Designation: F 599 – 95

An American National Standard

Standard Specification for Poly(Vinylidene Chloride) (PVDC) Plastic-Lined Ferrous Metal Pipe and Fittings[1]

This standard is issued under the fixed designation F 599; 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 poly(vinylidene chloride) (PVDC) plastic-lined ferrous metal pipe and fittings primarily intended for conveying corrosive liquids and gases. Requirements for materials, workmanship, dimensions, construction, working pressure and temperatures, test methods, and markings are included.

NOTE 1—This specification does not include products *coated* with PVDC nor does it define the suitability of PVDC-lined components in chemical environments.

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

1.3 The ferrous piping products shall meet the requirements of the relevant specifications listed in 1.3.1, 1.3.2, and 1.3.3. Nominal sizes from 1 through 8 in. in 125, 150, and 300 psi ratings are covered.

NOTE 2—The PVDC sealing faces may prevent achievement of the full pressure rating of the ferrous housing. For pressure limitations, the manufacturer should be consulted.

1.3.1 *For Ferrous Pipe*:

Title of Specification	ASTM Designation
Pipe, Steel, Black, and Hot-Dipped, Zinc-Coated, Welded and Seamless	A 53
Seamless Carbon Steel Pipe for High-Temperature Service	A 106
Electric-Resistance-Welded-Carbon and Alloy Steel Mechanical Tubing.	A 513
Electric-Resistance-Welded Steel Pipe	A 135
Electric-Welded Low-Carbon Steel Pipe for the Chemical Industry	A 587

1.3.2 *For Ferrous Flanges*:

Title of Specification	ASTM Designation
Gray Iron Castings	A 48
Forgings, Carbon Steel for Piping Components	A 105
Gray Iron Castings for Valves, Flanges, and Pipe Fittings	A 126
Forgings, Carbon Steel for General Purpose Piping	A 181
Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service	A 182
Carbon-Steel Castings Suitable for Fusion Welding for High-Temperature Service	A 216
Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650°F (345°C)	A 278
Ferritic Ductile Iron Pressure-Retaining Castings for Use At Elevated Temperatures	A 395
Ductile Iron Castings	A 536

1.3.3 *For Ferrous Fittings*:

Title of Specification	ASTM Designation
Gray Iron Castings	A 48
Forgings, Carbon Steel for Piping Components	A 105
Gray Iron Castings for Valves, Flanges and Pipe Fittings	A 126
Forgings, Carbon Steel, for General Purpose Piping	A 181
Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service	A 182
Carbon-Steel Castings Suitable for Fusion Welding for High-Temperature Service	A 216
Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures	A 234
Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650°F (345°C)	A 278
Alloy Steel Castings Specially Heat-Treated for Pressure-Containing Parts Suitable for High-Temperature Service	A 389
Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures	A 395
Wrought Austenitic Stainless Steel Piping Fittings	A 403

1.4 The PVDC-lined pipe and fitting assemblies are limited to use from −18 to 79°C (0 to 175°F). For use below −18°C (0°F) consult the manufacturer. Use in specific aggressive environments may alter the above temperature range. The operating temperature range shall be established by mutual agreement between consumer and producer.

NOTE 3—Storage or handling below −7°C (20°F) of uninstalled 4, 6, and 8-in. lined pipe should be avoided.

2. Referenced Documents

2.1 *ASTM Standards:*

D 729 Specification for Vinylidene Chloride Molding Compounds[2]

D 792 Test Methods for Specific Gravity (Relative Density)

[1] This specification is under the jurisdiction of ASTM Committee F-17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.11 on Composite.

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[2] *Annual Book of ASTM Standards*, Vol 08.01.

and Density of Plastics by Displacement[2]
D 1505 Test Method for Density of Plastics by the Density-Gradient Technique[2]
D 1600 Terminology for Abbreviated Terms Relating to Plastics[2]
F 412 Terminology Relating to Plastic Piping Systems[3]
2.2 *ANSI Standards:*
B 16.1 Cast Iron Pipe Flanges and Flanged Fittings[4]
B 16.5 Steel Pipe Flanges and Flanged Fittings[4]

3. Terminology

3.1 The terminology used is in accordance with Terminology F 412, and abbreviations are in accordance with Terminology D 1600, unless otherwise specified.

3.2 The abbreviation for poly(vinylidene chloride) is PVDC.

4. Materials

4.1 *Lining*:

4.1.1 *Material*—The lining shall be made from PVDC compounds conforming to the requirements of Specification D 729, except that up to a 20 weight % glass fiber filler is used to modify physical properties, and a maximum of 1 weight % of colorant is permissible for identification. Organic colorants, if used, shall be identified in the manufacturer's specification.

4.1.2 The PVDC shall be virgin compound or clean reworked compound.

4.1.3 *Mechanical Properties*—The minimum tensile strength and minimum elongation at yield when tested in accordance with Specification D 729 shall be 1500 psi (10.34 MPa) and 2 % respectively. The minimum values for tensile strength and elongation shall apply to both the longitudinal and circumferential directions.

4.1.4 *Specific Gravity*—The linings manufactured from PVDC resins with 20 % glass fibers shall have a relative density of 1.8 to 1.9 when tested in accordance with the requirements of Test Methods D 792 and D 1505.

4.2 *Ferrous Pipe and Fittings*:

4.2.1 *Mechanical Properties*—The mechanical properties of the pipe and fittings shall conform to the requirements of the appropriate specification of 1.3 except as they are influenced by accepted methods of processing in the industry, for example, Van Stone flaring, bending, swaging, and welding. The carbon steel pipe and wrought fittings shall be welded or seamless steel, Schedule 40 or Schedule 80, except that Schedule 30 pipe may be used in 8-in. nominal size.

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 integrity or performance of the lining.

4.3 *Back-Up Gaskets*:

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

4.3.2 *Material*—Plain gaskets meeting the temperature requirements, or perforated metallic gaskets, may be used.

5. Requirements

5.1 *Dimensions*:

5.1.1 *Housings*—Housing installation dimensions are as required in the applicable material specification listed in 1.3.

5.1.2 *Wall Thickness*—Fitting linings shall have a minimum wall thickness of 3⁄32 in. (2.4 mm), and shall have a uniform face thickness of not less than 3⁄32 in. Pipe linings shall have a minimum wall thickness of 3⁄32in., and the flared radius and gasket faces shall have a uniform thickness of not less than 80 % of the wall thickness. Molded faces shall not be less than 3⁄32 in. thick.

5.1.3 *PVDC Face Diameter*—The outside diameter of the PVDC covering the gasket face of the flange or the full face of the lap-joint stub end shall not be less than the diameter specified in Table 1. They shall be concentric within 1⁄16 in. (1.6 mm).

5.1.4 *Tolerances*—Tolerance for pipe, flanges, and fittings shall be as specified in Table 2. Bolt holes in both flanges on a fixed spool shall straddle the same center line to facilitate alignment. Finish lined (plastic face to plastic face) fabricated fittings shall conform to the nominal face-to-face, etc., as specified in ANSI B 16.1 or B 16.5 with the applicable tolerances.

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 flange shall be fully back-welded to the pipe housing and the inside surfaces of the socket flanges shall be welded and ground smooth.

5.2.3 Slip-on flanges shall be fully back-welded.

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

5.2.4 Lap-joint (or Van Stone) flanged ends may be manufactured by standard forming techniques or by using fully welded stub ends or collars. Lap-joints shall not contain any cracks or buckles.

NOTE 5—The use of lap-joint flanges in a piping system may simplify alignment.

5.3 *Workmanship*:

5.3.1 Pipe and fitting linings shall show no evidence of pinholes, porosity, or cracks when inspected in accordance with 5.4.2. The lining shall fit snugly inside the pipe and fitting

TABLE 1 PVDC Face Diameter

Nominal Pipe Size, in.	Minimum PVDC Face Diameter, in. (mm)
1	1 7⁄8 (47.62)
1.5	2 11⁄16 (68.26)
2	3 7⁄16 (87.31)
2.5	3 15⁄16 (104.01)
3	4 5⁄8 (117.48)
4	5 15⁄16 (150.81)
6	8 (203.20)
8	10 1⁄16 (255.59)

[3] *Annual Book of ASTM Standards*, Vol 08.04.

[4] Available from the American National Standards Institute, 11 West 42nd St., 13th Floor, New York, NY 10036.

TABLE 2 Tolerances for Pipe, Flanges, and Fittings

	Tolerance, in. (mm)
Pipe:	
Length	± ⅛ (±3)
Fixed flange bolt hole alignment	± 1/16 (±1.6)
Flange perpendicularity (with pipe centerline)	3/32 in./ft (2.38 mm/m) of diameter
Flanges and Fittings:	
All dimensions	per ANSI B 16.1 or ANSI B 16.5

housings. Any bulges or other obvious indication of poor contact with the housing shall be cause for rejection.

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

5.4 *Performance*:

5.4.1 *Qualification*—PVDC-lined pipe and fittings must be capable of meeting the requirements specified in Section 6.

5.4.2 *Inspection*:

5.4.2.1 Each lined pipe and fitting, prior to shipment, shall be subjected to a hydrostatic test or an electrostatic test, or both, as specified in 7.1 or 7.2. The test or tests to be used shall be at the option of the manufacturer, unless otherwise specified by the purchaser.

5.4.2.2 Each lined pipe and fitting shall subsequently be visually inspected prior to shipment to verify conformance to the design and dimensional requirements of 5.3.

5.4.2.3 Each lined pipe and fitting shall bear an inspection verification impression stamp on the housing to indicate compliance with the requirements of this specification.

6. Qualification Tests

6.1 *Temperature Test*:

6.1.1 Representative production samples of PVDC-lined pipe and fittings shall be cycled in an oven from room temperature to 79 ± 3°C (175 ± 5°F) to determine the ability of the lined components to withstand heat aging and temperature cycling. A minimum of two pipe spools, tees, and 90-deg elbows shall be tested in each size.

6.1.2 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 (0.9-m) long. After 3 h in an oven at 79°C (175°F) as indicated by the thermocouple, air cool the lined components to 29°C (85°F) maximum. Repeat this test for a total of three cycles.

6.1.3 Inspect the PVDC-lined pipe and fittings after each cycle for distortion or cracks in the lining. At the completion of the third cycle, subject specimens to either the hydrostatic or electrostatic test described in 7.1 or 7.2.

6.2 *Thermo Cycling Test*:

6.2.1 Subject representative production samples of PVDC-lined pipe and fittings to hot water-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-deg elbows in each size.

6.2.2 Assemble the PVDC-lined pipe and fittings with suitable-blind flanges having provision for the introduction of air, hot and cold water, and drainage. Install the flanges using the manufacturer's recommended torque value. Pipe-spool length shall be 10 ft (3 m) minimum. Mount the test specimens in such a manner as to permit complete drainage and then subject them to 100 hot water-cold water cycles, each of which shall consist of the following in the sequence given:

6.2.2.1 Circulate 79 ± 3°C (175 ± 5°F) water through the specimens until the ferrous housing skin temperature adjacent to the flange at the outlet end of the test specimen has been maintained at the maximum stabilized temperature for 30 min.

6.2.2.2 Close off hot water.

6.2.2.3 Drain and introduce air to purge the specimens for a minimum of 1 min.

6.2.2.4 Circulate water at a maximum temperature of 25°C (77°F). Circulate the cooling water until the ferrous housing-skin temperature adjacent to the flange at the outlet end of the test specimen measures 38°C (100°F) maximum.

6.2.2.5 Drain and introduce air to purge the specimens for a minimum of 1 min, making certain that specimens are completely drained.

6.2.3 There shall be no evidence of leakage from the flanges during the 100 cycles. At the completion of the test, the liner shall show no evidence of buckling, cracking, or crazing.

6.2.4 At the conclusion of the testing specified in 6.2.2, the lined pipe or fitting shall be subjected to the hydrostatic test specified in 7.1, or, after drying, to the electrostatic test specified in 7.2.

6.3 *Vacuum Testing*:

6.3.1 Test representative production samples of the PVDC-lined pipe and fittings to determine the vacuum ratings of the lined components. Test a minimum of two pipe spools, tees, and 90-deg elbows in each size. Conduct tests at room temperature and at the manufacturer's-maximum recommended service temperature.

NOTE 6—Vacuum-temperature ratings should be published in the manufacturer's literature.

6.3.2 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 provisions for measuring the ferrous housing temperature. Heat the specimens uniformly externally with the sight-glass end visible, and after the specified ferrous housing temperature is reached, begin the test. Hold a selected initial vacuum level for 8 h, and if no failure occurs, increase the vacuum by 2 in. Hg (6.8 kPa). Repeat every 8 h until full vacuum is reached. Failure is defined as any buckling or collapse of the liner. Full vacuum is defined as 29.6 in. Hg (100 kPa) corrected (a gage pressure of −100 kPa). If failure occurs at the initial-vacuum level selected, test a new specimen at a lower-vacuum level to determine the failure threshold. The vacuum-failure threshold is defined as 1 in. Hg (3.4 kPa) below that at which failure occurs.

NOTE 7—The external-pressure method to simulate higher than full vacuum can be used to establish the failure threshold when full vacuum is achievable. With the use of pressure taps, an external pressure is applied between the liner outside diameter and the pipe inside diameter.

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

6.3.4 At the test (6.3.2) completion, and after the vacuum rating (6.3.3) is established, heat a duplicate specimen to the specified test temperature. Apply the rated vacuum to the specimen after the specified-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 vacuum rating shall be considered acceptable.

6.4 *Retest*—When a test specimen fails to meet the requirements of 6.1, 6.2, or 6.3, the cause of failure shall be sought and corrected. Repeat the temperature test specified in 6.1, the hot water-cold water cycling test specified in 6.2, and the vacuum test specified in 6.3, using double the number of test specimens.

7. Inspection Tests

7.1 *Hydrostatic-Pressure Test*—The internal test pressure shall be 250 psi (1720 kPa) minimum for 125-psi (862-kPa) components and 425 psi (2930 kPa) for 150-psi and 300-psi 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 application of pressure. Reach full test pressure within 1 min and maintain for a further 3 min. Observe the pressure gage and test specimen, 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. Marking

8.1 Marking on pipe and fittings shall include the following:

8.1.1 Nominal pipe size,

8.1.2 Liner material identification (PVDC),

8.1.3 Manufacturer's name (or trademark),

8.1.4 This designation "ASTM F 599,"

8.1.5 Length (on pipe only), and

8.1.6 . Other information such as order numbers, part numbers, item numbers, etc., at the purchaser's request.

8.2 Pipe-liner identification shall be provided on a band containing the raised letters "PVDC". One band is required on fittings and on pipe lengths up to 6 ft (2 m); two bands are required for pipe lengths over 6 ft. The band will typically be located near the flange.

9. Packaging

9.1 The gasket face of each lined pipe and fitting shall be protected by end plates or other suitable protective means, such as individual boxing.

10. Quality Assurance

10.1 When the product is marked with this designation, F 599, 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.