

# INSTALLATION HANDBOOK:

## Cross-linked Polyethylene (PEX) Hot- and Cold- Water Distribution Systems

### IMPORTANT NOTICE

The information in this manual was gathered from publicly available sources, including reports of tests conducted by various independent entities under the test conditions specified in the standards listed.

The contents of this manual are informational only and are not intended as an endorsement or warranty with respect to any product or system.

The Plastic Pipe and Fittings Association (PPFA) and its members have no responsibility for the design, administration, results or evaluation of any test. PPFA and its members make no warranties, express or implied, as to: the fitness of any product or system for any particular purpose; the suitability of any product or system for any specific application; or the performance of any product or system in actual construction.

No product or system should be used or installed without first reviewing all applicable plumbing or building code provisions and the manufacturer's installation or application instructions. Local code authorities and the product or system manufacturer should be consulted with respect to unresolved questions or uncertainties.

In the event there is any conflict or inconsistency between the content of this MANUAL and the applicable building or plumbing code and the manufacturer's installation or application instructions, the codes and the instructions shall be followed.

### REVISION POLICY

The PPFA Flexible Polyolefin Hot and Cold Water Systems Product Line Committee is responsible for revision of the manual. All suggestions and recommendations for revisions shall be addressed to the Committee, which shall respond to them as promptly as reasonably possible.

The Committee shall review the manual in its entirety at least once every three (3) years.

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## MANUAL CONTENT & USE

This Manual contains information on the installation of Cross-linked Polyethylene (PEX) tubing for hot and cold water distribution systems in residential and light commercial installations using tubing up to 1" in diameter.

Information in this manual shall not be separated as it is often interrelated.

Consult local codes for additional installation requirements.

For additional information contact:

Local officials having jurisdiction (for codes)

Manufacturer (for specific product information)

PPFA (for general installation instructions)

Plastic Piping Institute (PPI)

## OTHER USES OF CROSS-LINKED POLYETHYLENE (PEX) TUBING

- Hydronic Radiant Heating
- Heat Pump Applications
- Other Uses With Similar Service Requirements

**Note:** Consult tubing manufacturer for details.

## TUBING IDENTIFICATION

Check the PEX tubing for the proper ASTM identification marking.

Use	ASTM Standard	Canadian Standard
Hot/Cold Water	F 876 or F 876/F 877 and Standard for Fittings	CSA B137.5

Please refer to the "Tubing Markings" table below.

Check for potable water listing (NSF International, Inc. [NSF-pw], or other recognized listing agency).

### Tubing Markings

Marking	Typical Example
Tube size	¾" CTS (0.875 O.D.)
ASTM Standard	ASTM F 876 or F 876/F 877
Standard dimension ratio	SDR 9
Pressure rating	160 psi @ 73.4°F, 100 psi @ 180° F
Marks of listing agencies	NSF -pw NSF International CSA Canadian Standards Assoc. UPC IAPMO UL Underwriters Laboratories, Or others.
List of fittings standards with which tubing is compatible	*Note: Manufacturers may choose the agency (or agencies) with which they list. All of the examples shown are not required on an individual product.  Examples (ASTM F 1807, F 1960, F 2080 or others)
Manufacturer name or trademark	Depends upon manufacturer
Production code	Depends upon manufacturer
Designation code	PEX 1006

## FITTING IDENTIFICATION

All fittings shall be marked with:

Manufacturer's name or Trademark or other identification mark, plus the ASTM standard specification with which the fitting complies.

## APPLICABLE STANDARDS

- **ASTM F 876** - Specification for Cross-linked Polyethylene (PEX) Tubing.
- **ASTM F 877** - Specification for Cross-linked Polyethylene (PEX) Plastic Hot and Cold Water Distribution Systems.
- **ASTM F 1807** - Specification for Metal Insert Fittings Utilizing a Copper Crimp Ring for SDR 9 Cross-linked Polyethylene (PEX) Tubing
- **ASTM F 1960** - Specification for Cold Expansion Fittings with PEX Reinforcing Rings for use with Cross-linked Polyethylene (PEX) Tubing
- **ASTM F 2159** - Standard Specification for Plastic Insert Fittings Utilizing a Copper Crimp Ring for SDR9 Cross-linked Polyethylene (PEX) Tubing
- **ASTM F 2080** - Standard Specification for Cold-Expansion Fittings With Metal Compression-Sleeves for Cross-Linked Polyethylene (PEX) Pipe
- **ASTM F2098** - Standard Specification for Stainless Steel Clamps for Securing SDR9 Cross-linked polyethylene (PEX) Tubing to Metal Insert Fittings
- **CSA B137.5** - Cross-linked Polyethylene (PEX) Tubing Systems for Pressure Applications

## LIMITATIONS ON PEX USE

- Do not use in applications where the temperature of the water could exceed 180° F at 100 psi unless specifically approved in the code, e.g., water heater relief line. See manufacturer's recommendations for higher operating temperatures at lower pressures.

- Do not use in any application where tubing will be exposed to direct sunlight.

- Do not allow tubing to come in extended contact with any of at least the commonly encountered construction materials listed below:

(This list is not all-inclusive.)

Pipe thread sealing compounds;  
 Fire wall penetration sealing compounds. *Exception: water soluble, gypsum-based caulking or other sealants approved by the PEX tube manufacturer;* Petroleum-based materials or sealants such as: Kerosene, Benzene, Gasoline, Solvents, Fuel Oils, Cutting Oils, Asphaltic Paint, and Asphaltic Road Materials, Acetone, Toluene, Xylene. Consult your tubing manufacturer if you have questions about these or any other materials not listed.

- Do not place any PEX tubing in heavily contaminated soils or other heavily contaminated environments.

- Do not use tubing with gouges, cuts, cracks, abrasions, evidence of chemical attack, or other defects, or tubing which has been crushed or kinked.

- Do not use in swimming pool piping systems.

- Copper or brass fittings, when used in a PEX piping system, have the same limitations as copper or brass fittings used in plumbing or heating systems.

- Store fittings in containers that are free of oil, grease, lubricants, solder flux or other chemicals, and away from corrosive atmospheres (Example: Ammonia).

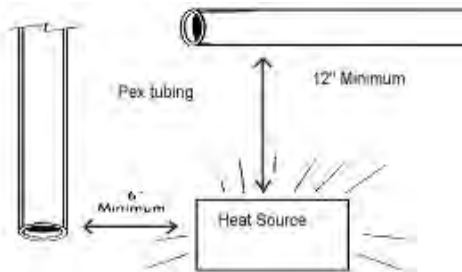
## TUBING INSTALLATION PRACTICES

### GENERAL INSTALLATION

Review all limitations on the use of cross-linked polyethylene tubing, and

the fitting system you have selected to use.

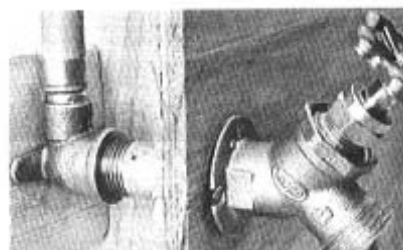
- Keep tubing a minimum of 12 inches vertically or 6 inches horizontally from sources of high heat, such as recessed light fixtures, flue gas vents, or heating appliances.



- Do not install PEX tubing downstream of any point-of-use water heater or immersed coil heater in a boiler where the output temperature can exceed 180° F or closer than 6 inches upstream. Contact manufacturer for recommended metallic transition fittings.

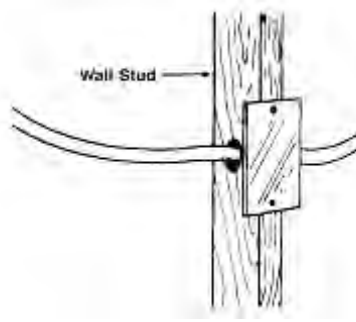
- PEX tubing may be connected directly to residential electric water heaters, if the local code and manufacturer's instructions allow. When connecting PEX tube to gas water heaters, the tube must be kept at least 6 inches away from the exhaust vent of the heater. Flexible metal water heater connectors may be needed in some instances.

- Hose bibbs shall not be supported by PEX tubing. Hose bibbs shall be anchored to prevent strain on PEX tubing.



- Use only continuous length tubing (no fittings) when installing PEX under or within a slab. Protect PEX tubing with nonmetallic sleeves where it penetrates a slab or foundation. (Examples: PVC bend guides, PE

sleeving). Protect tubing from nail damage where appropriate.



### BENDING THE TUBING

Do not bend PEX tubing tighter than the following minimum recommended bending radii .

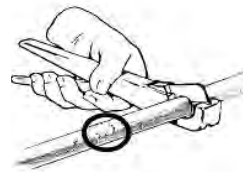
Tubing size (in.nominal)	Minimum bending radius (in.) CTS
3/8	4
1/2	5
3/4	7
1	9

**NOTE:** If using tubing in coils, and bending the tubing against the coil direction, the minimum bending radius is 3 times the radius given above (e.g., 3/8" Tubing = 3 x 4 = 12").

### Handling and Storing Tubing and Fittings



- Do not drag the tubing over rough terrain, rocks, or any surface that can cut, puncture, or damage the tubing wall.
- Do not crush or kink the tubing.
- Inspect all tubing and fittings



before and after installation. Cut out and replace all damaged sections or fittings.

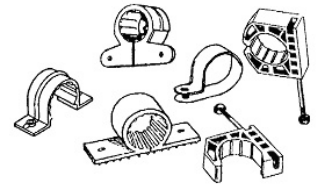
■ Tubing shall be stored in a way to protect the system from mechanical damage (slitting, puncturing, etc.). Tubing and fittings shall be stored undercover for cleanliness and to avoid exposure to sunlight. Consult



manufacturer for recommended limits for outside storage.

### Tubing Supports: Selection and Inspection

Plastic hangers and straps are recommended, but metal supports which are designed for use with plastic tubing can be used.

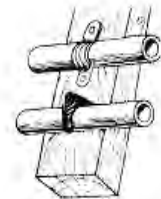
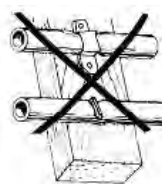


Do not use supports that pinch or cut the tubing. Support should allow free tubing movement.

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

**INCORRECT**

**CORRECT**



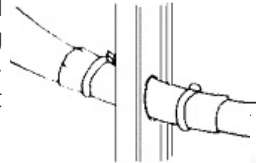
## SUPPORT SPACING & LOCATION

Nominal Tubing Diameter (in.)	Spacing (in.)
3/8, 1/2, 3/4, 1	32

Vertical tubing shall be supported at every floor (8-foot to 10-foot height) and at the mid floor guide between floors.

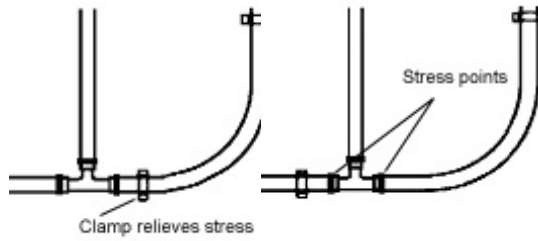
When penetrating metal studs, utilize a properly-designed bushing or sleeving material on all penetrations to protect tubing.

Tubing and fittings shall be installed without placing stress on the connection. Stress on connections frequently occurs when tubing is not properly strapped at changes of directions. See illustrations at right for proper methods.



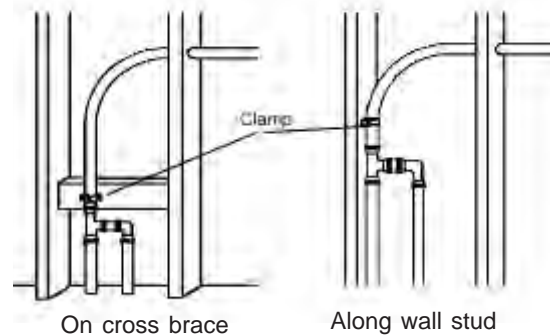
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INCORRECT



*Examples of the use of straps when making bends directly from fittings.*

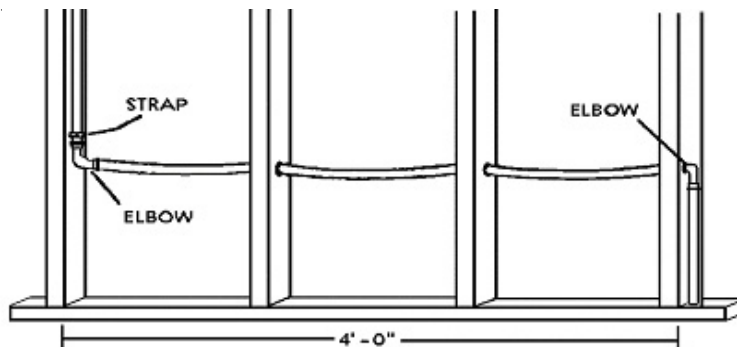
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## EXPANSION / CONTRACTION OF TUBING

Do not pull tubing tight during installation. This can cause excessive tensile forces on fittings and connections when tubing cools and contracts. Allow 1/8-inch slack per foot of installed tubing.

Expansion can usually be accommodated by tubing's flexibility for sizes up to and including 1-inch size tubing.



## HYDRAULIC SHOCK (Pressure Surge)

The following table provides the maximum pressure that will occur from rapid closure of a valve in the various tubing systems at a given velocity. The faster the velocity, the greater the hydraulic shock (pressure surge). Excessive hydraulic shock (pressure surge) may result in audible water hammer with metallic piping systems, though this is highly unlikely with PEX tubing due to the flexibility of the tubing itself.

Table 2 shows the additional hydraulic shock (pressure surge) that can occur in various types of pipes at the water velocities shown when a fast-acting valve closes. Hydraulic shock pressure is in addition to the system static pressure (measured on site). To determine the instantaneous total system pressure that occurs, add the hydraulic shock pressure to the static pressure.

For normal plumbing installations, water hammer arrestors are not necessary with a PEX tubing system.

In predominantly metal piping systems in which PEX is used, it may be necessary to install water hammer arrestors.

Hydraulic shock (psi at 73 F)				
Velocity (fps)	4	6	8	10
PEX	58	87	116	145
Copper	200	300	400	505
Galv.				
Steel	240	360	475	595

## MANIFOLD PLUMBING SYSTEMS

The parallel manifold plumbing concept is relatively simple. Each faucet or water outlet is fed by its own dedicated line which runs from a central manifold. By providing each outlet with its own distribution line, the system offers quieter water flow, more bal-

anced water pressure, a dramatic reduction in the number of fittings required, and the ability to save both water and energy, versus traditional system designs.

The following information applies to a PEX tubing plumbing manifold system in addition to the general limitations and installation information on PEX tubing and fittings in this manual.

- Manifolds can be installed in a horizontal or vertical position.

- In larger installations, with multiple water heaters, remote manifolds may be used to handle groups of remote outlets.

- Each faucet or water outlet is fed by its own dedicated line from the manifold, which may be located near the water supply or water heater.

- Tubing shall 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 to a distribution line that was mistakenly cut too short during installation. Excessive use of fittings is unnecessary.

- Shutoff valves can be placed at the manifold or fixture. Check with your local inspector.

- Tubing shall not be pulled tight. Leave slack to allow for expansion and contraction.

- Install tubing cautiously to avoid binding, kinking, or abrasion.

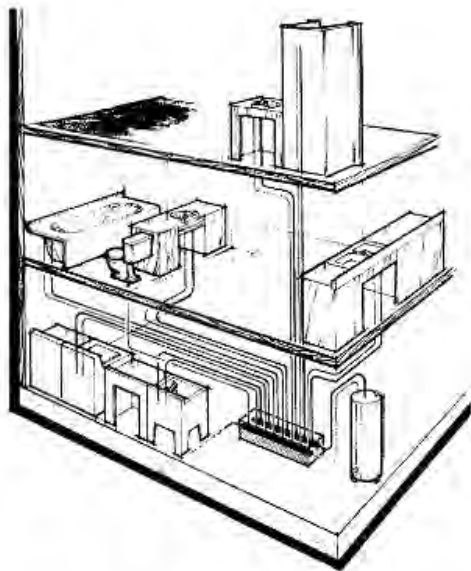
- Leave excess tubing at the beginning and end of runs for connection to fixtures and the manifolds.

- 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.

- Do not use tape when bundling tubing as it may restrict movement of tubing runs.

- 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.



*This drawing represents a typical manifold system.*

### PARALLEL WATER DISTRIBUTION MANIFOLD PLUMBING (HOME RUN) SYSTEMS

Each faucet or water outlet is fed by its own dedicated line from the manifold. Manifolds for hot water should be installed near the water heater to minimize hot water delivery time. Manifolds shall be installed at least 36" away vertically, or 18" away horizontally from the water heater. A manifold for cold water only may be installed near the water supply.

The following information applies to a PEX tubing plumbing manifold system in addition to the general limitations and installation information on PEX tubing and fittings in this manual.

- Manifolds can be installed in a horizontal or vertical position.
- In larger installations, with multiple water heaters, use a manifold at each water heater for the fixtures served by the water heater.
- Tubing shall 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. Excessive use of fittings is unnecessary.

- Shutoff valves may be placed at the manifold or at the fixture. Check with your local inspector for the local requirements.
- Tubing shall not be pulled tight. Leave slack to allow for expansion and contraction.
- 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.

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.

Manifolds shall be accessible and protected from freezing and exposure to sunlight.

Hot water and cold water manifolds shall be sized in accordance with the following table:

Nominal Size Internal Diameter (in.)	Maximum	Demand
	Velocity at 4 fps	(gpm) Velocity at 8 fps
½"	2	5
¾"	6	11
1"	10	20
1-¼"	15	31
1-½"	22	44

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.

Individual distribution lines supplied from a manifold and installed as part of a parallel water distribution system shall be sized in accordance with the following table:

Minimum Sizes of Fixture Water Supply Lines in Manifold Systems	
Fixture	Minimum Pipe Size (in.)
Bathtubs and Whirlpool Tubs	1/2"
Tub and Shower	1/2"
Shower only (single head)	3/8"
Bathroom lavatory	3/8"
Water closet, residential	3/8"
Water closet, commercial	1/2"
Kitchen sink	3/8"
Laundry washing machine	3/8"
Utility sink	3/8"
Bar sink	3/8"
Urinal, flush tank	3/8"
Urinal, flush valve	1/2"

**THAWING PEX TUBING SYSTEMS**

PEX tubing systems should not be intentionally subjected to freezing.

Do not use open torch or excessive heat to thaw PEX tubing. Tubing failure or damage can result. Use a hot air gun or a blowdryer.



Heat (DO NOT USE A TORCH) must be applied directly to the frozen tubing section. Temperature on tubing shall not exceed 180° F.

Several suitable methods exist to thaw PEX tubing. They include:

- A commercial system which pumps heated water through the tube to the ice blockage, and returns the cooled water for reheating.
- Wet hot towels
- Hot water
- Hand-held hair dryer
- Low wattage electrical heating tape

**PRESSURE TESTING AND INSPECTION OF THE COMPLETED SYSTEM**

- Test system with water.
- Test pressure shall be at least equal to the expected working pressure (main pressure), but not less than 40 psi and not greater than 225 psi at 73° F.
- Compressed air testing is only recommended when water is not available or when cold weather could freeze the system. Compressed air tests shall include appropriate safety precautions and the test pressure shall not exceed 100 psi. PEX tubing is ductile and will not shatter during a pressure test and release shards of plastic. However, plastic fittings or other system components, or unassembled fittings, may cause a hazard. Check with local codes before using air pressure testing.
- Test duration should not be less than 15 minutes.
- Do not allow water in system to freeze.

**DISINFECTION OF POTABLE WATER SYSTEMS**

If disinfection of the system is required by code, and the conditions are not specified, the following procedures can be used.

Chlorine Concentration	Disinfection Period	Authority
50 to 100 ppm	3 hours	AWWA*
50 ppm	6 hours	ICC**

\*American Water Works Association  
 \*\*International Codes Council

Use one of the recommendations above. Premix the solution before injection into the system. Thoroughly flush all lines of the system at the end of the disinfection period. **Failure to do so may damage the plumbing system.**

## BURIED PEX WATER SERVICE LINES

### Fittings

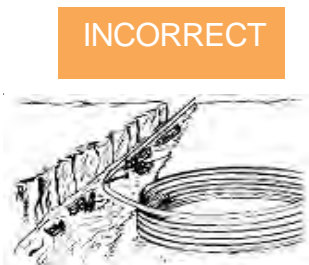
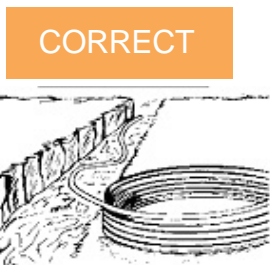
Consult manufacturer for proper fittings for water service application.

### Trench Preparation

Trench bottom shall be solid with no hollows, lumps, rocks, or other materials that could damage the tubing.

### Laying the Tubing

■ Tubing should be laid with sufficient slack (snaking) to accommodate any contraction due to cooling prior to backfilling. Tubing will expand or contract approximately 1 inch in length for each 10° F change in tubing temperature for each 100 feet of tubing.



■ Do not use blocking for support, or to change the tubing's elevation.

■ Minimum bending radius requirements for PEX tubing shall be followed. See "Bending the Tubing" Table, Page 6.

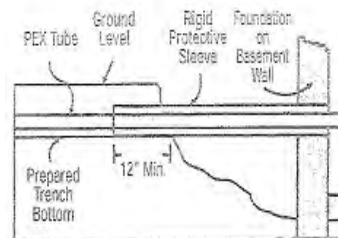
■ Inspect tubing for damage. Remove and replace damaged sections.

■ In poor soil conditions, such as mud, rock, black gumbo, or clay, it is necessary to excavate deeper and use good clean fill or granular fill to smooth the trench bottom.

### Penetrating Foundation or Basement Walls

When PEX is run 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. The purpose of this protective sleeve is to prevent 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 to prevent leakage into the building.

Note: Petroleum-based caulks or sealants should not come in direct contact with PEX.



### Slab-on-Grade Installation Laying and Supporting Tubing Under Slab

Only continuously-run lengths of tubing without fittings shall be used when installing PEX under a slab. All connections shall be outside or above the slab. Tubing shall be completely buried by a suitable, easily compacted, backfill material such as sand or pea gravel. PEX tubing should be installed under the re-bar, re-mesh or

tensioning cables in the slab. PEX tubing shall be covered or fastened to prevent the tubing from floating or being pulled up to the slab surface.

PEX tubing does not have to be sleeved its entire length where it lies beneath a slab. PEX tubing shall be protected with a non-metallic sleeve where it comes through the slab. Because PEX is flexible, it may need support to keep it from falling back onto the slab once it exits the slab. To prevent this, PEX can be carefully tied to re-bar, wood stakes or rigid drain pipe for support. This will serve to protect the PEX tubing as the slab is poured, leveled and smoothed and from subsequent framing and construction work.

### Protection of Tubing and Fittings from UV Exposure After the Pour

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

### Backfilling

- Do not use clay, silt, or rocky backfill. Remove the construction materials, trash or foreign objects from trench prior to backfilling.

- The tubing and fittings should be surrounded with good clean fill, or sand, or river run gravel of 1/2-inch maximum particle size.

- Compact the initial backfill around the tubing to provide adequate tubing support and prevent settlement. It is particularly important to adequately compact the soil around the tap connection.

- It is recommended that the tubing be pressurized with water prior to backfilling to reveal any damage.

### TECHNICAL DATA Tubing Dimensions and Weights (ASTM F 876/F 877)

Nominal Size Internal Diameter (in.)	Maximum Velocity at 4 fps	Demand (gpm) Velocity at 8 fps
1/2"	2	5
3/4"	6	11
1"	10	20
1-1/4"	15	31
1-1/2"	22	44

### Friction Losses

Consult manufacturer for other fitting friction losses.

Tubing water flow rate, velocity, and frictional losses are given in the following tables. Long-radius tubing bends have the same head loss as straight tubing.

Type of Fitting	Equivalent Length of Tubing (ft.)			
	3/8" size	1/2" size	3/4" size	1" size
Coupling	2.9	2.0	0.6	1.3
Elbow 90°	9.2	9.4	9.4	10.0
Tee-branch	9.4	10.4	8.9	11.0
Tee-run	2.9	2.4	1.9	2.3

### Friction Loss and Velocity vs. Flow Rate PEX Plumbing Tubing (CTS) (ASTM F 876/F 877)

Nominal Size	3/8"		1/2"		3/4"		1"	
Average ID	0.350		0.475		0.671		0.863	
GPM	F. Loss	Vel	F. Loss	Vel	F. Loss	Vel	F. Loss	Vel
1	7.0	3.33	1.6	1.81	0.3	0.96	0.1	0.55
2	25.4	6.67	5.8	3.62	1.1	1.81	0.3	1.10
3	53.9	10.00	12.2	5.43	2.3	2.72	0.7	1.65
4	91.8	13.34	20.8	7.24	3.9	3.63	1.1	2.19
5			31.4	9.05	5.9	4.54	1.7	2.74
6			44.0	10.86	8.2	5.44	2.4	3.29
7			58.6	12.67	10.9	6.35	3.2	3.84
8					14.0	7.26	4.1	4.39
9					17.4	8.17	5.1	4.94
10					21.1	9.07	6.2	5.48
11					25.2	9.98	7.4	6.03
12					29.6	10.89	8.7	6.58
13					34.3	11.79	10.1	7.13
14					39.4	12.70	11.6	7.68
15							13.2	8.23
16							14.8	8.78

NOTE: Friction Loss based on Hazen-Williams Formula (C = 150)  
 CTS Tubing manufactured per ASTM F 876/F 877  
 Friction Loss is expressed as -psi per 100 ft. of tubing  
 Velocity (VEL) feet per second

## CONNECTION (TRANSITION) TO OTHER PIPING MATERIALS

Solder copper transition fittings onto the copper pipe and allow to cool before connecting to PEX tubing. High heat (greater than 180° F) may damage the PEX tubing.

Do not use plastic male threads or non-gasketed female threads when making a connection to metal threads. Use only manufacturer's recommended transition fittings.

When making connections to CPVC pipe or fittings, use only approved transition fittings.

## JOINING PROCEDURES UTILIZING METALLIC OR POLYMER INSERT FITTINGS INSERT FITTING WITH A BLACK COPPER CRIMP RING (ASTM F 1807 OR ASTM F 2159)

### Making a Connection

1. Cut tubing squarely, remove burrs, and slip the copper crimp ring onto the tube.
2. Insert fitting into tube to the tube stop; do not apply lubricant or pipe dope on the insert fitting. Position crimp ring 1/8" to 1/4" from end of tubing. To prevent ring from moving, squeeze the ring slightly with your fingers or a pair of pliers.
3. Center crimping tool jaws over the ring. Keeping both ring and tool square with tube, close the tool completely. DO NOT CRIMP TWICE.
4. It is recommended that the finished crimps be checked with the appropriate GO NO/GO gauge. Slip gauge squarely over the crimped ring. If the "GO" slot of the gauge doesn't fit across the crimped ring, the diameter of the ring is too large and the fitting must be cut out. DO NOT RECRIMP. If the "NO/GO" slot of the gauge fits across the crimped ring, the diameter of the ring is too small and the fitting must be replaced. Cut out the ring and fitting, and replace them.

### Incorrect Connections

The consequence of not following correct procedures is a potential for leaks.

1. Ring crimped over end of tube.  
Result: Doesn't cover enough ribs and / or tool could crush or crack fitting
2. Tool not at 90 degrees to tube when crimped.  
Result: Insufficient rib coverage; tubing dented.
3. Ring not completely covered by crimp tool.  
Result: Ring distortion, non-uniform crimp.
4. Tubing not cut squarely.  
Result: Insufficient rib coverage.
5. Ring too far from pipe end.  
Result: Insufficient rib coverage.

## Tools and Rings

Use tools recommended by fitting and tubing manufacturers.

All tools must make a full-circle crimp.

Check tool adjustment at least daily and readjust as necessary.

Use only black colored crimp rings designed for this PEX system.

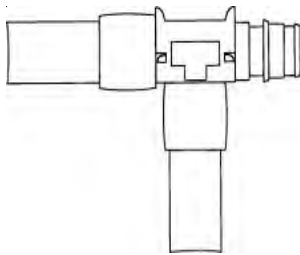
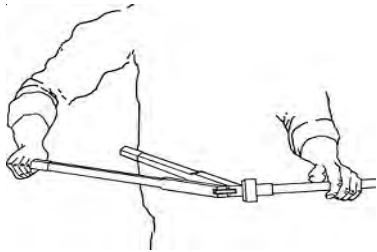
## Joining Procedures Utilizing ASTM F 1960 Fittings and PEX Rings

1. Cut the PEX tubing perpendicular to the length of the tubing using a cutter designed for plastic tubing. Remove all excess material or burrs that might affect the fitting connection.
2. Slide the Pex Ring over the end of the tubing.

The Pex Ring should extend over the end of the tubing no more than a 1/16". The end of the tubing and inside of the Pex Ring must be dry and free of grease or oil to prevent the Pex Ring from sliding out of place during expansion.

3. Place the free handle of the tool against your hip, or place one hand on each handle when necessary. Fully separate the tool handles and insert the expander head into the end of the tubing until it stops. Be sure you have the correct size expander head on the tool. Full expansion are necessary to

make a proper connection. Bring the handles together to expand. Separate the handles, remove the head from the tubing and rotate it 1/8 turn. Slide the tool head into the tubing in the newly rotated position and expand again.



4. Repeat the expansion process until the tubing and ring are snug against the shoulder on the expander head.

5. Immediately remove the tool and slide the tubing over the fitting until the tubing reaches the stop on the fitting. As you slide the tubing over the fitting, you should feel some resistance. If the tubing reaches the shoulder of the fitting without any resistance, the tubing may be over-expanded and may require additional time to fully shrink over the fitting. To ensure a proper connection, the Pex Ring must be seated up against the shoulder of the Pex fitting.

7. At minimum, ASTM F 1960 connections must be pressure tested to the system's working pressure. PEX tubing and fittings are safe for air and hydrostatic testing. Refer to your local code for additional requirements.

### ASTM F 1960 Connections, Helpful Hints

- Holding the tubing in the expanded position increases the time it takes for the tubing to shrink around

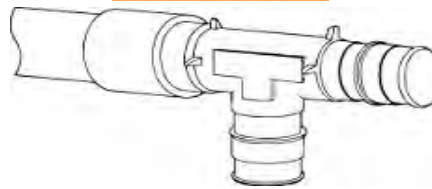
the fitting.

- The tubing should hold the fitting firmly after just a few seconds. If the fitting appears loose for more than a few seconds, the tubing has been over-expanded.

- If there is more than 1/16" between the PEX Ring and the fitting, square cut the tubing two inches away from the fitting and make another connection using a new PEX Ring.

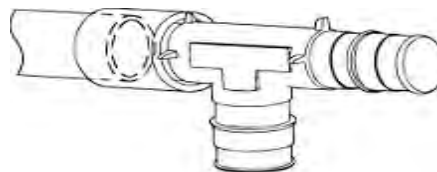
- Ring does not meet the pipe stops on the fitting. Tubing and rings should both meet the pipe stops on the fitting

**INCORRECT**



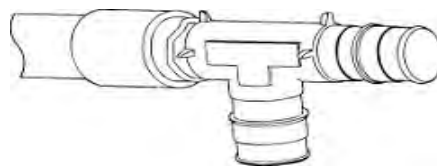
- Tubing does not meet the pipe stops on the fitting. Tubing and rings should both meet the pipe stops on the fitting

**INCORRECT**



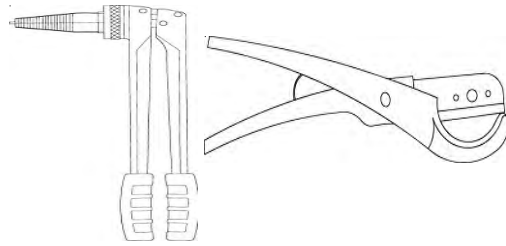
- Tubing and ring do not meet the pipe stops on the fitting. Tubing and rings should both meet the pipe stops on the fitting. Tubing is not cut square.

**INCORRECT**



## Tools

There are a variety of PEX expander tools that are designed for ease of use when making reliable, permanent connections.



## Joining Procedures utilizing ASTM F 2080 Fittings and Compression-Sleeves

### Summary:

Fittings shall be joined to PEX pipe by first expanding the end of the pipe with the expander tool, inserting the cold-expansion fitting into expanded pipe, then pulling the compression-sleeve over the PEX pipe and the fitting, compressing the pipe between the compression-sleeve and the fitting.

### Procedure:

- Slide the compression-sleeve onto the pipe so that the inside-beveled end is facing toward the end of the pipe. Slide the compression-sleeve far enough down the pipe so that it will not prevent expansion of the pipe.

- Insert the head of the expander tool into the pipe. The expander tool segments shall be centered inside the pipe.

Fully expand the pipe, holding it open for approximately 3 seconds, and remove the tool. Rotate the tool approximately 30°, insert the expander-tool into the pipe and repeat the expansion process. This ensures that the pipe is round inside.

- The cold-expansion fitting should be inserted within 30 seconds of the expansion, otherwise the pipe will shrink back to its original size and become too small for fitting expansion. The fitting is properly inserted when the PEX pipe is pushed up against the last rib of the cold-expansion fitting. If full insertion is not possible, remove the cold-expansion fitting immediately

and expand the pipe again for 3 seconds.

- When the expansion is complete, and the cold-expansion fitting is inserted properly into the PEX pipe, the metal compression-sleeve shall be pulled over the fitting with the compression tool (this may be the same tool as the expander tool, or a separate tool).

- Use the compression tool to pull the compression-sleeve over the cold-expansion fitting and the PEX pipe end until the sleeve touches the collar of the fitting or until the tool stops.

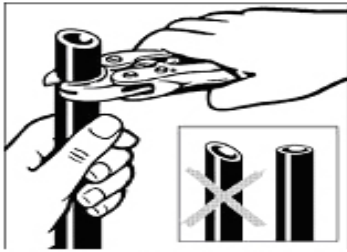
- The maximum allowable gap between the edge of the compression-sleeve and the collar of the cold-expansion fitting shall be 0.040 in. If this gap is too large, the repeat the compression step and/or adjust the tool.

## Other Fitting Systems

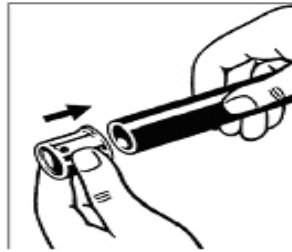
Some PPFA Members have proprietary fitting systems for which ASTM standards have not been written. These systems are typically listed as meeting the performance requirements of ASTM F 877 for PEX systems but their fitting dimensions and materials have not been specified in a standard. These fittings are typically available only through a single manufacturer and the components of the system do not interchange with similar looking parts from a different manufacturer.

When using these systems, users are cautioned to be sure they do not mix components from different manufacturers even if they look the same.

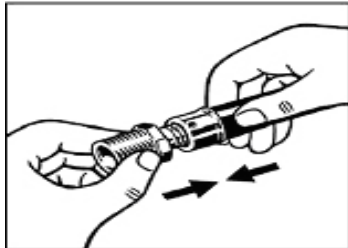
## Making a Stainless Steel Sleeve Hand Tool Connection



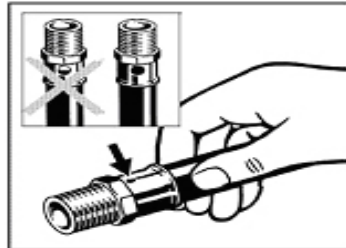
1. Square off tubing to proper length.



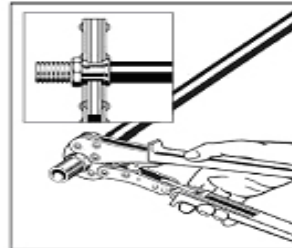
2. Slide press sleeve fully over end of tubing.



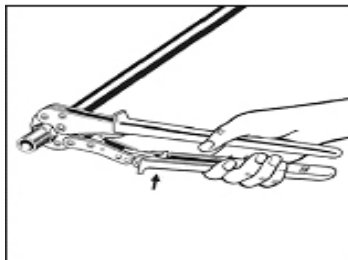
3. Insert press fitting into tubing. And engage fully.



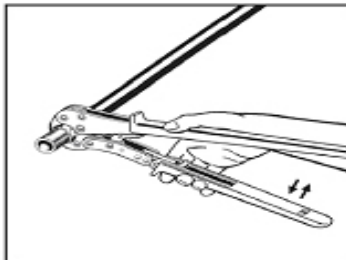
4. Check full tubing insertion at view hole of sleeve.



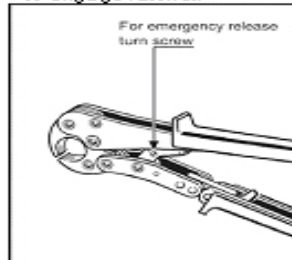
5. Position press tool perpendicular over press sleeve and close tool jaws to engage ratchet.



6. Close handles utilizing trigger to reduce grip span if desired.



7. Extend handle and continue ratcheting until automatic tool release occurs at proper compression force.



9. Warning: The connection is not leak proof when the tool has been opened by emergency release.