



# Standard Specification for Plastic-Lined Ferrous Metal Pipe, Fittings, and Flanges<sup>1</sup>

This standard is issued under the fixed designation F1545; 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 reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

## 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 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, polypropylene plastics cover those materials defined as both polypropylene plastics and propylene plastics in Terminology [F412](#). Both materials are identified as “PP” on the product. Note that this is at variance with Terminology [D1600](#), 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 standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

<sup>1</sup> 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.

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1.5 *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:<sup>2</sup>

- [A48/A48M](#) Specification for Gray Iron Castings
- [A53/A53M](#) Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
- [A105/A105M](#) Specification for Carbon Steel Forgings for Piping Applications
- [A106/A106M](#) Specification for Seamless Carbon Steel Pipe for High-Temperature Service
- [A126](#) Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
- [A135/A135M](#) Specification for Electric-Resistance-Welded Steel Pipe
- [A182/A182M](#) Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
- [A216/A216M](#) Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
- [A234/A234M](#) Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
- [A278/A278M](#) Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 650°F (350°C)
- [A312/A312M](#) Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
- [A351/A351M](#) Specification for Castings, Austenitic, for Pressure-Containing Parts
- [A395/A395M](#) Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures
- [A403/A403M](#) Specification for Wrought Austenitic Stainless Steel Piping Fittings

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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

- A513/A513M Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
- A536 Specification for Ductile Iron Castings
- A587 Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry
- D729 Specification for Vinylidene Chloride Molding Compounds (Withdrawn 2000)<sup>3</sup>
- D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
- D1457 Specification for Polytetrafluoroethylene (PTFE) Molding and Extrusion Materials (Withdrawn 1996)<sup>3</sup>
- D1505 Test Method for Density of Plastics by the Density-Gradient Technique
- D1600 Terminology for Abbreviated Terms Relating to Plastics
- D2116 Specification for FEP-Fluorocarbon Molding and Extrusion Materials
- D3159 Specification for Modified ETFE-Fluoropolymer Molding and Extrusion Materials
- D3222 Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials
- D3307 Specification for Perfluoroalkoxy (PFA)-Fluorocarbon Resin Molding and Extrusion Materials
- D3350 Specification for Polyethylene Plastics Pipe and Fittings Materials
- D4101 Specification for Polypropylene Injection and Extrusion Materials
- D4894 Specification for Polytetrafluoroethylene (PTFE) Granular Molding and Ram Extrusion Materials
- D4895 Specification for Polytetrafluoroethylene (PTFE) Resin Produced From Dispersion
- D5575 Classification System for Copolymers of Vinylidene Fluoride (VDF) with Other Fluorinated Monomers
- F412 Terminology Relating to Plastic Piping Systems
- F714 Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter

### 2.2 ASME Standards:

- B16.1 Cast Iron Pipe Flanges Flanged Fittings<sup>4</sup>
- B16.5 Steel Pipe Flanges and Flanged Fittings<sup>4</sup>
- B16.9 Factory-Made Wrought Steel Butt Welding Fittings<sup>4</sup>
- B16.28 Wrought Steel Buttwelding Short Radius Elbows and Returns
- B16.42 Ductile Iron Pipe Flanges and Flanged Fittings—Section IX of the ASME Boiler and Pressure Vessel Code<sup>4</sup>

### 2.3 Manufacturers Standardization Society (MSS) Standard: MSS SP-43 Wrought Stainless Steel Butt-Welding Fittings<sup>5</sup>

## 3. Terminology

3.1 *General*—The definitions used are in accordance with Terminologies F412 and D1600, unless otherwise indicated.

<sup>3</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

<sup>4</sup> Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990, <http://www.asme.org>.

<sup>5</sup> Available from Manufacturers Standardization Society of the Valve and Fittings Industry (MSS), 127 Park St., NE, Vienna, VA 22180-4602, <http://www.msshq.com>.

## 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 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 D792 or D1505, 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 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. 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	ASME B16.5
Ductile iron	ASME B16.42
Cast iron	ASME B16.1

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 *Liner Flange Hub-or-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). Alternately, machined plastic stub-end hubs bonded to the installed plastic liner of the same material, may be used with the metallic raised-face flange or lap-joint flange

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 ASME B16.1, B16.42, or B16.5 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 be used with flared laps formed by flaring the metallic pipe. The backing flange for the flared metallic lap shall have at least a 1/8-in. bevel or 1/8-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 dimension of an ASME B16.9 lap-joint stub end.

5.2.5 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 ASME 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 plastic flare. Only lap joint flanges in accordance with ASME B16.42 and B16.5 shall be used.

5.3 *Venting*—Each lined pipe and fitting shall be provided with a venting system that will release any annular pressure between the polymer liner and the host metallic component.

NOTE 5—One or more holes in the housing, or a helical groove system inside the housing, that connects flange vents, has provided adequate venting.

NOTE 6—Venting is not required with PVDF, PP, ETFE, or PVDC liners.

## 5.4 Workmanship:

5.4.1 Pipe and fittings 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 indications of poor contact with the housing shall be cause for rejection.

5.4.2 The gasket seating surface of the lining 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 face thickness, nor, across the full width of the hub's plastic face.

## 5.5 Performance:

5.5.1 *Qualification*—Lined pipe and fittings shall meet the qualification requirements specified in 6.1, 6.2, 6.3 and 6.4 when tested. Qualification testing shall be conducted for each liner material including PTFE liner material formulation. Any changes to manufacturing or design of lined pipe and fittings which affect the fit between the liner and the housing (either pipe or fitting) shall be subjected to qualification testing as specified in 6.1, 6.2, 6.3 and 6.4.

NOTE 7—Qualification testing results will be retained for audit purposes for a period of time consistent with the manufacturer's quality plan.

5.5.2 *Inspection*—Each spool and fitting, prior to shipment, shall be hydrostatically or electrostatically tested in accordance with Section 7 and shall subsequently be inspected visually to verify conformance to the requirements of 5.4.

## 6. Test Methods

### 6.1 High-Temperature Test:

6.1.1 Cycle representative production samples of lined pipe and fittings in an oven from room temperature to the test temperature of the liner type (Table 9) 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.

6.1.2 *Procedure*—Install companion flanges at the manufacturer's recommended torque value, and affix a thermocouple in the ferrous housing to measure the temperature. Pipe spools shall be at least 3 ft (1 m) long. After 3 h in an oven at the test temperature (Table 9) as indicated by the thermocouple, air cool the lined components to 122°F (50°C) maximum. Repeat this test for a total of three cycles.

6.1.3 *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 Section 7.

### 6.2 Low-Temperature Test:

6.2.1 After the high-temperature test, subject the same parts used for 6.1 to a cold test at 0°F (−18°C) for a minimum of 48 h. New parts may also be used.

6.2.2 *Procedure*—Install companion flanges 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. After 48 h at or below 0°F (−18°C), as indicated by the thermocouple, allow the parts to warm to a minimum of 60°F (16°C).

6.2.3 *Inspection*—Inspect lined pipe and fittings for distortion or cracks in the lining. Subject tested specimens in the hydrostatic or electrostatic test described in Section 7.

### 6.3 Steam-Cold Water Cycling Test: