



# Standard Specification for Poly(Vinylidene Fluoride) (PVDF) Plastic-Lined Ferrous Metal Pipe and Fittings<sup>1</sup>

This standard is issued under the fixed designation F 491; 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 fluoride) (PVDF) plastic-lined ferrous metal pipe and fittings, primarily intended for conveying corrosive liquids and gases. Requirements for materials, workmanship, dimensions, design, construction, working pressures and temperatures, test methods, and markings are included.

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

1.2 The ferrous piping products shall meet the requirements of the relevant specification listed in 1.2.1. Nominal sizes from 1 through 10 in. in 150 and 300-psi ratings are covered.

### 1.2.1 For Ferrous Pipe:

Title of Specification	ASTM Designation
Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless (Types E and S)	A 53
Seamless Carbon Steel Pipe for High-Temperature Service	A 106
Electric-Resistance Welded Steel Pipe	A 135
Electric-Welded Low-Carbon Steel Pipe for the Chemical Industry	A 587
Seamless and Welded Austenitic Stainless Steel Pipe	A 312
Electric-Resistance Welded Carbon and Alloy Steel Mechanical Tubing	A 513

### 1.2.2 For Ferrous Flanges:

Title of Specification	ASTM Designation
Forgings, Carbon Steel, for Piping Components	A 105
Forged or Rolled Steel Pipe Flanges, Forged Fittings and Valves and Parts for General Service	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 (Grade WCB)	A 216
Ferritic Ductile Iron Pressure Retaining Castings for Use at Elevated Temperatures (60-40-18)	A 395
Ductile Iron Castings (60-40-18, 64-45-12, 80-55-06)	A 536

### 1.2.3 For Ferrous Fittings:

Title of Specification	ASTM Designation
------------------------	------------------

Forgings, Carbon Steel, for Piping Components	A 105
Forged or Rolled Steel Pipe Flanges, Forged Fittings, and Valves and Parts for General Service	A 181
Carbon Steel Castings Suitable for Fusion Welding for High-Temperature Service (Grade WCB)	A 216
Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures	A 234
Austenitic Steel Castings for High-Temperature Service	A 351
Alloy Steel Castings Specially Heat-Treated for Pressure-Containing Parts Suitable for High-Temperature Service	A 389
Ductile Iron Castings (60-40-18, 64-45-12, 80-55-06)	A 536
Ferritic Ductile Iron Pressure Retaining Castings for Use at Elevated Temperatures (60-40-18)	A 395
Wrought Austenitic Stainless Steel Piping Fittings	A 403

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

1.3 The PVDF-lined flanged pipe and fitting assemblies are limited to use from -18 to 135°C (0 to 275°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 limits shall be established by mutual agreement between the purchaser and the seller.

## 2. Referenced Documents

### 2.1 ASTM Standards:

- D 1600 Terminology for Abbreviated Terms Relating to Plastics<sup>2</sup>
- D 3222 Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding, Extrusion and Coating Materials<sup>3</sup>
- F 412 Terminology Relating to Plastic Piping Systems<sup>4</sup>

### 2.2 ANSI Standard:

- B 16.5 Steel Pipe Flanges and Flanged Fittings<sup>5</sup>

## 3. Terminology

3.1 Definitions—Definitions are in accordance with Terminology F 412, and abbreviations are in accordance with Terminology D 1600, unless otherwise specified. The abbreviation for poly(vinylidene fluoride) is PVDF.

## 4. Materials

### 4.1 Lining:

<sup>1</sup> 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.

Current edition approved Sept. 10, 1995. Published November 1995. Originally published as F 491 – 77. Last previous edition F 491 – 93a.

<sup>2</sup> Annual Book of ASTM Standards, Vol 08.01.

<sup>3</sup> Annual Book of ASTM Standards, Vol 08.03.

<sup>4</sup> Annual Book of ASTM Standards, Vol 08.04.

<sup>5</sup> Available from American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036.

4.1.1 *Material*—The lining shall be made from PVDF resins conforming to the requirements of Specification D 3222, except that a maximum of 1 % by weight of additives or colorants, or both, is permissible. Organic colorants, if used, shall be identified in the manufacturer’s specification.

4.1.2 The PVDF lining shall be made from virgin resin or clean reworked resin.

4.1.3 *Mechanical Properties*—The lining shall have a minimum tensile strength at yield of 5000 psi and a minimum elongation at yield of 8 % when tested in accordance with the requirements of Specification D 3222, except that the test specimens shall be obtained from extruded or molded PVDF liner. The minimum values for tensile strength and elongation shall apply to both the longitudinal and circumferential directions.

4.2 *Ferrous Pipe Fittings:*

4.2.1 The mechanical properties of the pipes and fittings shall conform to the requirements of the appropriate specification of 1.2 except as they are influenced by accepted methods of processing in the industry—for example, Van Stone flaring, bending, swagging, 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 and 10-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 that may adversely affect the 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 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 that could damage the lining.

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

5. **Finish**

5.1 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.

6. **Requirements**

6.1 *Dimensions:*

6.1.1 *Housing*—Housing installation dimensions are as required in the specifications listed in 1.2.

6.1.2 *Wall Thickness*—Fitting linings shall have minimum wall thickness of 3/32 in. and a uniform face thickness of not less than 3/32 in. Pipe linings shall have a minimum wall thickness of 0.050 in. and the flared radius and gasket faces shall have a uniform thickness not less than 80 % of the wall thickness.

6.1.3 *PVDF Face Diameter*—The outside diameter of the PVDF 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 the following table. They shall be concentric within 1/16 in.

PVDF Face Diameter

Nominal pipe size, in.	Minimum PVDF face diameter, in.
1	1 7/8
1 1/2	2 1/16
2	3 7/16
3	4 5/8
4	5 15/16
6	8
8	10 1/16
10	12 1/4

6.1.4 *Tolerances*—Tolerances for pipe, flanges, and fittings shall be as specified in the following table. Bolt holes in both flanges on a fixed flange spool shall straddle the same center line to facilitate alignment. Finished lined (plastic face to plastic face) fabricated fittings shall conform to the nominal face-to-face, etc. as specified in ANSI B 16.5 with the applicable tolerances.

Tolerances for Pipe, Flanges, and Fittings, in.	
Pipe	Tolerance
Length	± 1/8
Fixed flange bolt hole alignment	± 1/16
Flange perpendicularity (with pipe centerline)	3/32 in./ft of diameter
Flanges and Fittings	
All dimensions	in accordance with ANSI B16.5

6.2 *Flange Construction:*

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

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

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

NOTE 3—No welding shall be done on lined components.

6.2.4 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 4—The use of lap-joint flanges in a piping system may simplify alignment.

6.3 *Venting*—Each pipe and fitting have a liner thickness less than that shown in the following table shall be provided with a venting system that will release any gases between the liner and the housing and will also indicate any leakage through the liner, in the event of liner failure. Such a system may consist of a series of 1/16 to 5/32-in. diameter holes in the housings.

NOTE 5—Vent holes should not be plugged with paint, cement, etc. since this negates the intended purposes listed in 6.3.1.

Minimum Liner Thickness for Non-Vented Piping	
Nominal pipe size, in.	Liner thickness, in.
1	0.100
1 1/2	0.120
2	0.130
3	0.150
4	0.160
6	0.180
8	0.180
10	0.180

6.4 *Workmanship:*

6.4.1 Pipe and fitting linings shall show no evidence of pinholes, porosity, or cracks when inspected in accordance with 6.5.2. The linings shall fit snugly inside the pipe and