



# Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-linked Polyethylene (PEX) and Polyethylene of Raised Temperature (PE-RT) Tubing<sup>1</sup>

This standard is issued under the fixed designation F1960; 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 ( $\epsilon$ ) 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 nominal tubing sizes of  $\frac{3}{8}$ ,  $\frac{1}{2}$ ,  $\frac{5}{8}$ ,  $\frac{3}{4}$ , 1,  $1\frac{1}{4}$ ,  $1\frac{1}{2}$ , 2,  $2\frac{1}{2}$ , and 3 in. that meet the requirements of Specifications F876 and for use with Polyethylene of Raised Temperature (PE-RT) pipe in nominal tubing sizes of  $\frac{3}{8}$ ,  $\frac{1}{2}$ ,  $\frac{5}{8}$ ,  $\frac{3}{4}$ , 1,  $1\frac{1}{4}$ ,  $1\frac{1}{2}$ , 2,  $2\frac{1}{2}$ , and 3 that meet the requirements of Specification F2769. 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, 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 standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

- A351/A351M Specification for Castings, Austenitic, for Pressure-Containing Parts
- B16/B16M Specification for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines
- B140/B140M Specification for Copper-Zinc-Lead (Red Brass or Hardware Bronze) Rod, Bar, and Shapes
- B62 Specification for Composition Bronze or Ounce Metal Castings
- B75/B75M Specification for Seamless Copper Tube
- B283/B283M Specification for Copper and Copper-Alloy Die Forgings (Hot-Pressed)
- B371/B371M Specification for Copper-Zinc-Silicon Alloy Rod
- B453/B453M Specification for Copper-Zinc-Lead Alloy (Leaded-Brass) Rod, Bar, and Shapes
- B584 Specification for Copper Alloy Sand Castings for General Applications
- B927/B927M Specification for Brass Rod, Bar, and Shapes
- B967/B967M Specification for Copper-Zinc-Tin-Bismuth Alloy Rod, Bar and Wire
- D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
- D1505 Test Method for Density of Plastics by the Density-Gradient Technique
- D1600 Terminology for Abbreviated Terms Relating to Plastics
- D2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings
- D2765 Test Methods for Determination of Gel Content and Swell Ratio of Crosslinked Ethylene Plastics
- D3035 Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
- D6394 Specification for Sulfone Plastics (SP)
- F412 Terminology Relating to Plastic Piping Systems

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.10 on Fittings

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

\*A Summary of Changes section appears at the end of this standard

**F876** Specification for Crosslinked Polyethylene (PEX) Tubing

**F877** Specification for Crosslinked Polyethylene (PEX) Hot and Cold-Water Distribution Systems

**F2769** Specification for Polyethylene of Raised Temperature (PE-RT) Plastic Hot and Cold-Water Tubing and Distribution Systems

2.2 *ANSI Standard:*

**B1.20** Pipe Threads General Purpose<sup>3</sup>

**B16.18** Cast Copper Alloy Solder Joint Pressure Fittings

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

2.3 *NSF Standards:*

**NSF 14** for Plastic Piping Components and Related Materials<sup>4</sup>

**NSF 61** for Drinking Water System Components-Health Effects<sup>4</sup>

2.4 *Manufacturers' Standardization Society Standards:*

**SP-104** Wrought Copper Solder Joint Pressure Fittings<sup>5</sup>

5.1.1.2 *Forged Brass*—Forged brass fittings shall be made from material meeting the requirements of Specification **B283/B283M**, Copper Alloy UNS Nos. C27450, C27451, C27453, C35330, C36500, C37700, C46400, C48600, C49260, C49340, or C69300.

5.1.1.3 *Cast Copper Alloys*—Cast copper alloy fittings shall be made from material meeting the requirements of Specification **B584**, Copper Alloy UNS Nos. C84400, C83800, C87850 or C89844 or C89836 or Specification **B62**, Copper Alloy UNS No. C83600, or Standard EN 1982, copper alloy EN Symbol CuSn4Zn6Pb3–C.

5.1.2 *Sulfone:*

5.1.2.1 *20 % Glass-Filled Polysulfone*—Polysulfone fittings produced using glass reinforcement shall be molded from polysulfone materials as specified in Specification **D6394**. The polymers shall consist of polysulfone and glass fiber and meet the following line call out for additional properties (SP0113G20A30430).

5.1.2.2 *Unreinforced Sulfone Plastic (SP)*—Fittings shall be molded from sulfone plastic (SP) as specified in Specification **D6394**. The material shall be unreinforced polysulfone (group 01, class 1, grade 2), or polyphenylsulfone (group 3, class 1, grade 2.) Material may also be an unreinforced blend of these two materials with the polyphenylsulfone continuous phase comprising 55 to 80% of the blend.

5.1.2.3 Clean rework material of the same commercial designation, generated for the manufacturer's own production may be used by the same manufacturer, provided the fittings meet all of the requirements of this specification. Rework material shall not be introduced at a ratio exceeding 25%.

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

5.3 *Stainless Steel*—fittings shall be made from material meeting the requirements of Specification **A351/A351M**, stainless steel UNS No. J92800.

5.4 *Wrought Copper*—Wrought copper fittings shall be made from material meeting the requirements of Specification **B75/B75M** for one of the following coppers: copper UNS C10200, C10300, C10800, or C12200.

## 6. General Requirements

6.1 *General*—All performance tests shall be performed on assemblies of fittings, PEX reinforcing rings and PEX or PE-RT tubing. Fittings and reinforcing rings shall meet the material and dimensional requirements of this specification. PEX tubing shall meet the requirements of Specifications **F876**. PE-RT tubing shall meet the requirements of Specification **F2769**. Assembly of test specimens shall be in accordance with **10.1**. Each assembly shall contain at least two joints. Use separate sets of assemblies for each performance test requirement.

6.1.1 Fitting manufactured according to this specification and intended for use with PEX tubing meeting requirements of Specification **F876**, shall comply with the following performance requirements of Specification **F877**. When a section with an identical title appears in this specification, it contains additional requirements that supplement those found in Specification **F877**.

## 3. Terminology

3.1 *Definitions:*

3.1.1 Definitions are in accordance with Terminology **F412** and abbreviations are in accordance with Terminology **D1600**, unless otherwise indicated.

3.1.2 *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 **F876** and with PE-RT tubing that meets the requirements of Specification **F2769**.

## 5. Materials and Manufacture

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

5.1.1 Brass:

5.1.1.1 *Machined Brass*—Machined brass fittings shall be made from material meeting the requirements of one of the following listed below:

Specification	Alloy
ASTM <b>B16/B16M</b>	UNS C36000
ASTM <b>B140/B140M</b>	UNS C31400
ASTM <b>B371/B371M</b>	UNS C69300
Standard EN 12164	CW614N
ASTM <b>B453/B453M</b>	UNS C35300
ASTM <b>B927/B927M</b>	UNS C27450, C27451
ASTM <b>B967/B967M</b>	UNS C49260, C49340

<sup>3</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>

<sup>4</sup> Available from NSF International, P.O. Box 130140, 789 N. Dixboro Rd., Ann Arbor, MI 48113-0140, <http://www.nsf.org>.

<sup>5</sup> Available from Manufacturers Standardization Society of the Valve and Fittings Industry (MSS), 127 Park St., NE, Vienna, VA 22180-4602, <http://www.mss-hq.com>.

- 6.1.1.1 Requirements,
- 6.1.1.2 Test Methods, and
- 6.1.1.3 Retest and Rejection.

6.1.2 Fittings, manufactured according to this specification and intended for use with PE-RT tubing meeting the requirements of Specification **F2769**, shall comply with the following performance requirements of Specification **F2769**. When a section with an identical title appears in this Specification, it contains additional requirements that supplement those found in Specification **F2769**.

- 6.1.2.1 Requirements,
- 6.1.2.2 Test Methods, and
- 6.1.2.3 Retest and Rejection.

6.2 *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 **D2122**, except determine diameter by making measurements at four locations spaced at approximately 45° apart around the circumference. Inspection and gauging of solder joint ends shall be in accordance with ANSI B16.18, ANSI B16.22, or Manufacturers' Standardization Society SP-104.

## 7. Performance Requirements

### 7.1 PEX Reinforcing Rings:

7.1.1 *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<sup>3</sup>.

7.1.2 *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.

7.1.3 *Stabilizer Migration Resistance*—When tested in accordance with **11.3**, the time  $t^2$ , shall be at least 50% of the time,  $t^1$ .

## 8. Dimensions

8.1 *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 **6.2**.

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

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

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

## 9. Workmanship, Finish, and Appearance

9.1 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.

## 10. Assembly

10.1 *Cold Expansion Joints*—Fittings shall be joined to PEX or PE-RT tubing by the contraction of the expanded

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 **F876**. PE-RT tubing shall meet the requirements of Specification **F2769**.

10.2 *Expansion Tool*—The expansion tool shall expand the PEX tubing and reinforcing ring to a maximum inside diameter as listed in **Table 1**. 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.

### 10.3 Procedure:

10.3.1 *Assembly of Connections*—Refer to manufacturers written installation instructions.

## 11. Reinforcing Ring Testing Methods

11.1 *Density*—Determine the density of the reinforcing ring material in accordance with Test Method **D1505**, or Test Method **D792**, using three specimens.

11.2 *Degree of Cross-Linking*—Determine the degree of cross-linking in accordance with Test Method **D2765**, Method B except for the following: during sample preparation, place a reinforcing ring in a lathe with automatic feeding. Shave a strip approximately 0.004 in.-thick that consists of the full thickness of the ring. For the purpose of this specification, the degree of cross-linking ( $V$ ) is defined as 100 % minus the extract percent =  $V$ .

11.3 *Stabilizer Migration Resistance*—Cut two 0.4-in. (10-mm) long samples from the reinforcing ring. Store one of the samples covered at room temperature for 1000 h. Place the other sample in a round-bottom flask with large-mouth, ground-glass or cork joint. The flask size shall be 500 mL for each test sample. Fill with distilled water. Put the flask in a heating mantle to heat the flask to boil water. Put a reflux condenser with ground-glass or cork joint to fit into the flask. Boil for 1000 h but change the distilled water at even intervals two times per week. Place the two samples hanging on a thin steel rod (approximately 0.1-in. (2.5-mm) diameter) in an oven at 311 °F (155 °C) in accordance with Practice **D3035**. Let the samples hang in the oven until both have failed. Failure is an obvious change in the shape or color of the samples, observed visually. The start of melting of surfaces, drip formation, or cracks indicates a shape change. Color change must be significant if it shall be counted as a failure. Observation of the tube samples must be made at intervals making it possible to read the time-to-failure within 15 % of the total testing time. Measure the time-to-failure of the unboiled sample ( $t_1$ ) and the boiled sample ( $t_2$ ).

## 12. Product Marking

### 12.1 Cold Expansion Fitting:

12.1.1 *Quality of Marking*—The marking shall be applied to the fittings in such a manner that it remains legible after installation and inspection.

### 12.1.2 Content of Marking:

12.1.2.1 Manufacturer's name or trademark, or both,