Designation: F 2080 – 01

# Standard Specification for Cold-Expansion Fittings With Metal Compression-Sleeves for Cross-Linked Polyethylene (PEX) Pipe[1]

This standard is issued under the fixed designation F 2080; 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 metal cold-expansion fittings using metal compression-sleeves for use with cross-linked polyethylene (PEX) plastic pipe in ½-in., ¾-in., and 1-in. nominal diameters, whereby the PEX pipe is cold-expanded before fitting assembly. These cold-expansion fittings and metal compression-sleeves are intended for use in residential and commercial, hot and cold, potable water distribution systems, as well as sealed central heating, including underfloor heating systems, with continuous operation at pressures up to and including 100 psi (690 kPa), and at temperatures up to and including 180°F (82°C).

1.2 Included in this specification are the requirements for materials, workmanship, dimensions, burst pressure and sustained pressure, excessive temperature and pressure, and thermocycling tests, and markings to be used on the fittings and compression-sleeves.

1.3 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 only.

1.4 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:*

A 582/A 582M Specification for Free-Machining Stainless and Heat Resisting Steel Bars[2]

B 16/B 16M Specification for Free-Cutting Brass Rod, Bar, and Shapes for Use in Screw Machines[3]

B 140/B 140M Specification for Copper-Zinc-Lead (Leaded Red Brass or Hardware Bronze) Rod, Bar and Shapes[3]

B 283 Specification for Copper and Copper-Alloy Die Forgings (Hot-Pressed)[3]

B 689 Specification for Electroplated Engineering Nickel Coatings[4]

B 851 Specification for Automated Controlled Shot Peening of Metallic Articles Prior to Nickel, Autocatalytic Nickel, or Chromium Plating, or As a Final Finish[4]

D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing[5]

D 792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement[5]

D 1505 Test Method for Density of Plastics by the Density-Gradient Technique[5]

D 1598 Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure[6]

D 1599 Test Method for Short-Time, Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings[6]

D 1600 Terminology for Abbreviated Terms Relating to Plastics[5]

D 2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings[6]

D 2765 Test Methods for Determination of Gel Content and Swell Ratio of Cross-Linked Ethylene Plastics[7]

D 3045 Practice for Heat Aging of Plastics Without Load[7]

F 412 Terminology Relating to Plastic Piping Systems[6]

F 876 Specification for Crosslinked Polyethylene (PEX) Tubing[6]

F 877 Specification for Crosslinked Polyethylene (PEX) Plastic Hot- and Cold-Water Distribution Systems[6]

2.2 *Canadian Standards Association:*

CAN/CSA B137.5 – M99[8]

2.3 *ANSI Standards:*

B1.20.1 Pipe Threads General Purpose (Inch)[9]

B16.18 Cast Copper Alloy Solder Joint Pressure Fittings (Inch)[9]

[1] This specification is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.61 on Water. Current edition approved Jan. 10, 2001. Published April 2001.

[2] *Annual Book of ASTM Standards*, Vol 01.03.

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

[4] *Annual Book of ASTM Standards*, Vol 02.05.

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

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

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

[8] Available from the Canadian Standards Association, 178 Rexdale Blvd., Rexdale (Toronto), Canada M9W 1R3

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

B16.22 Wrought Copper Alloy Solder Joint Pressure Fittings (Inch)[9]

2.4 *NSF Standards:*

Standard No. 14 for Plastic Piping Components and Related Materials[10]

Standard No. 61 for Drinking Water System Components – Health Effects[10]

2.5 *MSS Standards:*

SP-104 Wrought Copper Solder Joint Pressure Fittings[11]

## 3. Terminology

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

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *cross-linked polyethylene, n*—plastics prepared by cross-linking (curing) polyethylene compounds (PEX).

3.2.2 *fitting assembly, n*—comprised of a metal cold-expansion fitting and a metal compression-sleeve, whereby the PEX pipe is cold-expanded before fitting insertion, and the compression-sleeve is pulled over the PEX pipe.

## 4. Classification

4.1 This specification covers one class of metal cold-expansion fittings with metal compression-sleeves suitable for use with PEX pipe that meets the requirements of Specifications F 876 and F 877.

## 5. Materials and Manufacture

5.1 *Fittings*—Cold-expansion fittings shall be made from one of the following materials:

5.1.1 *Machined Brass*—Machined brass cold-expansion fittings shall be made from material meeting the requirements of Specification B 16/B 16M, copper-alloy UNS C36000, or Specification B 140, copper alloy UNS C31400, or Specification B 283, copper-alloy UNS C89844.

5.1.2 *Machined Stainless Steel*—Machined stainless steel cold-expansion fittings shall be made from material meeting the requirements of Specification A 582, stainless steel alloy 304L.

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

5.1.4 *Cast Copper Alloys*—Cast copper alloy cold-expansion fittings shall be made from material meeting the requirements of Specification B 62 copper alloy UNS C83600, or Specification B 584, copper-alloy UNS C83800, C84400 or C89844.

5.2 *Compression-Sleeves*—Metal compression-sleeves shall be made from one of the following materials:

5.2.1 *Machined Brass*—Machined brass compression-sleeves shall be made from material meeting the requirements of Specification B 16/B 16M copper-alloy UNS C36000.

5.2.2 *Machined Stainless Steel*—Machined stainless steel compression-sleeves shall be made from material meeting the requirements of Specification A 582/A 582M, stainless steel alloy 304L.

5.3 *Plating*—Plating of either fitting component with nickel or chrome, or both, is optional and must fall within the dimensional tolerances of this specification.

5.3.1 *Nickel Plating*—Application of electroplated nickel coating shall meet the requirements of Specifications B 689 and B 851.

5.3.2 *Chrome Plating*—Application of electroplated chrome coating shall meet the requirements of Specification B 851.

## 6. Performance Requirements

6.1 *General*—All performance tests shall be conducted on assemblies of fittings (cold-expansion fittings and compression-sleeves) and PEX pipe. Fittings shall meet the material and dimensional requirements of this specification. PEX pipe shall meet the requirements of Specifications F 876 and F 877. Assembly of test specimens shall be in accordance with 9.3. Each assembly shall contain at least two joints. Use separate sets of assemblies for each performance test requirement.

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

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

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

6.5 *Excessive Temperature Hydrostatic Sustained Pressure*:

6.5.1 *General*—Assemblies shall have the ability to accommodate the short-term test conditions: 30 days of 210°F (99°C) and 150 psi (1034 kPa).

6.5.2 *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.

**TABLE 1 Minimum, Hydrostatic Burst Strength Requirements for Cold-Expansion Fittings and PEX Piping Assemblies[A]**

| Nominal Piping Size | | Minimum Burst Pressure at Different Temperatures | | | |
|---|---|---|---|---|---|
| In. | mm | psi @ 73.4°F | (kPa @ 23°C) | psi @ 180°F | (kPa @ 82.2°C) |
| ½ | 13 | 480 | (3309) | 215 | (1482) |
| ⅝ + | 16+ | 475 | (3275) | 210 | (1448) |

[A] The fiber stress used to derive this test pressure is:
At 74.3°F (23°C) 1900 psi (13.10 MPa)
At 180°F (82.2°C) 850 psi (5.86 MPa)

[10] Available from NSF International, P.O. Box 130140, Ann Arbor, MI 48113–0140.

[11] Available from Manufacturer's Standardization Society of the Valve and Fittings Industry, 5203 Leesburg Pike, Suite 502, Falls Church, VA 22041.

**TABLE 2 Minimum, Hydrostatic Sustained Strength Requirements for Cold-Expansion Fittings and PEX Piping Assemblies[A,B]**

| Nominal Piping Size | | Pressure Required for Test, psi (kPa)[A] | |
|---|---|---|---|
| In. | mm | 180°F | (82.2°C) |
| ½ | 13 | 195 | (1344) |
| ⅝ + | 16+ | 190 | (1310) |

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

**TABLE 3 Excessive Temperature and Pressure Requirements for Cold-Expansion Fittings and PEX Piping Assemblies**

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

## 7. Dimensions

7.1 *Dimensions and Tolerances*—The dimensions and tolerances of the cold-expansion fittings and compression-sleeves, when measured in accordance with 10.4, shall be as shown in Table 4 and Table 5.

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 end dimensions shall be in accordance with ANSI B16.18, ANSI B16.22, or MSS SP-104.

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

## 8. Workmanship, Finish and Appearance

8.1 The fittings shall be made from materials that are homogeneous throughout. All sealing surfaces shall be smooth and free of foreign material. The walls of cold-expansion fittings and compression-sleeves shall be free of cracks, holes, blisters, voids, foreign inclusions, or other defects that are visible to the unaided eye and that affect wall integrity.

## 9. Assembly

9.1 *Joints*:

9.1.1 *Cold-Expansion Joints*—Fittings shall be joined to PEX pipe by first expanding the end of the pipe with the expander tool, inserting the cold-expansion fitting into expanded pipe, then pulling the compression-sleeve over the PEX pipe and the fitting, compressing the pipe between the compression-sleeve and the fitting. Cold-expansion fittings and compression-sleeves shall meet the dimensional and material requirements of this specification. PEX pipe shall meet the requirements of Specifications F 876 and F 877.

9.1.2 *Materials*—Only combinations of materials for cold-expansion fittings and compression-sleeves as listed in Table 6 shall be used.

9.2 *Expander Tool*:

9.2.1 The expander tool shall have a six-section expanding cylindrical-shaped head with unexpanded and maximum expanded diameters as show in Table 7.

9.2.2 The expander tool shall be inspected according to manufacturer's instructions.

9.3 *Procedure*:

9.3.1 Slide the compression-sleeve onto the pipe so that the 30° inside-beveled end is facing toward the end of the pipe. Slide the compression-sleeve far enough down the pipe so that it will not prevent expansion of the pipe. Insert the head of the expander-tool into the pipe with expander-tool handles fully separated until the expander head is completely inserted into the pipe. The expander-tool segments shall be centered inside the pipe. Draw the handles of the expander-tool together, thereby expanding the pipe, and hold for approximately 3 s. Separate the expander-tool handles, rotate the tool approximately 15°, insert the expander-tool into the pipe and repeat the expansion process. The cold-expansion fitting shall be inserted within 30 s of the second expansion. The fitting is properly inserted when the PEX pipe is pushed up against the last rib (dimensioned as Rib I in Fig. 1) of the cold-expansion fitting. If full insertion is not possible, remove the cold-expansion fitting immediately and expand the pipe again for 3 s.

9.3.2 When the expansion is complete, and the cold-expansion fitting is inserted properly into the PEX pipe, the metal compression-sleeve shall be pulled over the fitting with a compression tool.

9.3.3 The compression procedure shall be as follows: Slide the compression-sleeve towards the cold-expansion fitting by hand as far as it will go. Separate the compression-tool handles and insert the cold-expansion fitting, sleeve, and pipe into the tool cavity. Draw the handles of compression-tool together, pulling the compression-sleeve over the cold-expansion fitting and the PEX pipe end. The maximum allowable gap between the edge of the compression-sleeve and the collar of the cold-expansion fitting (surface A on Fig. 1) shall be 0.040 in. (1 mm) (see Fig. X1.1).

9.3.4 Each fitting assembly shall be checked per the manufacturer's instructions.

## 10. Test Methods

10.1 *Conditioning*—Condition specimens at 73 ± 4°F (23 ± 2°C) and 50 ± 5 % relative humidity for not less than 4 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 a standard laboratory atmosphere at 73 ± 4°F (23 ± 2°F) and 50 ± 5 % relative humidity, unless otherwise specified in the test methods of in this specification.

10.3 *Sampling*—A sample of cold-expansion fittings, compression-sleeves and PEX pipe, sufficient to determine conformance with this specification, shall be taken at random.

10.4 *Dimensions*—Use any randomly selected cold-expansion fitting or fittings and compression-sleeves to determine dimensions. Measurements shall be made in accordance with Test Method D 2122, except to determine the diameters, 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 MSS SP-104.

10.5 *Burst Pressure*—Determine the minimum hydrostatic burst strength, in accordance with Test Method D 1599, on at

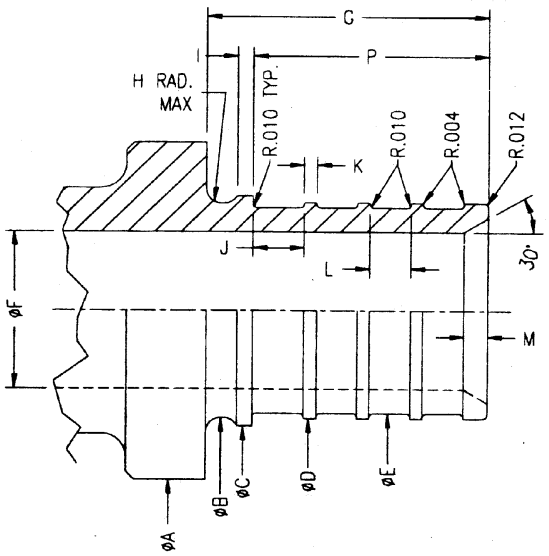
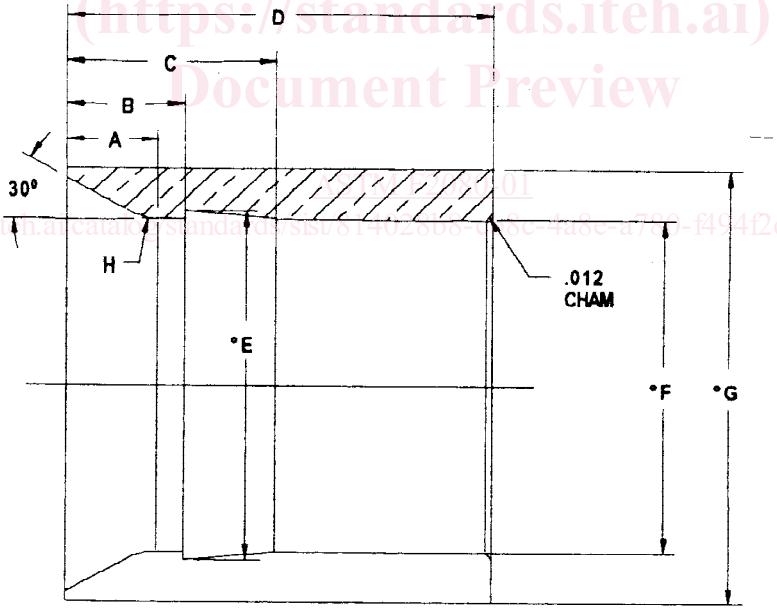



FIG. 1 Cold-Expansion Fitting






NOTE 1—All dimensions shall be measured with appropriate micrometers, such as pin or ball micrometers for wall thickness, and outside-diameter micrometers with flat anvils, or vernier calipers, to measure outside diameter and width of cold-expansion fittings and compression-sleeves.

NOTE 2—The average measurement is obtained from measurements taken in at least four locations spaced at approximately 45° around the circumference, in accordance with 10.4.

FIG. 2 Compression-Sleeve

least six assemblies for each temperature listed in Table 1, except as herein specified. Leakage or separation at any of the