Designation: F1545 – 97(Reapproved 2009)

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

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 reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

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 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.

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:*[2]

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 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

[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 Aug. 1, 2009. Published September 2009. Originally approved in 1995. Last previous edition approved in 2003 as F1545 – 97(2003). DOI: 10.1520/F1545-97R09.

[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.

A513 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)[3]
D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
D1457 Specification for Polytetrafluorethylene (PTFE) Molding and Extrusion Materials[3]
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
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

2.2 *ANSI/ASME Standards:*
B 16.1 Cast Iron Pipe Flanges Flanged Fittings[4]
B 16.5 Steel Pipe Flanges and Flanged Fittings[4]
B 16.9 Factory-Made Wrought Steel Butt Welding Fittings[4]
B 16.28 Wrought Steel Buttwelding Short Radius Elbows and Returns
B 16.42 Ductile Iron Pipe Flanges and Flanged Fittings—Section IX of the ASME Boiler and Pressure Vessel Code[4]

2.3 *Manufacturers Standardization Society (MSS) Standard:*
MSS SP-43 Wrought Stainless Steel Butt-Welding Fittings[5]

3. Terminology

3.1 *General*—The definitions used are in accordance with Terminologies F412 and D1600, 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 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 ⅛-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 ⅛-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	ANSI 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:*

[3] The last approved version of this historical standard is referenced on www.astm.org.
[4] Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990, http://www.asme.org.
[5] Available from Manufacturers Standardization Society of the Valve and Fittings Industry (MSS), 127 Park St., NE, Vienna, VA 22180-4602, http://www.mss-hq.com.

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 be used with flared laps formed by flaring the pipe. The backing flange for the flared metallic lap shall have a 1 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 ANSI B 16.9 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 ANSI B 16.9 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 ANSI B 16.42 and B 16.5 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 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.

5.5 *Performance:*

5.5.1 *Qualification*—Lined pipe and fittings must be capable of meeting the qualification requirements specified in Section 6.

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:*

6.3.1 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.

6.3.2 *Procedure*—Assemble lined pipe and fittings with suitable flanges having provision for the introduction of steam air, cold water, and for drainage. Install the flange using the manufacturer's recommended torque value. Pipe spool length shall be 10 ft (3 m) minimum. Mount the sample in such a manner as to permit complete drainage and venting. Then

subject the sample to 100 consecutive steam-cold-water cycles, each consisting of the following in the sequence given:

6.3.2.1 Circulate gage saturated steam at the pressure listed in Table 10 through the sample until the ferrous housing skin temperature adjacent to the flange at the outlet end of the sample has not changed more than 5°F (3°C) in 10 min.

6.3.2.2 Close off the steam.

6.3.2.3 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) or lower.

6.3.2.4 Vent and introduce air to purge the sample for a minimum of 1 min making certain that it is completely drained of water.

6.3.3 *Inspection*—There shall be no evidence of leakage from the venting system or from behind the plastic faces during the 100 cycles. At the completion of the test, the liner shall exhibit no buckling or cracking. On PFA, PTFE, and FEP, formation of water blisters shall not be cause for rejection.

NOTE 7—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.

6.3.4 Subject the lined pipes or fittings to either the hydrostatic test described in Section 7 or, after drying, to the electrostatic test described in Section 7.

6.4 *Vacuum Testing:*

6.4.1 Test representative 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 one intermediate temperature level. Full vacuum is defined as 29.6 in. Hg corrected to sea level.

NOTE 8—Vacuum temperature ratings for pipe and fittings are published in the manufacturer's literature.

NOTE 9—The 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.

6.4.2 *Procedure*—For pipe spools, specimen lengths shall be at least 10 pipe diameters. Install a flange incorporating a sight glass at one end and a flange suitable for drawing a vacuum at the other end. Affix a thermocouple to the ferrous housing to measure the temperature. Heat the specimens uniformly externally with the sight glass end visible. Begin the test after the desired ferrous housing temperature has been reached. Hold a selected initial vacuum level for 8 h, and if no failure occurs, increase the vacuum by 5 in. Hg. Repeat this every 8 h 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 test specimen at a lower vacuum level to determine the failure threshold. The vacuum failure threshold is defined as 1 in. Hg below that at which failure occurs.

NOTE 10—The external pressure method to simulate higher than full vacuum can be used to establish the failure threshold when full vacuum is achieved. With the use of pressure taps, a pressure is applied between the plastic liner outside diameter and the pipe inside diameter.

6.4.3 The vacuum rating shall be 80 % of the failure threshold value.

6.4.4 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.

6.5 *Retest*—When a test specimen fails to meet the requirements of either 6.1.3, 6.2.3, 6.3.3, 6.3.4, 6.4.2, or 6.4.4, correct the cause of failure and repeat the specified test.

7. Inspection Tests

7.1 *Hydrostatic Pressure Test*—The internal test pressure shall be 250 psi (1.7 MPa) minimum for Class 125 (0.9-MPa) components and 425 psi (2.9 MPa) minimum for Class 150 (1.0-MPa) and Class 300 (2.1-MPa) components. Conduct the test at ambient temperature. Completely fill the pipe and fitting 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 a further 3 min. Observe the pressure gage throughout the test for any evidence of leakage, which shall be cause for rejection.

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

8. Finish

8.1 The outside surface of all lined pipe and fittings, other than stainless steel, shall be coated with a corrosion-resistant primer over a properly prepared surface.

9. Quality Assurance

9.1 When the product is marked with this designation, F1545, 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

10. Marking

10.1 *Quality Assurance*—When the product is marked with this ASTM designation, it affirms that the product was manufactured, inspected, sampled, and tested in accordance with this specification and has been found to meet its requirements

10.2 *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.

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

10.3.1 Nominal pipe size,

10.3.2 Liner material identification,

10.3.3 Manufacturer's name (or trademark),

10.3.4 Length (on pipe only), and