



Standard Specification for Multilayer Thermoplastic And Flexible Steel Pipe And Connections¹

This standard is issued under the fixed designation F2805; 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 and test methods for materials, dimensions, workmanship, markings for factory manufactured multilayer flexible steel pipe with thermoplastic inner and outer layers and end connections (Fig. 1). It covers nominal sizes 2 in. through 8 in. (50 mm through 200 mm). Flexible steel pipes are multilayered pipe products manufactured in long continuous lengths and reeled for storage, transport and installation. The multilayer thermoplastic and flexible steel pipe governed by this standard are intended for use for the transport of crude oil, natural gas, hazardous chemicals, industrial chemicals and water.

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

2. Referenced Documents

2.1 ASTM Standards:²

- A109/A109M Specification for Steel, Strip, Carbon (0.25 Maximum Percent), Cold-Rolled
- A312/A312M Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
- A333/A333M Specification for Seamless and Welded Steel Pipe for Low-Temperature Service
- A506 Specification for Alloy and Structural Alloy Steel, Sheet and Strip, Hot-Rolled and Cold-Rolled
- A519 Specification for Seamless Carbon and Alloy Steel Mechanical Tubing
- 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
- D2321 Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
- D2765 Test Methods for Determination of Gel Content and Swell Ratio of Crosslinked Ethylene Plastics
- F412 Terminology Relating to Plastic Piping Systems

2.2 ANSI Standard:³

- B 16.5 Pipe, Flanges, and Flanged Fittings

2.3 API Standards:⁴

- 17B Recommended Practice for Flexible Pipe
- 17B Recommended Practice for Flexible Pipe
- 17J Specification for Unbonded Flexible Pipe

2.4 ISO Standards:⁵

- ISO 9080 Plastics Piping and Ducting Systems Determination of the Long-Term Hydrostatic Strength of Thermoplastics Materials in Pipe Form by Extrapolation

¹ This specification is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.11 on Composite. Current edition approved Dec. 15, 2009. Published February 2010. DOI:10.1520/F2805-09.

Current edition approved Aug. 1, 2011. Published September 2011. Originally approved in 2009. Last previous edition approved in 2009 as F2805-09. DOI:10.1520/F2805-11.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.

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

⁴ Available from American Petroleum Institute (API), 1220 L. St., NW, Washington, DC 20005-4070, http://www.api.org.

⁵ Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, Case postale 56, CH-1211, Geneva 20, Switzerland, http://www.iso.ch.

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

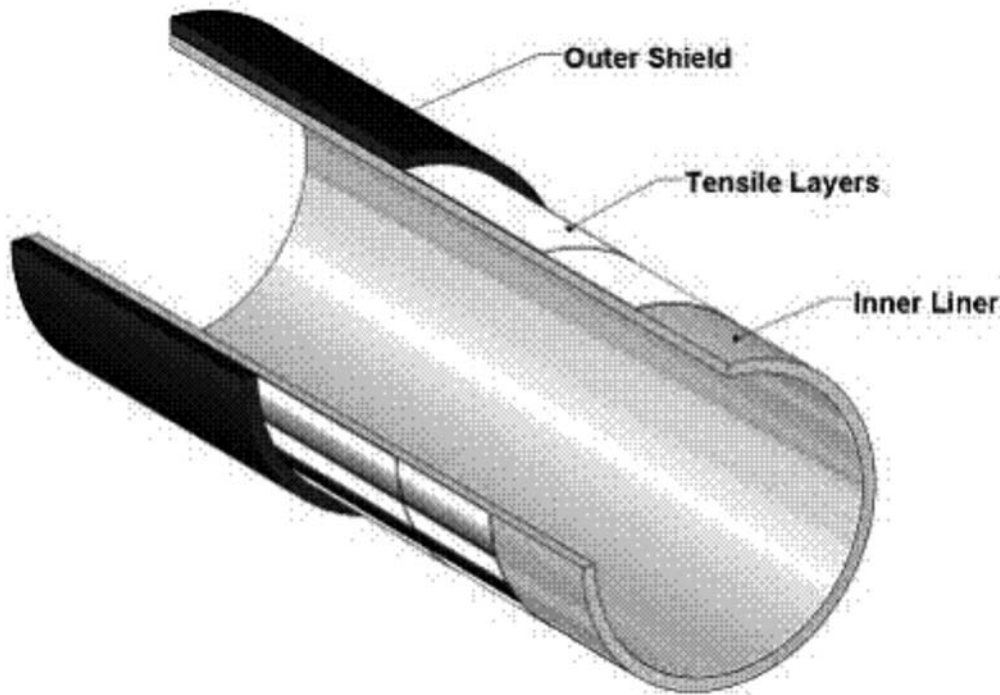


FIG. 1 Cutaway of Flexible Steel Pipe

2.5 PPI Standards:⁶

TR-4 PPI Listing of Hydrostatic Design Basis (HDB), Strength Design Basis (SDB), Pressure Design Basis (PDB), and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe
 TR-19 Thermoplastics Piping for the Transport of Chemicals

2.6 BSI Standards:⁷

EN 10210 Hot Finished Structural Hollow Sections of Non-Alloy and Fine Grain Steels
 EN 10297 Seamless Circular Steel Tubes for Mechanical and General Engineering Purposes

3. Terminology

3.1 Definitions—Definitions are in accordance with Terminology F412 and abbreviations are in accordance with Terminology D1600, unless otherwise specified.

3.2 Definitions of Terms Specific to This Standard:

3.2.1

3.3 inner sheath layer, *n*—pipe lining made from extruded thermoplastic compound.

3.2.2

3.4 tensile armor layer, *n*—hoop and structural reinforcement helically wrapped over the inner sheath layer. The steel layers are not bonded.

3.2.3

3.5 outer sheath layer, *n*—external extruded thermoplastic coating applied to resist mechanical damage and to provide the underlying layers of the pipe protection from the environment.

3.2.4

3.6 end connection, *n*—connects the pipe ends with adjacent pipe or other parts of the system.

4. Materials

4.1 Polyethylene Materials—Polyethylene compounds used in the manufacture of these products shall have a minimum cell classification of 444474 in accordance with Specification D2321 (PE4710 as defined in PPI TR-4) or PE100 in accordance with ISO 9080. Addition of pigments or stabilizers to natural polyethylene compounds during extrusion is permitted.

4.2 Crosslinked Polyethylene Materials—Crosslinked polyethylene compounds used in the manufacture of these products shall be made from polyethylene compounds which have been crosslinked by peroxides, azo compounds or silane compounds in extrusion or by other means such that the inner sheath layer and/or the outer sheath layer meets the following performance requirements:

⁶ Available from Plastics Pipe Institute (PPI), 105 Decker Court, Suite 825, Irving, TX 75062, <http://www.plasticpipe.org>.

⁷ Available from British Standards Institute (BSI), 389 Chiswick High Rd., London W4 4AL, U.K., <http://www.bsi-global.com>.

4.2.1 *Density*—When determined in accordance with Test Method D1505 or D792, the crosslinked polyethylene material shall have a minimum density of 0.033 lb/in³ (0.926 g/cm³).

4.2.2 *Degree of Crosslinking* —When tested in accordance with Test Method D2765, Method B, the degree of crosslinking for the PEX material shall be within the range of 65% to 89% inclusive.

4.3 *Long Term Hydrostatic Strength* —Polyethylene and crosslinked polyethylene compounds used in the manufacture of these products shall have Hydrostatic Design Basis (HDB) listings in PPI TR-4.

4.4 *Rework materials*—Reground or reprocessed thermoplastic materials are not permitted to be used.

4.5 *Steel Materials:*

4.5.1 Steel tensile armor layers shall consist of steel strip manufactured in accordance with Specification A506 or Specification A109/A109M with a number 3 edge and number 1 or 2 finish.

4.5.2 Steel in end connections shall meet the requirements of Specification A312/A312M, Specification A333/A333M, Specification A519, EN 10210, or EN 10297 (Fig. 2). Specialty steel grades requested by the purchaser must meet the same minimum performance requirements.

5. Requirements

5.1 *Workmanship*- The inside and outside surfaces of the pipe shall be semi-matte or glossy in appearance and free of chalking, sticky or tacky materials. The pipe surfaces shall be free of cracks, holes, blisters, voids, foreign inclusions or other defects that are visible to the naked eye.

5.2 *Multilayer Pipe Dimensions*—Pipe Dimensions shall comply with Table 1, Table 2 and Table 3, when measured in accordance with Test Method D2122.

5.3 *Design Pressure*—The pipe shall have the design pressures listed in Table 2 and Table 3.

NOTE 1—The typical multilayer pipe construction is a three layer structure consisting of an extruded thermoplastic inner liner or pipe, helically wrapped layers of steel armor, and an extruded thermoplastic outer layer or sheath.

5.4 *Outside Diameter*—The outside diameter of the applicable pipe layer shall be as shown in Table 1, Table 2 or Table 3 when measured in accordance with Section 7.

5.5 *Pipe Wall Thickness*—The wall thickness of the applicable pipe layer shall be as shown in Table 1, Table 2 or Table 3 when measured in accordance with Section 7.

5.6 *Laying Length* —The pipe may be sold in any laying length agreeable to the user.

6. Quality Assurance Tests

6.1 *Factory Acceptance Test* —Prior to shipment, the continuous length of pipe shall be pressure tested in accordance with

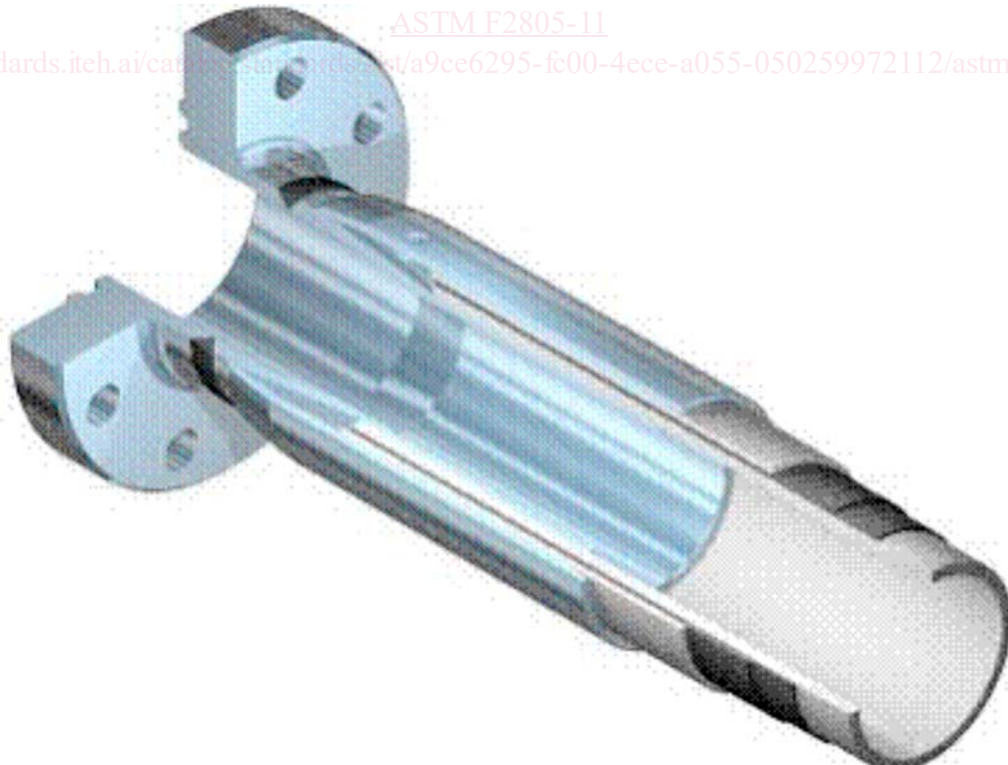


FIG. 2 Typical End Connection

TABLE 1 Inner Sheath Layer Wall Thickness Range and Outside Diameter Range

Nominal Pipe Size, in. (mm)	Minimum Wall Thickness, in. (mm)	Maximum Wall Thickness, in. (mm)	Minimum Outside Diameter, in. (mm)	Maximum Outside Diameter, in. (mm)
2 (50)	0.098 (2.5)	0.197 (5)	2.14 (54.3)	2.33 (59.3)
3 (75)	0.098 (2.5)	0.236 (6)	3.02 (76.6)	3.29 (83.6)
4 (100)	0.098 (2.5)	0.276 (7)	3.87 (98.2)	4.22 (107.2)
5.5 (140)	0.138 (3.5)	0.433 (11)	5.43 (137.8)	6.02 (152.8)
6 (150)	0.138 (3.5)	0.433 (11)	5.88 (149.2)	6.47 (164.2)
7 (175)	0.138 (3.5)	0.433 (11)	6.78 (172.1)	7.37 (187.1)
8 (200)	0.138 (3.5)	0.630 (16)	7.90 (200.7)	8.88 (225.7)

TABLE 2 Inner Sheath Layer Wall Thickness Range and Outside Diameter Range

Nominal Pipe Size, in. (mm)	Design Pressure, psi (kPa)	Minimum Outside Diameter, in. (mm)	Maximum Outside Diameter, in. (mm)
2 (50)	750 (5,171)	2.18 (55.5)	2.41 (61.2)
2 (50)	1,000 (6,895)	2.22 (56.5)	2.46 (62.5)
2 (50)	1,500 (10,342)	2.23 (56.7)	2.49 (63.1)
2 (50)	2,250 (15,513)	2.28 (57.9)	2.54 (64.6)
2 (50)	3,000 (20,684)	2.31 (58.7)	2.59 (65.8)
3 (75)	750 (5,171)	3.09 (78.5)	3.40 (86.5)
3 (75)	1,000 (6,895)	3.11 (79.1)	3.44 (87.5)
3 (75)	1,500 (10,342)	3.16 (80.3)	3.50 (88.9)
3 (75)	2,250 (15,513)	3.21 (81.5)	3.58 (90.9)
3 (75)	3,000 (20,684)	3.25 (82.5)	3.62 (92.0)
4 (100)	750 (5,171)	3.96 (100.7)	4.37 (111.1)
4 (100)	1,000 (6,895)	3.99 (101.3)	4.41 (111.9)
4 (100)	1,500 (10,342)	4.02 (102.1)	4.49 (114.1)
4 (100)	2,250 (15,513)	4.13 (104.9)	4.61 (117.0)
4 (100)	3,000 (20,684)	4.15 (105.3)	4.65 (118.2)
5.5 (140)	750 (5,171)	5.55 (140.9)	6.23 (158.3)
5.5 (140)	1,000 (6,895)	5.57 (141.5)	6.28 (159.5)
5.5 (140)	1,500 (10,342)	5.62 (142.7)	6.34 (161.1)
5.5 (140)	2,250 (15,513)	5.66 (143.7)	6.45 (163.8)
6 (150)	750 (5,171)	6.00 (152.3)	6.67 (169.4)
6 (150)	1,000 (6,895)	6.03 (153.1)	6.73 (170.9)
6 (150)	1,500 (10,342)	6.13 (155.7)	6.85 (174.0)
6 (150)	2,250 (15,513)	6.18 (157.0)	6.91 (175.4)
7 (175)	750 (5,171)	6.90 (175.1)	7.57 (192.2)
7 (175)	1,000 (6,895)	6.93 (176.0)	7.65 (194.2)
7 (175)	1,500 (10,342)	7.03 (178.6)	7.76 (197.1)
7 (175)	2,250 (15,513)	7.08 (179.8)	7.81 (198.5)
8 (200)	750 (5,171)	8.02 (203.7)	9.16 (232.8)
8 (200)	1,000 (6,895)	8.05 (204.5)	9.28 (235.8)
8 (200)	1,500 (10,342)	8.16 (207.2)	9.35 (237.5)
8 (200)	2,250 (15,513)	8.20 (208.4)	9.44 (239.9)

manufacturer's documented procedures as detailed in 7.3.

6.2 *Retest and Rejection*—Retesting in the event of a test failure shall be conducted to the same test procedures or requirements.

7. Test Methods

7.1 *Outside Diameter*—The outside diameter of each completed layer shall be measured and recorded according to manufacturer's procedures. The outside pipe diameter of each completed layer shall be measured at a frequency of every 30 ft (10 m) for the first 150 ft (50 m) and according to manufacturer's procedures thereafter.

7.2 *Wall Thickness*—The thickness of the extruded polymer layers shall be checked by means of a calibrated ultrasonic thickness instrument, with an absolute accuracy of at least 50 T (2 mil). The extruded layer wall thickness shall be measured at a frequency of every 30 feet (10 m) for the first 150 ft (50 m) and according to manufacturer's procedures thereafter.

7.3 *Pressure Testing*—Unless otherwise specified by the purchaser, the pipe shall be tested for a minimum of 8 hours at 1.3 times the stated design pressure.

NOTE 2—A pipeline system is typically commissioned after completion by filling it with water and conducting a pressure test. Flexible steel pipe behavior when hydrotested is somewhat different from the behavior of rigid steel pipes. The layers are un-bonded and upon initial pressurization undergo a stabilization process referred to as conditioning. After conditioning, the pipe is held at the test pressure for a period of time.

8. Test Reports and Certification

8.1 Upon request of the purchaser, the manufacturer shall provide certification that the product was manufactured and tested in accordance with this specification. This certification shall be furnished at the time of shipment.