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An American National Standard

Standard Specification for Coextruded Poly(Vinyl Chloride) (PVC) Plastic Pipe With a Cellular Core[1]

This standard is issued under the fixed designation F 891; 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 coextruded poly(vinyl chloride) (PVC) plastic pipe with a cellular core and concentric inner and outer solid layers, and is produced using a multilayer coextrusion die for nonpressure use in three series: an IPS Schedule 40 series; a PS series with an iron pipe size outside diameter with varying wall thickness as required for pipe stiffness of 25, 50, and 100; and a sewer and drain series.

1.2 The function of this specification is to provide standardization of product-technical data and serve as a purchasing guide.

1.3 The text of this specification references notes, footnotes, and appendixes which provide explanatory material. The notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the specification.

NOTE 1—All the pipe series covered by this specification are permitted to be perforated or belled for joining by solvent cement or belled for joining by an elastomeric seal (gasket). Because this pipe is OD controlled, the inside diameter will vary, and therefore, the pipe ID is not suitable for use as a socket.

NOTE 2—This standard specifies dimensional, performance and test requirements for plumbing and fluid handling applications, but does not address venting of combustion gases.

1.4 *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.*

~~1.5The values stated in inch-pound units are to be regarded as the standard.~~

1.5 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.

NOTE 3—Specifications related to this specification are as follows: D 2665, D 2729, D 3034, F 512, F 758, and F 789.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D 618 Practice for Conditioning Plastics for Testing
D 1600 Terminology for Abbreviated Terms Relating to Plastics
D 2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings
D 2152 Test Method for Adequacy of Fusion of Extruded Poly(Vinyl Chloride) (PVC) Pipe and Molded Fittings by Acetone Immersion
D 2321 Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
D 2412 Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
D 2444 Test Method for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)
D 2564 Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
D 2665 Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
D 2672 Specification for Joints for IPS PVC Pipe Using Solvent Cement
D 2729 Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
D 2855 Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
D 3034 Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings

[1] This specification is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.25 on Vinyl Based Pipe.

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[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.

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

D 3212 Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
D 3311 Specification for Drain, Waste, and Vent (DWV) Plastic Fittings Patterns
D 4396 Specification for Rigid Poly(Vinyl Chloride) (PVC) and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds for Plastic Pipe and Fittings Used in Nonpressure Applications
F 402 Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings
F 412 Terminology Relating to Plastic Piping Systems
F 477 Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
F 512 Specification for Smooth-Wall Poly(Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation
F 545 Specification for PVC and ABS Injected Solvent Cemented Plastic Pipe Joints[3]
F 656 Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings
F 758 Specification for Smooth-Wall Poly(Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage
F 789 Specification for Type PS-46 and Type PS-115 Poly(Vinyl Chloride) (PVC) Plastic Gravity Flow Sewer Pipe and Fittings[3]

2.2 *Federal Standard:*
Fed. Std. No. 123 Marking for Shipment (Civil Agencies)[4]
2.3 *Military Standard:*
MIL-STD-129 Marking for Shipment and Storage[4]
2.4 *ANSI Standards:*
Z34.1 American National Standard for Certification-Third-Party Certification Program[5]
Z34.2 American National Standard for Certification-Self-Certification by Producer or Supplier[5]

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(vinyl chloride) plastic is PVC.

3.1.1 *cellular plastic*—a plastic containing numerous cells, intentionally introduced, interconnecting or not, distributed throughout the mass.

3.1.2 *coextruded pipe*—pipe consisting of two or more concentric layers of material bonded together in processing by any combination of temperature, pressure, grafting, crosslinking, or adhesion.

3.1.3 *coextrusion*—a process whereby two or more heated or unheated plastic material streams, forced through one or more shaping orifice(s), become one continuously formed piece.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *lot*—a lot shall consist of all pipe of the same size produced from one extrusion line during one designated shift.

3.2.2 *IPS Schedule 40 Series*—pipe produced to an iron pipe outside diameter with a Schedule 40 wall thickness.

3.2.3 *PS Series*— pipe produced to an IPS outside diameter and having the required wall thickness to meet a designated pipe stiffness.

3.2.4 *sewer and drain series*—pipe produced to a sewer and drain outside diameter and having a minimum wall thickness to meet a designated pipe stiffness.

4. Classification by Application

4.1 Coextruded PVC plastic pipe, in an IPS Schedule 40 series, is referenced in Table 1 for use in 4.1.1. A PS series with an iron pipe outside diameter, with varying wall thickness as required for pipe stiffness of 25, 50, and 100 is referenced in Table 2 for use in 4.1.2, and a sewer and drain series is referenced in Table 2 for use in 4.1.3 and 4.1.4.

4.1.1 Drain, waste, and vent pipe in IPS Schedule 40 series.

4.1.2 Underground communication conduit in PS series is not for underground electrical power distribution usage.

4.1.3 Nonpressure sewer and drain pipe for underground burial outside of the building.

4.1.4 Highway underdrain in sewer and drain series.

4.2 Recommendations for storage, joining, and installation are provided in Appendix X1, Appendix X2, and Appendix X3, respectively.

NOTE ~~4—Before installing pipe for industrial waste disposal use, the approval of the cognizant building code authority must be obtained, as conditions not commonly found in normal use may be encountered.~~ 4—Before installing pipe for industrial waste disposal use, the approval of the cognizant building code authority must be obtained, as conditions not commonly found in normal use may be encountered.

NOTE 5—This specification does not include requirements for pipe and fittings intended to be used to vent combustion gases.

5. Material

5.1 *Material Specification*—The PVC material shall conform to the requirements prescribed in Specification D 4396 with a cell

[3] Withdrawn.
[4] Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA ~~19111-5094, Attn: NPODS.~~19111-5098, http://www.dodssp.daps.mil.
[5] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

TABLE 1 Minimum Wall Thickness,[A] Pipe Stiffness, and Impact Strength for IPS Schedule 40 Series

Nominal Pipe Size, in.	Wall Thickness, in.	Pipe Stiffness, lbf/in.^{2}	Impact Strength, ft·lbf
1¼	0.140	600	40
1½	0.145	600	50
2	0.154	300	80
3	0.216	300	100
3½	0.226	250	100
4	0.237	200	100
5	0.258	120	100
6	0.280	120	120
8	0.322	100	120
10	0.365	60	120
12	0.406	50	120

[A] The maximum wall thickness shall not be greater than 1.25 times the minimum wall thickness.

TABLE 2 Minimum Wall Thickness[A] for PS Series or Sewer and Drain Series for Minimum Pipe Stiffness

Nominal Pipe Size, in.	Wall Thickness, in.						
	PS Series				Sewer and Drain Series		
	PS 25	PS 50	PS 100	PS 12.5	PS 25	PS 50	PS 100
2	. . .	. . .	0.100	. . .	. . .	. . .	. . .
3	. . .	0.103	0.130	. . .	. . .	0.100	0.120
3½	0.100	0.118	0.148	. . .	. . .	. . .	. . .
4	0.106	0.133	0.167	. . .	0.100	0.124	0.156
5	0.131	0.164	0.206	. . .	. . .	. . .	. . .
6	0.156	0.195	0.245	0.118	0.148	0.185	0.232
8	. . .	. . .	. . .	. . .	0.198	0.248	0.310
10	. . .	. . .	. . .	. . .	. . .	0.310	0.388
12	. . .	. . .	. . .	. . .	. . .	0.369	0.462
15	. . .	. . .	. . .	. . .	. . .	0.452	0.565
18	. . .	. . .	. . .	. . .	. . .	0.548	0.691

[A] The maximum wall thickness shall not be greater than 1.25 times the minimum wall thickness.

class of 11432. PVC material, which has a higher cell class than those listed, is acceptable.

5.2 *Rework Material*—The manufacturer shall use only his own clean rework pipe material conforming with these cell class requirements. It shall be used only in the core layer if it contains any residual blowing agent. The pipe produced shall meet all requirements of this specification.

6. Requirements

6.1 *Workmanship*—The pipe shall be homogeneous throughout and free of visible cracks, holes, foreign inclusions, or other defects. The pipe shall be as uniform as commercially practicable in color, opacity, density, and other physical properties.

6.2 *Dimensions and Tolerances*:

6.2.1 *Outside Diameter*—The outside diameter and tolerances for the IPS Schedule 40 series, PS series, and the sewer and drain series shall meet the requirements of Table 3 when measured in accordance with Test Method D 2122. The tolerances for

TABLE 3 Outside Diameter and Tolerances

Nominal Pipe Size, in.	Outside Diameter		Tolerance on Average Outside Diameter, in.	Out-of-Roundness Maximum Diameter Minus Minimum Diameter, in.
	IPS Schedule 40 Series, in. PS Series, in.	Sewer and Drain Series, in.		
1¼	1.660	. . .	±0.005	0.060
1½	1.900	. . .	±0.006	0.060
2	2.375	. . .	±0.006	0.060
3	3.500	3.250	±0.008	0.060
3½	4.000	. . .	±0.008	0.100
4	4.500	4.215	±0.009	0.100
5	5.563	. . .	±0.010	0.100
6	6.625	6.275	±0.011	0.100
8	8.625	8.400	±0.015	0.150
10	10.750	10.500	±0.015	0.150
12	12.750	12.500	±0.015	0.150
15	. . .	15.300	±0.023	0.150
18	. . .	18.700	±0.028	0.200

out-of-roundness shall apply to the pipe prior to shipment.

6.2.2 *Wall Thickness*—The wall thickness for the IPS Schedule 40 series shall equal or exceed the minimum dimensions in Table 1, and for the PS series and sewer and drain series it shall equal or exceed the minimum dimensions in Table 2, when measured in accordance with Test Method D 2122.

6.2.3 *Length*—The pipe length may be 10 or 20 ft with a tolerance on length of +½ , –0 in., unless otherwise specified.

6.3 *Performance Requirements*:

6.3.1 *Pipe Stiffness*—The minimum pipe stiffness values at 5 % deflection when measure in accordance with Test Method D 2412, shall equal or exceed the value in Table 1 for IPS Schedule 40 series, or the value in Table 2 or PS series and sewer and drain series. Three specimens shall be tested. If all three meet this requirement, the sample meets this requirement. If one or two fail, additional testing shall be conducted in accordance with 6.3.1.1. If all three fail, the sample does not meet the requirement.

6.3.1.1 *Pipe Stiffness and Lower Confidence Limit*—In the event that one or two of the specimens tested in 6.3.1 fail to meet the minimum requirement, the average pipe stiffness of 11 specimens shall meet or exceed the minimum requirement given in Table 1 for IPS Schedule 40 series pipe, and Table 2 for PS Series and Sewer and Drain pipe. The 99 % lower confidence limit (LCL) shall be within 15 % of the average value. The LCL shall be calculated using the Student's "*t*" distribution, with *N*-1 degrees of freedom, where *N* is the number of specimens (11). The critical *t* value shall be used to at least three significant digits. Alternatively, if the LCL exceeds the minimum PS requirement in the applicable table, but is not within 15 % of the average, the sample meets the requirements of the pipe stiffness testing. The 11 specimens include the three tested under 6.3.1, and an additional eight with rotation by 35°, as specified in D 2412, continuing throughout the remaining specimens.

The LCL based on testing eleven specimens is calculated as follows:

$$\text{LCL} = (\text{avg PS}) - \{2.76\ (\text{std. dev.})/\sqrt{(N)}\}$$

where:

N = 11

(avg PS) = $[\Sigma(\text{PS}_i)]/(11)$

(std.dev.) = $\left[\dfrac{\Sigma PS^2 - (\Sigma PS)^2/N}{N-1}\right]^{1/2}$

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The 15 % requirement is calculated as follows:

$$(\text{avg} - \text{LCL})/(\text{avg}) \times 100 \leq 15\ \%$$

NOTE 5—~~The~~ 6—The 5 % deflection criteria is arbitrarily selected for testing convenience. It should not be considered as a limitation with respect to in-use deflection. The engineer is responsible for establishing the acceptable deflection limit.

NOTE 6—~~The~~ 7—The strength and load-carrying capabilities of plastic pipe are measured and reported as pipe stiffness, which is determined in accordance with Test Method D 2412. The term "crushing strength" is not applicable to plastic piping.

6.3.2 *Pipe Flattening*—There shall be no evidence of cracking, delamination, or rupture when pipe is deflected 60 % of the initial inside diameter, when tested in accordance with Test Method D 2412. Three specimens shall be tested and all shall pass.

NOTE 7—~~This~~ 8—This test is intended only for use as a quality control test, and not as a simulated service test.

6.3.3 *Impact Resistance*—The minimum impact resistance, when tested at the time of manufacture, shall comply with Table 1 for IPS Schedule 40 series and Table 4 for the PS series and sewer and drain series. Test in accordance with Test Method D 2444, using Tup B and Holder B. Use a 20-lb (9.1-kg) tup for testing pipe sizes 4 in. and smaller and a 30-lb (13.6-kg) tup for pipe sizes larger than 4 in.

6.3.3.1 Test 10 specimens. When 9 or 10 specimens pass, accept the lot. When 2 or more specimens fail, test 10 additional specimens. When 17 of 20 specimens tested pass, accept the lot. When 4 or more of 20 specimens fail, test 20 additional specimens. When 32 of 40 specimens pass, accept the lot. When 9 or more of 40 specimens fail, the lot does not meet the requirements of this specification.

TABLE 4 Minimum Impact Strength for PS Series or Sewer and Drain Series

Nominal Pipe Size, in.	Minimum Impact Strength, ft·lbf			
	PS 12.5	PS 25	PS 50	PS 100
2	. . .	. . .	. . .	80
3	. . .	80	80	100
3½	. . .	80	80	100
4	. . .	80	100	100
5	. . .	100	100	100
6	70	100	100	120
8	. . .	140	140	140
10	. . .	160	160	160
12	. . .	200	200	200
15	. . .	. . .	220	. . .
18	. . .	. . .	220	. . .

6.3.3.2 Failure of the test specimen shall be shattering or any crack or break extending entirely through the pipe wall and visible to the unaided eye.

6.3.4 *Bond*—The bond between layers shall be strong and uniform. It shall not be possible to separate any two layers with a probe or the point of a knife blade so that the layers separate cleanly, nor shall separation of the bond occur between layers during testing performed under the requirements of this specification.

6.3.5 *Extrusion Quality*—The pipe shall meet the requirements of Test Method D 2152.

6.4 *Other Requirements*:

6.4.1 *Joining*—Coextruded poly(vinyl chloride) PVC plastic pipe produced in IPS Schedule 40 series and PS series are joined using fittings meeting the requirements of Specifications D 2665, D 3311, or F 512. Fittings meeting the requirements of Specifications D 2729, D 3034, or F 789 are used with the sewer and drain series, and Specification F 545 are permitted for all series.

6.4.2 *Solvent Cement*—In the assembly of solvent cement joints, the safety requirements of Practice F 402 shall be followed and the joint shall be assembled following Practice D 2855, using a cleaner or primer.

6.4.3 *Gaskets*—Elastomeric seals (gaskets) shall meet the requirements of Specification F 477.

6.4.4 *Lubricant*—The lubricant used for assembly shall have no detrimental effect on the gasket or on the pipe or fitting.

6.4.5 *Gasket Joints*—Gasket joints shall comply with Specification D 3212 and be designed so that the gasket inside the pipe will be compressed radially on the pipe spigot, when assembled, to form a water-tight seal.

6.4.6 *Gasket Displacement*—The joint shall be designed to avoid displacement of the gasket when installed. The assembly of the joint shall be in accordance with the manufacturer's recommendation.

7. Sampling and Conditioning

7.1 *Sampling*—The selection of the sample or samples of pipe shall be as agreed upon by the purchaser and seller. In case of no prior agreement, any sample selected by the testing lab shall be deemed adequate.

7.2 *Conditioning*:

7.2.1 For referee purposes, condition the specimens prior to test at 73.4 ± 3.6°F (23 ± 2°C) and 50 ± 5 % relative humidity in accordance with Practice D 618, Procedure A..

7.2.2 For routine quality control testing, condition the specimens at the temperature and humidity of the manufacturer's testing facility for not less than 1 h or until the specimens are at the room temperature.

7.3 *Test Conditions*:

7.3.1 For referee purposes, conduct tests in the standard laboratory atmosphere of 73.4 ± 3.6°F (23 ± 2°C) and 50 ± 5 % relative humidity.

7.3.2 For routine quality control testing, conduct tests at the room temperature and humidity of the manufacturer's testing area.

7.4 *Test Methods*—Only specified ASTM test methods shall be used.

8. Retest and Rejection

8.1 If the results of any test(s) do not meet the requirements of this specification, the test(s) shall be conducted again in accordance with an agreement between the purchaser and the seller. There shall be no agreement to lower the minimum requirements of the specifications by such means as omitting test methods that are a part of the specification, substitution, or modifying test methods, or by changing the specification limits. In retesting, the product requirements of this specification shall be met, and the test methods designated in this specification shall be followed. If, upon retest, failure occurs, the quantity of product represented by the test(s) does not meet the requirements of this specification.

9. Marking

9.1 *Quality of Marking*—The marking shall be applied to the pipe for end-use application in such a manner that it remains legible (easily read) after installation and inspection.

9.2 *Content of Marking*—The pipe shall be marked at least every 5 ft in letters not less than 3⁄16 in. high and in a color that contrasts with the color of the pipe, and shall contain the following information:

9.2.1 Manufacturer's name or trademark.

9.2.2 This designation, ASTM F 891, including the year of issue.

9.2.3 The wording "COEXTRUDED CELLULAR CORE PVC PIPE".

9.2.3.1 Typical marking for identification of each series shall be as follows: IPS Schedule 40 Series Coextruded Cellular Core PVC DWV Pipe, PS-25 or 50 or 100 Series Coextruded Cellular Core PVC Communication Conduit, and Sewer and Drain Series Coextruded Cellular Core PVC Sewer and Drain, or Highway Underdrain Pipe.

9.2.4 Nominal pipe size and series (for example: 1¼ in. IPS Schedule 40 series).

9.2.5 Manufacturer's code for identifying lot number, date, and year of manufacture, or other information as needed.

NOTE 8—~~Code~~ 9—Code bodies may require that pipe be marked on two opposite sides. For example, "DWV pipe."

10. Quality Assurance

10.1 When the product is marked with this designation, F 891, 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.

11. Keywords

11.1 cellular core; coextruded; drain; waste; and vent; PVC; Schedule 40; thermoplastic

SUPPLEMENTARY REQUIREMENTS

GOVERNMENT/MILITARY PROCUREMENT

These requirements apply *only* to federal/military procurement, not domestic sales or transfers.

S1. *Responsibility for Inspection* —Unless otherwise specified in the contract or purchase order, the producer is responsible for the performance of all inspection and test requirements specified herein. The producer may use his own or any other suitable facilities for the performance of the inspection and test requirements specified herein, unless the purchaser disapproves. The purchaser shall have the right to perform any of the inspections and tests set forth in this specification where such inspections are deemed necessary to ensure that material conforms to prescribed requirements.

NOTE S1.1—In U.S. federal contracts, the contractor is responsible for inspection.

S2. *Packaging and Marking for U.S. Government Procurement:*

S2.1 *Packaging*—Unless otherwise specified in the contract, the materials shall be packaged in accordance with the supplier's standard practice in a manner ensuring arrival at destination in satisfactory condition and which will be acceptable to the carrier at lowest rates. Containers and packing shall comply with Uniform Freight Classification rules or National Motor Freight Classification rules.

S2.2 *Marking*—Marking for shipment shall be in accordance with Fed. Std. No. 123 for civil agencies and MIL-STD-129 for military agencies.

NOTE S2.1—The inclusion of the U.S. Government procurement requirements should not be construed as an indication that the U.S. Government uses or endorses the products described in this specification.

APPENDIXES

(Nonmandatory Information)

X1. STORAGE

X1.1 *Outside Storage*—Plastic pipe should be stored on a flat surface or supported in a manner that will prevent sagging or bending.

X1.2 Inventories of plastic pipe should be used on a first-in-first-out basis.

X2. JOINING

X2.1 *Field Inspection*—Prior to use all pipe should be carefully inspected for cuts, gouges, deep scratches, damaged ends, and other major imperfections. Defective pipe should be rejected, and damaged sections should be cut out.

X2.2 *Pipe Fit*—Pipe is manufactured to close tolerances to ensure satisfactory "interference" fit between the pipe and the fittings socket during assembly. Use only combinations of pipe and fittings that give interference fits. Pipe that is a loose fit in the socket may not properly bond. The allowable tolerance assures a forced fit and when solvent cement is applied, the pipe and fitting will readily mate, thus assuring a physical fusion. The pipe should enter the dry fitting socket to between one half and two thirds of the fitting socket depth.

X2.3 *Cutting*—Pipe can be easily cut with an ordinary hacksaw or carpenter's saw. Fine-tooth blades with little or no set should be used for best results. The pipe should be cut square and all burrs removed with a sharp knife, a fine-tooth file, or other suitable device. A miter box is recommended to ensure square cut ends. Standard steel pipe or tubing cutters are not recommended for cutting PVC pipe since they may cause excessive heat and pressure, which can result in cracked or irregular pipe ends. There are special cutters available with extra wide rollers and thin cutting wheels that have been designed for cutting plastic pipe, and their use is recommended.

X2.4 *Cleaning*—Chemical or mechanical cleaners should be used to clean the pipe after all burrs have been removed and prior to assembly.