



Standard Specification for Plastic-Lined Ferrous Metal Pipe, Fittings, and Flanges¹

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1. Scope

1.1 This specification covers factory-made plastic-lined ferrous metal pipe, fittings, and flanges intended primarily for conveying corrosive fluids. Requirements for materials, workmanship, dimensions, design, fabrication, working pressure and temperatures, test methods, qualification requirements, and markings are included.

1.1.1 This specification does not define the suitability of different liner materials to various chemical and operating environments. Refer to the manufacturer's chemical resistance data for suitability recommendations.

1.1.2 This specification does not include products coated with plastics.

1.2 This specification covers plastic-lined pipe, flanges, and fittings as listed in Table 1. Pressure limitations shall be in accordance with ANSI/ASME B16 Standards, except reduced pressure limitations may be established by the manufacturer, considering both pressure and temperature limitations of the ferrous metal housing and the sealing ability of the liner.

NOTE 1—In this specification, propylene plastics cover those materials defined as both polypropylene plastics and propylene plastics in Terminology F 412. Both materials are identified as "PP" on the product. Note that this is at variance with Terminology D 1600, where "PP" is the abbreviation for polypropylene.

1.3 The plastic-lined flanged pipe and fitting assemblies are limited to temperatures shown in Table 2. End users should consult with manufacturers as to the likely result of using a particular lined piping component at temperatures below the rated minimum.

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 the manufacturer.

1.4 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are provided for information only.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the*

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TABLE 1 Specification Coverage

| Material | ANSI Class | Nominal Pipe Size, in. (mm) |
|--|-------------|-----------------------------|
| Ethylene Tetrafluoroethylene Copolymer (ETFE) | 150/300 | 1 to 10 (25 to 254) |
| Perfluoro (Alkoxyalkane) Copolymer (PFA) | 150/300 | ½ to 12 (13 to 305) |
| Perfluoro (Ethylene-Propylene) Copolymer (FEP) | 150/300 | 1 to 12 (25 to 305) |
| Poly(Vinylidene Chloride) (PVDC) | 125/150/300 | 1 to 8 (25 to 203) |
| Poly(Vinylidene Fluoride) (PVDF) | 150/300 | 1 to 10 (25 to 254) |
| Poly(Vinylidene Fluoride) Copolymer (PVDF) | 150/300 | 1 to 10 (25 to 254) |
| Polytetrafluoroethylene (PTFE) | 150/300 | ½ to 24 (13 to 610) |
| Propylene and Polypropylene (PP) | 125/150/300 | ½ to 16 (13 to 406) |

TABLE 2 Temperature Specifications

| Material | Temperature Range, °F (°C) |
|--|----------------------------|
| Ethylene Tetrafluoroethylene Copolymer (ETFE) | –20 to 300 (–29 to 149) |
| Perfluoro (Alkoxyalkane) Copolymer (PFA) | –20 to 500 (–29 to 260) |
| Perfluoro (Ethylene-Propylene) Copolymer (FEP) | –20 to 300 (–29 to 149) |
| Poly(Vinylidene Chloride) (PVDC) ^A | 0 to 175 (–18 to 79) |
| Poly(Vinylidene Fluoride) (PVDF) | 0 to 275 (–18 to 135) |
| Poly(Vinylidene Fluoride) Copolymer (PVDF) | –20 to 275 (–29 to 135) |
| Polytetrafluoroethylene (PTFE) | –20 to 500 (–29 to 260) |
| Propylene and Polypropylene (PP) | 0 to 225 (–18 to 107) |

^A Storage or handling below 20°F (–7°C) of uninstalled 4, 6, and 8-in. components should be avoided.

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 48 Specification for Gray Iron Castings²
- A 53 Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless³
- A 105 Specification for Forgings, Carbon Steel, for Piping Components³
- A 106 Specification for Seamless Carbon Steel Pipe for High-Temperature Service³
- A 126 Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings²
- A 135 Specification for Electric-Resistance-Welded Steel Pipe³

² Annual Book of ASTM Standards, Vol 01.02.

³ Annual Book of ASTM Standards, Vol 01.01.

TABLE 3 Polymer Standard Specifications^A

| Lining Material—Resin Type | Standard Resin Specification | Allowable Resin Classification | Standard Liner Color | Maximum Filler Material (by weight) |
|--|------------------------------|--------------------------------|----------------------|-------------------------------------|
| Polypropylene (PP) | ASTM D 4101 | Type I and II | orange | <30 % glass fiber |
| Poly(Vinylidene Chloride) (PVDC) | ASTM D 729 | | gray | <20 % glass fiber |
| Poly(Vinylidene Fluoride) (PVDF) | ASTM D 3222 | Type III | black | |
| Poly(Vinylidene Fluoride) Copolymer (PVDF) | ASTM D 5575 | | black | |
| Polytetrafluoroethylene (PTFE) | ASTM D 1457 | | white | |
| | ASTM D 4894 | | | |
| | ASTM D 4895 | | | |
| Perfluoro (Ethylene-Propylene) Copolymer (FEP) | ASTM D 2116 | Type II | green | |
| Perfluoro (Alkoxyalkane) Copolymer (PFA) | ASTM D 3307 | Type I | natural | |
| Ethylene Tetrafluoroethylene Copolymer (ETFE) | ASTM D 3159 | | natural | |

^A A maximum of 1 % by weight of additives or colorants, or both, is permissible. Colorants, if used, shall be identified in the manufacturer's specification. Clean, reworked resins may be used provided all mechanical property requirements are maintained. Only virgin PTFE resin may be used.

- A 182/A 182M Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service³
- A 216/A 216M Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service³
- A 234/A 234M Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures³
- A 278 Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 650°F²
- A 312/A 312M Specification for Seamless and Welded Austenitic Stainless Steel Pipes³
- A 351/A 351M Specification for Castings, Austenitic, Austenitic-Ferritic (Duplex), for Pressure-Containing Parts³
- A 395 Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures²
- A 403/A 403M Specification for Wrought Austenitic Stainless Steel Piping Fittings³
- A 513 Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing³
- A 536 Specification for Ductile Iron Castings²
- A 587 Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry³
- D 729 Specification for Vinylidene Chloride Molding Compounds⁴
- D 792 Test Method for Specific Gravity (Relative Density) and Density of Plastics by Displacement⁴
- D 1457 Specification for PTFE Molding and Extrusion Materials⁴
- D 1505 Test Method for Density of Plastics by the Density-Gradient Technique⁴
- D 1600 Terminology for Abbreviated Terms Relating to Plastics⁴
- D 2116 Specification for FEP-Fluorocarbon Molding and Extrusion Materials⁴
- D 3159 Specification for Modified ETFE-Fluoropolymer Molding and Extrusion Materials⁵
- D 3222 Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding, Extrusion, and Coating Materials⁵

- D 3307 Specification for PFA-Fluorocarbon Molding and Extrusion Materials⁵
- D 4101 Specification for Propylene Plastic Injection and Extrusion Materials⁵
- D 4894 Specification for Polytetrafluoroethylene (PTFE) Granular Molding and Ram Extrusion Materials⁶
- D 4895 Specification for Polytetrafluoroethylene (PTFE) Resins Produced from Dispersion⁶
- D 5575 Specification for Copolymers of Vinylidene Fluoride (VDF) with Other Fluorinated Monomers⁶
- F 412 Terminology Relating to Plastic Piping Systems⁷
- 2.2 *ANSI/ASME Standards:*
 - B 16.1 Cast Iron Pipe Flanges Flanged Fittings⁸
 - B 16.5 Steel Pipe Flanges and Flanged Fittings⁸
 - B 16.9 Factory-Made Wrought Steel Butt Welding Fittings⁸
 - B 16.28 Wrought Steel Butt-welding Short Radius Elbows and Returns
 - B 16.42 Ductile Iron Pipe Flanges and Flanged Fittings—Section IX of the ASME Boiler and Pressure Vessel Code⁸
- 2.3 *Manufacturers Standardization Society (MSS) Standard:*
 - MSS SP-43 Wrought Stainless Steel Butt-Welding Fittings⁹

3. Terminology

3.1 *General*—The definitions used are in accordance with Terminologies F 412 and D 1600, unless otherwise indicated.

4. Materials

4.1 Lining:

4.1.1 *Material*—The lining shall be made from a resin conforming to one of the requirements in Table 3.

4.1.2 *Mechanical Properties*—The minimum tensile strength and minimum elongation at break when tested in accordance with the specifications outlined in 4.1.1 shall conform to Table 4, except the test specimens shall be obtained from extruded or molded liners. Sample orientation is not critical except for PTFE liners made using the paste extrusion process. For paste-extruded PTFE liners, test specimens with

⁶ *Annual Book of ASTM Standards*, Vol 08.03.

⁷ *Annual Book of ASTM Standards*, Vol 08.04.

⁸ Available from American Society of Mechanical Engineers, 345 East 47th St., New York, NY 10017.

⁹ Available from Manufacturers Standardization Society of the Valve and Fittings Industry, Inc., 127 Park St. N.E., Vienna, VA 22180.

⁴ *Annual Book of ASTM Standards*, Vol 08.01.

⁵ *Annual Book of ASTM Standards*, Vol 08.02.

TABLE 4 Polymer Mechanical Properties

| Lining Material—Resin Type | Minimum Tensile Strength at Break, psi (MPa) | Minimum Elongation at Break, % |
|--|--|--------------------------------|
| Polypropylene (PP) Type I | 4000 (27.6) ^A | 10 ^A |
| Polypropylene (PP) Type II | 3000 (20.7) ^A | 10 ^A |
| Polypropylene (PP) 30 % Glass Filled | 2500 (17.3) ^A | 2 ^A |
| Poly(Vinylidene Chloride) (PVDC) | 1500 (10.3) ^A | 2 ^A |
| Poly(Vinylidene Fluoride) (PVDF) | 4500 (31.0) | 10 |
| Poly(Vinylidene Fluoride) Copolymer (PVDF) | 4000 (27.6) | 300 |
| Polytetrafluoroethylene (PTFE) | 3000 (20.7) | 250 |
| Perfluoro (Ethylene-Propylene) Copolymer (FEP) | 3000 (20.7) | 250 |
| Perfluoro (Alkoxyalkane) Copolymer (PFA) | 3800 (26.2) | 300 |
| Ethylene Tetrafluoroethylene Copolymer (ETFE) | 6500 (44.8) | 275 |

^A Minimum tensile strength and elongation at yield.

their major axis cut longitudinally shall meet the mechanical property criteria listed in Table 4, and specimens cut circumferentially shall have a minimum tensile strength at break of 2500 psi (17.3 MPa) and a minimum elongation of 200 %.

4.1.3 *Specific Gravity*—Specific gravity for polytetrafluoroethylene (PTFE) resins, when tested in accordance with Test Methods D 792 or D 1505, shall be as follows:

| Lining Material, Resin Type | Specific Gravity |
|---|------------------|
| Polytetrafluoroethylene (PTFE) Types I and IV | 2.14 to 2.19 |
| Polytetrafluoroethylene (PTFE) Type III | 2.13 to 2.21 |

4.2 *Ferrous Pipe and Fittings:*

4.2.1 *Mechanical Properties*—The mechanical properties of the pipes and fittings shall conform to the appropriate specifications listed in Table 5, except as they are influenced by accepted methods of processing in the industry (for example, Van Stone flaring, bending, swaging, welding, and threading). The carbon steel pipe and wrought fittings shall be welded or

TABLE 5 Approved Ferrous Metal Flange and Fitting Material Standards (ASTM)

| Lining Material | Pipe Specifications | Flange Specifications | Fitting Specifications |
|--------------------------------|---------------------|-----------------------|------------------------|
| PVDF, PTFE, FEP, ETFE, and PFA | A 53 | A 105 | A 105 |
| | A 106 | | |
| | A 135 | A 182 | A 182 |
| | A 312 | A 216 | A 216 |
| | A 513 | A 395 | A 234 |
| | A 587 | A 536 (60-40-18) | A 351 |
| | | | A 395 |
| | | | A 403 |
| | | | A 536 (60-40-18) |
| | | | |
| PP and PVDC | A 53 | A 105 | A 48 |
| | A 106 | | A 105 |
| | A 135 | A 182 | A 126 |
| | A 312 | A 216 | |
| | A 513 | A 395 | A 182 |
| | A 587 | A 536 | A 216 |
| | | | A 234 |
| | | | A 278 |
| | | | A 351 |
| | | | A 395 |
| | | A 403 | |
| | | A 536 | |

seamless steel, Schedule 40 or 80, except Schedule 30 pipe may be used in 8, 10, and 12-in. nominal size. Schedule 20 or standard wall may be used in nominal sizes 12 in. and larger.

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

4.2.3 *General*—All pipe and fitting end connections shall be manufactured to provide a minimum 1/8-in. radius or chamfer in the transition from pipe wall to flange or lap face. This radius or chamfer is required to reduce stress concentrations in the plastic liner as it is flared or molded over the flange face or stub end. For PTFE-lined pipe and fittings, a 1/8-in. minimum radius must be provided. A perforated metal collar which seats over the flange chamfer may be used to provide this required radius.

4.2.4 *Dimensional*—Flanges and fittings used for plastic-lined pipe shall conform dimensionally (Note 3) to the following industry ferrous flange and fitting dimensional standards:

| Metallurgy | Specification |
|--------------|---------------|
| Steel | ANSI B 16.5 |
| Ductile iron | ANSI B 16.42 |
| Cast iron | ANS B 16.1 |

NOTE 3—Center-to-face dimensions include the plastic lining.

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

5. Requirements

5.1 *Dimensions:*

5.1.1 *Housing*—Housing installation dimensions are as required in the applicable material specification in accordance with 4.2.4.

5.1.2 *Plastic Wall Thickness*—Pipe and fitting liners shall have a minimum wall thickness and face thickness in accordance with Table 6.

5.1.3 *Lining Flare Diameter*—The outside diameter of the flare covering the gasket portion of the flange or the full face of the lap-joint stub end shall not be less than the diameter specified in Table 7. 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 in accordance with Table 8. 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 center-to-face dimensions as specified in ANSI B 16.1, B 16.42, or B 16.5 with the applicable tolerances.

5.2 *Flange Construction:*

5.2.1 Threaded flanges shall be secured in position to prevent inadvertent turning of the flange.

5.2.2 Socket-type flanges, except threaded, shall be fully back-welded 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 back-welded.

NOTE 4—No welding shall be done on lined components in the field.

5.2.4 Modified slip-on flanges used as lap-joint flanges may