



Standard Specification for Multilayer Pipe Type 2, Compression Fittings, and Compression Joints for Hot and Cold Drinking-Water Systems¹

This standard is issued under the fixed designation F 1986; 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 requirements for multilayer pipe type 2 and compression fittings for hot and cold drinking-water systems, with a maximum pressure rating of 1000 kPa (145 psi) at 82°C (180°F).

NOTE 1—*Multilayer Pipe Type 2*—Construction-based pressure rated pipe comprising more than one layer in which at least 60 % of the wall thickness is polymeric material.

1.2 Multilayer pipe type 2 is produced using a butt-welded aluminum pipe as a core, with an extruded inside layer of crosslinked polyethylene (PEX). An adhesive layer is used to bond the inside layer to the wall of the aluminum pipe. An outer layer of polyethylene (PE) and an adhesive layer are extruded to the outer wall of the aluminum pipe.

1.3 Multilayer pipe type 2 is produced in configurations 1 and 2, as referenced in Fig. 1.

1.4 This specification includes compression fittings, which are referenced in Fig. 2 .

1.5 The following precautionary caveat pertains only to the test method portion 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.*

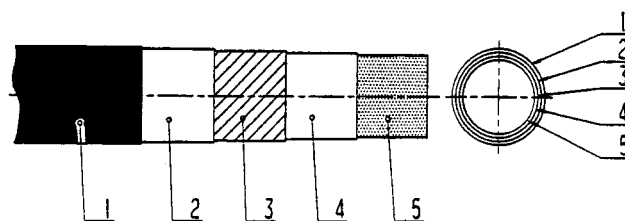
1.6 The values stated in either SI units or in inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the standard.

2. Referenced Documents

2.1 *ASTM Standards:*

¹ This test method is under the jurisdiction of ASTM Committee F-17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.11 on Composite.

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Layer:	1	2	3	4	5
Configuration 1 (drinking water)	HDPE	Adhesive Layer	Al - Alloy	Adhesive Layer	PEX ₍₁₎ crosslinked
Configuration 2 (drinking water)	MDPE	Adhesive Layer	Al - Alloy	Adhesive Layer	PEX ₍₁₎ crosslinked

PEX₍₁₎: Material is being crosslinked during manufacturing process.

FIG. 1 Multilayer Pipe Sample for Configuration 1 and 2

- B 283 Specification for Copper and Copper-Alloy Die Forgings (Hot-Pressed)²
- B 455 Specification for Copper-Zinc-Lead Alloy (Leaded Brass) Extruded Shapes²
- B 547/B 547M Specification for Aluminum and Aluminum-Alloy Formed and Arc-Welded Round Tube³
- B 584 Specification for Copper Alloy Sand Castings for General Applications²

² Annual Book of ASTM Standards, Vol 02.01.

³ Annual Book of ASTM Standards, Vol 02.02.

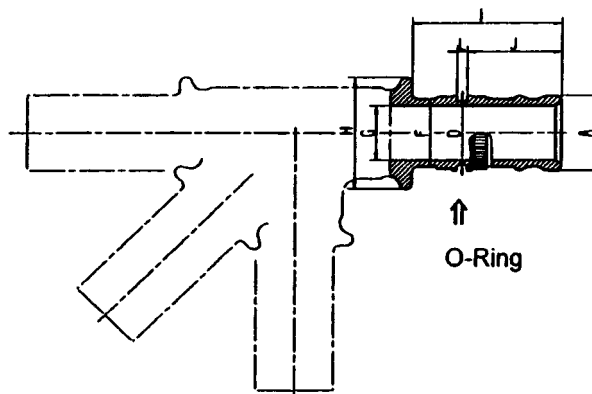


FIG. 2 Compression Fittings and O-Rings for Multilayer Pipe

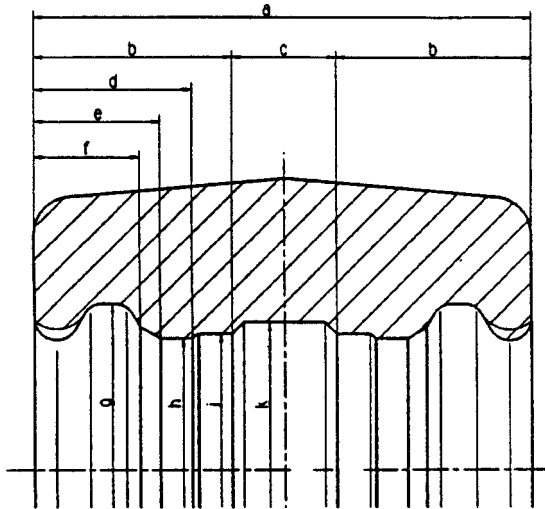


FIG. 3 Compression Tools for Multilayer Pipe

- D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing⁴
- D 1505 Test Method for Density of Plastics by the Density-Gradient Technique⁴
- D 1525 Test Method for Vicat Softening Temperature of Plastics⁴
- D 1598 Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure⁵
- D 1600 Terminology for Abbreviated Terms Relating to Plastics⁴
- D 1898 Practice for Sampling of Plastics⁴
- D 2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings⁵
- D 2765 Test Method for Determination of Gel Content and Swell Ratio of Crosslinked Ethylene Plastics⁶
- D 3222 Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding and Extrusion and Coating Materials⁶
- D 3350 Specification for Polyethylene Plastics Pipe and Fittings Materials⁶
- D 5033 Guide for the Development of Standards Relating to the Proper Use of Recycled Plastics⁷
- F 412 Terminology Relating to Plastic Piping Systems⁵
- F 477 Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe⁵
- 2.2 *ANSI Standard:*⁸
- ANSI/NSF 61 Drinking Water System Components—Health Effects
- 2.3 *ISO Standard:*⁸
- ISO 10508 Thermoplastics Pipe and Fittings for Hot and Cold Water Systems

⁴ Annual Book of ASTM Standards, Vol 08.01.

⁵ Annual Book of ASTM Standards, Vol 08.04.

⁶ Annual Book of ASTM Standards, Vol 08.02.

⁷ Annual Book of ASTM Standards, Vol 08.03.

⁸ Available from American National Standards Institute, 11 W 42nd Street, 13th Floor, New York, NY 10017.

2.4 *ARP Standard:*⁹

AS 568 A Aerospace Size Standard For O-Rings

3. Terminology

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

3.1.1 *crosslinked polyethylene (PEX), n*—a plastic prepared by crosslinking (curing) of PE compound.

3.1.2 *multilayer pipe type 2, n*—a pipe consisting of different materials with specific functional purpose to serve as pipe.

3.1.3 *pressure ratings (PR), n*—the maximum, continuous water pressure at a specified temperature that pipe is capable of withstanding without failure.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *adhesive*—a low-molecular-weight PE that functions as an adhesive layer and bonds the PEX to aluminum pipe.

3.2.2 *compression fittings for multilayer pipe, n*—a fitting specially developed for multilayer pipe in which the aluminum core is used as compression sleeve to develop sufficient mechanical strength for the connection (see Fig. 2).

3.2.3 *multilayer pipe, n*—abbreviation used in this specification for multilayer pipe type 2.

3.2.4 *lot, n*—a lot shall consist of all pipe of the same size produced from one extrusion line during one designated period.

4. Classification

4.1 Multilayer pipe and compression fittings produced under this specification shall be suitable for hot and cold drinking water at specified pressure ratings and temperatures.

5. Materials and Manufacture

5.1 *Specification for Material and Manufacture of Multilayer Pipe Configuration 1 and 2:*

5.1.1 *Polyethylene (PE)*—PE shall meet the requirement provided in Specification D 3350 and shall equal or exceed a minimum cell classification of 234233 B or 345442 B. Color and form of the material shall be in accordance with the agreement between purchaser and supplier under Specification D 3350.

5.1.2 *Crosslinked Polyethylene (PEX)*—PEX shall meet the minimum gel content of 65 % when evaluated in accordance with Test Method D 2765. The PEX raw material shall equal or exceed a minimum cell classification 344543 A in accordance with the Specification D 3350. The form of the material shall be in accordance with the agreement between purchaser and supplier.

5.1.3 *Adhesive Polymers*—Adhesive polymers shall be modified low-molecular-weight PE with a minimum density of 0.915 g/cm³ and different levels of comonomer for adhesion to aluminum and other substrates. The melting point shall not be less than 120°C (248°F). Density is determined under Test Method D 1505 and melting point under Test Method D 1525.

5.1.4 *Aluminum Pipe: Mechanical Properties*—Minimum tensile strength shall be 80 Mpa (11600 psi), minimum

⁹ Available from Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

elongation shall be 22 % A 5, in accordance with Specification B 547.

5.1.5 *Reusable Material*—Reusable material as defined in Guide D 5033 issued from the multilayer-pipe manufacturer shall be used only for the outside coating of the multilayer pipe.

5.2 *Specification for Material and Manufacture of Compression Fittings for Multilayer Pipe*:

5.2.1 Compression fittings made from cast bronze shall meet the requirements of Specification B 584 UNS Copper Alloy No. C83600.

5.2.2 Compression fittings made from brass shall meet the requirements of Specification B 455, UNS Copper Alloy No. C38500, or Specification B 283, UNS Copper Alloy No. C37700.

5.2.3 Compression fittings made from plastic shall be injection molded from virgin material and meet the requirements of Specification D 3222, Type II.

5.3 *Material Specification for O-Rings*—The O-ring material shall be EPDM, with a hardness of 70 IRHD, in accordance with Specification F 477. O-ring dimensions shall be in accordance with AS 568 A.

6. Requirements

6.1 Multilayer Pipe Dimensions:

6.1.1 *Outside Diameter*—The outside diameter shall meet the requirement of Table 1 when measured in accordance with Test Method D 2122.

6.1.2 *Wall Thickness*—The wall thickness of multilayer pipe shall meet the requirement of Table 1 when measured in accordance with Test Method D 2122. The wall thickness and the outside diameter of the aluminum pipe shall be determined prior to the next manufacturing steps.

6.1.3 *Average Thickness of Inner and Outer Layers*—The average thickness of the inner and outer layers of the multilayer pipe will be calculated as follows:

6.1.3.1 *Average Thickness of the Outer Layer*—The average outside diameter of the multilayer pipe minus the average outside diameter of the aluminum pipe multiplied by 0.5.

6.1.3.2 *Average Thickness of the Inner Layer*—The average wall thickness of the multilayer pipe minus the average wall thickness of the aluminum pipe minus the average wall thickness of the outer layer.

6.1.4 *Length*—The pipe shall be supplied in coils or in straight lengths in accordance with the agreement between purchaser and seller. The tolerance shall be +100 mm for coiled lengths and +10 mm for straight lengths.

6.2 *Compression-Fitting Dimensions*—Compression fittings shall meet the requirements of Table 2 when measured in accordance with Test Method D 2122.

6.2.1 *Compression Tool*—The compression tool shall meet the requirements of Table 3 when measured in accordance with Test Method D 2122.

6.3 *Minimum Burst Pressure*—The minimum burst pressure for multilayer pipe and compression fittings for hot and cold water systems shall be as given in Table 5.

6.4 *Sustained Pressure*—The multilayer pipe and fittings shall not fail at the test pressure and temperature given in Table 6 when tested in accordance with 8.1.

6.5 *Thermal Cycling Test*—The multilayer pipe and fittings shall not fail when tested in accordance with 8.2.

6.6 *Excessive Temperature-Pressure Capability*—In the event of a waterheating system malfunction, the multilayer pipe and fitting shall have adequate strength to accommodate short-term conditions, 30 days at 100°C (212°F), 1200 kPa (175 psi), until repairs can be made. Tests will be made in accordance with 8.7.

6.7 Multilayer pipe and compression fittings produced for the transportation of drinking water shall be evaluated and certified as safe for this purpose by a testing agency acceptable to the local health authority. The evaluation shall be in

TABLE 1

Configuration 1								
Outside Diameter	Inside Diameter	Wall Thickness	Thickness of Inside PEX Layer	Thickness of Inside Adhesive Layer	Aluminum Thickness	Thickness of Outside Adhesive Layer	Thickness of Outside HDPE Layer	Out-of-Roundness Minimum Inside Diameter
mm (in.)	mm (in.)	mm (in.)	mm (in.)	mm (in.)	mm (in.)	mm (in.)	mm (in.)	mm (in.)
16 ± 0.2 (0.630 ± 0.008)	11.5 ± 0.2 (0.453 ± 0.008)	2.25 +0.2 -0.1 (0.089 +0.008 -0.004)	1.00 ± 0.15 (0.039 ± 0.006)	0.15 (0.006)	0.50 +0.06 -0.02 (0.020 +0.002 -0.001)	0.15 (0.006)	0.45 ± 0.15 (0.018 ± 0.006)	10.8 (0.425)
20 ± 0.2 (0.787 ± 0.008)	15 ± 0.2 (0.591 ± 0.008)	2.50 +0.2 -0.1 (0.098 +0.008 -0.004)	1.10 ± 0.15 (0.043 ± 0.006)	0.15 (0.006)	0.60 +0.06 -0.02 (0.024 +0.002 -0.001)	0.15 (0.006)	0.50 ± 0.15 (0.020 ± 0.006)	14.3 (0.563)
26 ± 0.2 (1.024 ± 0.008)	20 ± 0.2 (0.787 ± 0.008)	3.00 +0.25 -0.1 (0.118 +0.010 -0.004)	1.25 ± 0.15 (0.049 ± 0.006)	0.15 (0.006)	0.70 +0.06 -0.02 (0.028 +0.002 -0.001)	0.15 (0.006)	0.75 ± 0.15 (0.030 ± 0.006)	19.3 (0.760)
32 ± 0.2 (1.260 ± 0.008)	26 ± 0.2 (1.024 ± 0.008)	3.00 +0.25 -0.1 (0.118 +0.010 -0.004)	1.25 ± 0.15 (0.049 ± 0.006)	0.15 (0.006)	0.80 +0.06 -0.02 (0.031 +0.002 -0.001)	0.15 (0.006)	0.65 ± 0.15 (0.026 ± 0.006)	25.3 (0.996)
40 ± 0.2 (1.575 ± 0.008)	33 ± 0.2 (1.299 ± 0.008)	3.50 +0.3 -0.1 (0.138 +0.012 -0.004)	1.45 ± 0.15 (0.057 ± 0.006)	0.15 (0.006)	1.00 +0.08 -0.03 (0.039 +0.003 -0.001)	0.15 (0.006)	0.75 ± 0.15 (0.030 ± 0.006)	32.3 (1.272)
50 ± 0.3 (1.969 ± 0.012)	42 +0.3 -0.2 (1.654 +0.012 -0.008)	4.00 +0.3 -0.1 (0.157 +0.012 -0.004)	1.80 ± 0.15 (0.071 ± 0.006)	0.15 (0.006)	1.00 +0.08 -0.03 (0.039 +0.003 -0.001)	0.15 (0.006)	0.90 ± 0.15 (0.035 ± 0.006)	41.3 (1.626)
63 ± 0.3 (2.480 ± 0.012)	54 +0.3 -0.2 (2.126 +0.012 -0.008)	4.50 +0.3 -0.1 (0.177 +0.012 -0.004)	2.30 ± 0.15 (0.091 ± 0.006)	0.15 (0.006)	1.00 +0.08 -0.03 (0.039 +0.003 -0.001)	0.15 (0.006)	0.90 ± 0.15 (0.035 ± 0.006)	53.3 (2.098)
Configuration 2								
16 ± 0.2 (0.630 ± 0.008)	11.5 ± 0.2 (0.453 ± 0.008)	2.25 +0.2 -0.1 (0.089 +0.008 -0.004)	0.60 +0.15 -0.1 (0.024 +0.006 -0.004)	0.15 (0.006)	0.40 +0.01 -0.03 (0.016 +0.000 -0.001)	0.15 (0.006)	0.95 +0.2 -0.1 (0.037 +0.008 -0.004)	10.8 (0.425)
20 ± 0.2 (0.787 ± 0.008)	15 ± 0.2 (0.591 ± 0.008)	2.50 +0.2 -0.1 (0.098 +0.008 -0.004)	0.70 +0.2 -0.1 (0.028 +0.008 -0.004)	0.15 (0.006)	0.47 +0.01 -0.03 (0.019 +0.000 -0.001)	0.15 (0.006)	1.03 +0.2 -0.1 (0.041 +0.008 -0.004)	14.3 (0.563)