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Standard Specification for Polytetrafluoroethylene (PTFE) Plastic-Lined Ferrous Metal Pipe, Fittings, and Flanges[1]

This standard is issued under the fixed designation F 423; 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 factory-made polytetrafluoroethylene (PTFE) plastic-lined ferrous metal pipe, fittings, and flanges primarily intended for conveying corrosive fluids. Included are requirements for material, workmanship, dimensions, working pressure and temperature, design, fabrication, test methods, marking, as well as qualification requirements.

NOTE 1—This specification does not include products coated with PTFE.

1.2 This specification covers ANSI Class 150 and 300 PTFE-lined pipe, flanges, and fittings in nominal diameters of ½ to 24 in. Pressure limitations shall be those established by the manufacturer considering both pressure and temperature limitations of the ferrous metal housings and sealing ability of the linear at flanged joints.

1.3 The PTFE-lined flanged pipe and fitting assemblies are limited for use from −20 to 500°F (−29 to 260°C). For use below −20°F (−29°C) consult the manufacturer.

NOTE 2—The temperature limitations are based on noncorrosive test conditions. Use in specific aggressive environments may alter temperature limitations. In such instances, specific temperature limits shall be established by mutual agreement between the purchaser and manufacturer.

1.4 The values given in parentheses are provided for information purposes only.

2. Referenced Documents

2.1 *ASTM Standards:*
A 536 Specification for Ductile Iron Castings[2]
D 792 Test Methods for Specific Gravity (Relative Density) and Density of Plastics by Displacement[3]
D 1457 Specification for Polytetrafluoroethylene (PTFE) Molding and Extrusion Materials[3]
D 1505 Test Method for Density of Plastics by the Density-Gradient Technique[3]
D 1600 Terminology for Abbreviated Terms Relating to Plastics[3,4]
F 412 Terminology Relating to Plastic Piping Systems[4]
2.2 *ANSI/ASME Standards:*
B16.5 Steel Pipe Flanges and Flanged Fittings[5]
B16.9 Factory-Made Wrought Steel Butt Welding Fittings[5]
B16.42 Ductile Iron Pipe Flanges and Flanged Fittings[5]
Section IX of the ASME Boiler and Pressure Vessel Code[6]
2.3 *MSS Standards:*
MSS SP-43 Wrought Stainless Steel Butt-Welding Fittings[7]
2.4 *Federal Standard:*
Fed. Std. No. 123 Marking for Shipment (Civil Agencies)[8]
2.5 *Military Standard:*
MIL-STD-129 Marking for Shipment and Storage[8]

3. Terminology

3.1 *Terminology*—Definitions are in accordance with Terminology F 412, and abbreviations are in accordance with Terminology D 1600, unless otherwise specified. The abbreviation for polytetrafluoroethylene is PTFE.

4. Materials

4.1 *Lining:*

4.1.1 *Material*—The lining shall be made from polytetrafluoroethylene resins conforming to the requirements of Specification D 1457, except that a maximum of 1 % by weight of additives or colorants, or both, is permissible for identification or other purposes. Organic additives or colorants, or both, if used, shall be identified in the manufacturer's specification.

4.1.2 The lining shall be made from virgin resin meeting Specification D 1457 or clean unsintered reworked resin capable of meeting the performance requirements of this specification.

4.1.3 *Mechanical Properties*—When tested in accordance with Specification D 1457 the minimum longitudinal tensile strength and elongation shall be 3000 psi (21 MPa) and 250 % respectively and the transverse minimum values 2500 psi (17 MPa) and 200 %.

4.1.4 *Specific Gravity*—The linings manufactured from PTFE resins meeting Specification D 1457, Types I and IV, shall have a specific gravity from 2.14 to 2.19, and those manufactured from Type III shall have a specific gravity

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[2] *Annual Book of ASTM Standards*, Vol 01.02.
[3] *Annual Book of ASTM Standards*, Vol 08.01.
[4] *Annual Book of ASTM Standards*, Vol 08.04.
[5] Available from American National Standards Institute, 11 West 42nd St., 13th Floor, New York, NY 10036.
[6] Available from American Society of Mechanical Engineers, 345 E. 47th St., New York, NY 10017.
[7] Available from Manufacturer's Standardization Society of the Valve and Fittings Industry, 5203 Leesburg Pike, Suite 502, Falls Church, VA 22041.
[8] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

TABLE 1 Specifications for Steel Pipe and Fittings

Pipe Section	Material	Specifications	
Piping	carbon steel	ASTM A 53	Welded and Seamless Steel Pipe[8] (Types E and S)
		ASTM A 106	Seamless Carbon Steel Pipe for High-Temperature Service[8]
		ASTM A 135	Electric-Resistance-Welded Steel Pipe[8]
		ASTM A 513	Electric-Resistance Welded Carbon and Alloy Steel Mechanical Tubing[8]
		ASTM A 587	Electric-Welded Low-Carbon Steel Pipe for the Chemical Industry[8]
Flanges	ductile iron	ASTM A 395	Ferritic Ductile Iron Pressure Retaining Castings for Use at Elevated Temperatures[9] (60-40-18)
		ASTM A 536	Ductile Iron Castings
		ANSI B16.42	Ductile Iron Pipe Flanges and Flanged Fittings[4]
	forged steel	ASTM A 105	Forgings, Carbon Steel, for Piping Components[9]
		ASTM A 181	Forgings, Carbon Steel for General Purpose Piping[9]
	cast steel	ASTM A 216	Carbon-Steel Castings Suitable for Fusion Welding for High-Temperature Service[8,9] (Grade WCB)
	steel	ANSI B16.5	Steel Pipe Flanges and Flanged Fittings[4]
Fittings	ductile iron	ASTM A 395	Ferritic Ductile Iron (for Pressure-Retaining Castings for Use at Elevated Temperatures[9] (60-40-18)
		ASTM A 536	Ductile Iron Castings
		ANSI B16.42	Ductile Iron Pipe Flanges and Flanged Fitting[4]
	forged steel	ASTM A 105	Forgings, Carbon Steel, for Piping Components[9]
		ASTM A 181	Forgings, Carbon Steel for General Purpose Piping[9]
	cast steel	ASTM A 216	Carbon-Steel Castings Suitable for Fusion Welding for High-Temperature Service[8,9] (Grade WCB)
		ASTM A 352	Ferritic and Martensitic Steel Castings for Pressure—Containing Parts Suitable for Low-Temperature Service[8,9]
		ASTM A 389	Alloy-Steel Castings Specially Heat Treated for Pressure Containing Parts Suitable for High-Temperature Service[8,9]
	carbon steel	ASTM A 234	Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures[8]
	steel	ANSI B16.5	Steel Pipe Flanges and Flanged Fittings[4]

[8] *Annual Book of ASTM Standards*, Vol 01.01.
[9] *Annual Book of ASTM Standards*, Vol 01.02.

from 2.13 to 2.21, when tested in accordance with Test Methods D 792 or D 1505.

4.2 *Pipe and Fittings:*

4.2.1 Mechanical properties of pipe and fitting shall conform to the requirements of the appropriate specification of Table 1 except as they are influenced by accepted methods of processing in the industry, that is, Van Stone flaring, bending, swaging, and welding. The carbon steel pipe and fittings shall be welded or seamless steel, Schedule 40 or Schedule 80, except that Schedule 30 may be used for pipe with 8 and 10-in. nominal size. Schedule 20 may be used for 12-in. nominal size and above with the agreement of the purchaser. Lighter schedules may be used by mutual agreement between the purchaser and the manufacturer.

4.2.2 *Welding*—All fusion welding shall be done by welders or welding operators using welding procedures qualified under the provisions of Section IX of the ASME Boiler and Pressure Vessel Code.

4.2.3 *Finish*—The interior surfaces of all housings shall be clean and free of mold burrs, rust, scale, or other protrusions that may adversely affect the integrity or performance of the lining.

4.3 *Back-Up Gaskets*—Back-up gaskets shall be used to cover the pipe end and gasket face of threaded or slip-on flanges unless a full radius is provided at the end of the pipe and a smooth transition is provided at the junction of the pipe and flange. Gaskets may also be required on fittings to provide accommodation or elimination, or both, of sharp corners that could damage the lining.

5. Requirements

5.1 *Dimensions:*

5.1.1 *Housings*—Housing installation dimensions are as required in the applicable material specification listed in Table 1.

5.1.2 *Wall Thickness*—Pipe and fitting linings shall have a minimum wall thickness and gasket face thickness as follows:

Minimum Linear and Gasket Face Thickness

Nominal Pipe Size, in.	Liner Wall, in. (mm)	Gasket Face Thickness, in. (mm)
1 to 4	0.050 (1.3)	0.040 (1.0)
6 to 14	0.100 (2.5)	0.080 (2.0)
16, 18	0.125 (3.2)	0.100 (2.5)
20, 24	0.150 (3.8)	0.120 (3.0)

5.1.3 *Lining Flare Diameter*—The outside diameter of the PTFE flare covering the gasket face portion of the flange or the full face of the lap-joint stub end shall not be less than the diameter specified in Table 2. The flared portion of the lining shall be concentric with the flared portion of the pipe within 1/16 in. (1.6 mm).

5.1.4 *Tolerances*—Tolerances for pipe, flanges, and fittings shall be as specified in Table 3. Bolt holes in both flanges on a fixed flange spool shall straddle the same center line to facilitate alignment. Finished lined (plastic flare to plastic flare) fabricated fittings shall conform to the nominal face-to-face dimensions as specified in ANSI B16.42 or B16.5 with the applicable tolerances.

TABLE 2 PTFE Flare Diameter

Nominal Pipe Size, in.	Minimum PTFE Flare Diameter, in. (mm)
½	1¼ (31.8)
¾	1⁹⁄₁₆ (39.7)
1	1⅞ (47.6)
1½	2¹¹⁄₁₆ (68.3)
2	3⅜ (87.3)
3	4⅝ (117.5)
4	5¹⁵⁄₁₆ (150.8)
6	8 (203.2)
8	10¹⁄₁₆ (255.6)
10	12¼ (311.2)
12	14⅜ (365.1)
14	15½ (393.7)
16	17¾ (450.9)
18	20¼ (514.4)
20	22¼ (565.2)
24	26¼ (666.8)

TABLE 3 Tolerances for Pipe, Flanges, and Fittings, in. (mm)

Pipe:	
Length	±⅛ (±3.2)
Fixed flange bolt hole alignment	±1/16 (±1.6)
Flange perpendicularity (with pipe centerline)	3/32 in./ft (7.8 mm/m) of diameter
Flanges:	
All dimensions	See ANSI B16.42 or ANSI B16.5
Fittings:	
All dimensions	See ANSI B16.42 or ANSI B16.5

5.2 *Flange Construction:*

5.2.1 Screw-type flanges shall be secured in position to prevent inadvertent turning of the flange.

5.2.2 Socket-type flanges shall be fully backwelded to the pipe housing and the inside surfaces of the socket flanges shall be ground smooth.

5.2.3 Slip-on flanges shall be fully backwelded.

NOTE 3—No welding *shall be done* on lined components in the field unless absolutely necessary and then only under the supervision of experienced and qualified personnel, since excessive heat can cause linear decomposition and failure. It is recommended that lined components be hydrostatically tested as specified in 6.2.1.1 after any welding in the field.

5.2.3.1 Modified slip-on flanges used as lap-joint flanges may be used with flared laps formed by flaring the pipe. The radius of the fillet of the flared lap shall not exceed ⅛ in. (3.8 mm) and the backing flange for the flared metallic lap shall have a ⅛-in. bevel or ⅛-in. corner radius at the bore to provide clearance for the fillet of the flared lap. The outside diameter of the flared lap shall be in accordance with the dimensions of an ANSI B16.9 lap-joint stub.

5.2.4 Lap-joint (or Van Stone) flanged ends may be manufactured by standard forming techniques or by using fully welded Type A MSS SP-43 or ANSI B16.9 lap-joint stub ends. Van Stone flares shall have a fillet radius compatible with the corner radius of the mating flange and shall not contain any cracks or buckles. Van Stone flares and stub ends shall have a radius to provide a smooth transition for the PTFE flare. Only lap joint flanges in accordance with ANSI B16.42 and B16.5 shall be used.

5.3 *Venting*—Each pipe and fitting shall be provided with a venting system that will release any pressure between the liner and the housing.

NOTE 4—A series of 1/16 to 5/32-in. (1.6 to 4.0-mm) diameter holes in the housings, or a helical groove system inside the housing, that connects flange vents, has provided adequate venting.

5.4 *Workmanship:*

5.4.1 Pipe and fitting linings shall show no evidence of pinholes, porosity, or cracks when inspected in accordance with 5.5.2. The linings shall fit snugly inside the pipe and fitting housings. Any bulges or other obvious indication of poor contact with the housing shall be cause for rejection.

5.4.2 The gasket seating surface of the linings shall be free of surface defects that could impair sealing effectiveness. Scratches, dents, nicks, or tool marks on the seating surface shall not be deeper than 10 % of the wall thickness.

5.5 *Performance:*

5.5.1 *Qualification*—Lined pipe and fittings must be capable of meeting the qualification requirements specified in 6.1.

5.5.2 *Inspection*—Each spool and fitting, prior to shipment, shall be hydrostatically or spark tested in accordance with 6.2.1.1 or 6.2.1.2 and shall subsequently be visually inspected to verify conformance to the requirements of 5.4.

6. Test Methods

6.1 *Qualification Tests:*

6.1.1 *Temperature Test*—Cycle representative production samples of lined pipe and fittings in an oven from room temperature to 500°F (260°C) to determine the ability of the lined components to withstand heat aging and temperature cycling. Test a minimum of two pipe spools, tees, and 90° elbows in each size.

6.1.1.1 *Test Method*—Install blind flanges with a center vent hole at the manufacturer's recommended torque value, and affix a thermocouple to the ferrous housing to measure the temperature. Pipe spools shall be at least 3 ft (1 m) long up to the 4-in. size and 10 pipe diameters in sizes 6 in. and larger to a 10-ft (3-m) maximum length. After 1 h in an oven at 500°F (260°C) as indicated by the thermocouple, air cool the lined component to 122°F (50°C) maximum. Repeat this test for a total of three cycles.

6.1.1.2 *Inspection*—Inspect lined pipe and fittings after each cycle for distortion or cracks in the lining. At the completion of the third cycle, subject tested specimens to the hydrostatic or electrostatic test described in 6.2.1.1 or 6.2.1.2.

6.1.2 *Steam-Cold Water Cycling Test*—Subject representative production samples of lined pipe and fittings to steam-cold water cycling to determine the ability of the lined components to withstand rapid temperature changes. Test a minimum of two pipe spools, tees, and 90° elbows in each size.

6.1.2.1 *Test Method*—Assemble lined pipe and fitting with suitable blind flanges having provision for the introduction of steam, air, cold water, and for drainage. Install the flanges using the manufacturer's recommended torque value. Pipe spool length shall be 10 ft (3 m). Mount the sample in such a manner as to permit complete drainage and venting. Then subject it to 100 consecutive steam-cold water cycles, each consisting of the following in the sequence given:

(*1*) Circulate 125 ± 5 psi (862 ± 35 kPa) gage saturated steam through the sample until the ferrous housing skin temperature adjacent to the flange at the outlet end of the sample has been maintained at the maximum stabilized temperature for 10 min.

(*2*) Close off steam.

(*3*) Circulate water at a maximum temperature of 77°F (25°C). Circulate the cooling water until the ferrous housing skin temperature adjacent to the flange at the outlet end of the sample measures 122°F (50°C).

(*4*) Vent and introduce air to purge the sample for a minimum of 1 min, making certain that it is completely drained of water.

6.1.2.2 *Inspection*—There shall be no evidence of leakage from the venting system during the 100 cycles. At the completion of the test, the liner shall evidence no buckling, cracking, or crazing. Formation of water blisters shall not be cause for rejection.

NOTE 5—These surface blisters are formed due to absorption of the steam vapors by the liner and subsequent condensation in the liner. The blisters do not adversely affect liner performance.

6.1.2.3 Subject the lined pipes or fittings to either the hydrostatic test described in 6.2.1.1 or, after drying, to the electrostatic test described in 6.2.1.2.

6.1.3 *Vacuum Testing*—Test representative production samples of lined pipe and fittings to determine the vacuum ratings of the lined components. Test a minimum of two pipe spools, tees, and 90° elbows in each size. Conduct tests at room temperature, at the manufacturer's maximum recommended service temperature, and at two intermediate temperature levels.

NOTE 6—Vacuum-temperature ratings for pipe and fittings are published in the manufacturers' literature.

NOTE 7—The above vacuum test is performed on pipe and fittings that have not been exposed to prior service. Use in specific environments may alter the vacuum-temperature ratings and these shall be established by mutual agreement between purchaser and manufacturer.

6.1.3.1 *Test Method*—For pipe spools, specimen length shall be at least ten pipe diameters. Install a flange incorporating a sight glass at one end and a blind flange suitable for drawing a vacuum at the other end. Make provision for measuring the ferrous housing temperature. Uniformly heat the specimen externally with the sight glass end visible, and after reaching the desired ferrous housing temperature, begin the test. Hold a selected initial vacuum level for a minimum of 8 h and if no failure occurs, increase the vacuum by 5 in. Hg (17 kPa) up to the 4-in. size and by 2 in. Hg (6.8-kPa) increments for sizes 6 in. and larger. Repeat for 8-h minimum periods until failure or full vacuum is reached. Failure is defined as any buckling or collapse of the liner. If failure occurs at the initial vacuum level selected, test a new specimen at a lower vacuum level to determine the failure threshold. The failure threshold vacuum is defined as 1 in. Hg (3.4 kPa) below that at which failure occurs.

NOTE 8—The external pressure method can be used to simulate higher than full vacuum to establish the failure threshold when full vacuum does not produce failure. With the use of pressure taps, an external pressure is applied between the liner outside diameter and the pipe inside diameter.

6.1.3.2 Set the vacuum ratings 20 % below the failure threshold.

6.1.3.3 At the test completion and after establishing the vacuum rating, place a duplicate specimen in an oven at the test temperature. Apply the rated vacuum to the specimen after the desired skin temperature has been reached. Achieve the rated vacuum within 2 min and apply continuously for 48 h. If no liner buckling or collapse occurs, the rated vacuum shall be considered acceptable.

6.1.4 *Retest*—When a test specimen fails to meet the requirements of either 6.1.1.2, 6.1.2.2, or 6.1.3.3, seek and correct the cause of failure and repeat the specified test, doubling the number of test specimens.

6.2 *Inspection Requirements:*

6.2.1 *Hydrostatic or Electrostatic Testing*—Subject each lined pipe and fitting, prior to shipment, to a hydrostatic test or electrostatic test as specified in 6.2.1.1 or 6.2.1.2. The test to be used shall be at the option of the manufacturer, unless otherwise specified by the purchaser.

6.2.1.1 *Hydrostatic Pressure Test*—The internal test pressure shall be 400 psi (2758 kPa) minimum, and the test shall be conducted at ambient temperature. Fill the pipe or fitting completely with clean water and bleed the system free of all air prior to the application of pressure. Reach full test pressure within 1 min and maintain for 3 min. Observe the pressure gage and the venting system in the test specimen throughout the pressure test for any evidence of leakage, which shall be cause for rejection.

6.2.1.2 *Electrostatic Test*—Conduct the test with a nondestructive high-voltage tester at an output voltage of 10 000 V. A visible or audible spark, or both, that occurs at the probe when electrical contact is made because of a defect in the liner, shall be cause for rejection.

6.2.2 *Final Inspection*—After the requirements of 6.2.1 have been met, visually inspect each lined pipe and fitting prior to shipment to verify conformance to the design and dimensional requirements of this specification and 5.4.

6.2.3 Each spool or fitting shall bear an inspection verification mark on the housing to indicate compliance with the requirements of this specification.

7. Finish

7.1 The outside surface of all lined pipe and fittings shall be coated with a corrosion-resistant primer over a properly prepared surface.

8. Marking

8.1 *Quality of Marking*—The markings shall be applied to the pipe in such a manner that it remains legible (easily read) after installation and inspection have been completed.

8.2 The pipe and fittings shall be marked with the following information:

8.2.1 Nominal pipe size,

8.2.2 Liner material identification (PTFE),

8.2.3 Manufacturer's name (or trademark),

8.2.4 This designation "ASTM F 423," and

8.2.5 Length (on pipe only).

8.3 Other information such as, order numbers, part numbers, item numbers, etc., shall be provided at the request of the purchaser.

8.4 Pipe liner identification shall be provided on a band containing the raised letters "PTFE." The band shall typically be located near the flange.

9. Packaging

9.1 The gasket face of each spool shall be protected by end plates or other suitable protective means.

9.2 Fittings shall have the same protective covers on the gasket faces unless protected by other means, such as individual boxing.

10. Federal Procurement

10.1 *Responsibility for Inspection*—Unless otherwise specified in the contract or purchase order, the producer is responsible for the performance of all inspection and test requirements specified herein. The producer may use his own or any other suitable facilities for the performance of the inspection and test requirements specified herein, unless disapproved by the purchaser. The purchaser shall have the right to perform any of the inspections and tests set forth in this specification where such inspections are deemed necessary to assure that material conforms to prescribed requirements.

NOTE 9—In federal contracts, the contractor is responsible for inspection.

10.2 *Packaging and Marking for U.S. Government Procurement:*

10.2.1 *Packaging*—Unless otherwise specified in the contract, the material shall be packaged in accordance with the supplier's standard practice in a manner ensuring arrival at destination in satisfactory condition, and that will be acceptable to the carrier at lowest rates. Containers and packing shall comply with Uniform Freight Classification rules.

10.2.2 *Marking*—Marking for shipment shall be in accordance with Fed. Std. No. 123 for civil agencies and MIL-STD-129 for military agencies.

NOTE 10—The inclusion of U.S. Government procurement requirements shall not be construed as an indication that the U.S. Government uses or endorses the products described in this document.

11. Quality Assurance

11.1 When the product is marked with this designation, F 423, the manufacturer affirms that the product was manufactured, inspected, sampled, and tested in accordance with this specification and has been found to meet the requirements of this specification.