



Standard Specification for Pressure-Rated Composite Pipe and Fittings for Elevated Temperature Service¹

This standard is issued under the fixed designation F 1335; 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 pressure-rated composite pipe and fittings for the transport of hot or cold liquids, beverages, or gases that are compatible with the composite pipe and fittings.

1.2 Composite pipe is produced using a butt welded aluminum pipe as a core, with an extruded inside layer of crosslinked polyethylene (PEX) or polyethylene (PE). 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 Composite pipe is produced in four configurations and referenced in Fig. 1, as Classes 1, 2, 3, and 4 composite pipe.

1.4 This specification includes compression fittings and compression joints, which are referenced in Fig. 2. Compression fittings as described in this specification are not compatible for gas transportation. Threaded fittings are referenced in Fig. 3.

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 acceptable SI units are to be regarded as the standard. The values given in parentheses are provided for information only. The values stated in each system are not exact equivalents, therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the specification.

2. Referenced Documents

2.1 ASTM Standards:

B 283 Specification for Copper and Copper-Alloy Die Forgings (Hot-Pressed)²

B 313/B 313M Specification for Aluminum and Aluminum-

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

Current edition approved April 10, 1998. Published November 1998. Originally published as F 1335 – 91. Last previous edition F 1335 – 97.

² Annual Book of ASTM Standards, Vol 02.01.

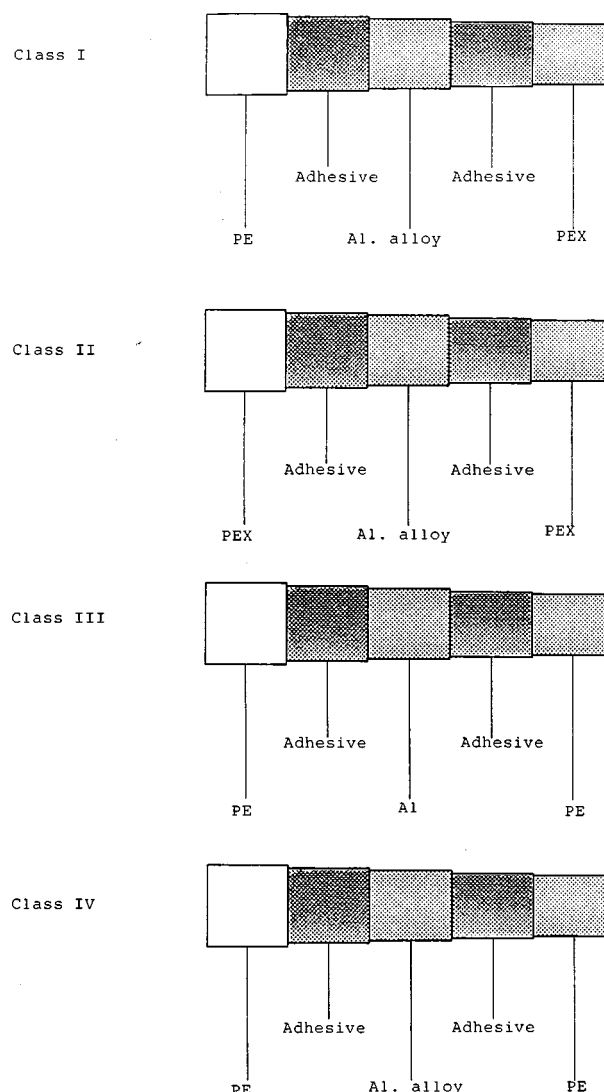
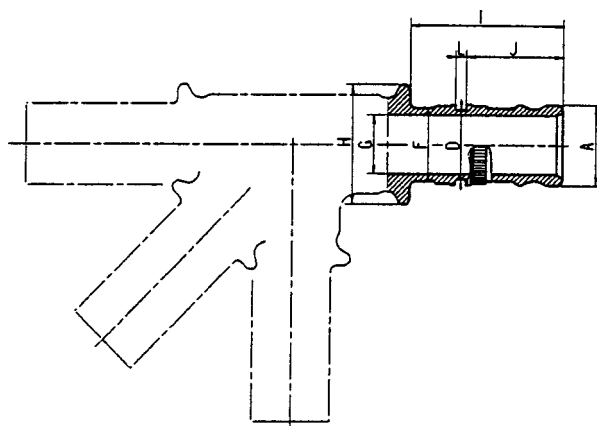


FIG. 1 Composite Pipe Composition

Alloy Round Welded Tubes³
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

³ Annual Book of ASTM Standards, Vol 02.02.

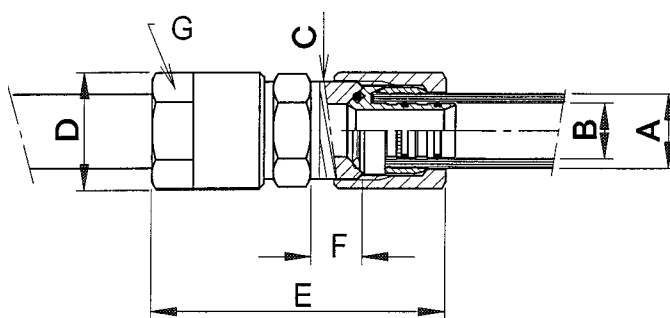
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Ø Pipes, mm (in.)	16 (0.630)	20 (0.787)	26 (1.024)	32 (1.260)	X ^A	40 (1.575)	X ^A	50 (1.969)	X ^A
Ø A	11.3 (0.445)	14.8 (0.583)	19.8 (0.780)	25.8 (1.016)		32.8 (1.291)		41.8 (1.646)	
Ø D	9.2 (0.362)	12.7 (0.500)	17.3 (0.681)	23.3 (0.917)		30.3 (1.193)		38.2 (1.504)	
Ø F	10 (0.394)	13.4 (0.528)	18 (0.709)	24 (0.945)		30.6 (1.205)		39.2 (1.543)	
Ø G	7.4 (0.291)	10.7 (0.421)	15 (0.591)	20.5 (0.807)		26.6 (1.047)		33 (1.299)	
Ø H	17.9 (0.705)	21.9 (0.862)	28.5 (1.122)	34.7 (1.366)		43.5 (1.713)		54 (2.126)	
I	26 (1.024)	28.5 (1.122)	33 (1.299)	29.5 (1.161)	38 (1.496)	35 (1.378)	44 (1.732)	39 (1.535)	5 (0.197)
J	16.7 (0.657)	18 (0.709)	20.5 (0.807)	15.2 (0.598)	23.7 (0.933)	18.3 (0.720)	27.3 (1.075)	19.3 (0.760)	30.3 (1.193)
L	2 (0.079)	2 (0.079)	2.4 (0.094)	2.4 (0.094)		2.4 (0.094)		3.5 (0.138)	

^A X = Plastic fittings.

FIG. 2 Compression Fittings and Dimensions for Composite Pipes



Reference	Pipe dimension mm (in.)			
A ^A	16 (0.630)	20 (0.787)	26 (1.024)	
B ^B	11.5 (0.453)	15 (0.591)	20 (0.787)	
C ^C	1/2 in.	3/4 in.	1 in.	
D ^D	25 (0.984)	30 (1.181)	38 (1.496)	
E ^E	62 (2.441)	68 (2.677)	68 (2.677)	
F ^F	11 (0.433)	11 (0.433)	13 (0.512)	
G ^G	22 (0.866)	27 (1.063)	34 (1.339)	

^A Outside diameter.

^B Inside diameter.

^C Thread.

^D Outside diameter of nut.

^E Total length.

^F Length of thread.

^G Tool aperture.

FIG. 3 Threaded Fitting for Composite Pipe

D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing⁴

D 638 Test Method for Tensile Properties of Plastics⁴

D 1238 Test Methods for Flow Rates of Thermoplastics by Extrusion Plastometer⁴

D 1248 Specification for Polyethylene Plastics Molding and Extrusion Materials⁴

D 1505 Test Method for Density of Plastics by the Density-Gradient Technique⁴

D 1525 Test Method for Vicat Softening Temperature of Plastics⁴

⁴ Annual Book of ASTM Standards, Vol 08.01.

D 1598 Test Methods for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure⁵
D 1599 Test Method for Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings⁵
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 Methods for Determination of Gel Content and Swell Ratio of Crosslinked Ethylene Plastics⁶
D 3222 Specification for Unmodified Poly (Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials⁶
D 3350 Specification for Polyethylene Plastics Pipe and Fittings Materials⁶
F 412 Terminology Relating to Plastic Piping Systems⁵
2.2 *National Sanitation Foundation (NSF) Standards:*
Standard No. 14 for Plastic Piping Components and Related Materials⁷
Standard No. 61 for Drinking Water System Components—Health Effects⁷
2.3 *ISO Standards:*
ISO 31 - 0 General principles⁸
ISO 32 3 Mechanics⁸
ISO 10508 Thermoplastics Pipe and Fittings for Hot and Cold Water Systems⁸
2.4 *DVGW Standard:*
W 534 Technical Rules for Connecting Pipe Elements and Pipe Connections for Pipe in Drinking Water Installations; Requirements and Testing⁹
2.5 *Federal Standard:*
Fed. Std. No. 123 Marking for Shipment (Civil Agencies)¹⁰
2.6 *Military Standard:*
MIL-STD-129 Marking for Shipment and Storage¹⁰

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 *composite pipe*—pipe consisting of two or more different materials arranged with specific functional purpose to serve as pipe.

3.1.2 *crosslinked polyethylene plastic*—plastic prepared by crosslinking (curing) polyethylene compounds.

3.1.3 *pressure ratings (PR)*—the estimated maximum pressure that water in the pipe can exert continuously with a high degree of certainty that failure of the pipe will not occur.

3.1.4 The abbreviation for polyethylene is PE, and the abbreviation for crosslinked polyethylene is PEX.

⁵ *Annual Book of ASTM Standards*, Vol 08.04.

⁶ *Annual Book of ASTM Standards*, Vol 08.02.

⁷ Available from NSF International, P.O. Box 1468, Ann Arbor, MI 48106.

⁸ Available from American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036.

⁹ Available from Süddeutsches Kunststoff-Zentrum Frankfurter Strasse 15-17-D-97082 Würzburg.

¹⁰ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

3.1.5 *Fittings for Composite Pipe:*

3.1.5.1 *compression fittings, compression joints*—fittings and joints specially developed for composite pipe in which the aluminum core is used as compression sleeve to develop sufficient mechanical strength for the connection.

3.1.5.2 *threaded fittings, threaded joints*—fittings and joints specially designed for composite pipe to avoid the possible galvanic current between the aluminum of the composite pipe and any metallic part of the fitting.

3.2 *Definitions of Terms Specific to This Standard:*

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

3.2.2 *Class 1 composite pipe*—composite pipe for elevated temperature and pressure ratings.

3.2.3 *Class 2 composite pipe*—composite pipe for elevated temperature and pressure ratings and better outside resistance.

3.2.4 *Class 3 composite pipe*—composite pipe for use at lower temperature and pressure ratings.

3.2.5 *Class 4 composite pipe*—composite pipe for low temperature, more specific for gas transportation.

3.2.6 *compression fittings for composite pipe*, (Fig. 2)—fittings specially developed for composite pipe in which the aluminum core is used as compression sleeve to develop sufficient mechanical strength for the connection.

3.2.7 *threaded fittings* (Fig. 3)—specially developed for composite pipe for the transport of liquids and gases.

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

4. Classification

4.1 Pipe and threaded fittings produced under this specification will provide suitable network for the transport of hot and cold liquids and compatible gases at specified pressure rating and temperatures.

4.2 Pipe and compression fittings produced under this specification will provide suitable network for hot and cold compatible liquids at specified pressure rating and temperatures.

5. Ordering Information

5.1 Orders for composite pipe under this specification shall include the following:

5.1.1 This specification number and year of issue,

5.1.2 Name of product,

5.1.3 Class of product,

5.1.4 Quantity (roll, length),

5.1.5 Dimensions (diameter, wall thickness),

5.1.6 Pressure rating,

5.1.7 Temperature use,

5.1.8 Product code number, and

5.1.9 Whether certification of the material by the producer is required.

5.2 Orders for compression and threaded fittings for composite pipe according to this specification shall include the following information:

5.2.1 Name of product,

5.2.2 Quantity,

5.2.3 Dimensions (diameter), and



Documents

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5.2.4 Product code number.

6. Materials and Manufacture

6.1 *Material Specification for Composite Pipe*—Virgin plastic materials (*adj.*), for use in composite pipe shall equal or exceed a minimum cell classification for each material and shall conform to the requirements prescribed in the material specification.

6.1.1 *Material Specification*—Polyethylene (PE) shall meet the requirements prescribed in Specification D 3350 and shall equal or exceed a minimum cell classification of 234233C. The color and form of the material shall be by agreement between the purchaser and supplier under Specification D 3350.

6.1.2 *Material Specification*—Crosslinked Polyethylene (PEX) shall meet the requirements prescribed in Specification D 3350 and shall equal or exceed a minimum cell classification of 354400C. The color and form of the material shall be by agreement between the purchaser and supplier under Specification D 3350.

6.1.3 *Material Specification*—Polyethylene (PE) and crosslinked polyethylene (PEX) under Specification D 1248 are referenced as Type I, II, III, and IV, and their normal density. The four normal densities, divided into three Classes, A, B, C, based on composition and use. The three classes, divided into five categories based on a broad range of flow rates when necessary definitions by grade are acceptable. Specification D 1248 referencing pipe materials that are identified by type and grades. For example, P 23 is a Type 2, Grade 3, with class and category added when needed. Polyethylene (PE) Grade P 23, Class C, Category 5, and Grade P 24, Class C, Category 5, are acceptable for composite pipe. Crosslinked polyethylene (PEX) under Specification D 1248 as P 23 / P 24, Class A, B, or C, Category 5, are acceptable.

6.1.4 *Material Specification*—Adhesive polymers are modified low molecular weight polyethylene (PE) with a minimum density of 0.915 g/cm³ and different levels of comonomer for adhesion to aluminum and other polar substrates. The melting point will not be less than 120°C (248°F) for composite pipe Classes 1 and 2, and 100°C (212°F) for composite pipe Classes 3 and 4. Density is determined under Test Method D 1505 and melting point under Test Method D 1525.

6.1.5 *Material Specification for Aluminum Pipe—Mechanical Properties:*

For Composite Pipe Classes 1, 2, and 4:

Tensile strength shall be at least 80 N/mm².

Elongation shall be at least 22 % when measured in accordance with Test Method D 638.

For Composite Pipe Class 3:

Tensile strength shall be at least 60 N/mm².

Elongation shall be at least 35 % when measured in accordance with Test Method D 638.

Aluminum Thickness—Shall follow Table 1.

6.1.6 *Reworkable Material*—Only reworkable material issued from the composite pipe manufacturer should be used for the outside coating of the composite pipe.

6.2 *Material and Manufacture of Fittings for Composite Pipe:*

6.2.1 *Material Specification*—Compression fittings in bronze, material 2.1096.01, following Specification B 584, manufactured by casting.

6.2.2 *Material Specification*—Compression fittings in brass, material CuZn40Pb1, material 2.04401, following Specification B 283, manufactured by forging.

6.2.3 *Compression Fittings in Plastic Material*—Virgin material (*adj.*) for use in compression fittings shall equal or exceed a minimum cell classification for each material and shall conform to the requirements provided in the materials specification. Material will be in accordance with Specification D 3222, Type 2. Compression fittings will be manufactured by injection molding.

7. Requirements

7.1 *Requirements for Composite Pipe:*

7.1.1 *Dimensions and Tolerances:*

7.1.2 *Outside Diameter*—The outside diameter and tolerance shall meet the requirements of Table 1 when measured in accordance with Test Method D 2122.

7.1.3 *Wall Thickness*—The wall thickness and tolerance of composite pipe shall meet the requirements of Table 1 when measured in accordance with Test Method D 2122. The wall thickness and outside diameter of aluminum pipe shall be determined prior to use.

7.1.4 *Average Thickness of Inner and Outer Layers*—The average thickness of the inner and outer layer of composite pipe shall be determined by determining the outside diameter of the aluminum pipe from the average outside diameter of the composite pipe, this equals the average thickness of the outer layer. Determine the average thickness of the inside layer by adding the aluminum pipe wall thickness plus the average outside layer thickness, as previously determined and subtract

TABLE 1 Composite Pipe Dimensions

Nominal Pipe Size		Outside Diameter, mm (in.)	Wall Thickness, mm (in.)	Minimum Aluminum Thickness, mm (in.)	Maximum Thickness of Inside Polymeric Coating, mm (in.)
Tolerances		±0.20 (0.008)	±0.10 (0.004)	±0.04 (0.002)	±0.10 (0.004)
Composite pipe, Classes 1, 2, and 4 dimensions	16	16 (0.630)	2.25 (0.089)	0.28 (0.011)	1.37 (0.054)
	20	20 (0.787)	2.5 (0.098)	0.36 (0.014)	1.49 (0.059)
	26	26 (1.024)	3.0 (0.118)	0.44 (0.017)	1.66 (0.065)
	32	32 (1.260)	3.0 (0.118)	0.6 (0.024)	1.60 (0.063)
	40	40 (1.575)	3.5 (0.138)	0.75 (0.030)	1.85 (0.073)
	50	50 (1.969)	4.0 (0.157)	1 (0.039)	2.0 (0.079)
Composite pipe, Class 3 dimensions	16	16 (0.630)	2.25 (0.089)	0.28 (0.011)	1.37 (0.054)
	20	20 (0.787)	2.50 (0.098)	0.36 (0.014)	1.49 (0.059)