Designation: F 1960 – 00

An American National Standard

Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-linked Polyethylene (PEX) Tubing[1]

This standard is issued under the fixed designation F 1960; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers cold expansion fittings and cross-linked (PEX) reinforcing rings for use with cross-linked polyethylene (PEX) plastic tubing in ⅜, ½, ⅝, ¾, 1, 1-¼, and 1-½in. nominal diameters. These fittings are intended for use in 100 psi (690 kPa) cold- and hot-water distribution systems operating at temperatures up to and including 180°F (82°C). The system is comprised of a PEX reinforcing ring and a cold expansion fitting. Included are the requirements for materials, workmanship, dimensions, burst pressure, sustained pressure, excessive temperature and pressure, temperature cycling tests, and markings to be used on the fitting components. The components covered by this specification are intended for use in residential and commercial, hot and cold, potable water distribution systems as well as sealed central heating, including under-floor-heating systems.

1.2 The values stated in inch-pound units are to be regarded as the standard. The SI values stated in parentheses are provided for information purposes.

1.3 The following precautionary caveat pertains only to the test method portion, Section 10, of this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

B 16 Specification for Free-Cutting Brass Rod, Bar, and Shapes for Use in Screw Machines[2]

B 140/B 140M Specification for Copper-Zinc-Lead (Leaded Red Brass or Hardware Bronze) Rod, Bar, and Shapes[2]

B 283 Specification for Copper and Copper-Alloy Die Forging (Hot Pressed)[2]

B 584 Specification for Copper Alloy Sand Castings for General Applications[2]

D 618 Practice for Conditioning Plastics and Electrical Insulating Materials For Testing[3]

D 792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement[3]

D 1505 Test Method for Density of Plastics by the Density-Gradient Technique[3]

D 1598 Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure[4]

D 1599 Test Method for Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings[4]

D 1600 Terminology for Abbreviated Terms Relating to Plastics[3]

D 2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings[4]

D 2765 Test Methods for Determination of Gel Content and Swell Ratio of a Crosslinked Ethylene Plastics[5]

D 3045 Practice for Heat Aging of Plastics Without Load[5]

F 412 Terminology Relating to Plastic Piping Systems[3]

F 876 Specification for Crosslinked Polyethylene (PEX) Tubing[4]

F 877 Specification for Crosslinked Polyethylene (PEX) Plastic Hot and Cold-Water Distribution Systems[4]

2.2 *Military Standard:*

MIL-STD-P46120A Polysulfone GF120[6]

2.3 *ANSI Standard:*

B1.20 Pipe Threads General Purpose[7]

B16.18 Cast Copper Alloy Solder Joint Pressure Fittings

B16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

2.4 *NSF Standards:*

NSF 14 for Plastic Piping Components and Related Materials[8]

NSF 61 for Drinking Water System Components-Health Effects[8]

2.5 *Manufacturers' Standardization Society Standards:*

[1] This specification is under the jurisdiction of ASTM Committee F-17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.10 on Fittings.

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[2] *Annual Book of ASTM Standards*, Vol 02.01.

[3] *Annual Book of ASTM Standards*, Vol 08.01.

[4] *Annual Book of ASTM Standards*, Vol 08.04.

[5] *Annual Book of ASTM Standards*, Vol 08.02.

[6] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robins Ave., Philadelphia PA 19111–5094, Attn: NPODS.

[7] Available from the American National Standards Institute, 11 West 42nd St., 13th Floor, New York, NY, 10036.

[8] Available from the National Sanitation Foundation (NSF International), PO Box 1468, Ann Arbor, MI, 48106.

SP 104 Wrought Copper Solder Joint Pressure Fittings[9]

3. Terminology

3.1 *Definitions*—Definitions are in accordance with Terminology F 412 and abbreviations are in accordance with Terminology D 1600, unless otherwise indicated.

3.1.1 *PEX reinforcing rings*—cross-linked polyethylene rings used to add contraction force around the cold expansion fittings.

4. Classification

4.1 This specification covers one class of cold expansion fittings with PEX reinforcing rings suitable for use with PEX tubing that meets the requirements of Specifications F 876 and F 877.

5. Materials and Manufacture

5.1 Cold expansion fittings shall be made from one of the following materials:

5.1.1 *Machined Brass*—Machined brass fittings shall be made from material meeting the requirements of Specification B 140 copper alloy UNS C31400 or Specification B 16 copper alloy UNS C36000.

5.1.2 *Forged Brass*—Forged brass fittings shall be made from material meeting the requirements of Specification B 283 copper alloy UNS C37700 or UNS C89844.

5.1.3 *Sand Casted Brass*—Sand casted brass fittings shall be made from material meeting the requirements of Specification B 584 copper alloy UNS C84400 or other approved material meeting the requirements of Specification B 584.

5.1.4 *20 % Glass-Filled Polysulfone*—Glass-filled polysulfone fittings shall be made from materials meeting the requirements of MIL-STD-P46120A Polysulfone GF120.

5.2 Reinforcing rings shall be made from PEX material meeting the performance requirements of 6.1.

6. Performance Requirements

6.1 *PEX Reinforcing Rings*:

6.1.1 *Density*—When determined in accordance with 11.1, the PEX reinforcing rings shall have a density in the range from 926 to 940 kg/m^3.

6.1.2 *Degree of Cross-Linking*—When tested in accordance with 11.2, the degree of cross-linking for PEX reinforcing rings shall be within the range from 70 to 89 %, inclusive.

6.1.3 *Stabilizer Migration Resistance*—When tested in accordance with 11.3, the time, t_2, shall be at least 50 % of the time, t_1.

6.2 *System Performance Requirements*:

6.2.1 *General*—All performance tests shall be performed on assemblies of fittings, PEX reinforcing rings and PEX tubing. Fittings and reinforcing rings shall meet the material and dimensional requirements of this specification. PEX tubing shall meet the requirements of Specifications F 876 and F 877. Assembly of test specimens shall be in accordance with 9.1. Each assembly shall contain at least two joints. Use separate sets of assemblies for each performance test requirement.

6.2.2 *Hydrostatic Burst*—Assemblies shall meet the minimum hydrostatic burst requirements shown in Table 1 when tested in accordance with 10.5.

6.2.3 *Hydrostatic Sustained Pressure Strength*—Assemblies shall meet the hydrostatic sustained pressure requirements shown in Table 2 when tested in accordance with 10.6.

6.2.4 *Thermocycling*—Assemblies shall not leak or separate when thermocycled 1000 cycles between the temperatures of 60 and 180°F (16 and 82°C) when tested in accordance with 10.7.

6.2.5 *Excessive Temperature Hydrostatic Sustained Pressure*—Assemblies shall have the ability to accommodate the short-term conditions shown in Table 3 when tested in accordance with 10.8.

7. Dimensions

7.1 *Dimensions and Tolerances*—The dimensions and tolerances of fittings and PEX reinforcing rings shall be as shown in Figs. 1 and 2 and Fig. 4 when measured in accordance with 10.4.

7.1.1 *Alignment*—The maximum angular variation of any opening shall not exceed 1° off the true centerline axis.

7.1.2 *Fittings with Solder Joint Ends*—Solder joint ends shall be in accordance with ANSI B16.22, ANSI B16.18 or MSS SP-104.

7.1.3 *Tapered Threaded Ends*—Fitting threads shall be right-hand conforming to ANSI B1.20.1. They shall be taper threads (NPT).

8. Workmanship, Finish and Appearance

8.1 The fittings shall be made from compounds that are homogeneous throughout. The sealing surfaces of the insert shall be smooth and free of foreign material. The fitting walls shall be free of cracks, holes, blisters, voids, foreign inclusions, or other defects that are visible to the naked eye and that affect wall integrity.

9. Assembly

9.1 *Cold Expansion Joints*—Fittings shall be joined to PEX tubing by the contraction of the tubing and reinforcing ring over the insert of the cold expansion fitting. Fittings and PEX reinforcing rings shall meet the dimensional and material requirements of this standard. PEX tubing shall meet the requirements of Specification F 876 or F 877.

9.2 *Expansion Tool*—The expansion tool shall expand the PEX tubing and reinforcing ring to a maximum inside diameter

TABLE 1 Minimum Hydrostatic Burst Strength Requirements for Cold Expansion Fittings, PEX Reinforcing Ring and PEX Tubing Assemblies[A]

Nominal Tubing Size, in. (mm)		Minimum Burst Pressure at Different Temperatures, psi (kPa) and °F (°C)			
in.	(mm)	psi[A] at 73.4°F	(kPa) at (23°C)	psi[A] at 180°F	(kPa) at (82.2°C)
⅜	(10)	620	(4275)	275	(1896)
½	(13)	480	(3309)	215	(1482)
⅝ and larger	(16 and larger)	475	(3275)	210	(1448)

[A]The fiber stress used to derive this test pressure is 1900 psi (13.10 MPa) at 73.4°F (23.0°C), and 850 psi (5.86 MPa) at 180°F (82.2°C).

[9] Available from Manufacturers' Standardization Society of the Valve and Fittings Industry 127 Park St. NE Vienna, VA 22180

TABLE 2 Minimum Hydrostatic Sustained Strength Requirements for Cold Expansion Fittings, PEX Reinforcing Ring and PEX Tubing Assemblies[A,B]

Nominal Tubing Size, in. (mm)		Pressure Required for Test at 180°F (82.2°C), psi (kPa)[A]	
⅜	(10)	250	(1724)
½	(13)	195	(1344)
⅝ and larger	(16 and larger)	190	(1310)

[A]The fiber stress used to derive this test pressure is 770 psi (5.31 MPa) at 180°F (82.2°C).
[B]Test duration is 1000 h.

TABLE 3 Excessive Temperature and Pressure Requirements for Cold Expansion Fittings, PEX Reinforcing Ring and PEX Tubing Assemblies

Test Duration	Hydrostatic Test Pressure Air Bath, psi (kPa)	Air Bath Temperature, °F (°C)
30 days	150 (1034)	210 (99)

as listed in Table 4. The expanded tubing shall be round to ensure uniform contraction of the tubing around the cold expansion fitting. The expansion tool shall be inspected for wear according to the manufacturer's instructions.

9.3 *Procedure*:

9.3.1 *Assembly of Connections*—Affix the cold expansion fitting to the PEX tubing by sliding the PEX reinforcing ring onto the tubing and positioning the ring so that the end of the ring overhangs the end of the tubing a maximum of 1⁄16 in. (1.6 mm). Insert the expansion head into the tubing as far as it will go. Holding the tool so that the centerline of the expansion head is approximately in line with the centerline of the tubing, operate the tool until the tubing and reinforcing ring are fully expanded. After completing the expansion process, remove the expansion tool and insert the cold expansion fitting until the tubing hits the shoulder of the fitting or the tube stop. Hold the fitting in place until the tubing contracts sufficiently to hold the fitting in place.

9.3.2 *Improper Connections*—If the insert fitting was not fully inserted to its shoulder or tube stop or the reinforcing ring was not placed in accordance with 9.3.1, remove the tubing and ring from the fitting and trim 2 in. from the tubing. Using a new reinforcing ring, repeat the procedure in 9.3.1.

10. Test Methods

10.1 *Conditioning*—Condition specimens at 73 ± 4°F (23 ± 2°C) and 50 ± 5 % relative humidity for not less than 40 h prior to testing. Practice D 618 shall be used to the extent possible as a guide to other conditions.

10.2 *Test Conditions*—Conduct the tests in the standard laboratory atmosphere at 73 ± 4°F (23 ± 2°C) and 50 ± 5 % relative humidity unless otherwise specified in the test methods or in this specification.

10.3 *Sampling*—A sample of the fittings, PEX reinforcing rings and PEX tubing, sufficient to determine conformance with this specification, shall be taken at random.

10.4 *Dimensions*—Any randomly selected fitting or fittings and PEX reinforcing rings shall be used to determine dimensions. Measurements shall be made in accordance with Test Method D 2122 except determine diameter by making measurements at four locations spaced at approximately 45° apart around the circumference. Inspection and gaging of solder joint ends shall be in accordance with ANSI B16.18, ANSI B16.22, or MSS SP-104.

10.5 *Burst Pressure*—Determine the minimum hydrostatic burst strength for tubing and fitting assemblies for each temperatures listed in Table 1 in accordance with Test Method D 1599, except as herein specified. Leakage or separation at any of the joints tested at less than the minimum burst requirements for the temperatures specified in Table 1 shall constitute a failure in this test.

10.5.1 *Procedure*—Test a single specimen assembly, containing at least six joints prepared from tubing, fittings, and reinforcing rings meeting the requirements of this specification. Attach end closures and fill the specimen with water. Condition in water at the test temperature for a minimum if 2 h (or in air for a minimum of 4 h). For testing at 180°F (82°C), fill the sample with water at a temperature of at least 120°F (50°C) prior to conditioning.

10.5.1.1 Increase the internal pressure at a constant rate so as to reach the maximum burst requirement in 60 to 70 s. Leakage or separation at any of the fittings tested, at less than the minimum hydrostatic burst requirements for either temperature specified in Table 1, shall constitute failure in this test.

10.6 *Hydrostatic Sustained Pressure*—Perform the test on at least six assemblies in accordance with Test Method D 1598, except for the following:

10.6.1 Test temperature shall be 180 ± 4°F (82 ± 2°C),

10.6.2 The external test environment shall be air or water,

10.6.3 The specimens shall be filled with water at a temperature of at least 120°F (50°C), and

10.6.4 Leakage or separation at any joint tested at less than 1000 h at the sustained pressure given in Table 2 shall constitute failure in this test.

10.7 *Thermocycling*:

10.7.1 *Summary of Test Method*—This test method describes a pass-fail test for thermally cycling assemblies comprised of cold expansion fittings, PEX reinforcing rings and PEX tubing over a critical temperature range for a selected number of cycles while subjected to an internal pressure. The test provides a measure of failure due to the combined effects of differential thermal expansion and creep of connections intended for use up to and including 180°F (82°C).

10.7.2 *Apparatus*—A pressure source capable of maintaining an internal pressure of 100 ± 10 psi (690 ± 69 kPa) on the specimens is required. An immersion system shall consist of two water reservoirs controlled at 60 ± 4°F (16± 2°C) and 180 ± 4°F (82 ± 2°C) into which the pressurized specimens will be cycled. Either samples are cycled manually using flexible connectors or alternately the hot or cold water is cycled over the test specimens automatically and returned to the proper reservoir (Note 1).

NOTE 1—Automatic cycling may be accomplished by pumping from each reservoir through a delivery system having timer-actuated valves, to a specimen trough having synchronized, timer-actuated return drains. Any automatic apparatus shall provide for complete immersion of the test specimens in the trough.

10.7.3 *Specimen Assembly*—Test six assemblies. Attach the