position (see **Figure 9.54**)
- In larger installations, with multiple water heaters, use a manifold at each water heater for the fixtures served by the water heater
- Tubing should be run continuously and as directly as possible between manifold and fixture locations
- Approved fittings may be used to repair kinked or damaged PEX distribution lines or to add additional length to a distribution line that was mistakenly cut too short during installation
- Tubing shall not be pulled tight. Leave slack to allow for expansion and contraction

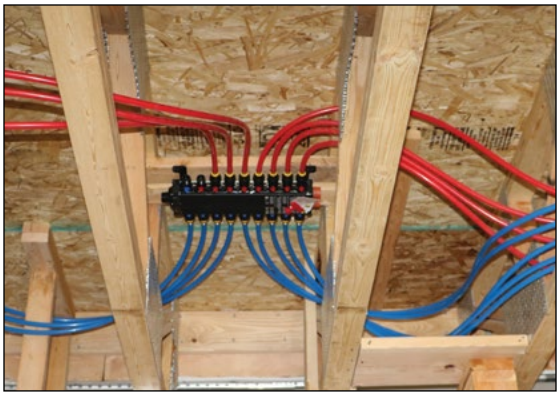


Figure 9.54 Hot- and Cold-Water Manifolds Installed Horizontally Below a Floor

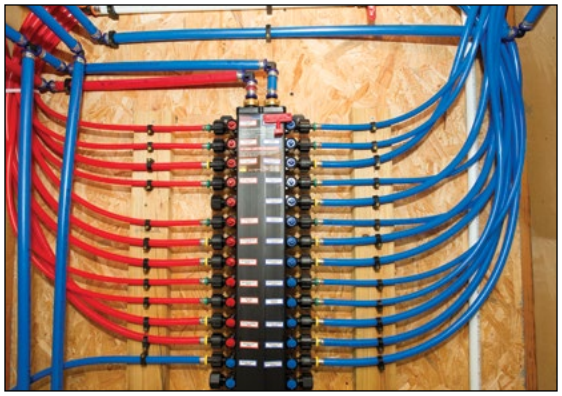


Figure 9.55 Hot- and Cold-Water Runs Labelled

- Install tubing cautiously to avoid bending, kinking, or abrasion
- Leave excess tubing at the beginning and end of runs for connection to fixtures and the manifolds
- When running lines to a group of fixtures, they may be bundled together but must be bundled loosely enough to allow individual tubing movement. Plastic ties may be used. Hot and cold lines may be bundled together but some jurisdictions do not permit this practice. Be sure to check with the local authority
- Do not use tape when bundling tubing, as it may restrict movement of tubing runs and cause chemical compatibility problems
- When bundled lines pass through conventional structural members, cut a hole at the centerline of the member. Consult the applicable code for maximum allowable hole size
- Identify and mark all lines at the manifold (see **Figure 9.55**)
- Manifolds with valves shall be accessible and protected from freezing and exposure to sunlight
- Individual fixture shutoff valves may be installed at the manifold if permitted by the local authority. If installed, they shall be identified as to the fixture being supplied

Retrofit Installations

PEX tubing is ideal for retrofit applications and may be used to repair or replace lead, galvanized steel, copper, polybutylene, or other piping materials. The flexibility of the product and continuous lengths allow for easier installation in existing walls and structures than traditional rigid piping systems. In some cases, existing pipes may even be downsized to smaller diameter PEX tubing, when flow calculations indicate that original pipes are larger than needed. This may help to improve water quality by reducing exposure to older metal pipes and by reducing water stagnation with smaller pipes.

Several varieties of fitting adapters are available for simple transition between piping systems, such as solder, threaded, and polybutylene adapters. Consult the manufacturer for available product offerings. The use of PEX in retrofit applications should follow the same installation instructions described in this guide, as well as local codes.

Thawing Frozen PEX Tubing Systems

Although PEX tubing has been shown to be freeze-break resistant (see **Chapter 3 *Material Properties***), PEX tubing systems should not be intentionally subjected to freezing.

For frozen tubing that is accessible, the following methods of safely thawing it may be used:

- Pour warm or hot water over the affected portion of the frozen tubing
- Apply hot air to the outside of the tubing using a hot air gun or hair dryer to heat frozen areas. Ensure that the temperature of the tubing does not exceed 180°F (82°C); ice should thaw long before this temperature is reached
- Wrap a warm moist towel around frozen tubing to thaw ice
- Use a temporary space heater to warm the general area around the frozen tubing

Thawing inaccessible frozen tubing can be performed using available hot water injection equipment which sprays hot water into an open end of a tube through a nozzle which is designed to propel itself forward through the tube until it reaches the ice blockage. This is usually performed at moderately warm water temperatures. The maximum water temperature allowed for thawing is 180°F.

After thawing, PEX tubing can immediately be put back into service, unless there are signs of damage.

Follow the manufacturer's published guidelines and recommendations.

Figure 9.56 Inappropriate Use of Flame on PEX Tubing

NOTICE: Do not use an open flame, excessive heat, or an electric resistance pipe thawing device (e.g., HotShot™) to thaw frozen plastic pipe, as this could damage the tubing and result in property damage and loss of water pressure (see **Figure 9.56**).

Disinfection of Potable Water Systems

New or repaired potable water systems shall be disinfected prior to use where required by the Authority Having Jurisdiction. The method to be followed shall be that prescribed by the local code or Health Authority. See **Chapter 3 *Material Properties*** section on "Resistance to Disinfectants" for more information.

One resource for disinfections procedures is the "AWWA Technical Report Disinfecting Building Potable Water Plumbing in New or Repaired Systems," first published in November 2024. Excerpt: "The purpose of this technical report is to recommend procedures for the process of preparing and disinfecting new and repaired building potable water systems. Guidance provided in this technical report was developed for implementation in buildings constructed with a reasonable standard of clean and sanitary practices to keep water piping, components, and equipment clean during construction or repair."

Pressure Testing and Inspection of the Completed System

Pressure testing of a completed piping system is typically required by local code regulations and the tubing manufacturer to ensure pressure-tightness. When performing hydrostatic testing (i.e., testing with water pressure), test the system with potable water only to prevent contamination. Do not allow water in the system to freeze.

Test pressure shall be at least equal to the expected working pressure of the plumbing system, but not less than 50 psi (345 kPa) and not greater than 160 psi at 73°F (1,103 kPa at 23 °C), or as recommended by the tubing manufacturer.

If it is difficult to test using pressurized water because of freezing conditions, insufficient water supply, or insufficient water pressure, pressure testing using compressed air or inert gas (e.g., helium, nitrogen) is a recommended solution, when approved by the PEX system manufacturer and local codes. While some types of plastic pipe and fitting materials are not suitable and not permitted to be tested with compressed air or gas, PEX tubing is not subject to brittle failure.

For systems that incorporate plastic fittings, valves, or manifolds, air testing shall be in accordance with each component manufacturer's instructions. If the manufacturer of any pressurized component does not recommend air pressure testing at the required pressure, then that component must be isolated or removed from the system prior to an air pressure test.

WARNING: Compressed air or inert gas used for pressure testing has high potential (stored) energy. Any uncontrolled release of that energy can present serious safety hazards.

ASTM F2786 *Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Gaseous Testing Media Under Pressure (Pneumatic Leak Testing*) provides several recommendations for safely testing polyethylene pipes in a wide variety of sizes and situations. See **PPI Recommendation F *Testing PEX and PE-RT Tubing Systems with Compressed Air or Gas*** for more details.

Friction Losses

For friction loss through PEX tubing, please use the **PPI Plastic Pipe Design Calculator** at www.plasticpipecalculator.com.

For friction loss through PEX fittings, please contact the PEX system manufacturer.

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