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1.1 The Roth Advantage

Since incorporating in 1947, Roth has become an industry leader for products in home improvement and plastics technology. Roth has over 1,100 employees worldwide, 8 manufacturing plants with 861,000 sq. ft. of building space on 110 acres of land. The revenues in 1996 exceeded 200 million US dollars. Roth's ISO9001 certified PEX tubing manufacturing plant is one of the largest in Europe.

The Roth Plumbing System was engineered to provide the installer with products that could be installed quickly and with the flexibility needed to meet the requirements of the individual project. The result is a system that is reliable, long-lasting and safe – all at a competitive price.

Roth has been a market leader for the past 50 years because it is constantly developing and improving its products to provide solutions for the modern plumbing system. This commitment guarantees that our systems will perform as designed and have the flexibility to adapt to meet future challenges. The combination of innovation, modern manufacturing equipment, technical know-how and experienced personnel will ensure the continuing evolution and success of the Roth Plumbing System.

1.2 The PEX Advantage

The backbone of the Roth Plumbing System is our high-quality PEXc tubing. We crosslink our tubing with high-energy electron beams and not with chemicals like other manufacturers. We are one of the largest plastic pipe manufacturing companies in Germany and our experience and quality shows through.

PEX tubing is becoming the material choice for modern piping systems and there are many reasons for it.

- Corrosion free and not subject to the pitting and erosion caused by water quality, electrolysis and chemical reaction that destroy traditional metal piping systems.
- Resistant to the scaling and mineral build-up that plagues metal piping systems. Flow rates remain constant over the life of the system.
- Non-toxic pipe and connections eliminate the problem of chemicals leaching from your piping into your water supply.
- Environmentally friendly when compared to the impact of mining, refining and manufacturing metal piping materials.
- Electron beam cross-linked PEX is the material of choice for potable water systems in Europe.
- Proven long-term strength when operated within our specifications.
- Easy to install flexible PEX tubing can be run around obstacles without hidden joints all the way to the fixture.
- Quieter than metal piping systems because flow velocity noise is absorbed instead of amplified.
- Abrasion resistant on the outside and erosion resistant on the inside – because PEX tubing has thick, flexible plastic walls that resist installation damage and have less flow resistance than metal pipes.
- Lightweight and easy to handle because a 300' coil of 1/2" tubing only weighs 16 lbs (7.25 kg).

- Repair kinks in the tubing with a heat gun without impairing strength or performance.
- Remains flexible at low temperatures and with-stands up to 110 psi at 230°F (758 kPa @ 110°C) for short durations in the case of a system mal-function.
- The flexibility of Roth PEX tubing helps it resist freeze damage (but it's not freeze-proof) that would normally destroy traditional rigid metal piping systems.
- Twenty-five (25) year limited warranty on Roth PEX tubing and five (5) year limited warranty on Roth plumbing accessories (see warranty for details).
- PEX prices are more stable than metal piping prices.
- Available in coils of varying length or 20' (6 m) straight lengths to fit your project.

The benefits of the Roth PEX Plumbing system are many. This manual will help you make the most of the Roth PEX advantage!

2.1 Roth PEX Tubing



2.1.1 The Manufacturing

Roth PEXc Plumbing tubing is polyethylene (PE) tubing that is cross-linked (X) using high-energy electron beams (c). This process creates additional lateral bonds between the long PE molecules, creating a three-dimensional lattice that gives our tubing more strength and a higher temperature and pressure rating than standard PE tubing. This process is unique in that it does not rely on adding free radicals during the extrusion process (which require adding antioxidants to stabilize the tubing) or passing the tubing through chemical baths which add large bridge molecules to link the PE chains (requiring a very thorough rinse process to flush any chemical residue). Unlike the chemical bath, our cross-linking method results in a uniform lattice through the entire wall thickness of the tubing and not just on the inner and outer surfaces. It's the most chemical-free and widely accepted method of cross-linking for potable water tubing in Europe where PEX has been used for the past thirty years.

2.1.2 The Specification

Roth PEX tubing is certified by independent, third-party labs to meet or exceed all of the current standards for PEX tubing. These standards include ASTM F876/877, F1807 (when used with F1807 fitting), NSF Standards 14 and 61, Plastic Pipe Institute (PPI) long-term temperature and pressure ratings (160 psi @ 73.4°F, 100 psi @ 180°F and 80 psi @ 200°F), CSA B137.5, Chlorine Resistance for Traditional

Systems under F2023 (expected in May 2005), NSF-pw, NSF-U.P.Code (meets the requirements of the Uniform Plumbing Code) and various other standards and listing agencies. In short, the Roth PEX Plumbing System meets all of the dimensional tolerance, strength, cross-linking, performance, safety and health standards for the modern plumbing system.

2.1.3 The Quality

Our production facilities carry the ISO 9001 certification which indicates that our manufacturing-processes and quality controls meet international standards. In addition, we are subject to third party inspections from organizations, such as NSF International, to verify that we are following the procedures that we have established to obtain our certification. With this certification we can say that Roth PEX tubing is truly world class.

2.1.4 Limitations

The Roth PEX Plumbing System (tubing, fittings and accessories) is designed for potable hot and cold water distribution systems. Our warranty is limited to use of products that have been tested and approved by Roth (included in our cata-logue) that have been correctly applied and installed. Refer to our warranty for further details.

Although PEX plumbing systems have been generally approved by national and state codes, you should consult with your local code officials to verify that they are approved in your area.

Roth PEX tubing as described in this book is intended only for hot and cold water distribution systems within the temperature and pressure limitations noted below. Roth PEX tubing is not approved for or intended for use with natural gas, propane, fuel oil or any other fluid, chemical or product.

The maximum working pressure of the tubing is based on the operating temperature and exceeding these limits may result in a tubing failure that is not covered by our warranty. These limits are: 160 psi @ 73.4°F, 100 psi @ 180°F and 80 psi @ 200°F (1103 kPa @ 23°C, 690kPa @ 82°C and 556kPa @ 93°C).

The minimum bend radius for Roth PEX tubing is approximately 6 times the outside diameter of the tubing.

Roth PEX tubing is less flexible at cold temperatures. It is easier to handle and install if the tubing is stored in a conditioned space and allowed to warm up prior to installation.

PEX tubing expands at the rate of 1.1" per 100' of tubing for each 10°F (2.8cm per 30m of tubing for each 5.5°C) increase in temperature when it is not embedded in concrete. It is important to consider this and use proper installation techniques to compensate for this during installation of the system.

Roth PEX tubing should not be exposed to direct sunlight for more than 3-4 weeks because UV light may damage the tubing. Tubing should be covered during installation, if needed, to prevent damage. PEX tubing should always be stored and covered in a manner that prevents UV damage.

Roth PEX tubing is freeze-resistant, but not freeze-proof. Tubing embedded in concrete that is subjected to freezing conditions will likely damage both the concrete and the tubing. Tubing that is not embedded and frozen may not damage the tubing but may damage joints or manifolds. Be sure to carefully pressure test, inspect and repair systems that have been subjected to a freeze prior to returning them to normal operation.

Use only fittings and accessories that have been tested and approved for the Roth PEX Plumbing System.

Always use nail plates to protect PEX tubing from screws or nails when the tubing is routed through an area that may be subject to punctures. PEX tubing is softer than metal pipes and you may not notice if you pierce it.

Certain adhesives may react negatively with PEX tubing. It is best to avoid applying adhesives directly to PEX if you are unsure of long-term consequences.

PEX tubing is non-conductive and will not provide a suitable grounding mechanism for electric systems.

Do not solder fittings closer than 18" to Roth PEX tubing and maintain at least the stated minimum clearance to combustibles from heat producing equipment, such as recessed lighting cans and flue pipes.

Always follow local codes when installing the Roth PEX Plumbing System.

2.1.5 Sizes & Lengths

Roth PEX Plumbing Tubing is available in four (4) nominal diameters: 3/8", 1/2", 3/4" and 1". Each size is available in a variety of coil lengths from 100' to 1000', depending on the diameter. We also have packages of 20' straight lengths available for 1/2", 3/4" and 1". This should cover most applications for residential and light commercial potable water distribution systems. Traditional piping material should be used if larger size piping is required for a specific application.

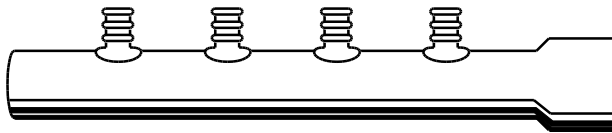
2.2 Roth Plumbing Manifolds

2.2.1 Roth 3/4" PEX Manifolds with closed end.

These manifolds are fully assembled and ready to install. The trunk consists of a nominal 1 in. Class L Copper pipe. This generous pipe size eliminates the risk for erosion corrosion that otherwise could occur. It is normally adequate for at least 10 gpm (consult your local plumbing code). The inlet has a 3/4" nominal PEX insert in accordance with ASTM F 1807. Note that Crimp rings and Crimp tools to use with inserts are sold separately. The opposite trunk end is spun closed and has heavier wall thickness than the trunk so that strength is not compromised. The manifold branches are equipped with ASTM F 1807 inserts for 1/2", or for 3/8" PEX tubing; 2 in. on center. Select 4, 6, 8, 10, or 12 branches. For branches intended for future use: attach a short section of PEX tubing equipped with insert plugs (and crimped rings). As these manifolds have no valves they do not require an access panel (consult local

plumbing code). Use our 1" Tubing Fastener (see Page 13) to mount manifold vertically or horizontally to stud or board. Although stop valves are typically installed at outlets, it may be practical to install isolation valves at accessible manifolds (for all the manifold, or for certain outlet runs). Use Roth insert in-line valves for this purpose (see Page 10).

2.2.2 Roth PEX Manifold Blocks.



Roth 3/4" PEX Manifolds w. closed end is the most commonly used manifold type. However, there are many situations when several other configurations may be preferred. Roth PEX Manifold blocks allows the user to design his/her own configuration. These manifolds are equipped with ASTM F 1807 inserts for 1/2", or for 3/8" PEX tubing; 2 in. on center. The trunk consists of a nominal 1 in. Class L Copper pipe, normally adequate for at least 10 gpm (consult your local plumbing code). One trunk end is female and the other is male (equal to 1" Copper pipe), so they can easily be sweat together for more fixtures, or for a mix of 1/2" and 3/8" PEX fixtures. The Manifold Blocks are available with 3, 4, & 5 branches for 1/2" PEX and with 2, 3, & 4 branches for 3/8" PEX

The male and female trunk ends allows for complete customizing of the manifolds. Here are a few options:

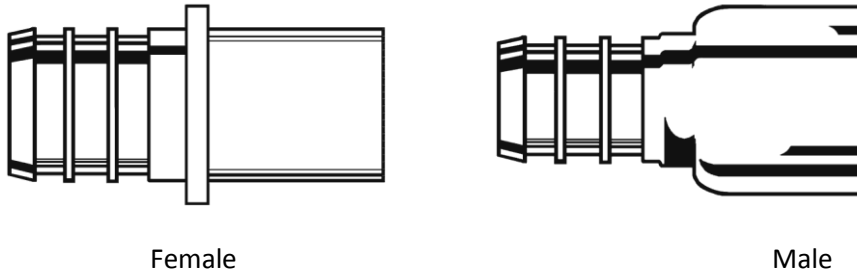
- 90° sweat; male/female
- sweat to 1" Copper
- sweat to insert for 3/4" PEX
- sweat adapter-3/4"Copper
- sweat to insert for 1" PEX
- sweat end cap
- sweat to valve
- sweat to thread
- sweat Tee

With only few Roth PEX Manifold blocks in stock the user will still be able to compose almost any configuration.

Crimp rings and Crimp tools to use with inserts are sold separately. All sweat connections must be made prior to crimping PEX tubing to inserts. ASTM F 877 advises that soldered metal fittings should not be made closer than 18 in. to an installed plastic-to-metal adapter in the same (water) line. Manifolds equipped with valves require an access panel. Use our 1" pipe fastener to mount manifold vertically or horizontally to stud or board.

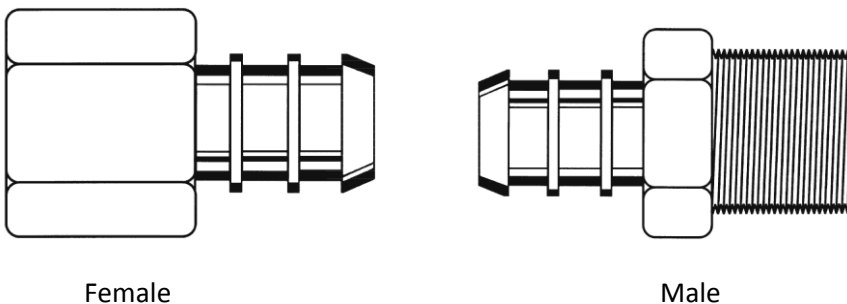
2.3 Roth PEX Transitions

2.3.1 Roth PEX inserts to Sweat adapters



PEX inserts to sweat adapter are used to complete Roth PEX Manifold blocks, or to connect PEX tubing to copper pipes or other sweat components. Female ends are manufactured to fit over actual copper pipes or male manifold ends, while male ends have the OD of actual copper pipe. All sweat connections must be made prior to crimping PEX tubing to inserts. ASTM F 877 advises that soldered metal fittings should not be made closer than 18 in. to an installed plastic-to metal adapter in the same (water) line. Crimp rings and Crimp tools to use with inserts are sold separately.

2.3.2 Roth PEX inserts to IP thread transitions



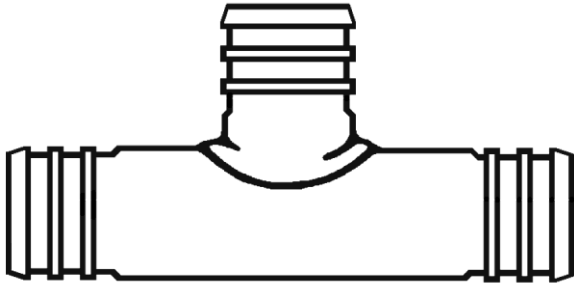
PEX inserts to IP thread transitions are used to connect PEX tubing to IP threaded components. They are available with both female (non swivel) and male threads. Crimp rings and Crimp tools to use with inserts are sold separately.

2.4 Roth PEX Fittings

Roth PEX fittings have been available in both copper (F877) and brass (F1807) construction in the past, however, as the F1807 standard is becoming more widely accepted and the various configurations of the brass fittings are becoming more available, we anticipate that the copper fittings will be phased out of our system and ultimately replaced with the new F1807 brass fittings. It is important to note that virtually all of the fittings commonly used today are available to meet the new F1807 fitting standard. These fittings also meet the current CSA standards. The application and installation of the F1807 fittings is the same as the F877 fittings shown here. Please refer to the current Roth Plumbing Catalogue to see

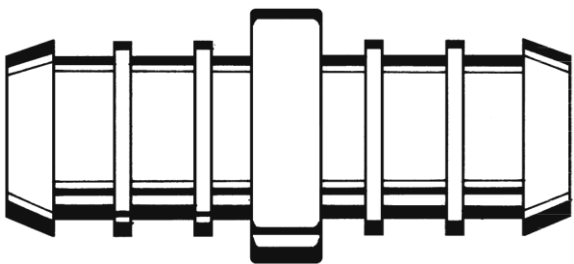
our updated parts offerings as we are continually evaluating and adding new fittings to meet the needs of modern plumbing systems. Please contact your local Roth office for any additional information on the various approvals our fittings carry. Contact your local building department for information on the requirements of plumbing systems in your area.

2.4.1 PEX insert Tees



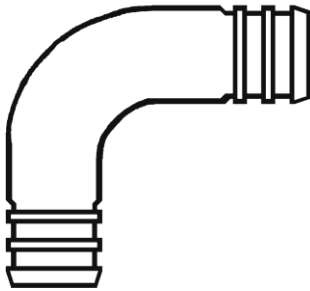
PEX insert Tees have PEX inserts in all three directions. The branch direction (90°) size is listed last in price and part lists. The insert fittings (this is valid for all Roth PEX insert components) are manufactured to ASTM F 1807 and are third party certified by CSA. Use Roth tubing fasteners (see Page 13) to secure tubing (and consequently also the Tee) around the Tee where appropriate. When a Tee branch is intended for future use, attach a short section of PEX tubing equipped with insert plug (and crimped rings). Crimp rings and Crimp tools to use with inserts are sold separately.

2.4.2 PEX insert Couplings



A Roth PEX insert coupling can be used as a repair coupling when a PEX tubing run has become accidentally damaged. Although the couplings are completely safe, the use of them to salvage short lengths of leftover tubing is not recommended. Unnecessarily increasing the number of fittings is not a good practice. Crimp rings and Crimp tools to use with inserts are sold separately.

2.4.3 PEX insert Elbows

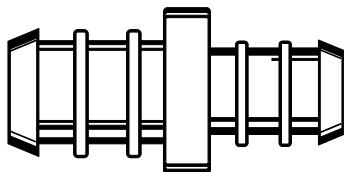


Roth PEX tubing can easily be installed in bent position by carefully holding the tubing in position as desired and apply pipe fasteners before and after the bend. The minimum acceptable bending radius in accordance with ASTM F 877 is 6 times the tubing outside diameter. The outside diameter is equal to nominal size plus 1/8". This results in following minimum bending radii:

Tubing Size	Bend Radius
3/8"	3"
1/2"	3 3/4"
3/4"	5 1/4"
1"	6 3/4"

Roth PEX Tubing may also be installed in a 90° angle using the Roth snap-in Bend Support -see section 10.5. Use Roth PEX insert Elbows when PEX Tubing runs require a narrow 90° turn. Apply Roth Tubing Fastener (see Page 13) before and after the turn where the Elbow needs to be fixed in position. Crimp rings and Crimp tools to use with inserts are sold separately.

2.4.4 PEX insert Reducer Coupling



A tubing run may occasionally need to be larger than the downstream nominal fitting size to provide for adequate flow (specifically when system pressures are comparatively low). Roth PEX insert reducer coupling allows the installer to reduce the tubing size to appropriate fitting size. The reducer couplings

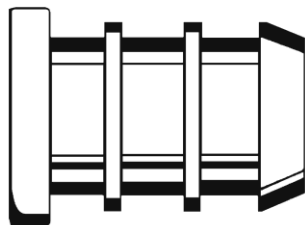
are available for transition from 1" PEX tubing to 3/4", and from 3/4" tubing to 1/2" Crimp rings and Crimp tools to use with inserts are sold separately.

2.4.5 PEX to PB Transition insert Coupling



Use PEX to PB transition insert couplings at repairs of PB tubing installations, or at add-ons to PB tubing installations where acceptable to local codes. Note that Roth warranties apply only to Roth PEX tubing installations (not to PB tubing or PB connections). These transitions are available for 1/2" and 3/4" tubing, only. Crimp rings and Crimp tools to use with inserts are sold separately. Note that crimp rings for PEX are of annealed black copper, while crimp rings for PB are natural copper color. These rings are not interchangeable. The crimp tools are the same for PEX and PB.

2.4.6 PEX insert Plugs

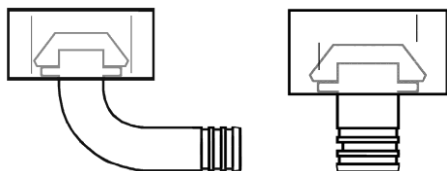


Brass

Roth Insert Plugs are used for both initial pres-sure testing and permanently closing off branch stubs at the end of a run or at a manifold. The plugs are available in 3/8", 1/2", 3/4" and 1". Crimp rings and tools are sold separately.

2.5 Roth Special Connectors

2.5.1 PEX insert to Faucet Connector

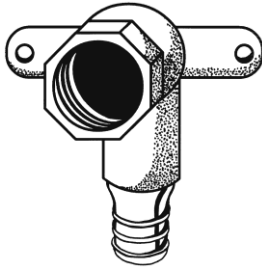


Straight

Elbow

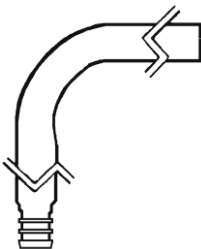
PEX inserts to Faucet connectors are used to connect PEX tubing to male Faucet IP 1/2" threads. The swivel nut is made out of impact resistant plastic and is equipped with a Buna N rubber nose cone. The connectors are available in both straight and elbow versions, and for both 3/8" and 1/2" PEX pipes. Crimp rings and Crimp tools to use with inserts are sold separately.

2.5.2 PEX insert Drop-ear Elbow



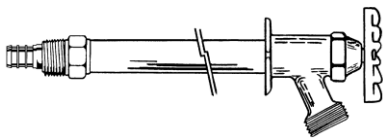
Roth PEX Insert Drop-ear Elbow secured in a stud wall provides a rigid wall penetration to female IP threads. The PEX tubing inside the wall (or floor) is connected at a 90° angle for easy installation. Crimp rings and Crimp tools to use with inserts are sold separately.

2.5.3 PEX insert Elbow to Sweat Tub



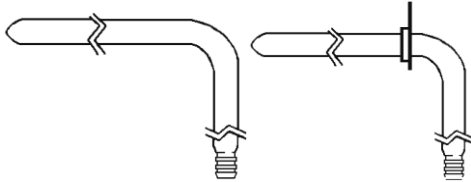
Roth PEX insert Elbow to sweat tub is used to connect Roth PEX tubing to tub or shower valves via a 90° angle. The elbow's male copper pipe end will fit to the female sweat cup of the tub or shower valve. Cut the elbow's copper end using appropriate tool(s) when required to fit properly. This fitting is available for 3/8" and 1/2" PEX tubing to 1/2" Copper pipe and for 3/4" PEX tubing to 3/4" Copper pipe. All sweat connections must be made prior to crimping PEX tubing to inserts. ASTM F877 advises that soldered metal fittings should not be made closer than 18 in. to an installed plastic-to-metal adapter in the same (water) line. Crimp rings and Tools are sold separately.

2.5.4 PEX insert to Frost proof Sillcock



This Sillcock valve has a brass body with nickel plated finish and a black handle. The stem to threaded hose connection is comparatively long for easy access. It is equipped with antisiphon of approved type and offered in two lengths. The pipe ends with an insert for 1/2" PEX tubing. Crimp rings & Tools are separate.

2.5.5 PEX insert to Stub-out Elbow (closed end)



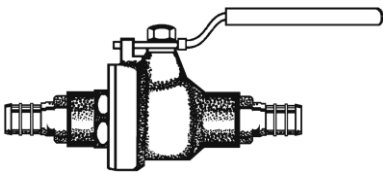
Stub-out elbows should be securely fastened inside walls to provide a rigid wall penetration (as an alternative to Drop-ears). The closed copper pipe (Class L) end allows pressure testing prior to final installation. When finishing, cut the stub-out copper pipe to appropriate length using appropriate tool(s) and sweat to valve's female solder cup, or apply its compression fitting.

This elbow is available for 3/8" PEX tubing to 1/2" Copper, 1/2" PEX tubing to 1/2" Copper (two configurations), and 3/4" PEX tubing to 3/4" Copper. Two of these versions are also available with a mount plate. Use with wood blocks or suitable brackets.

All sweat connections must be made prior to crimping PEX tubing to inserts. ASTM F877 advises that soldered metal fittings should not be made closer than 18 in. to an installed plastic-to metal adapter in the same (water) line.

Crimp rings and Crimp tools to use with inserts are sold separately. We also recommend using these stub-out elbows when connecting to appliance or lavatory/sink outside walls. Metal risers (1/4" or 3/8") are connected via sweat elbow (or straight) compression adapters, typically equipped with stop valve. In spite of the ruggedness and versatility of PEX tubing - many users prefer rigid metal pipes outside walls.

2.5.6 PEX insert in-line valves

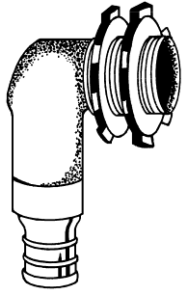


Roth has three (3) sizes of in-line ball valves with PEX insert connections: 1/2", 3/4" and 1". You can also use a standard valve with sweat or threaded connections by installing the appropriate PEX transition fittings. Valves should be installed wherever needed to provide proper isolation and service of the system and individual components.

Valves must always be installed so they are accessible. Consult your local codes for additional information.

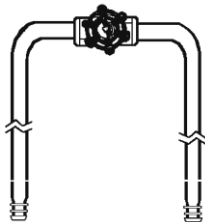
Roth also has a variety of configurations of straight and angle stops available for connecting various fixtures. Check our catalogue for the current offerings.

2.5.7 PEX insert to 2" Shower-lock Elbow



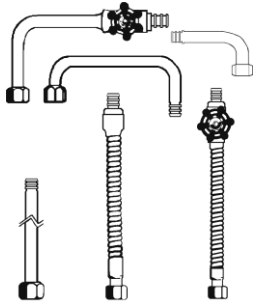
Shower cabin installations (and similar walls like fiberglass units) may not be able to provide means for a secure penetration in conventional way. This elbow to PEX insert is equipped with 2" brass lock nuts to "sandwich" the finished wall for a solid installation. The 1/2" female IP thread for shower or tub nipple is outside the wall. Crimp rings and Tools are sold separately.

2.5.8 PEX insert service loop w/200 W.O.G. gate valve



This Roth valved service loop can be used to provide an easily accessible shut off valve to the main plumbing line. It is equipped with a 200 psi W.O.G. standard port gate valve facing out. Available with PEX inserts (both sides) for a 3/4" & 1" PEX tubing. Crimp rings and Crimp tools to use with inserts are sold separately.

2.5.9 PEX 3/4" insert to 3/4" swivel IP thread



Roth offers an assortment of connectors that simplify installations to or from main plumbing lines, water heaters, and other appliances or equipments. PEX tubing must be installed a minimum of 6" apart from vent of (gas-, oil-, wood-, etc.) fired water heaters and using one of above type connectors may be the most practical way of accomplishing this. There is no limitation as regards to connecting PEX tubing to electric water heaters (direct connection acceptable).

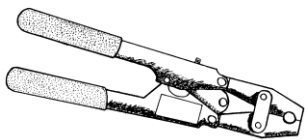
Products available:

- Elbow connectors: one valved and two configurations without valves
- U connector
- Straight connectors: two lengths
- Flexible connectors: with or without a 150 WOG gate valve

Crimp rings and Crimp tools to use with inserts are sold separately.

2.6 Roth Tools & Accessories

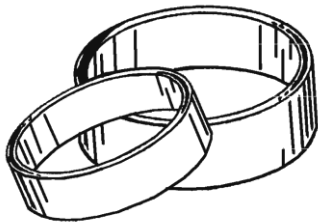
2.6.1 PEX Crimp Tool



The correct Roth PEX Crimp Tool must be used to crimp PEX Copper Crimp Rings over PEX tubing equipped with PEX inserts. Crimping procedure: Square cut PEX tubing. Slide the crimp ring onto the tubing, insert the ribbed end of the fitting (the PEX insert) into the end of the tubing until the tubing contacts the shoulder of the fitting or tube stop. The crimp ring should then be positioned on the tubing so the edge of the crimp ring is 1/8 in. to 1/4 in. from the end of the tube. The jaws of the crimping tool shall be centered over the crimp ring and the tool shall be held so that the crimping jaws are approximately perpendicular to the axis of the barb. The jaws of the crimping tool shall be closed around the crimp ring, compressing the crimp ring onto the tubing. The crimp ring shall not be crimped more than once. Each crimp shall be checked to determine conformance to the after crimped dimensional requirements.

A GO/NO-GO gauge is supplied with the Crimp Tool, so that this dimensional requirement can be secured. Use the gauge (in accordance with the instructions enclosed with tool) in at least two places to check conformance. Do not gauge the ring on the scoring mark on the ring where the jaws of the tool overlap. If the crimped joint fails the test, the crimped joint must be replaced. Additionally, the crimp tool may need adjustment (using the adjustment wrench supplied) in accordance with instructions enclosed with the tool. Each size tool can be used for its respective tubing size/crimp ring size, only.

2.6.2 PEX Crimp Rings

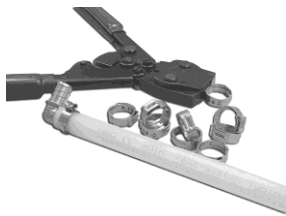


Use only annealed black copper PEX crimp rings with PEX tubing. These rings cannot be used with PB tubing.

2.6.3 PB Crimp Rings

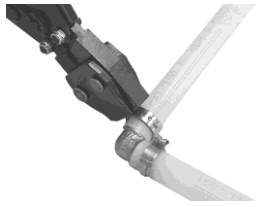
Use only natural copper color PB crimp rings with PB tubing. These rings cannot be used with PEX tubing.

2.6.4 Roth HDSS PEX Clamp & Tool



Roth is introducing a new PEX tubing fastening system that can be used as a simple alternative to the traditional copper crimp ring system that we have used in the past. We now offer the HDSS PEX Clamp (heavy-duty stainless steel) for securing Roth PEX tubing to our F1807 barbed fittings. These clamps are easily installed with a single small tool (only about 1.5 lbs and less than 12" long) instead of a separate tool for each size tubing and crimp ring. The clamps are made of stainless steel – stronger and more durable than copper – to insure long life and reliable service. The HDSS PEX Clamps are designed to meet or exceed the performance requirements of ASTM F2098.

2.6.5 HDSS PEX Clamp Installation



Preparation and layout of a system using the HDSS PEX Clamp is similar to any other Pex plumbing system except for the clamp itself. Follow the normal procedures for sizing, measuring, routing and supporting the PEX tubing. Be sure to examine all fittings for any damage that may cause an improper seal. These clamps are easiest to install when the ambient temperature is above 40°F (4.5°C) because PEX tubing is less flexible and resilient at cold temperatures. It is advisable during cold weather installations to store your tubing in a conditioned space to warm up the tubing prior to installation. You should uncompress the clamp tool slowly during cold so weather installations. This will allow the tubing to compress properly on the fitting and reduce the possibility of damage or failure to the clamp during installation. Failure to follow this advice may result in clamp failures or leaks at the fittings.

Cut the tubing to the desired length with a sharp plastic tubing cutter and examine the end to be sure that it is square and free burrs or jagged edges. Examine the fitting to ensure that the barb is clean, smooth and free of cuts or dents on the sealing surfaces. Slide a clamp over the tubing and insert the fitting barb into the end of the tubing until the tubing reaches the stop/shoulder on the fitting. Grab the bulge of the clamp in the jaws of the installation tool and position the clamp so approximately 1/8" to 1/4" of tubing is exposed at the fitting. When the clamp is properly positioned begin to slowly compress the tool. Once engaged, the ratchet mechanism of the tool will not release until the clamp is completely compressed. You will receive the best results by slowly compressing the tool, especially during the last few clicks. After installation open the jaws to remove the tool from the clamp.

The HDSS PEX Clamp does not require the use of a "Go/No-Go" gauge to verify the correct compression such as is required with standard copper crimp rings. The clamp is designed to tighten correctly each time when installed with our tool. The tool should be replaced if you notice excessive wear or the clamps fail to tighten correctly.

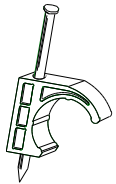
After rough-in installation is complete the system should be air pressure tested for leaks in the normal procedure. If a leak is found, you can try to slowly compress the clamp one time. This is sometimes effective, especially if the system was installed in cold conditions. If this does not work the fitting should be cut out and replaced with a new fitting and new clamps because the problem may be a damaged fitting.

2.6.6 HDSS PEX Clamp Removal

Pex clamps can be easily removed with a pair of end-cutting pliers. Grab the clamp in the opposite direction from installation and cut through the pinch nub with a slight twisting motion. This will release the tension on the clamp. The tubing can then be twisted and removed from the fitting. Cutting the tubing free from the fitting with a blade may result in scoring the sealing surfaces and permanently damaging the fitting. If this occurs the fitting must be replaced.

You can also use the installation tool to remove the clamp using the same procedure as with the end-cutting pliers but continued use for clamp removal will damage the jaws, resulting in pre-mature failure of tool. This will require replacement of the tool.

2.6.7 Tubing Fastener



2.6.8 Twin Fastener



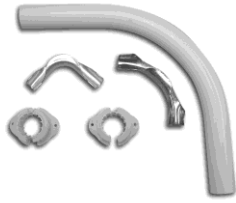
Roth Tubing Fasteners are used not only to secure PEX tubing, but also to hold Roth Manifolds (use the 1" size) and other nominal size tubing products. ASTM F 877 recommends that for PEX tubing, supports should be installed at least every 32 inches. Smooth plastic hangers (such as Roth Tubing Fasteners) should be used; not rigid metal supports and similar devices. Standard fasteners are available for all 4 sizes. Our single model Twin fastener can be used for both 1/2" & 3/4" PEX tubing.

2.6.9 Plastic Ties



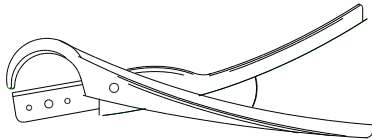
Use Roth Plastic Ties to tie PEX tubing to wire mesh, rebar, and other metal tubing supports. Do not install tubing close to sharp metal edges. The plastic ties are clean, light, require no tools, and are fast to use. Wrap around and pull through hole until tight.

2.6.10 Roth Bend Supports and Isolator Guides



Roth has a variety of bend supports and tubing isolators available for your application. Bend supports are available as solid plastic (slide-on) and metal (clip-on) that can be used anywhere you need a stable, tight bend. Our plastic isolators can be used to reduce friction for tubing runs through wood or metal framing members. We also have metal bend supports with nail tabs. Consult our current catalogue for our latest offerings.

2.6.11 Tubing Cutter



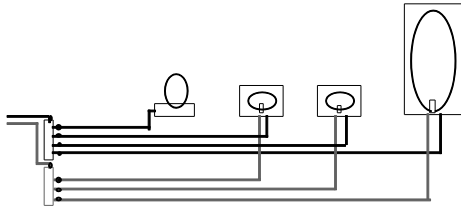
PEX tubing must be cut so the end is smooth and square, free from burrs and deformations. This is accomplished with Roth Tubing Cutter - and your proper workmanship. For PEX tubing up to 1".

2.6.12 Other Accessories

Roth is constantly evaluating new products and accessories for the PEX Plumbing System. The items shown in this manual are not the only items available and we are continuously updating our product offering. If you don't see it here, check our current catalogue and you'll probably find what you need for your project.

3.1 Layout Options

3.1.1 Manifold Systems



The above drawing shows a basic bathroom installation using manifolds. The main lines from the utility room feeds a 4-branch Manifold for cold water and a 3-branch Manifold for warm water. There are a total of 9 in-line fittings using this design method. If the manifolds are placed accessibly, all fittings are available for service.

When compared to using tees and branches more tubing is used with the manifold method. This is normally true, but when manifolds are located close to where most fixtures are located, the difference may be small.

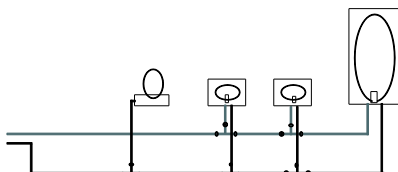
As every fixture is serviced by its own PEX tubing line, fluctuations in flow and temperature are small. This advantage is appreciated by users.

As each fixture has its own supply line, there is a larger share of small size tubing in Manifold systems. Smaller size PEX tubing is more flexible and easier to work with, a fact that many installers appreciate. This is valid for PEX tubing. Copper or CPVC pipes are not flexible, and Manifold systems are normally not appealing for these pipes.

Sizing of a Manifold system is comparatively easy. The sizes required are decided by pressures available and tubing lengths.

When fixtures are located far from the water heater, recirculation may be required. Using one of the Manifold branches for recirculation can be a practical solution.

3.1.2 Tee Systems



This sketch is the same installation as previous page, but using the conventional branching method. The main lines from the utility room run directly to Tees that branch off to the individual fixtures. There are a

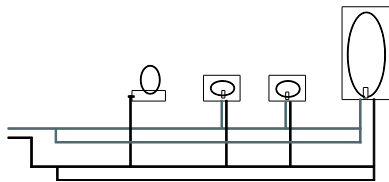
total of 15 in-line fittings when using this design method. (Fittings are marked as black dots in both illustrations). The Tees are normally not accessible for service.

This installation method is most efficient when fixtures are far apart, or when there is no suitable location for a local manifold. When acceptable to codes and to building owners, the Tee method may sometimes be more economical as less material is required.

Design the systems properly to minimize flow and temperature fluctuations due to excessive pressure drops. Loss of pressure when several fixtures are being used at the same time can cause annoying temperature changes.

The size of the main line can be reduced as you progress further downstream in a tee and branch system because there are fewer fixtures to supply but the flow in each section of tubing should be calculated to ensure that the main line has adequate size to carry the load. It is important to remember to add in the pressure losses for the fittings when sizing these systems.

3.1.3 Combination Systems



It is sometimes advantageous to combine the Manifold and Tee methods to reach optimal benefits. A remotely located combination of a few fixtures may be well serviced by tee branching; while a concentration of many fixtures often make Manifolds the best choice.

The above figure displays a Tee method to achieve some of the advantages of the manifold method. A Tee is introduced before a group of fixtures, and its branch is connected to the last fixture in the group by an additional Tee. The individual fixtures are in this way being supplied from two sides. At simultaneous use of two or more fixtures in the group, the variation of flow will be considerably reduced, and/or a smaller size pipe may be possible to use.

3.2.1 The Fixture Unit Method

When considering the flow required by different kinds of fixtures it has become practical to introduce a standardized flow demand rating called Fixture Units. This factor does not directly describe flow requirements, but it is rather a measure of demand of water over time. The Table starts by listing the minimum tubing size connecting to the fixture for private and public installations. Larger sizes are required at low pressures, long tubing distances, or by local codes.

Table 3.1 Minimum Tubing Size

Outlet Type	Minimum Tubing Size	
	Private	Public
Drinking Fountain		3/8
Lavatory	3/8	1/2
Dishwasher	1/2	
Wash Basin	3/8	1/2
Kitchen Sink	1/2	3/4
Shower	1/2	3/4
Bath	1/2	3/4
Washing Machine (8 lbs)	1/2	3/4
Laundry Tray	1/2	
WC or urinal (tank)	3/8	1/2
Sillcock	1/2	3/4
WC or urinal (flush 1")	1	1

The next table displays commonly accepted Fixture Unit tables. The first table is for Distribution Pipes. It displays assigned Fixture Units for Private installations (residential) and for Public Installations (commercial, etc.). The higher demand in the column for Public does not necessarily mean a faster flow through the fixture-it also considers a more frequent use of the fixture – it also considers a more frequent use of the fixture. Note that these columns are valid for both the cold water and the hot water distribution lines (separately, and where applicable).

Table 3.2 A sample Fixture Unit Table for Distribution pipes

Outlet Type	Minimum Tubing Size	
	Private	Public
Drinking Fountain		0.25
Lavatory	1	2
Dishwasher	1	
Wash Basin	1.5	3
Kitchen Sink	2	4
Shower	2	4
Bath	2	4
Washing Machine (8 lbs)	2	
Laundry Tray	3	
WC or urinal (tank)	3	5
Sillcock	3	5
WC or Urinal (flush 1")	6	10

The next table can be used for sizing of Service Pipes, only (supply pipes before branching to water heater, etc.). These columns account for total flow (cold + hot water, if applicable).

Table 3.3 A sample Fixture Unit Table for Service pipes

Outlet Type	Fixt.Units – Distr. Pipe	
Drinking Fountain		0.25
Lavatory	0.75	1.5
Dishwasher	1	
Wash Basin	1	2.25
Kitchen sink	1.5	3

Shower	1.5	3
Bath	1.5	3
Washing machine (8 lbs)	1.5	2.25
Laundry Tray	2.25	
WC or Urinal (tank)	3	5
Sillcock	3	5
WC or Urinal (flush 1")	6	10

Design using Fixture Units is a simplified method, and it may, or may not be an approved method for your actual project. Consult your local codes for advice.

3.2 Sizing Methods

3.2.2 Designing using the Fixture Unit Method

This section must be regarded as an example on a method to size systems using Fixture Units. If using the Fixture Unit method described here, it must be verified as acceptable to your local code, and Tables used must be checked for conformance to the local code applicable to actual installations.

Consider a project for a residential home. First step is to count the total Fixture Unit load using column: "Fixture Units - Serv. Pipe; Private" in Table 3.3. When adding all fixtures, say that the result is 25 Fixture Units. We also assume that the service pipe from the main in the street to the utility room is a 50 ft. long 3/4" pipe. You measure that the longest Tubing run (to the most distant fixture) from the utility room is 45ft. The sum of these two is 95 ft. Now, you look for this value in Table 3.4 (next page). Check in the column for next longer Tubing length than 95 ft. For 100 ft. you can supply 33 Fixture Units (which is more than the required 25) when using a 1 in. Distribution Pipe. If there were just one fixture, and it had a load of 25 Fixture Units, you would need to utilize a 1 in. Distribution Pipe to accommodate the project. However, this may not be required so we continue the sizing of the Distribution pipes more precisely.

We now calculate the Cold water demand and the Hot water demand separately, using the column: "Fixt.Units-Distr. Pipe; Private" in Table 3.2.

Table 3.3.4 A sample Table over maximum permissible Fixture Units acceptable for different Tubing Lengths and combinations of Service and Distribution pipes.

Service Pipe	Dist. Pipe	Max # F. Units/Length		
		40 ft	60 ft	80 ft
3/4	1/2	9	8	7
3/4	3/4	27	23	19
3/4	1	44	40	36
1	1	60	47	41

Service Pipe	Dist. Pipe	Max. # F. Units/Length		
		100 ft	150 ft	200 ft
3/4	1/2	6	5	4
3/4	3/4	17	14	11
3/4	1	33	28	23
1	1	36	30	25

We come up with the result 22.5 for the Cold water and 11.5 for the Hot water. Note that the sum of these two does not at all correspond to the total FU (Fixture Unit) demand of 25. It should not..

The distance to the furthest fixture is still 45ft for both the Hot and the Cold water. In the above table we can see that for 60 ft. (next over 45 ft.) a 3/4" Distribution Pipe can handle 23 FU (barely over the 22.5 for the Cold water but well over the 11.5 for the Hot water). So we can use 3/4" as main distribution lines for both Hot water and for Cold water.

Say now that we are going to size a branch of the main that is supplying a bathroom like on page 3.1 to 3.3. The Cold water load is 6 FU and 3 FU for the Hot water. The length of this Tubing branch could be 25 ft. In above table we can see that a 1/2 in. size is adequate to supply 9 FU for lengths of up to 40 ft. So 1/2 in. is adequate for both H & C water lines. Sizing of other parts of the system are made correspondingly.

When measuring Tubing lengths to be used in designs, make sure to be generous. Allowances for pressure loss in fittings must also be included. Table 3.5 displays some examples on "Equivalent Pipe Lengths" to be added to the individual Tubing sections. The Table tells how many additional ft. of tubing to add for each fitting used in actual section.

Table 3.5 A sample Table of Equivalent Tubing Length for various fittings.

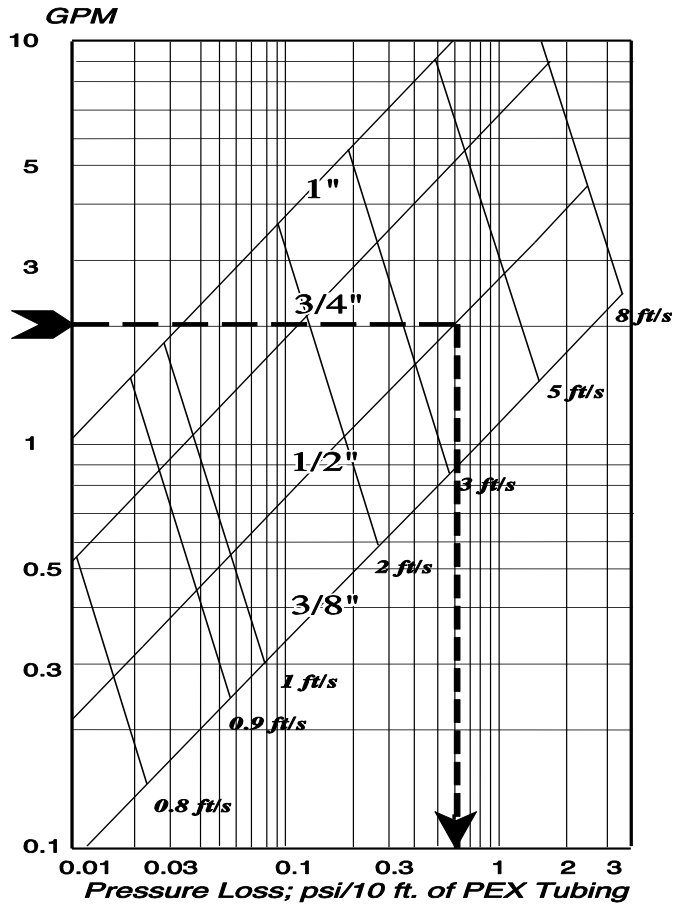
In-Line Fitting	Tubing Size		
	1/2	3/4	1
Crimp Ftg.	1	2	2
Elbow	2	2.5	3
Tee (run)	0.5	1	1
Gate valve	0.5	0.5	1
Angle Valve	8	12	15

We strongly recommend not using "border-line sizing". When tubing size is questionable -always use the larger size.

Design using Fixture Units is a simplified method, and it may, or may not be an approved method in your local code, or for the actual project. Where exact designs are required, a licensed engineer (or licensed plumber, where applicable) will need to perform calculations and size the systems as prescribed. At such designs, the Pressure Loss Charts for Roth PEX Tubing on following pages may be helpful.

3.3 PEX Tubing Pressure Loss

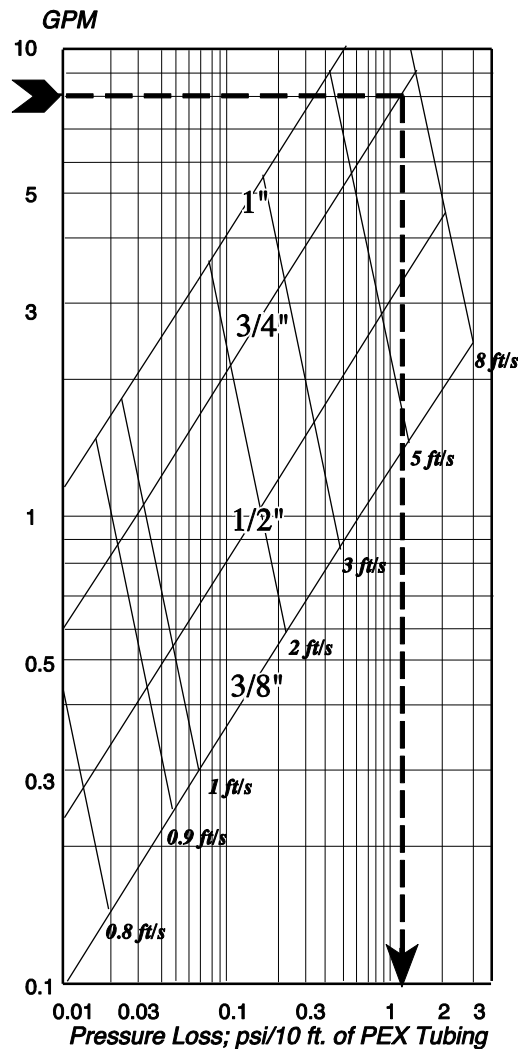
3.3.1 Chart for 60°F



The example line used: A 40 ft cold water 1/2" tubing line has a flow of 2 GPM. Following the arrows we read that the pressure loss is 0.6 psi/10 ft of length. So the total loss is 4 times higher (for 40 ft) $4 \times 0.6 = 2.4$ psi

We can also red the flow rate to be 4 ft/s

3.3.2 Chart for 120°F



The example line used: A 50 ft warm water 3/4" PEX tubing lien has a flow of 8 GPM. Following the arrows we read that the pressure loss is 1.2 psi/10 ft. of length. So the total loss is 5 times higher (for 50 ft.) $5 \times 1.2 = 60$ psi.

We can also read the flow rate to be 7 ft/s

4.1 Installation of Tubing runs

4.1.1 Applications & Limitations

Section 2 of this handbook includes many guide-lines for the use of Roth PEX Tubing, Fittings & Accessories. Read applicable parts for advice on how the products should be utilized. This section provides additional information related to installation.

4.1.2 Arrival inspection

Always inspect the parts to be used for the installation. Immediately report any damages or missing parts at delivery or pick-up. Check that all parts and accessories needed for the installation are available.

4.1.3 Working with PEX Tubing

PEX tubing has different properties than traditional metal piping systems. It is important to consider these differences and their impact on installation.

- **PEX Tubing is Flexible**

Take advantage of the flexibility of PEX tubing! PEX can be easily routed around corners and past obstacles without using additional fittings. Because it is flexible, PEX tubing also requires more pipe supports than traditional metal piping systems. Roth PEX tubing should be supported every 32" (81cm) in horizontal runs and every 48" (122cm) in vertical runs. The Roth Tubing Fasteners are ideal for this purpose. You can make 90° bends without using fittings, but be sure to observe the minimum bend radii listed in section 2.4.3. Some bends may benefit from using the Roth Bend Supports. Unlike traditional metal elbows, tubing bends are "long sweep" and have virtually no additional pressure loss. In addition, fewer fittings means fewer possibilities of leaks.

- **Roth PEX Tubing has "Memory"**

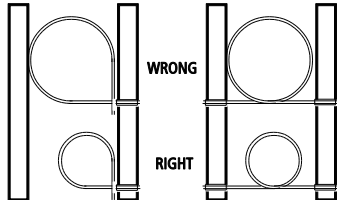
If Roth PEX tubing is kinked during installation the damage can be easily repaired. Relieve the stress at the kink by straightening the tubing. Using a heat gun (never an open flame!); carefully and evenly warm the tubing in the immediate vicinity of the kink until the tubing becomes soft. This occurs at approximately 265°F (130°C) and should take less than five minutes. Do not overheat the tubing or it may burn. As the tubing starts to soften you will see the kink start to disappear and the tubing will return to its original shape. As the tubing cools it will return to its original cream opacity and the kink will be gone, without any reduction in strength or performance limitation. This is due to the "memory" of its original extruded shape is a property unique to PEX tubing.

This repair method is limited to kinks in the tubing. If the tubing is cut, broken or cracked the damaged section must be removed and replaced. This type of damage cannot be repaired with a heat gun.

- **PEX Tubing Expands**

Thermal expansion and contraction of PEX tubing is much higher than for metal pipes. PEX tubing changes length by approximately 1.1" per 100' of tubing for every 10°F (~9cm per 100m of tubing for every 5°C) change in temperature. To put this into perspective, if you increase the water temperature from 100°F to 120°F (38°C to 49°C) in the tubing – not uncommon in a DHW system that is not recirculated – you can expect the tubing length to increase ~2 1/4" (5 3/4cm) for every 100' (30m) of tubing. This may not seem like a large amount, but if you do not allow for the movement you may

experience noise from the PEX movement. On long, straight runs of PEX you may need to include expansion loops.



- **PEX Tubing Insulates**

PEX tubing has much less heat transmission than standard metal piping materials. This means that water in the tubing will neither warm up nor cool down as quickly in PEX plumbing systems when compared to metal piping systems. The result is that you don't have to run a fixture as long to get hot or cold water. This could result in a substantial energy and water savings over a year's time. It also results in less condensation ("sweating") on the pipes. This does not mean that PEX pipes don't require insulation, but it does mean that there is greater energy and water savings even if you do have insulation on your pipes. Consult your local codes for pipe insulation requirements in your area.

- **PEX Tubing does not freeze**

PEX tubing does not become brittle at low temperatures and its flexibility will allow it to expand slightly, when it is in an unconfined space, to accommodate the volume increase when water freezes. Even repeated freezing may not damage the PEX tubing. This will not happen with traditional metal piping systems. However, if the PEX tubing is in a confined space, such as a concrete slab, the freeze may damage both the concrete and the PEX tubing because there is no space for expansion. **YOU SHOULD NEVER ALLOW WATER TO FREEZE IN PEX TUBING THAT IS EMBEDDED IN CONCRETE.**

PEX tubing that has frozen requires care if you are trying to thaw it. **NEVER USE AN OPEN FLAME TO THAW A FROZEN SECTION OF PEX TUBING.** Warm air, less than 300°F (149°C), or hot water can be used to thaw the PEX if it is carefully applied. It is also important to check any metal fittings in the area of the freeze prior to putting the system back into operation since metal fittings can rupture during the freeze.

- **PEX Tubing is Quiet**

The walls of PEX tubing are thicker, softer and smoother than metal piping. This helps to reduce the generation and transmission of velocity noise when water is flowing. PEX tubing also uses less fittings which further reduces the turbulence in the pipe. Since the wall of PEX tubing is flexible, it can reduce the pressure surges ("water hammer") caused by fast-closing solenoid valves, such as those commonly used in dishwashers and washing machines. This feature of PEX tubing helps to reduce pressure surge damage to sensitive components in the system. This may not eliminate the need for shock arrestors in the system. Good piping practices and local codes should be observed.

- **PEX Tubing works better in concrete**

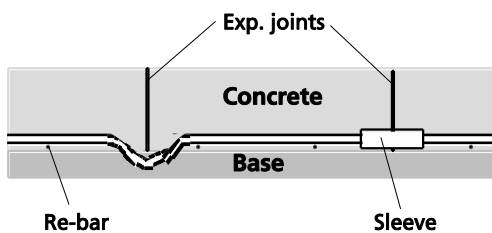
The physical and chemical properties of concrete are damaging to traditional metal piping systems.

Concrete restricts the expansion of metal pipes and causes damage to buried joints. Concrete can also cause erosion and pit-ting to the outside of metal pipe walls. When confined, PEX tubing expands by thickening its wall—not by increasing its length. PEX tubing is available in long lengths virtually eliminate the need for buried fittings. PEX tubing is impervious to the chemical reactions which destroy metal pipes encased in concrete. PEX tubing also has much less heat transmission than metal piping systems helping to maintain hot or cold water temperatures.

Care should be taken to prevent tubing damage when it is encased in concrete. The tubing should be secured every 2' to 4' (0.6m to 1.2m) to hold it at the correct level in the slab during a pour. When crossing expansion control joints the tubing should be run under the slab or sleeved with insulation when crossing joint to prevent damage to the tubing if the slabs shift. Be sure that the tubing is far enough down in the slab to avoid saw cuts for control joints. Always pressurize the tubing with air during a concrete pour to prevent or identify damage that may occur during the pour.

- **PEX Tubing is resistant to aggressive water conditions**

PEX tubing is not affected by water chemistry and electrolysis like metal piping systems. PEX tubing will not erode, pit and eventually perforate and leak like metal pipes. It's not exactly clear what combinations of conditions cause metal pipe failures, but PEX systems resist the chemical processes which cause this problem. PEX water distribution systems can generally be expected to outlast metal piping systems in these conditions.



- **PEX Tubing is Long**

Roth Plumbing PEX is available in a variety of coil lengths from 100' (30m) to 1000' (300m) depending on the diameter of the tubing. This means a minimum of joints where you don't need them. PEX tubing is also lighter than traditional metal piping. The end result is a more reliable and easier system to install. You can use the Roth Uncoiler to unspool longer length coils and use exactly the amount of tubing you need with much less waste. If you like to use the standard 20' (6m) straight lengths, we have them, too. The choice is yours.

- **PEX Tubing is Smooth**

PEX tubing has less flow resistance than traditional metal pipes because the inner wall is smoother. This can result in the ability to use a smaller size PEX line than a traditional metal pipe and still get the same

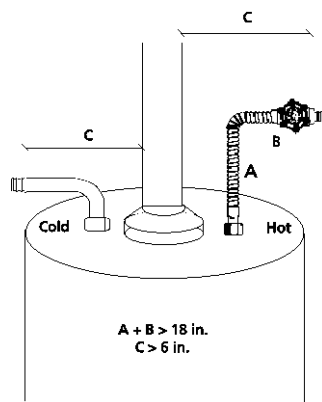
flow or less pressure drop. Consult the design charts in this book and your local codes when laying out a system.

4.2 Finishing the Installation

4.2.1 Working with the Roth PEX Plumbing System Components

+The description, application, installation instructions and limitations for the majority of the Roth PEX Plumbing System Components are covered in section 2 of this manual. Read this section carefully to familiarize yourself with these prior to installing the system. In general, the parts and accessories we use are applied and installed in a manner similar to their traditional metal piping system counterparts.

4.2.2 Water Heater Connections



You must maintain a minimum distance of 6" (15 cm) between PEX tubing and a water heater flue connection. The distance may be increased by the manufacturer of the appliance, local codes, the fuel that used for the water heater and the type of vent material used. In addition, the manufacturer or local codes may require a certain length of metal piping between the hot and cold water connections on the tank and connection to the PEX tubing. Roth recommends the use of metal connectors for a minimum of 18" (45cm) between the water connections and the PEX tubing. Be sure to review these requirements prior to connecting any water heater with PEX tubing. Roth has a number of suitable connectors available to meet these requirements. Some are shown in section 2.5.9 and others may be available in our current catalogue. The previous illustration shows a typical water heater connection.

4.2.3 Pressure Testing the System

All potable water distribution systems must be tested, inspected and approved by the local authority prior to the system being concealed and connected to the service and the fixtures. The local jurisdiction usually sets the minimum test pressure and whether water or air is used. Good installation practices may also dictate that a higher than "minimum" pressure be used for the test, such as 1.5 times the expected normal operating pressure. It is the responsibility of the installer to comply with these requirements.

We recommend using air to pressure test the system, especially if there is a danger of freezing. The test should be maintained for sufficient time to check all of the connections and verify that there are no leaks. Since it is more difficult to use air to test the system because there are no visual leak indicators (drips) and ambient temperature fluctuations can cause the gauge pressure to fluctuate, it is always a good idea to spray a mild soap solution on all of the fittings to check for small leaks. In addition, PEX tubing may expand slightly for a short period after pressure is applied to the system resulting in a small loss of gauge pressure.

When using water pressure to test a system you must be able to drain the entire system of water when the test is complete if there is a danger of freezing temperatures. PEX tubing is not freeze-proof and damage resulting from a freeze is not considered a manufacturer's defect. This means that freeze damage is not a valid warranty claim.

4.2.4 The Final Word

The Roth PEX Plumbing System is designed to meet the requirements of the national codes and standards in effect at the time of publication; however, local plumbing and mechanical codes govern the design and installation of potable water distribution systems within their jurisdiction. In some cases these requirements may be more stringent than national or state codes and these jurisdictions have the authority to require installers to conform to their local regulations. If there is a conflict between this handbook and your local codes, the local codes shall prevail in all situations. It is the plumbing professional's responsibility to understand and comply with these local regulations and to ensure that the system is correctly and safely installed and operationally sound.

Roth is constantly seeking to improve and broaden its product offering to meet the current standards of modern plumbing systems and changes in national codes. With this in mind, we may, from time to time, add or delete items from our catalogue. We will continue to make updates as we adopt new products and techniques in an effort to better serve the plumbing professional.