Chapter 3
Uponor Tubing Products

PEX is an acronym for crosslinked polyethylene. The “PE” refers to the raw material used to make polyethylene, and the “X” refers to the crosslinking of the polyethylene across its molecular chains. The molecular chains are linked into a three-dimensional network that makes PEX remarkably durable within a wide range of temperatures and pressures.

Currently, three methods for producing PEX exist:
• Engel or peroxide method (PEX-a)
• Silane method (PEX-b)
• Electron beam (e-beam) or radiation method (PEX-c)

All three processes generate tubing that is crosslinked to various degrees and that is acceptable for potable water-distribution applications according to ASTM F876 and F877 standards.

**Engel Method (PEX-a)** — Uponor manufactures Engel-method PEX-a tubing. The PEX tubing industry considers this tubing superior because the crosslinking is done during the manufacturing process when the polyethylene is in its amorphic state (above the crystalline melting point). Accordingly, the degree of crosslinking reaches approximately 85%, resulting in a more uniform product with no weak links in the molecular chain.

**Silane Method (PEX-b)** — PEX-b tubing is crosslinked after the extrusion process by placing the tubing in a hot water bath or steam sauna. The degree of crosslinking for PEX-b is typically about 65% to 70%. This method produces PEX that is not as evenly crosslinked as that produced by the PEX-a method. In addition, PEX-b lacks the same degree of thermal memory, which allows kinked tubing to be reshaped with the use of a heat gun.

**Electron Beam Method (PEX-c)** — PEX-c uses an e-beam to change the molecular structure of the tubing (i.e., crosslink) after the extrusion process. The PEX-c method requires multiple passes of the tubing under the beam to reach a 70% to 75% degree of crosslinking. This method produces PEX that is not as evenly crosslinked as that produced by the PEX-a method. Side effects of this process are discoloration due to oxidation (from natural white to yellow, unless other pigment is added), and a slightly stiffer product.

**PEX-a Distinctions**
The properties of PEX-a tubing make it the most flexible PEX on the market. This flexibility allows the tightest bend radius available — 6 times the outside diameter of the tubing. Its flexibility also greatly reduces instances of kinked tubing.

However, in the rare instance of a kink, that’s okay, because PEX-a tubing has thermal memory. Thermal memory allows the repair of kinked tubing with a simple shot of heat from a heat gun. The shape memory of PEX-a tubing offers the unique opportunity for ProPEX® fitting connections. Shape memory allows PEX-a to expand and then shrink back to normal size — creating strong, durable and reliable fitting connections.

Finally, PEX-a tubing offers more resistance to crack propagation (how a crack grows) than PEX-b or PEX-c tubing. A crack that occurs in PEX-a tubing is the least likely to grow over time and cause leaks or damage.

**Stress Resistance**
Tubing installed in radiant floor, wall and ceiling applications must be capable of withstanding the extreme stresses that result from installation within a concrete slab or a structural wood floor. Typical stresses include:
• Expansion and contraction that result from repeated heating and subsequent cooling of the heat-transfer fluid
• Mechanical abrasion, shearing, and stretching that occurs as a result of installation, normal structural movement, and heating and cooling from seasonal weather changes

Uponor PEX provides the durability and reliability that’s needed for these applications and currently holds the unofficial world record for long-term testing at elevated temperature and pressure. From 1973 to 2009, the tubing was subjected to ongoing testing at 203°F/175 psi by Studvik in Sweden and BASF in Germany. The resulting data indicates a life expectancy of well over 100 years.

**Chemical Resistance**
Crosslinked polyethylene has greatly enhanced resistance to chemical-dissolving agents. The unique molecular structure is stable, inert and unaffected by chemicals commonly found in plumbing and heating systems. PEX is also resistant to many other chemical-dissolving agents, making it suitable for many applications. Please contact Uponor at 800.321.4739 (U.S.) or 888.994.7726 (Canada) with questions about specific chemical resistance.
Oxygen Diffusion
Oxygen diffusion can cause corrosion problems in a heating system. All non-metallic (plastic or rubber) tubing is permeable to the passage of dissolved oxygen molecules through its walls. Permeability allows these dissolved oxygen molecules to enter an otherwise closed hydronic heating system.

In any new hydronic heating installation, dissolved oxygen molecules exist in the new, fresh water. The large bubbles are purged from the system prior to initial start-up. The dissolved oxygen, however, remains. This dissolved oxygen is not visible in the form of bubbles, and cannot be eliminated by the use of an air vent or scoop.

As the heating system brings the water up to temperature, these dissolved oxygen molecules increasingly bond with ferrous components in the system. The result is corrosion or rust. After a few years of operation, a layer of rust on all ferrous components becomes apparent.

In a typical hydronic system using metallic pipe, almost all dissolved oxygen molecules are used up and cause a non-aggressive rust called “ferrous oxide” usually within the first 72 hours. That’s the end of the corrosion process.

However, in a non-metallic system using plastic or rubber tubing, oxygen continues to enter the system through the permeable tubing. Accordingly, the corrosion process continues. Left unchecked, this corrosion will cause considerable damage to the ferrous components of the radiant heating system.

Damage may include:
- Circulator failures
- Pinhole leaks at expansion tanks
- A red, sludgy build-up inside the system tubing (reducing flow)
- Eventual boiler failure (if a cast-iron or steel boiler is used)

Here are four ways to manage oxygen-diffusion corrosion.

Option 1 — Use tubing that limits the oxygen diffusion into the heat-transfer fluid to a level consistent with established standards. Use Wirsbo hePEX™ or Multi-layer Composite (MLC) tubing (formerly MultiCor®) for these applications.

Option 2 — Isolate the heat-transfer fluid from components likely to corrode (e.g., cast-iron pumps, boilers, expansion tanks, etc.) with a non-ferrous heat exchanger. Uponor AquaPEX® tubing, without the oxygen-diffusion barrier, is available for those systems that isolate the heating loops from the heat plant and circulator components. All other components (e.g., expansion tanks, circulators and piping) on the floor heating side of the heat exchanger must be made of a non-ferrous material as well.

Option 3 — Eliminate all corrosive ferrous components from the system. Uponor AquaPEX is available for those systems that use non-ferrous components (e.g., bronze pumps, copper tube boilers with bronze headers, etc.).

Option 4 — Treat all heat-transfer fluid with corrosion inhibitors. Corrosion inhibitors require regular maintenance from the heat plant manager to maintain the correct inhibitor level. In the event the system mixture is allowed to lapse, corrosion damage may occur. For these reasons, Uponor does not recommend the use of corrosion inhibitors to counter the effects of oxygen diffusion.

Handling Guidelines for PEX Tubing
The following list highlights the most common guidelines when handling Uponor PEX-a tubing.

- Always install Uponor systems according to the installation instructions.
- Do not use PEX-a tubing where temperatures and pressures exceed ratings.
- Do not use or store PEX-a tubing where it will be exposed to direct sunlight for more than 30 days.
- Do not weld, glue or use adhesives or adhesive tape with PEX-a tubing.
- Do not apply open flame to PEX-a tubing.
- Do not install PEX-a tubing within 6 inches of any gas appliance vents, with the exception of double-wall B-vents, which have a minimum clearance of 1 inch.
- Do not install PEX-a tubing within 12 inches (over or under) of any recessed light fixture unless the tubing line is protected with suitable insulation.
- Do not solder within 18 inches of any PEX-a tubing in the same water line. Sweat connections must be made prior to making a ProPEX connection.
- Do not spray on or allow organic chemicals, pesticides, strong acids or strong bases to come into contact with PEX-a tubing.
- Do not use petroleum or solvent-based paints, greases or sealants on PEX-a tubing.
- Do not use or store PEX-a tubing where such conditions cause permeation, corrosion, degradation or structural failure of the tubing. Where such conditions are suspected, perform a chemical analysis of the soil or groundwater to ascertain the acceptability of the soil or groundwater.
of PEX-a tubing for the specific installation. Check local codes for additional requirements.

**Reforming Kinked Tubing**

If the tubing is kinked and hinders flow, repairs can be made easily.

1. Make sure the system is not pressurized.
2. Straighten the kinked portion of the tubing.
3. Heat the kinked area to approximately 265ºF with an electric heat gun (approximately 450 watts of power). Apply the heat evenly until the tubing returns to its original size and shape. Do not use an open flame.
4. Let the repaired tubing cool undisturbed to room temperature. When the tubing returns to its opaque appearance, the repair is complete.

**Caution:** Temperature of the tubing surface must not exceed 338ºF. Do not apply direct flame to the tubing. Uponor PEX-a tubing repaired according to these recommendations will return to its original shape and strength. If the tubing is sliced, punctured or otherwise damaged beyond the capacity of the crosslinked memory, install a ProPEX coupling. PEX tubing cannot be welded or repaired with adhesives.

**Thawing Frozen Tubing**

Uponor PEX-a tubing can withstand extreme freeze/thaw cycles better than other tubing or pipe. The crosslinking of the tubing allows it to expand and absorb much of the expansion energy from the freezing process. No tubing product is freeze-proof, but Uponor PEX-a tubing is extremely resistant to freeze damage.

If freezing occurs, the contractor should advise the end user to correct the lack of insulation or heat to eliminate the problem from reoccurring. Should Uponor PEX-a tubing experience an ice blockage, thaw the tubing using these methods:

1. Pour hot water over the tubing’s affected area.
2. Wrap hot towels around the tubing’s affected area.
3. Place a small portable heating unit in the area to heat the space and thaw the ice blockage from the tubing.
4. Slowly heat the affected area with a heat gun. Rub a hand over the area while heating to ensure the tubing does not get too hot.

**Uponor Tubing**

With more than 35 years of service — longer than any other PEX manufacturer in North America — Uponor is the leader in PEX tubing for radiant heating, plumbing and fire-protection systems. More than two billion feet of Uponor PEX tubing is in service in North America alone, and more than 12 billion feet of tubing is installed worldwide. With that kind of history, you can count on Uponor PEX to offer the highest-quality tubing for all your application needs.

The Uponor ProPEX fitting system (ASTM F1960) was tested with various components provided by Uponor, including the PEX-a pipe, PEX-a ring and ProPEX fitting, and the assembly was listed by CSA. The testing program included sustained pressure testing, bent-tube pressure testing, excessive temperature and pressure capability testing as well as several other tests with weekly and yearly follow-up procedures. Uponor’s unique cold-expansion fitting system is highly reliant on the elastic memory of the product and the unique material properties in its formulation. CSA will only provide a system certification if warranted; properties of each component are proven to be required to form a fully functional system.

**Selecting an Uponor Tubing Product**

Uponor offers the following tubing products for distribution and supply and return mains for use in radiant heating and cooling installations:

- **Distribution** — Wirsbo hePEX, MLC, Uponor AquaPEX and Ecoflex®
- **Supply and return mains** — Large-dimension Wirsbo hePEX, high-density polyethylene (HDPE) and Ecoflex
### Uponor Tubing

<table>
<thead>
<tr>
<th><strong>Wirsbo hePEX</strong></th>
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<tbody>
<tr>
<td><strong>Application</strong> — Wirsbo hePEX is designed for use in closed-loop hydronic radiant heating systems operating at sustained temperatures up to 200°F. Corrodible or ferrous components may be used in hot-water heating systems designed with Wirsbo hePEX tubing.</td>
</tr>
<tr>
<td><strong>Standards, Listings and Ratings</strong></td>
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<tr>
<td>Wirsbo hePEX is manufactured to meet ASTM F876 and ASTM F877 standards. Wirsbo hePEX has a Standard Grade Hydrostatic Design Stresses and Pressure Rating in accordance with all three temperatures and pressures listed in Table 1 of ASTM F876. Wirsbo hePEX tubing is tested in accordance with PPI TR-3 and listed in PPI TR-4.</td>
</tr>
<tr>
<td>The Standard Grade hydrostatic ratings are:</td>
</tr>
<tr>
<td>• 200°F at 80 psi • 180°F at 100 psi • 73.4°F at 160 psi</td>
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<tr>
<td>The Hydrostatic Design Stress Board of the Plastics Pipe Institute (PPI) issues these pressure and temperature ratings. These values listed are ratings, not limitations. If the designer stays within these parameters during design, there should not be a problem with the product. Burst pressures are values used only in manufacturing the product, not for the system specification or design.</td>
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<tr>
<td>Wirsbo hePEX is listed with the following agencies.</td>
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<tr>
<td>• Council of America Building Officials (CABO) One and Two Family Dwelling Code</td>
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<td>• CAN/CSA B137.5, “Crosslinked Polyethylene (PEX) Tubing Systems for Pressure Applications”</td>
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<tr>
<td>• ICBO Evaluation Service — ER Number 4407, 5143</td>
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<tr>
<td>• Southern Building Code Congress International (SBCCI) Standard Plumbing Code (PST and ESI Report Number 9661)</td>
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<tr>
<td>• U.S. Department of Housing and Urban Development (HUD) Material Release Number 1269</td>
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<tr>
<th><strong>Multi-layer Composite (MLC) Tubing</strong></th>
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<td><strong>Application</strong> — MLC is designed for use in closed-loop hydronic heating systems operating at sustained temperatures up to 200°F. Corrodible or ferrous components may be used in hot-water heating systems designed with MLC.</td>
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<tr>
<td><strong>Standards, Listings and Ratings</strong></td>
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<tr>
<td>MLC is manufactured to ASTM F1281 as certified by NSF International. MLC has a Standard Grade Hydrostatic Pressure Rating in accordance with the temperatures and pressures listed in Section X1 of ASTM F1281. MLC is tested in accordance with PPI TR-3 and listed in PPI TR-4.</td>
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<tr>
<td>The Standard Grade hydrostatic ratings are:</td>
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<tr>
<td>• 200°F at 100 psi • 180°F at 125 psi</td>
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<tr>
<td>• 140°F at 160 psi • 73°F at 200 psi</td>
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<tr>
<td>The Hydrostatic Design Stress Board of PPI issues these pressure and temperature ratings. These values listed are ratings, not limitations. If the designer stays within these parameters during design, there should not be a problem with the product. Burst pressures are values used only in manufacturing the product, not for the system specification or design.</td>
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<tr>
<td>MLC is listed with the following agencies.</td>
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<tr>
<td>• ICBO Evaluation Service — ER Number 5298</td>
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<tr>
<td>• Southern Building Code Congress International (SBCCI) Standard Plumbing Code (PST and ESI Report Number 9829)</td>
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<tr>
<td>Barrier Information</td>
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<td>Wirbo hePEX is sealed with a special polymer barrier to prevent the diffusion of oxygen through the tubing wall and to protect the ferrous components of a closed-loop hydronic heating system from corrosion damage. The barrier consists of an ethylene vinyl alcohol (EVOH) layer co-extruded onto the tubing during the manufacturing process. Uponor applies another thin polyethylene layer over the EVOH barrier on the tubing to reduce possible onsite damage to the oxygen-diffusion barrier. This polyethylene layer also provides protection for the EVOH barrier if the tubing is immersed in high-moisture applications. The Wirbo hePEX barrier meets the requirements of the German DIN Standard 4726 for oxygen-diffusion prevention. The amount of oxygen that enters the system must be less than 0.10 grams per cubic meter per day at 104°F.</td>
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<td>MLC offers 100% oxygen-diffusion protection due to the aluminum within the tubing wall.</td>
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**Uponor Tubing**

**Uponor AquaPEX**
Uponor AquaPEX is a registered trade name for the company’s hot and cold potable water tubing. It is essentially the same product as Wirsbo hePEX, but without the oxygen-diffusion barrier.

**Application and Design Considerations**
- **Application** — Uponor AquaPEX can be used in closed-loop hydronic heating systems operating at sustained temperatures up to 200°F, provided any issues concerning oxygen diffusion are properly addressed. Corrodible or ferrous components may not be used in a system designed with Uponor AquaPEX unless these components are isolated from the tubing.
- **Design Considerations** — Uponor AquaPEX is permeable to oxygen at a rate up to 13.6 grams per cubic meter per day at 158°F. Radiant floor systems using Uponor AquaPEX tubing must be designed to accept oxygen permeation.

**Standards, Listings and Ratings**
Uponor AquaPEX is manufactured to meet: ASTM F876, ASTM F877 and CAN/CSA B137.5. Uponor AquaPEX has a Standard Grade Hydrostatic Design Stresses and Pressure Rating in accordance with all three temperatures and pressures listed in Table 1 of ASTM F876. Uponor AquaPEX tubing is tested in accordance with PPI TR-3 and listed in PPI TR-4. The Standard Grade hydrostatic ratings are:
- 200°F at 80 psi
- 180°F at 100 psi
- 73.4°F at 160 psi

The Hydrostatic Design Stress Board of PPI issues these pressure and temperature ratings. These values listed are ratings, not limitations. If the designer stays within these parameters during design, there should not be a problem with the product. Burst pressures are values used only in manufacturing of the product, not for the system specification or design.

Uponor AquaPEX is listed with the following agencies.
- ANSI/NSF 14 and 61 Certified
- Council of America Building Officials (CABO) One and Two Family Dwelling Code
- ICBO Evaluation Service — ER Number 5142, 5143
- UPC Listing — Files 3558, 3946, 3960
- U.S. Department of Housing and Urban Development (HUD) Material Release Number 1269

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**High-density Polyethylene (HDPE)**
Uponor high-density polyethylene (HDPE) tubing (PE 3408) is a non-barrier product that is joined by heat-fusion welding. Flange adapters are available to transition to nonferrous piping. Refer to the Uponor Product Catalog for additional fitting and component information.

**Application** — Uponor HDPE can be used as supply and return mains in closed-loop hydronic heating systems operating at sustained temperatures up to 140°F, provided any issues concerning oxygen diffusion are properly addressed. Corrodible or ferrous components may not be used in a system designed with Uponor HDPE unless these components are isolated from the tubing.

**Design Considerations** — HDPE tubing has an oxygen-diffusion rate greater than that allowed by the German DIN 4726. Hydronic heating systems using HDPE tubing must be designed to accept oxygen permeation or be isolated from ferrous components in the system.

**Standards, Listings and Ratings**
Uponor HDPE tubing and fittings are manufactured by Phillips Driscopipe to meet ASTM D3350 and ASTM D3261. The HDPE tubing has the following hydrostatic pressure and temperature ratings from PPI.
- 140°F at 80 psi
- 120°F at 101 psi
- 100°F at 125 psi
- 73°F at 160 psi

HDPE conforms to the following certifications.
- Standards: PE 3408, PE 3608, AWWA, C901/C906; ASTM F714
- Listings: NSF/ANSI 61 or NSF-pw
<table>
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<tr>
<th>Barrier Information</th>
<th>Linear Expansion Rate</th>
<th>Dimensions</th>
<th>Coil Lengths</th>
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</table>
| Uponor AquaPEX is a non-barrier product. | The unrestrained linear expansion (thermal) rate for Uponor AquaPEX tubing is approximately 1.1 inches per 10°F temperature change per 100 feet of tubing. | • ½” nominal inside diameter (contains 0.24 gallons/100’ of tubing)  
• ⅜” nominal inside diameter (contains 0.50 gallons/100’ of tubing)  
• ½” nominal inside diameter (contains 0.92 gallons/100’ of tubing)  
• ⅝” nominal inside diameter (contains 1.34 gallons/100’ of tubing)  
• ¾” nominal inside diameter (contains 1.84 gallons/100’ of tubing)  
• 1” nominal inside diameter (contains 3.03 gallons/100’ of tubing)  
• 1¼” nominal inside diameter (contains 4.53 gallons/100’ of tubing)  
• 1½” nominal inside diameter (contains 6.32 gallons/100’ of tubing)  
• 2” nominal inside diameter (contains 10.85 gallons/100’ of tubing)  
• 2½” nominal inside diameter (contains 16.53 gallons/100’ of tubing)  
• 3” nominal inside diameter (contains 23.51 gallons/100’ of tubing) | Refer to the Uponor Product Catalog for available coil lengths. Custom coil lengths are also available for qualifying orders. Allow six weeks for delivery. Call Uponor Customer Service at 888.594.7726 for availability and pricing. |
| Uponor HDPE is a non-barrier product. | The unrestrained linear expansion (thermal) rate for HDPE tubing is approximately 1.4 inches per 10°F temperature change per 100 feet of tubing. | • 2” nominal inside diameter (contains 15.0 gallons/100’ of tubing)  
• 3” nominal inside diameter (contains 32.6 gallons/100’ of tubing)  
• 4” nominal inside diameter (contains 53.87 gallons/100’ of tubing) | Uponor HDPE is only available in 20-foot straight lengths. |
Ecoflex Pre-insulated Pipe Systems

Designed for fluid transfer in a variety of hydronic heating, cooling and potable-water applications, Ecoflex pre-insulated pipes are easy to install, dependable, cost-effective and energy-saving.

Lightweight and flexible, Ecoflex installs easily and quickly in commercial and residential applications — even over obstacles and around corners.

Recognized for its ability to stand up to harsh environments, Ecoflex — now available in ASTM sizes — is virtually maintenance-free. This feature is especially important since Ecoflex usually involves an underground installation. With coil lengths available up to 600 feet, Ecoflex practically eliminates the need for underground joints — resulting in seamless runs of piping.

Ecoflex Thermal

ASTM Ecoflex Thermal is a pre-insulated pipe for buried or above-ground commercial and residential hydronic radiant heating and cooling applications with single or twin pipe options. Service pipes are made from PEX-a Wirsbo hePEX (oxygen-diffusion barrier) tubing, protected by multi-layer, PEX-foam insulation and covered by a corrugated, watertight, HDPE jacket. Use with ProPEX fittings (up to 2") or WIPEX dezincification-resistant (DZR) brass compression fittings.

Codes and Standards — ASTM F876, F877 and F1960; CSA B137.5; NSF-rfh

Ecoflex Potable PEX

Ideal for hot and cold potable-water applications, ASTM Ecoflex Potable PEX features Uponor AquaPEX (PEX-a) service pipe protected by multi-layer, PEX-foam insulation and covered by a corrugated, watertight HDPE jacket. Ecoflex Potable PEX uses ProPEX fittings (up to 2") or WIPEX DZR brass compression fittings.

Codes and Standards — UPC, IPC, NSPC, NPC of Canada; ASTM F876, ASTM F877; CSA B137.5; NSF-pw; PEX S106

Ecoflex Potable HDPE

Perfect for cold potable water, cooling and low-temperature heating applications, ASTM Ecoflex Potable HDPE features HDPE service pipe protected by multi-layer, PEX-foam insulation and covered by a corrugated, watertight, HDPE jacket. Ecoflex Potable HDPE uses any industry-standard SDR11 HDPE fitting method.

Codes and Standards — UPC, IPC, NSPC, NPC of Canada; PE 3408, PE 3608 or PE 3454; AWWA C906; ASTM F714; NSF-pw
Fire-resistant Standards

National building codes, such as the IBC and UBC, require that products used in commercial construction meet specific standards. In addition to recognized product standards, PEX tubing systems must meet fire-resistant construction standards. To ensure compliance with all national standards, Uponor commissioned Intertek Testing Services (formerly known as Warnock Hersey) to test and list Uponor AquaPEX and Wirsbo hePEX tubing and systems. Uponor PEX achieved the following fire-resistant construction ratings when tested in accordance with the applicable standards:

  - UL Design No. K913 rating applies to ½” to 2” Uponor AquaPEX and Wirsbo hePEX tubing, fittings and manifolds installed in one and two-hour concrete floor/ceiling unrestrained (and restrained) assemblies.
  - UL Design No. V444 rating applies to ½” to 2” Uponor AquaPEX and Wirsbo hePEX tubing, fittings and manifolds installed in one-hour wood frame floor and ceiling assemblies.
  - UL Design No. L557 rating applies to ½” to 2” Uponor AquaPEX and Wirsbo hePEX tubing, fittings and manifolds installed in one-hour wood frame floor and ceiling assemblies.

  - Certification of flame spread/smoke development rating of 25/50 in accordance with ASTM E84 for the following Uponor AquaPEX and Wirsbo hePEX tubing sizes: ⅛”, ⅜”, ⅝”, ⅞” and ¾”.

Firestop Listings

Numerous firestop systems are listed with PEX tubing in one- and two-hour through penetration assemblies. Several firestop manufacturers listed their products for use with PEX tubing when installed in accordance with the listed construction assembly. Acceptable firestop systems are tested in accordance with the standard below. For the most current list of manufacturers, refer to www.uponorpro.com or www.uponorengineering.com.

  - 3M Fire Protection Products
  - HILTI, Inc.
  - RectorSeal, Metacaulk