

ANSI/AWWA

C904-22

(Revision of *ANSI/AWWA C904-16*)

AWWA Standard

Crosslinked Polyethylene (PEX) Pressure Tubing, 1/2 In. Through 3 In., for Water Service

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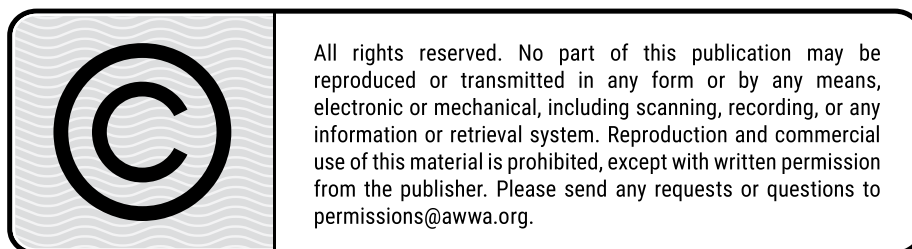
AWWA Standard

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Foreword

This foreword is for information only and is not a part of ANSI /AWWA C904.*

I. Introduction.

I.A. *Background.* This standard describes crosslinked polyethylene (PEX) pressure tubing for use primarily as potable service lines in the construction of underground water distribution systems.

This standard describes tubing made with a materials designation code of PEX 1306, or higher, according to [ASTM International \(ASTM[†]\) Standard F876](#). This standard describes tubing in nominal dimensions ½ in. through 3 in. with a standard dimension ratio of 9 (SDR9) and pressure class of 160 psi.

I.B. *History.* On June 18, 2002, the American Water Works Association (AWWA) Committee on Polyolefin Pressure Pipe and Fittings was approached to develop a standard describing PEX for water service applications. On June 15, 2004, the polyolefin committee unanimously approved and authorized the development of a new standard for PEX, ½ in. through 3 in., for water service. A new PEX subcommittee was also formed at this time to begin development of this standard within AWWA. The first edition was approved by the AWWA Board of Directors on June 11, 2006. The second edition was approved on Jan. 16, 2016. This edition was approved on June 10, 2022.

I.C. *Acceptance.* In May 1985, the US Environmental Protection Agency (USEPA) entered into a cooperative agreement with a consortium led by NSF International (NSF) to develop voluntary third-party consensus standards and a certification program for direct and indirect drinking water additives. Other members of the original consortium included the Water Research Foundation[‡] (formerly AwwaRF) and the Conference of State Health and Environmental Managers (COSHEM). AWWA and the Association of State Drinking Water Administrators (ASDWA) joined later.

In the United States, authority to regulate products for use in, or in contact with, drinking water rests with individual states.[§] Local agencies may choose to impose requirements more stringent than those required by the state. To evaluate the health

* American National Standards Institute, 25 West 43rd Street, Fourth Floor, New York, NY 10036.

† ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428.

‡ Water Research Foundation, 6666 West Quincy Avenue, Denver, CO 80235.

§ Persons outside the United States should contact the appropriate authority having jurisdiction.

effects of products and drinking water additives from such products, state and local agencies may use various references, including:

1. Specific policies of the state or local agency.
2. Four standards developed under the direction of NSF: NSF[‡]/ANSI/CAN 60, Drinking Water Treatment Chemicals—Health Effects; NSF/ANSI/CAN 61, Drinking Water System Components—Health Effects; NSF/ANSI/CAN 372, Drinking Water System Components—Lead Content; and NSF/ANSI/CAN 600, Health Effects Evaluation and Criteria for Chemicals in Drinking Water.
3. Other references, including AWWA standards, *Food Chemicals Codex*, *Water Chemicals Codex*,** and other standards considered appropriate by the state or local agency.

Various certification organizations may be involved in certifying products in accordance with NSF/ANSI/CAN 61. Individual states or local agencies have authority to accept or accredit certification organizations within their jurisdictions. Accreditation of certification organizations may vary from jurisdiction to jurisdiction.

NSF/ANSI/CAN 600 (which formerly appeared in NSF/ANSI/CAN 60 and NSF/ANSI/CAN 61 as Annex A, “Toxicology Review and Evaluation Procedures”) does not stipulate a maximum allowable level (MAL) of a contaminant for substances not regulated by a USEPA final maximum contaminant level (MCL). The MALs of an unspecified list of “unregulated contaminants” are based on toxicity testing guidelines (noncarcinogens) and risk characterization methodology (carcinogens). Use of NSF/ANSI/CAN 600 procedures may not always be identical, depending on the certifier.

NSF/ANSI/CAN 372 Drinking Water System Components—Lead Content is the standard that establishes procedures for the determination of lead content based on the wetted surface areas of the products. For products evaluated to NSF/ANSI/CAN 61, with the exception of those exempted in the Safe Drinking Water Act of the United States, the wetted surfaces of the products shall have a weighted average lead content $\leq 0.25\%$ when evaluated in accordance with NSF/ANSI/CAN 372.

ANSI/AWWA C904 does not address additive requirements. Thus, users of this standard should consult the appropriate state or local agency having jurisdiction in order to:

1. Determine additive requirements, including applicable standards.

[‡] NSF International, 789 North Dixboro Road, Ann Arbor, MI 48105.

** Both publications are available from National Academy of Sciences, 500 Fifth Street, NW, Washington, DC 20001.

2. Determine the status of certifications by parties offering to certify products for contact with, or treatment of, drinking water.

3. Determine current information on product certification.

II. Special Issues. AWWA’s “Committee Report—Design and Installation of Crosslinked Polyethylene (PEX) Pipe in Accordance with AWWA C904” was developed and approved by the AWWA Standards Committee on Polyolefin Pressure Pipe and Fittings and was published in the March 2012 *Journal AWWA*. The full committee report is now included in this standard as Appendix A, Design and Installation of Crosslinked Polyethylene (PEX) Tubing in Accordance with ANSI/AWWA C904, and will be included until such time as a manual of practice is developed to cover this information.

II.A. Design Criteria.

II.A.1. Hydrostatic design stress (HDS). For PEX materials covered by this standard, the value of the hydrostatic design stress (hydrostatic design basis [HDB] multiplied by the design factor [DF], which in this standard is 0.5) is given in Table F.1. This value is for service temperatures of 73°F (23°C) or lower and should be modified for higher service temperatures (see Appendix A).

II.A.2. Material designation code. The PEX material designation code per [ASTM F876](#) is the abbreviation for the material, PEX, followed by four numbers. The first number refers to chlorine resistance in one of four categories when tested in accordance with [ASTM F2023](#) and evaluated in accordance with [ASTM F876](#).

- A digit “0” indicates that the PEX tubing either has not been tested for chlorine resistance or does not meet the minimum requirement for chlorine resistance.
- A digit “1” indicates the PEX tubing has been tested and meets the [ASTM F876](#) requirement for minimum chlorine resistance at the end-use condition of 25 percent of the time at 140°F (60°C) and 75 percent of the time at 73°F (23°C).
- Digit “2” is reserved for future application.

Table F.1 Hydrostatic design basis and hydrostatic design stress for PEX tubing

Standard PEX Code	Hydrostatic Design Basis at 73°F (23°C)		Hydrostatic Design Stress at 73°F (23°C)	
	<i>psi</i>	<i>(kPa)</i>	<i>psi</i>	<i>(kPa)</i>
PEX 1306	1,250	(8,620)	630	(4,340)

- A digit “3” indicates that the PEX tubing has been tested and meets the [ASTM F876](#) requirement for minimum chlorine resistance at end-use condition of 50 percent of the time at 140°F (60°C) and 50 percent of the time at 73°F (23°C).
- Digit “4” is reserved for future application.
- A digit “5” indicates that the PEX tubing has been tested and meets the requirement for minimum chlorine resistance at end-use conditions of 100 percent of the time at 140°F (60°C).
- A chlorine resistance digit of “1” is established as the minimum requirement in this standard for water service line applications. Digits of “3” or “5” exceed this requirement.

The second number refers to UV resistance in one of four categories when tested in accordance with [ASTM F2657](#) and evaluated in accordance with [ASTM F876](#).

- A digit “0” indicates that the PEX tubing either has not been tested for UV resistance or does not meet the next category for UV resistance.
- A digit “1” indicates that the PEX tubing meets the requirements for 1 month UV resistance.
- A digit “2” indicates that the PEX tubing meets the requirements for 3 months UV resistance.
- A digit “3” indicates that the PEX tubing meets the requirements for 6 months UV resistance.
- A UV resistance digit of “3” is established as the minimum requirement in this standard for water service line applications.

The third and fourth numbers refer to the HDS for water at 73°F (23°C) in units of 100 psi.

II.A.3. Design factor. The allowable long-term strength of ANSI/AWWA C904 PEX materials takes into consideration the duration of application loading and considers two general groups of conditions. The first group considers the manufacturing and testing variables, specifically normal variations in the material, manufacture, dimensions, good handling techniques, and HDB testing and evaluation procedures. The second group considers the application or use, specifically installation and unknown local effects such as ovaling and longitudinal bending that occur in installed buried pipe, environment, temperature, hazard involved, life expectancy, and the degree of reliability. These factors are accounted for using a DF of 0.5 for the PEX materials covered by this standard. Because HDB, DF, and HDS relate exclusively to sustained long-term internal pressure service, there is no relationship between the

0.5 DF and short-term bursting pressure. In this standard, short-term bursting tests are required solely for quality control purposes.

II.B. *Installation.*

II.B.1. Bending. Bends in PEX tubing are not permitted closer than 10 pipe diameters from any fitting or valve. The recommended minimum radius of curvature is 8 times the tubing diameter when unsupported (free) bends are made. Manufacturer-approved snap-on bend supports may be used to achieve this bend radius. Bending of coiled tubing against the coil (reverse bending beyond straight) may be restricted with certain PEX tubing. Consult the tubing manufacturer for specific bending limitations and recommendations.

II.B.2. Joining methods and fittings. Fittings used on PEX service line applications shall be insert-stiffener type complying with the material and performance requirements of [ANSI/AWWA C800](#) and the manufacturer's requirements for dimensions and tolerances. Insert stiffeners shall be used with [ANSI/AWWA C800](#) fittings and valves. The use of fittings that are not covered by a nationally accredited standard is subject to the judgment and discretion of the purchaser.

Alternatively, one of the PEX fitting systems listed in Sec. II.B.2.1 to Sec. II.B.2.7 may be used for joining PEX tubing. Materials shall comply with NSF/ANSI/CAN 61, and fittings shall comply with the dezincification resistance and stress corrosion cracking resistance requirements of NSF/ANSI 14.

The corrosion of metal fittings in buried applications depends on the conditions of the soil and water. Appropriate fitting material should be selected based on the environmental conditions. Each such fitting should be qualified before use by investigation and by independent third-party tests when necessary to determine that the fitting is suitable and safe for the intended service.

PEX tubing can be joined to other PEX tubing or fittings or to tubing or appurtenances of other materials using one or more joining systems. The purchaser should verify with the tubing and fittings manufacturer that fittings are capable of restraining PEX tubing from pullout, especially for larger-diameter products with thicker walls. Pressure classes for tubing and fittings should be the same or compatible. Further information and specific procedure should be obtained from the tubing and fittings manufacturers.

The following PEX fitting systems may be used for water service applications when approved by the tubing manufacturer for this application:

II.B.2.1. Cold expansion fittings with PEX reinforcing rings ([ASTM F1960](#)). Cold expansion fittings with PEX reinforcing rings are available for PEX tubing in a

variety of configurations including couplings, tees, and adapters. Tubing ends shall be prepared for such fittings by cutting the tubing end square using a cutter tool designed for cutting plastic tubing. Connections are made by sliding a PEX ring over the PEX tubing and expanding the ring and tubing simultaneously with an expander tool that meets the fitting manufacturer's guidelines. The expanded tubing and PEX ring then slide over the cold expansion fitting. The connection is made as the PEX tubing/flex ring shrinks over the inserted fitting. Do not install cold expansion fittings in temperatures below 5°F (–15°C). This system includes sizes from ½ in. to 3 in. nominal.

NOTE: Not all types of PEX tubing are compatible with [ASTM F1960](#) fittings. Check with specific tubing manufacturer.

II.B.2.2. Cold expansion fittings with metal compression sleeves ([ASTM F2080](#)). Cold expansion fittings with metal compression sleeves are available for PEX tubing in a variety of configurations including couplings, tees, and adapters. Tubing ends shall be prepared for such fittings by cutting the tubing end square using a cutter tool designed for cutting plastic tubing. Slide the brass sleeve over the tubing. Expand the PEX tubing end two times using an expander tool that meets the fitting manufacturer's guidelines. Insert the fitting and then pull the brass compression sleeve over the cold expansion fitting and tubing with a compression tool that meets the fitting manufacturer's guidelines until the sleeve is seated against the shoulder of the cold expansion fitting. This system includes sizes from ½ in. to 2 in. nominal.

NOTE: Not all types of PEX tubing are compatible with [ASTM F2080](#) fittings. Check with specific tubing manufacturer.

II.B.2.3. Metal insert fittings with copper crimp rings ([ASTM F1807](#)). Metal insert fittings utilizing a copper crimp ring are available for PEX tubing in a variety of configurations including couplings, tees, and adapters. Tubing ends shall be prepared for such fittings by cutting the tubing end square using a cutter tool designed for cutting plastic tubing. Connections are made by the compression of a copper crimp ring around the outer circumference of the tubing (using a tool that meets the fitting manufacturer's guidelines), forcing the tubing material into the annular spaces formed by the ribs of the fitting. [ASTM F1807](#) metal insert fittings shall be used with copper crimp rings only. This system includes sizes from ½ in. to 2 in. nominal.

II.B.2.4. Plastic insert fittings with copper crimp rings ([ASTM F2159](#)). Plastic insert fittings utilizing a copper crimp ring are available for PEX tubing in a variety of configurations including couplings, tees, and adapters. Tubing ends shall be prepared for such fittings by cutting the tubing end square using a cutter tool designed for cutting plastic tubing. Connections are made by the compression of a copper crimp

ring around the outer circumference of the tubing (using a tool that meets the fitting manufacturer's guidelines), forcing the tubing material into the annular spaces formed by the ribs of the fitting. [ASTM F2159](#) plastic insert fittings shall be used with copper crimp rings only. This system includes sizes from ½ in. to 1 in. nominal.

II.B.2.5. Metal press insert fittings with stainless steel press sleeve ([ASTM F3347](#)). Metal insert fittings utilizing a stainless steel press sleeve are available for PEX tubing in a variety of configurations including couplings, tees, and adapters. Tubing ends shall be prepared for such fittings by cutting the tubing end square using a cutter tool designed for cutting plastic tubing. Connections are made by the compression of a stainless steel press sleeve around the outer circumference of the tubing (using a tool that meets the fitting manufacturer's guidelines), forcing the tubing material into the annular spaces formed by the ribs of the fitting. This system includes sizes from ½ in. to 2 in. nominal.

II.B.2.6. Plastic press insert fittings with stainless steel press sleeve ([ASTM F3348](#)). Plastic insert fittings utilizing a stainless steel press sleeve are available for PEX tubing in a variety of configurations including couplings, tees, and adapters. Tubing ends shall be prepared for such fittings by cutting the tubing end square using a cutter tool designed for cutting plastic tubing. Connections are made by the compression of a stainless steel press sleeve around the outer circumference of the tubing (using a tool that meets the fitting manufacturer's guidelines), forcing the tubing material into the annular spaces formed by the ribs of the fitting. This system includes sizes from ½ in. to 2 in. nominal.

II.B.2.7 Metal push-fit fittings (ASSE 1061*). Push-fit fittings are available for PEX tubing in a variety of configurations including couplings, tees, and adapters. Tubing ends shall be prepared for such fittings by cutting the tubing end square using a cutter tool designed for cutting plastic tubing. If the fitting manufacturer requires the use of an insert stiffener, an insert stiffener for PEX tubing shall be used. If the fitting has an integral insert stiffener for PEX tubing within the fitting, do not remove it. Measure the tubing for the appropriate insert depth of the fitting and mark the tubing. Push the fitting onto the tubing to ensure that it has reached the proper insertion depth. Wrap the assembly with self-sealing silicone wrap encompassing the fitting and out to 1 in. (25 mm) outside of each end of the tubing. This system includes sizes from ½ in. to 2 in. nominal.

II.B.3. Embedment of tubing. ANSI/AWWA C904 PEX tubing is intended only for underground installation and should be installed in trench bottoms that provide

* ASSE International, 18927 Hickory Creek Drive, Suite 220, Mokena, IL 60448.

continuous support and are free from rocks, stones, and debris (see [ASTM D2774](#)). The initial backfill, from 3 in. (76 mm) below the pipeline to 4–6 in. (100–150 mm) above the tubing, should be sand or other materials, as allowed in [ASTM D2774](#) or as approved by the tubing manufacturer. To prevent freezing in the water lines, the tubing should be installed below the frost line. Snap-on bend supports, if utilized in the trench, shall be manufacturer-approved for direct burial and not subject to corrosion.

II.B.4. *Testing.* The purchaser should test the system for leakage in accordance with the applicable code or engineering standards. (See Appendix A for recommended test procedures, including the use of [ASTM F2164](#) standard practice.)

II.C. *Water System Disinfection.* PEX tubing should be disinfected in accordance with [ANSI/AWWA C651](#), Disinfecting Water Mains. Refer to Sec. A.4.10 and Sec. A.5.1 for more information on disinfection.

II.D. *Squeeze-Off.* The use of squeeze-off techniques for emergency shutoff should be performed only on materials, wall thicknesses, and tubing diameters as recommended by the tubing manufacturer. Squeeze-off should be performed in accordance with [ASTM F1041](#) using tools that comply with [ASTM F1563](#). Using incorrect procedures and improper squeeze-off tools can damage PEX tubing and cause premature failure.

II.E. *References.* The latest editions of the following documents are incorporated by reference in Sec. II of this foreword to the extent specified. In case of conflict, the provisions of Sec. II shall prevail. These references are provided for information only and are not part of the ANSI/AWWA C904 standard itself.

[ANSI/AWWA C651](#)—Disinfecting Water Mains.

[ANSI/AWWA C800](#)—Underground Service Line Valves and Fittings.

ASSE 1061—Performance Requirements for Push-Fit Fittings.

[ASTM D2774](#)—Standard Practice for Underground Installation of Thermoplastic Pressure Piping.

[ASTM F876](#)—Standard Specification for Crosslinked Polyethylene (PEX) Tubing.

[ASTM F1041](#)—Standard Guide for Squeeze-Off of Polyolefin Gas Pressure Pipe and Tubing.

[ASTM F1563](#)—Standard Specification for Tools to Squeeze-Off Polyethylene (PE) Gas Pipe or Tubing.

[ASTM F1807](#)—Standard Specification for Metal Insert Fittings Utilizing a Copper Crimp Ring, or Alternate Stainless Steel Clamps, for SDR9 Crosslinked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing.

[ASTM F1960](#)—Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Crosslinked Polyethylene (PEX) and Polyethylene of Raised Temperature (PE-RT) Tubing.

[ASTM F2023](#)—Standard Test Method for Evaluating the Oxidative Resistance of Crosslinked Polyethylene (PEX) Pipe, Tubing and Systems to Hot Chlorinated Water.

[ASTM F2080](#)—Standard Specification for Cold-Expansion Fittings with Metal Compression-Sleeves for Crosslinked Polyethylene (PEX) Pipe and SDR9 Polyethylene of Raised Temperature (PE-RT) Pipe.

[ASTM F2159](#)—Standard Specification for Plastic Insert Fittings Utilizing a Copper Crimp Ring, or Alternate Stainless Steel Clamps, for SDR9 Crosslinked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing.

[ASTM F2164](#)—Standard Practice for Field Leak Testing of Polyethylene (PE) and Crosslinked Polyethylene (PEX) Pressure Piping Systems Using Hydrostatic Pressure.

[ASTM F2657](#)—Standard Test Method for Outdoor Weathering Exposure of Crosslinked Polyethylene (PEX) Tubing.

[ASTM F3347](#)—Standard Specification for Metal Press Insert Fittings with Factory Assembled Stainless Steel Press Sleeve for SDR9 Crosslinked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing.

[ASTM F3348](#)—Standard Specification for Plastic Press Insert Fittings with Factory Assembled Stainless Steel Press Sleeve for SDR9 Crosslinked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing.

NSF/ANSI 14—Plastics Piping System Components and Related Materials.

NSF/ANSI/CAN 60—Drinking Water Treatment Chemicals—Health Effects.

NSF/ANSI/CAN 61—Drinking Water System Components—Health Effects.

NSF/ANSI/CAN 372—Drinking Water System Components—Lead Content.

III. Use of This Standard. It is the responsibility of the user of an AWWA standard to determine that the products described in that standard are suitable for use in the particular application being considered.

III.A. *Purchaser Options and Alternatives.* The following items should be provided by the purchaser.

1. Standard used, that is, ANSI/AWWA C904, Crosslinked Polyethylene (PEX) Pressure Tubing, ½ In. Through 3 In., for Water Service, latest revision.
2. Whether compliance with NSF/ANSI/CAN 61, Drinking Water System Components—Health Effects, is required.
3. Tubing.
 - a. Standard code designation of the PEX material (Sec. 4.2.1.1).

- b. Nominal size, pressure class (PC), standard dimension ratio, form (straight or coiled), length of individual pieces, and total linear feet (linear meters) for each different item to be furnished (Tables 2–4 and Sec. 4.3).
- 4. Specifications. The following requirements should be specified:
 - a. Details of federal, state, provincial, territorial, and local requirements (Sec. 4.2).
 - b. Quality-control program (Sec. 5.1).
 - c. Plant inspection (Sec. 5.6).
 - d. Marking (Sec. 6.1).
 - e. Special preparation for shipment (Sec. 6.2).
 - f. Affidavit of compliance (Sec. 6.3).

III.B. *Modification to Standard.* Any modification to the provisions, definitions, or terminology in this standard must be provided by the purchaser.

IV. Major Revisions. Major changes made to the standard in this revision include the following:

- 1. Metric conversions for nominal pipe sizes have been removed from the document title and Tables 2, 3, and 4 to be consistent with ASTM standards such as [F876](#) as there are not equivalent metric nominal sizes for this type of piping. When referring to a dimension such as depth or length, metric conversions are included in the standard.
- 2. Additional information on PEX fitting systems has been moved from Appendix A to the foreword (Sec. II.B.2), including information on four additional types of fitting systems (Sec. II.B.2.4–II.B.2.7).
- 3. New definitions are included for design factor, potable water, reclaimed water, and wastewater (Sec. 3).
- 4. A new section on tubing ends and length has been included (Sec. 4.3.2.1).
- 5. A minimum PEX Tubing Material Designation Code for chlorine resistance has been included (Sec. 4.3.9).
- 6. A minimum PEX Tubing Material Designation Code for UV resistance has been included (Sec. 4.3.10).
- 7. Requirements for the manufacturer's quality-control program have been clarified (Sec. 5.1.1).
- 8. The requirements for plant inspection by the purchaser (Sec. 5.6) have been clarified, including inspection limitations, proprietary process limitations, and safety requirements.

9. Marking requirements have been clarified (Sec. 6.1), including production code and color of tubing.

10. Appendix A on Design and Installation of PEX has been updated with primary changes related to pressure surge dissipation, freeze-break resistance, chlorine resistance, and dezincification of copper alloy fittings.

V. Comments. If you have any comments or questions about this standard, please contact AWWA Engineering and Technical Services at 303.794.7711; write to the department at 6666 West Quincy Avenue, Denver, CO 80235-3098; or email at standards@awwa.org.

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