PS 35-70 File Copy

DEPARTMENT OF COMMERCE
NATIONAL INSTITURE OF STANDARDS AND TECHNOLOGY
OFFICE OF STANDARDS SERVICES

VOLUNTARY PRODUCT STANDARD PS35-70
POLY (VINYLIDENE FLOURIDE) (PVF_2)
PLASTIC LINED STEEL PIPE AND FITTINGS

Product Standard PS35-70, Poly (Vinylidene Fluoride) (PVF_2), Plastic Lined Steel Pipe and Fittings was withdrawn.

This product standard was replaced by American Society for Testing and Materials (ASTM) Standard Specification F491-77, Poly (Vinylidene Fluoride) (PVF_2), Plastic Lined Steel Pipe and Fittings. This specification is under the jurisdiction of Committee F17 on Plastic Piping Systems, and is the direct responsibility of Subcommittee F17.11 on Composite.

The Staff Manager can provide assistance and information on additional ASTM standards and subcommittee contacts.

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DEPARTMENT OF COMMERCE

National Bureau of Standards

VOLUNTARY PRODUCT STANDARD

Action of Withdrawal

In accordance with section 10.12 of the Department's "Procedures for the Development of Voluntary Product Standards" (15 CFR Part 10), notice is hereby given of the withdrawal of Voluntary Product Standard PS 35-70, "Poly(Vinylidene Fluoride) (PVF_2) Plastic Lined Steel Pipe and Fittings."

This withdrawal action is being taken for the reason that PS 35-70 is adequately covered by the American Society for Testing and Materials' standard ANSI/ASTM F 491-77, "Standard Specification for Poly(Vinylidene Fluoride) (PVDF) Plastic-Lined Ferrous Metal Pipe and Fittings," and duplication is inappropriate and not in the public interest. This action is taken in furtherance of the Department's announced intentions as set forth in the public notice appearing in the FEDERAL REGISTER of October 27, 1978 (43 FR 50236) to withdraw this standard.

The effective date for the withdrawal of this standard will be 60 days after the publication of this notice. This withdrawal action terminates the authority to refer to this standard as a voluntary standard developed under the Department of Commerce procedures.

Dated: December 5, 1978.

ERNEST AMBLER,
Director.

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FEDERAL REGISTER, VOL. 43, NO. 238—MONDAY, DECEMBER 11, 1978

federal register

DEPARTMENT OF COMMERCE

National Bureau of Standards

VOLUNTARY PRODUCT STANDARD

Intent To Withdraw

In accordance with § 10.12 of the Department's "Procedures for the Development of Voluntary Product Standards" (15 CFR Part 10), notice is hereby given of the intent to withdraw voluntary product standard PS 35-70, "Poly(Vinylidene Fluoride) (PVF2) Plastic Lined Steel Pipe and Fittings."

This withdrawal action is being proposed for the reason that PS 35-70 is adequately covered by the American Society for Testing and Materials' standard ANSI/ASTM F 491-77, "Standard Specification for Poly(Vinylidene Fluoride) (PVDF) Plastic-Lined Ferrous Metal Pipe and Fittings," and duplication is inappropriate and not in the public interest.

Any comments or objections concerning this intended withdrawal of this standard should be made in writing to Standards Development Services, National Bureau of Standards, Washington, D.C. 20234, on or before November 27, 1978. The effective date of withdrawal will not be less than 60 days after the final notice of withdrawal. Withdrawal action terminates the authority to refer to a published standard as a voluntary standard developed under the Department of Commerce procedures from the effective date of withdrawal.

Dated: October 23, 1978.

THOMAS A. DILLON,
Acting Director.

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FEDERAL REGISTER, VOL. 43, NO. 209—FRIDAY, OCTOBER 27, 1978

AMERICAN NATIONAL STANDARD **ANSI/ASTM F 491 - 77**

AMERICAN SOCIETY FOR TESTING AND MATERIALS
1916 Race St., Philadelphia, Pa. 19103
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If not listed in the current combined index, will appear in the next edition.

Standard Specification for POLY(VINYLIDENE FLUORIDE) (PVDF) PLASTIC-LINED FERROUS METAL PIPE AND FITTINGS[1]

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.

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

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
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 fit-

[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 Pipe.
Current edition approved Feb. 25, 1977. Published May 1977.

ting 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. Applicable Documents

2.1 *ASTM Standards:*

D 883 Definitions of Terms Relating to Plastics[2]

D 1600 Abbreviations of Terms Relating to Plastics[3]

D 3222 Polyvinylidene Fluoride (PVDF) Molding and Extrusion Materials[4]

F 412 Definitions of Terms Relating to Plastic Piping Systems[2]

2.2 *ANSI Standard:*

B 16.5 Steel Pipe Flanges and Flanged Fittings[5]

3. Terminology

3.1 The definitions used in this specification are in accordance with Definitions D 883, Definitions F 412, and Abbreviations D 1600, unless otherwise indicated. The abbreviation for poly(vinylidene fluoride) is PVDF.

4. Materials

4.1 *Lining:*

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 and 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, 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 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. Requirements

5.1 *Dimensions:*

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

5.1.2 *Wall Thickness*—Fitting linings shall have a 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.

5.1.3 *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.

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[2] *Annual Book of ASTM Standards*, Part 34.
[3] *Annual Book of ASTM Standards*, Part 35.
[4] *Annual Book of ASTM Standards*, Part 36.
[5] Available from the American National Standards Institute, 1430 Broadway, New York, N.Y. 10018.

PVDF Face Diameter

Nominal pipe size, in.	Minimum PVDF face diameter, in.
1	1 7/8
1 1/2	2 11/16
2	3 7/16
3	4 5/8
4	5 15/16
6	8
8	10 1/16
10	12 1/4

5.1.4 *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 B16.5 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	per ANSI B16.5

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 flanges 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 3—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 4—The use of lap-joint flanges in a piping system may simplify alignment.

5.3 *Venting:*

5.3.1 Each pipe and fitting having 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 5.3.1.

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

5.4 *Workmanship:*

5.4.1 Pipe and fitting linings 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 indication of poor contact with the housing shall be cause for rejection.

5.4.2 The gasket face of the PVDF 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.

5.5 *Performance:*

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

5.5.2 *Inspection:*

5.5.2.1 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.

5.5.2.2 Each lined pipe and fitting shall subsequently be visually inspected prior to shipment to verify conformance to the design and dimensional requirements of 5.4.

5.5.2.3 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 Cycle representative production

samples of PVDF-lined pipe and fittings in an oven from room temperature to 135 ± 3°C (275 ± 5°F) 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-deg elbows 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 long. After 3 h in an oven at 135°C (275°F) as indicated by the thermocouple, air cool the lined components to 50°C (122°F) maximum. Repeat this test for a total of three cycles.

6.1.3 Inspect PVDF-lined pipe and fittings after each cycle for distortion or cracks in the PVDF 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 *Steam-Cold Water Cycling Test:*

6.2.1 Subject representative production samples of PVDF-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-deg elbows in each size.

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

6.2.2.1 Circulate 30 ± 2 psig saturated steam 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 steam.

6.2.2.3 Vent 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) until the ferrous housing skin temperature adjacent to the flange at the outlet end of the test specimen measures 50°C (122°F) maximum.

6.2.2.5 Drain, then 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 venting system or 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, subject the PVDF-lined pipe or fitting 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 PVDF-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, at the manufacturer's maximum recommended service temperature, and at one intermediate temperature if a full vacuum rating cannot be achieved at the maximum recommended service temperature. Full vacuum is defined as 29.6 in. Hg corrected.

NOTE 5—Vacuum-temperature ratings should be published in the manufacturer's literature.

6.3.2 For pipe spools, specimen length shall be at least 10 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 provision for measuring the ferrous housing 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 24 h and if no failure occurs, increase the vacuum by 2 in. Hg. Repeat this every 24 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 6—The external pressure method to s imulate 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 completion and after the vacuum rating is established, heat a duplicate specimen to 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 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 steam-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 425 psi minimum. 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 and the venting system in the 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 one that is 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. Marking

9.1 Marking on the pipe and fitting shall include the following:

9.1.1 Nominal pipe size,

9.1.2 Liner material identification ("PVDF"),

9.1.3 Manufacturer's name (or trademark),

9.1.4 The designation "ASTM F 491,"

9.1.5 Length (on pipe only), and

9.1.6 Other information such as order numbers, part numbers, item numbers, etc., which shall be provided at the purchaser's request.

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

10. Packaging

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

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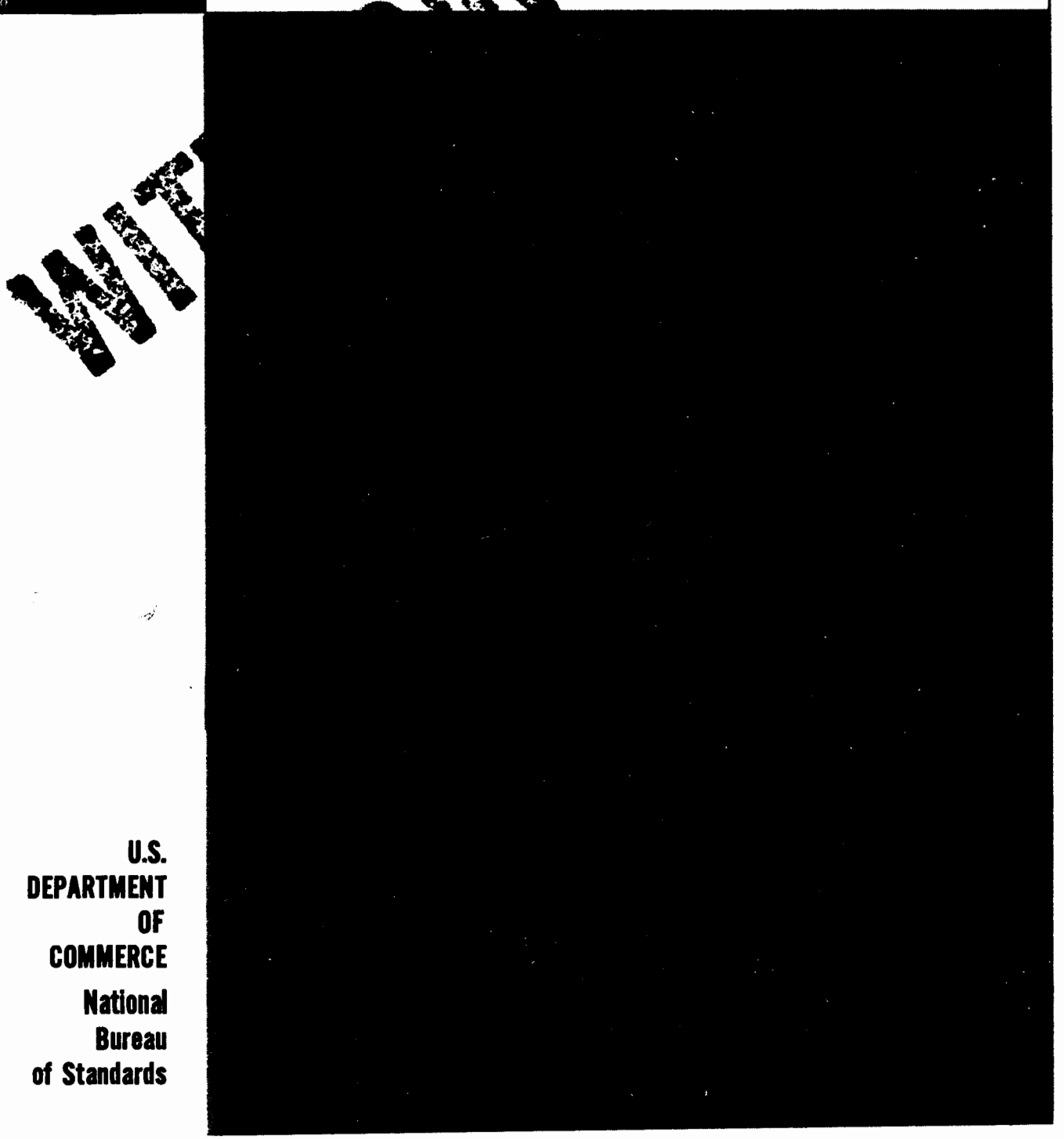
NBS Voluntary Product Standard

PS 35-70



U.S. DEPARTMENT OF COMMERCE

National Bureau of Standards

Voluntary Product Standard

(PS 35–70)

Poly(Vinylidene Fluoride) (PVF_2) Plastic Lined Steel Pipe and Fittings

Technical Standards Coordinator: L. H. Breden

Abstract

This Voluntary Product Standard covers requirements and methods of test for the material, dimensions, construction, and performance of commercially available steel pipe and fittings lined with poly(vinylidene fluoride) (PVF_2) plastic intended to be used for conveying acids, gases, solvents, and other corrosive materials.

Key words: Pipe and fittings, steel, plastic lined; plastic lined steel pipe; poly(vinylidene fluoride) plastic lined pipe; PVF_2 lined pipe; steel pipe and fittings, plastic lined.

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CODEN: XNPSA

CONTENTS

VOLUNTARY PRODUCT STANDARDS

Voluntary Product Standards are standards developed under procedures established by the Department of Commerce (15 CFR Part 10, as amended, May 28, 1970). The standards may include (1) dimensional requirements for standard sizes and types of various products, (2) technical requirements, and (3) methods of testing, grading, and marking. The objective of a *Voluntary Product Standard* is to establish requirements which are in accordance with the principal demands of the industry and, at the same time, are not contrary to the public interest.

Development of a VOLUNTARY PRODUCT STANDARD

The Office of Engineering Standards Services of the National Bureau of Standards has been assigned by the Department of Commerce the responsibility to work closely with scientific and trade associations and organizations, business firms, testing laboratories, and other appropriate groups to develop *Voluntary Product Standards*. The Bureau has the following role in the development process: It (1) provides editorial assistance in the preparation of the standard; (2) supplies such assistance and review as is required to assure the technical soundness of the standard; (3) acts as an unbiased coordinator in the development of the standard; (4) sees that the standard is representative of the views of producers, distributors, and users or consumers; (5) seeks satisfactory adjustment of valid points of disagreement; (6) determines the compliance with the criteria established in the Department's procedures cited above; and (7) publishes the standard.

Industry customarily (1) initiates and participates in the development of a standard; (2) provides technical counsel on a standard; and (3) promotes the use of, and support for, the standard. (A group interested in developing a *Voluntary Product Standard* may submit a written request to the Office of Engineering Standards Services, National Bureau of Standards, Washington, D.C. 20234.)

A draft of a proposed standard is developed in consultation with interested trade groups. Subsequently, a Standard Review Committee is established to review the proposed standard. The committee, appropriately balanced, includes qualified representatives of producers, distributors, and users or consumers of the product being standardized. When the committee approves a proposal, copies are distributed for industry consideration and acceptance. When the acceptances show general industry agreement, and when there is no substantive objection deemed valid by the Bureau, the Bureau announces approval of the *Voluntary Product Standard* and proceeds with its publication.

Use of a VOLUNTARY PRODUCT STANDARD

The adoption and use of a *Voluntary Product Standard* is completely voluntary. *Voluntary Product Standards* have been used most effectively in conjunction with legal documents such as sales contracts, purchase orders, and building codes. When a standard is made part of such a document, compliance with the standard is enforceable by the purchaser or the seller along with other provisions of the document.

Voluntary Product Standards are useful and helpful to purchasers, manufacturers, and distributors. Purchasers may order products that comply with *Voluntary Product Standards* and determine for themselves that their requirements are met. Manufacturers and distributors may refer to the standards in sales catalogs, advertising, invoices, and labels on their product. Commercial inspection and testing programs may also be employed, together with grade labels and certificates assuring compliance, to promote even greater public confidence. Such assurance of compliance promotes better understanding between purchasers and sellers.

Poly(Vinylidene Fluoride) (PVF_2) Plastic Lined Steel Pipe and Fittings

Effective September 1, 1970 (See section 7.)

(This voluntary Standard, initiated by The Society of the Plastics Industry, Inc., has been developed under the *Procedures for the Development of Voluntary Product Standards*, published by the U.S. Department of Commerce. See Section 8, *History of Project*, for further information.)

1. PURPOSE

The purpose of this Voluntary Product Standard is to establish nationally recognized dimensions and quality and performance requirements for commercially available integrally flanged steel pipe and fittings lined with poly(vinylidene fluoride) (PVF_2) plastic. This Standard is intended to provide producers, distributors, and users with a basis for common understanding of the characteristics of this product.

2. SCOPE AND CLASSIFICATION

2.1. Scope—This Voluntary Product Standard covers requirements and methods of test for the material, dimensions, construction, and performance of commercially available steel pipe and fittings lined with PVF_2 plastic intended to be used for conveying acids, gases, solvents, and other corrosive materials. Methods of marking to indicate compliance with this Standard are included.

2.2. Classification

2.2.1. Pressure-temperature rating—This Standard covers steel pipe and fittings produced in two series: one based on the rated working pressure of 150 psi and one based on the rated working pressure of 300 psi. The PVF_2 resin used in the liner has a maximum heat stability temperature of 149 °C (300 °F); however, the maximum operational range of the liner may be less than this temperature and is dependent on the type of material in contact with the inner surface of the liner, mechanical considerations, the pressure, and the temperature. Therefore, the manufacturer shall be consulted regarding chemical, pressure, temperature, and vacuum ratings.

2.2.2. Size—This Standard covers lined pipe and fittings in the following sizes:

Nominal inside diameter

½ inch	2 inches	5 inches
¾ inch	2½ inches	6 inches
1 inch	3 inches	8 inches
1½ inches	4 inches	10 inches
		12 inches

3. REQUIREMENTS

3.1. General—All products represented as complying with this Voluntary Product Standard shall meet all of the requirements listed herein and shall be marked as specified in section 5.

3.2. Linings

3.2.1. Material—The linings shall be made from poly (vinylidene fluoride) resins conforming to the requirements of Military Specification MIL–P–46122 A–1970 (MR), *Plastic Molding Material—Polyvinylidene Fluoride,*[1] except that a maximum of 1 percent by weight of additives is permissible for identification or other purposes. Organic additives, if used, shall be identified in the manufacturer's specifications.

3.2.2. Tensile and elongation—The lining shall have a minimum tensile strength of 4000 psi and a minimum elongation of 50 percent when tested in accordance with the requirements of the American Society for Testing and Materials (ASTM) D 638–68, *Standard Method of Test for Tensile Properties of Plastics.*[1] The minimum values for tensile strength and elongation shall apply to both the longitudinal and the circumferential directions. When the size of the liner does not permit the selection of test specimens conforming to the sizes required in ASTM D 638–68, both the longitudinal and the transverse test specimens shall be prepared in accordance with ASTM D 1708–66, *Standard Method of Test for Tensile Properties of Plastics by Use of Microtensile Specimens.*[1]

3.2.3. Specific gravity—The linings shall have a minimum specific gravity of 1.76 when tested in accordance with the requirements of ASTM D 792–66, *Standard Methods of Test for Specific Gravity and Density of Plastics by Displacement.*[1]

3.2.4. Wall thickness—The linings shall have a minimum wall thickness of 0.050 inch, and the flared gasket faces shall be not less than 0.040 inch in thickness when tested in accordance with

TABLE 1. *Flare (lap face) outside diameter*

Nominal pipe size	Minimum flare diameter
inches	*inches*
½	1¼
¾	1 9/16
1	1⅞
1½	2 11/16
2	3 7/16
2½	3 15/16
3	4⅝
4	5 15/16
5	7 1/16
6	8
8	10 1/16
10	12¼
12	14½

[1] Later issues of all MIL and ASTM publications referenced in this Standard may be used providing the requirements are applicable and consistent with the issue designated. Copies of MIL publications are obtainable from the Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pa. 19120. Copies of ASTM publications are obtainable from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pa. 19103.

TABLE 2. *Specifications for steel pipe and fittings*

Pipe section	Material	Specifications[a]	
Piping	Carbon steel	ASTM A53–69a	Welded and seamless steel pipe (Types E and S)
		ASTM A106–68	Seamless carbon steel pipe for high-temperature service
		ASTM A135–69	Electric-resistance-welded steel pipe
		ASTM A587–68	Electric-welded low-carbon steel pipe for the chemical industry
	Stainless steel	ASTM A312–70	Seamless and welded austenitic stainless steel pipe
		ANSI B36.19–65	Stainless steel pipe
Flanges	Ductile iron	ASTM A395–70	Ductile iron for pressure containing castings for use at elevated temperatures (60–45–15)
		ASTM A445–70	Ferritic ductile iron castings for valves, flanges, pipe fittings, and other piping components (60–40–18)
		ASTM A536–70	Ductile iron castings (60–45–12)
	Forged steel	ASTM A181–68	Forged or rolled steel pipe flanges, forged fittings, and valves and parts for general service
	Stainless steel	ASTM A182–69	Forged or rolled alloy-steel pipe flanges, forged fittings, and valves and parts for high-temperature service
	Ductile iron	ASTM A395–70	Ductile iron for pressure containing castings for use at elevated temperatures (60–45–15)
		ASTM A445–70	Ferritic ductile iron castings for valves, flanges, pipe fittings, and other piping components (60–40–18)
	Stainless steel	ASTM A351–69	Ferritic and austenitic steel castings for high-temperature service
		ASTM A389–68	Alloy steel castings specially heat treated for pressure containing parts suitable for high-temperature service
Fittings	Forged steel	ASTM A181–68	Forged or rolled steel pipe flanges, forged fittings, and valves and parts for general service
	Cast steel	ASTM A216–70	Carbon-steel castings suitable for fusion welding for high-temperature service (Grade WCB)
		ANSI B16.5–68	Steel pipe flanges and flanged fittings

[a] Later issues of all ASTM or ANSI publications in this table may be used providing the requirements are applicable and consistent with the issue designated. Copies of ASTM publications are obtainable from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pa. 19103. Copies of ANSI publications are obtainable from the American National Standards Institute, 1430 Broadway, New York, New York 10018.

the requirements of ASTM D 2122–70, *Standard Method of Determining Dimensions of Thermoplastic Pipe.*[2]

3.2.5. Flare (lap face) outside diameter—The outside diameter of the flare covering the gasket face portion of the flange or the full face of the lap-joint stub end shall not be less than the diameter specified in table 1. The flared portion of the lining shall be concentric with the flared portion of the pipe.

3.3. Pipe and fittings

3.3.1. Material—Prior to the installation of a venting system, the pipe and fittings, including flanges, fitting housings, and spacers, shall conform to the requirements of the appropriate specifications listed in table 2. The pipe shall be of welded or seamless steel, Schedule 40 or 80, except that Schedule 30 may be used for pipe with 8-inch and larger nominal size diameter. All sharp corners shall be removed by grinding or reaming to give a minimum radius of 1/8 inch.

3.3.2. Finish—The outside surface of all finished pipe and fittings, other than stainless steel, shall be coated with a corrosion resistant primer of an epoxy or zinc phosphate chemical coating. Precaution shall be taken to avoid plugging vent holes. In addition, if cleaning of the vent holes is required, care must be taken to prevent damage to the liner. The interior surfaces of all pipe and fittings shall be clean and free of casting-mold burrs, rust, scale, or other protrusions which may affect the integrity or performance of the liner component.

3.3.3. Tolerances—Tolerances shall be as specified in table 3. Centerline-to-face dimensions may be taken from the metal flange face or from the gasket face as indicated in the manufacturer's specifications.

TABLE 3. *Tolerances for pipe, flanges, and fittings*

Pipe section	Tolerances	
		inches
Pipe	Length	±1/8
	Bolt-hole alinement	±1/16
	Flange alinement (with theoretical pipe centerline)	±3/64 for 6-inch-diameter pipe and over or ±1/32 for pipe under 6 inches in diameter
Flanges	All dimensions	as specified in ANSI B16.5–1968
Fittings	All dimensions	as specified in ANSI B16.5–1968
	Flange perpendicularity (with theoretical pipe centerline at the flange outside diameter)	±3/64 for 6-inch-diameter pipe and over or ±1/32 for pipe under 6 inches in diameter

[2] See footnote 1, page 4.

3.3.4. Flange construction

3.3.4.1. Screw-type flanges shall be tack-welded to the pipe housing, or locked in position by other suitable means, before the pipe is lined to prevent inadvertent turning of the flange.

3.3.4.2. Slip-on and socket-type flanges shall be fully back-welded to the pipe housing before the pipe is lined. The inside surface of socket flanges shall be welded and ground smooth.

3.3.4.3. Lap-joint and Van Stone types of 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: Use of one Van Stone flange in each straight run of pipe in a piping system simplifies alinement.

3.3.5. Venting—Each pipe or fitting shall be provided with a venting system which will release any gases that may be entrapped between the liner and the housing, and which will indicate any leakage through the liner. A vent hole system which provides adequate venting is described in 3.3.5.1, 3.3.5.2, and 3.3.5.3. Other systems which are safe and provide equal venting performance shall be acceptable under this Standard.

3.3.5.1. Lined pipe—Each lined pipe is provided with vent holes of not less than $\frac{1}{16}$ inch and not more than $\frac{1}{8}$ inch in diameter in the pipe-wall location as follows:

a. Lined pipe over 72 inches long shall have two holes, 180° apart, located in back of each flange within 6 inches of the flange, and one hole located every 36 inches along the length of the pipe, rotated approximately 90° from the preceding hole.
b. Lined pipe 36 to 72 inches long, inclusive, shall have two holes, 180° apart, located in back of each flange within 6 inches of the flange, and one vent hole in the approximate center of the assembly.
c. Lined pipe between 18 and 36 inches in length shall have two holes, 180° apart, located in back of each flange within 6 inches of the flange.
d. Lined pipe 18 inches or less in length shall have two vent holes, 180° apart, located between flanges.

3.3.5.2. Fittings—All fittings shall have two vent holes, 180° apart, located between the flanges; however, fittings employing split-type housings need not incorporate vent holes.

3.3.5.3. Reducing flanges and reducers—A minimum of one vent hole is provided for reducing flanges. Standard and short tapered reducers shall have two vent holes, 180° apart, between the two flanges.

3.3.6. Gaskets—A $\frac{1}{16}$-inch-thick asbestos (or equal) backup gasket conforming to the requirements for Type 1, No. P 1161 A, of ASTM D 1170–62T, *Tentative Specifications for Nonmetallic Gasket Materials for General Automotive and Aeronautical Purposes,*[3] shall cover the pipe and gasket face of the threaded flanges. Back-up gaskets are not required when the flanged metal face has an uninterrupted surface and a minimum internal bore radius of $\frac{1}{8}$ inch.

3.4. Lined pipe and fittings

[3] See footnote 1, page 2.

3.4.1. Continuity—All lined pipe and fittings shall show no evidence of pinholes, porosity, or cracks when tested in accordance with 4.3.1.

3.4.2. Temperature and pressure—The lined pipe or fittings shall show no longitudinal or radial cracks or distortion which would impair the function of the liner component when tested in accordance with 4.3.2. On the completion of this test, each of the tested specimens shall meet the requirements of 3.4.1.

3.4.3. Steam and cold water—The lined pipe or fittings shall show no evidence of leakage through vent holes or other venting systems when tested in accordance with Procedure A or B of 4.3.3. The liners shall show no evidence of buckling, cracking, or crazing during the test. Formation of surface water blisters shall not be cause for rejection. On the completion of this test, each of the tested specimens shall then meet the requirements of 3.4.1.

3.4.4. Workmanship—The linings shall fit snugly inside the pipe and fitting housings. Scratches, dents, nicks, or tool marks on the surfaces of the lining shall not represent more than a 20 percent reduction in effective liner thickness or result in a minimum wall thickness of less than 0.050 inch. The gasket face portion of the lining shall be free of surface defects that would impair its effectiveness as a seal.

4. INSPECTION AND TEST PROCEDURES

4.1. General—The inspection and test procedures contained in this section are to be used to determine the conformance of products to the requirements of this Voluntary Product Standard. Each producer or distributor who represents his products as conforming to this Standard may utilize statistically based sampling plans which are appropriate for each particular manufacturing process but shall keep such essential records as are necessary to document with a high degree of assurance his claim that all of the requirements of this Standard have been met. Additional sampling and testing of the product, as may be agreed upon between purchaser and seller, is not precluded by this section.

4.2. Inspection—The lined pipe and fittings shall be visually inspected to determine their conformance to the finish, design, and dimensional requirements of this Standard. End plates shall be replaced immediately after inspection is completed and should not be removed until installation.

4.3. Tests

4.3.1. Electrostatic or hydrostatic testing—The lined pipe and fittings shall be subjected to an electrostatic or hydrostatic test as described in 4.3.1.1 or 4.3.1.2. The test to be used shall be at the option of the manufacturer, unless otherwise specified by the purchaser.

4.3.1.1. Electrostatic test—The test shall be performed with a nondestructive electrical coating-defect-tester. The output voltage shall be adjusted to 10,000 volts dc. A bronze scanning brush at this potential voltage, relative to the grounded lined pipe or fitting assembly, is moved through the interior of the component. Any leakage to ground is noted by the lighting of the neon indicator in the handle of the probe. A visible and audible spark, which

occurs at the probe section when contact is made because of a defect in the liner, shall be cause for rejection. The surface of the component being tested must be clean and dry for effective results.

4.3.1.2. **Hydrostatic pressure test**—The internal test pressure shall be 400 psi minimum, and the test shall be conducted in a temperature range of 20 °C to 30 °C (68 °F to 86 °F). The pipe and fittings shall be completely filled with clean water, and the system shall be bled free of all air prior to the application of pressure. Full test pressure shall be reached within 1 minute and maintained for an additional 3 minutes; the pressure shall then be reduced to zero, and the pipe and fittings shall then be subjected immediately to a second pressure cycle. The venting system in the pipe and fitting housings shall be observed throughout the pressure test for evidence of leakage, which shall be cause for rejection.

4.3.2. **Temperature and pressure test**—Specimens of the lined pipe or fittings shall be assembled with suitable blind flanges having provisions for the introduction of compressed air. The specimens shall be subjected to internal air pressure equal to the pressure rating of the pipe, but not less than 150 psi, while being subjected to continuous heating in an oven for a minimum of 2 hours at 149 °C (300 °F). The specimens under internal pressure shall then be cooled to room temperature, vented, examined for distortion and cracks in their linings, and subjected to the electrostatic or hydrostatic test described in 4.3.1.1 or 4.3.1.2.

4.3.3. **Steam and cold water cycling test**—The pipe or fittings shall be subjected to steam and cold water cycling tests in accordance with either Procedure A or B described below.

4.3.3.1. **Procedure A**—Specimens of the lined pipe or fittings shall be assembled with suitable blind flanges having fittings for the introduction of steam, air, and cold water and for drainage. Each specimen shall be subjected to 500 steam-cold water cycling tests. Each cycling test shall be conducted as follows:

(1) introduce steam into the specimen, attaining an internal pressure of 30 to 35 psi within 3 minutes, and maintain this pressure for a minimum of 3 minutes; (2) close off steam; (3) introduce air to get rid of the steam; (4) vent; (5) fill with water, at a maximum temperature of 26.6 °C (80 °F), and allow to remain for a minimum of 3 minutes; and (6) drain completely. After completion of the 500 cycles, the specimens shall be cooled to room temperature, and the liners shall be examined for evidence of buckling, cracking, crazing, or other characteristics indicative of malfunctioning. The dried lined pipe or fittings shall be subjected to the electrostatic or hydrostatic test described in 4.3.1.1 or 4.3.1.2.

4.3.3.2. **Procedure B**—Specimens prepared in accordance with Procedure A, shall be subjected to 100 steam-cold water cycling tests. Each cycling test shall be conducted as follows:

(1) introduce steam into the specimen, attaining an internal pressure of 30 to 35 psi within 3 minutes and maintain this pressure for a minimum of 165 minutes; (2) close off steam; (3) introduce air to get rid of the steam; (4) vent; (5) drain for ½ minute; (6) fill with water at a maximum temperature of 26.6 °C (80 °F), and allow to remain for a minimum of 14 minutes; and (7) drain completely. After completion of the 100 cycles, the

specimens shall be cooled to room temperature, and the liners shall be examined for evidence of buckling, cracking, crazing, or other characteristics indicative of malfunctioning. Formation of surface water blisters shall not be cause for rejection. The dried lined pipe or fittings shall be subjected to the electrostatic or hydrostatic test described in 4.3.1.1 or 4.3.1.2.

5. MARKING

Marking on the pipe and fittings shall include the following:

(1) The nominal pipe or fitting size
(2) The type of plastic liner (PVF_2)
(3) This Voluntary Product Standard designation, PS 35–70
(4) Manufacturer's name (or trademark)

6. IDENTIFICATION

In order that purchasers may identify products conforming to all requirements of this Voluntary Product Standard, producers and distributors may include a statement of compliance in conjunction with their name and address on product labels, invoices, sales literature, and the like. The following statement is suggested when sufficient space is available:

> This poly (vinylidene fluoride) (or PVF_2) lined pipe and these fittings conform to all of the requirements of Voluntary Product Standard PS 35–70, developed cooperatively with the industry and published by the National Bureau of Standards under the *Procedures for the Development of Voluntary Product Standards* of the U. S. Department of Commerce. Full responsibility for the conformance of this product to the standard is assumed by (name and address of producer or distributor).

The following abbreviated statement is suggested when available space on labels is insufficient for the full statement:

> Conforms to PS 35–70, (name and address of producer or distributor).

7. EFFECTIVE DATE

The effective date of this Voluntary Product Standard is the date upon which reference to the Standard may be made by producers, distributors, users and consumers, and other interested parties. Compliance by producers with all of the requirements of this Voluntary Product Standard may not actually occur until some time after its effective date. Products shall not be represented as conforming to this Voluntary Product Standard until such time as all requirements established in the Standard are met. The effective date of this Standard is September 1, 1970.

8. HISTORY OF PROJECT

In January 1969, The Society of the Plastics Industry, Inc., requested the assistance of the Department of Commerce in estab-

lishing a Voluntary Product Standard for poly(vinylidene fluoride) plastic lined steel pipe and fittings. A proposed draft of the Standard was developed, and in November 1969, the proposed Voluntary Product Standard was approved by the Standard Review Committee. In February 1970, public announcement was made, and the recommended Voluntary Product Standard was widely circulated to the industry for acceptance. The response to this circulation indicated a consensus of acceptability within the industry as defined in the *Procedures for Development of Voluntary Product Standards.* Accordingly, the Standard, designated PS 35–70, *Poly(Vinylidene Fluoride) (PVF$_2$) Plastic Lined Steel Pipe and Fttings,* was approved for publication by the National Bureau of Standards to be effective September 1, 1970.

Technical Standards Coordinator:
Leslie H. Breden, Product Standards Section
Office of Engineering Standards Services
National Bureau of Standards, Washington, D.C. 20234

9. STANDING COMMITTEE

The individuals whose names are listed below constitute the membership of the Standing Committee for this Standard. The function of the committee is to review all proposed revisions and amendments in order to keep this Standard up to date. Comments concerning this Standard and suggestions for its revision may be addressed to any member of the committee or to the Office of Engineering Standards Services, National Bureau of Standards, Washington, D.C. 20234, which acts as secretary for the committee.

Representing Producers

T. Morena, Resistoflex Corporation, Woodland Road, Roseland, New Jersey 07068 (Chairman)
B. R. Murphee, John L. Doré, Inc., P. O. Box 36617, Houston, Texas 77036
J. M. Ayres, Dow Chemical Company, Technical Services and Development, P. O. Box 467, Midland, Michigan 48460
Lester Keen, Raybestos-Manhattan, Inc., Manheim, Pennsylvania 17545

Representing Distributors

Phillip S. Penrose, Briggs Rubber Products Company, 203 Churchill Drive, Wilmington, Delaware 19803
R. W. Fowler, R. W. Fowler & Associates, Inc., 400 Levy Road, Atlantic Beach, Florida 32003
F. Deane Langworthy, L M H, Inc., 2802 Tenth Street, Berkeley, California 94710
I. W. Phillips, Triplex Rubber and Supply Corporation, Box 10815, Houston, Texas 77018

Representing Users

R. M. Ells, Humble Oil & Refining Company, P. O. Box 551, Baton Rouge, Louisiana 70821

W. M. Cady, Jefferson Chemical Company, P. O. Box 847, Port Neches, Texas 77651
L. R. Hays, U. S. Industrial Chemical Division, National Distillers and Chemical Corporation, Tuscola, Illinois 61953
F. X. Schoen, Union Carbide Corporation, Technical Center, P. O. Box 8361, South Charleston, West Virginia 25303

10. ACCEPTORS

The producers, distributors, users, and others listed below have individually indicated in writing their acceptance of this Voluntary Product Standard prior to its publication. The acceptors have indicated their intention to use this Standard as far as practicable but reserve the right to depart from it when necessary. The list is published to show the extent of recorded public support for this Standard.

ASSOCIATIONS
(General Support)

National Association of Home Builders, Washington, D.C.
Society of the Plastics Industry, Inc., The, New York, New York

PRODUCERS

Doré, John L., Company, Houston, Texas
Fluorodynamics, Inc., Newark, Delaware
Resistoflex Corporation, Roseland, New Jersey
Shamban, W. S., & Company, Los Angeles, California

DISTRIBUTORS, USERS, AND GENERAL INTEREST

Allied Chemical Corporation, Morristown, New Jersey
American Instrument Company, Silver Spring, Maryland
American Standards Testing Bureau, Inc., New York, New York
B & B Plastics, Lockport, New York
Barclay, Ayers and Bertsch Company, Grand Rapids, Michigan
Briggs Rubber Products Company, Wilmington, Delaware
Detroit Testing Laboratory, Detroit, Michigan
Diamond Shamrock Chemical Company, Cleveland, Ohio
Du Pont, E. I., De Nemours & Company, Inc., Wilmington, Delaware
Ferro Corporation, Bedford, Ohio
Gegner, Paul J., Barberton, Ohio
Glyco Chemicals, Inc., Greenwich, Connecticut
Gulf Research & Development Company, Pittsburgh, Pennsylvania
Hawaii, State of, Honolulu, Hawaii
Hercules, Inc., Wilmington, Delaware
Hoffman-LaRoche, Inc., Nutley, New Jersey
Horseley-Piggott (Coatings) Ltd., Staffordshire, England
Humble Oil & Refining Company, Baton Rouge, Louisiana
Jefferson Chemical Company, Inc., Port Neches, Texas
Jenkins Bros., Bridgeport, Connecticut
Kay-Fries Chemicals, Inc., West Haverstraw, New York
L M H, Inc., Berkeley, California
Lakewood, City of, Lakewood, Ohio
Lubrizol Corporation, The, Deer Park, Texas
Lubrizol Corporation, The, Wickliffe, Ohio
Merck & Company, Inc., Rahway, New Jersey
Metcalf & Eddy, Inc., Boston, Massachusetts
Modern Industrial Plastics Division, Dayton, Ohio
New York State Office of General Services, Albany, New York
Omaha Testing Laboratories, Inc., Omaha, Nebraska
Oregon, State of, Salem, Oregon
Pennwalt Corporation, King of Prussia, Pennsylvania
Plastomer Corporation, Newtown, Pennsylvania
Prodorite, Ltd., Wolverhampton (Staffs) England
Raybestos-Manhattan, Inc., Manheim, Pa.
Serck Audco Valve Manufacturers, Shropshire, England
Severna, Roseland, New Jersey
Sparta Manufacturing Company, Dover, Ohio
Stone & Webster Engineering Corporation, Boston, Massachusetts
Titanium Metals Corporation of America, Henderson, Nevada
Toni Company, The, St. Paul, Minnesota
Triplex Rubber & Supply Company, Houston, Texas
U. S. Industrial Chemicals Company, Tuscola, Illinois
Union Carbide Corporation, South Charleston, West Virginia
Ventron Corporation, Beverly, Massachusetts
Vulcan Materials Company, Wichita, Kansas
Whitford Chemical, Franklin Park, Illinois
Wilkins, M. P., Toledo, Ohio

FEDERAL GOVERNMENT

General Services Administration, Washington, D.C.
Interior, Department of, Washington, D.C.