



Standard Specification for Coextruded Composite Pipe¹

This standard is issued under the fixed designation F 1488; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

1. Scope

1.1 This specification covers coextruded composite pipe, produced by a coextrusion die system, in which the concentric layers are formed and combined before exiting the die.

1.1.1 Materials listed in the material section are permitted to be used in any layer of the coextruded composite pipe. When coextruded composite pipe is produced with three layers, the middle layer is permitted to be solid or thermally foamed.

1.1.2 The function of this specification is to provide standardization of product, to produce technical data, and to serve as a purchasing guide.

1.2 Compounds that do not meet the requirements of the material section are excluded.

1.3 The coextruded composite pipe is permitted to be perforated in accordance with any specified standard or by agreement between the purchaser and the supplier.

1.4 The coextruded composite pipe is permitted to be belled for joining by solvent cementing or belled for joining by an elastomeric seal (gaskets), in accordance with any specified standard or by agreement between the purchaser and the supplier.

1.5 Recommendations for storage, joining, installation, and rationale are listed in Appendixes X1, X2, X3, and X4, respectively.

1.6 The values stated in inch-pound units are to be regarded as the standard. A companion standard written in SI units is under development.

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

1.8 *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.*

NOTE 1—Related specifications are as follows: D 2661, D 2665, D 2729, D 2750, D 2751, D 2949, D 3034, F 512, F 628, F 758, F 789, and F 891.

2. Referenced Documents

2.1 The following standards contain provisions which, though referenced in this specification, constitute provisions of this specification. All standards are subject to revision and parties using this specification shall reference the most recent edition of the standards listed as follows.

2.2 ASTM Standards:

D 618 Practice for Conditioning Plastics and Electrical Insulating Material for Testing²

D 696 Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30C and 30C ²

D 883 Terminology Relating to Plastics²

D 1600 Terminology for Abbreviated Terms Relating to Plastics²

D 1898 Practice for Sampling of Plastics³

D 1972 Practice for Generic Marking of Plastic Products²

D 2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings⁴

D 2235 Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings⁴

D 2321 Practice for Underground Installation of Flexible Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications⁴

D 2412 Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading⁴

D 2444 Test Method for Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)⁴

D 2564 Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems⁴

D 2661 Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings⁴

D 2665 Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings⁴

D 2729 Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings⁴

D 2750 Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Utilities Conduit and Fittings⁴

D 2751 Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings⁴

D 2855 Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings⁴

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² Annual Book of ASTM Standards, Vol 08.01.

³ Discontinued; see 1997 Annual Book of ASTM Standards, Vol 08.01.

⁴ Annual Book of ASTM Standards, Vol 08.04.

- D 2949 Specification for 3.25-in. Outside Diameter Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings⁴
- D 3034 Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings⁴
- D 3139 Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals⁴
- D 3212 Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals⁴
- D 3965 Specification for Rigid Acrylonitrile-Butadiene-Styrene (ABS) Compounds for Pipe and Fittings⁵
- D 4000 Classification System for Specifying Plastic Materials³
- D 4396 Specification for Rigid Poly(Vinyl Chloride) (PVC) and Related Plastic Compounds for Nonpressure Piping Products⁶
- D 5033 Guide for the Development of Standards Relating to the Proper Use of Recycled Plastics⁶
- F 402 Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings⁴
- F 412 Terminology Relating to Plastic Piping Systems⁴
- F 477 Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe⁴
- F 493 Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings⁴
- F 512 Specification for Smooth-Wall Poly(Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation⁴
- F 545 Specification for PVC and ABS Injected Solvent Cemented Plastic Pipe Joints⁴
- F 628 Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe With a Cellular Core⁴
- F 656 Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings⁴
- F 758 Specification for Smooth-Wall Poly(Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage⁴
- F 789 Specification for Type PS-46 and Type PS-115 Poly(Vinyl Chloride) (PVC) Plastic Gravity Flow Sewer Pipe and Fittings⁴
- F 891 Specification for Coextruded Poly(Vinyl Chloride) (PVC) Plastic Pipe with a Cellular Core⁴
- F 913 Specification for Thermoplastic Elastomeric Seals (Gaskets) for Joining Plastic Pipe⁴
- 2.3 ANSI Standards:**
- ANSI Z 34.1 American National Standard for Certification-Third-Party Certification Program⁷
- ANSI Z 34.2 American National Standard for Certification-Self-Certification by Producer or Supplier⁷
- 2.4 Federal Standard:**

- Fed. Std. No. 123 Marking for Shipments (Civil Agencies)⁸
- 2.5 Military Standard:**
- MIL-STD-129 Marking for Shipment and Storage⁸
- 2.6 Uniform Classification Committee Standard:**
- Uniform Freight Classification⁹
- 2.7 National Motor Freight Traffic Association Standard:**
- National Motor Freight Classification¹⁰

3. Terminology

3.1 *Definitions*—Definitions are in accordance with Terminologies D 883 and F 412. Abbreviations are in accordance with Terminology D 1600. Plastic materials are classified in accordance with Classification System D 4000. Generic marking is in accordance with Practice D 1972.

3.1.1 *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.

3.1.2 *compound*—a mixture of a polymer with other ingredients, such as fillers, stabilizers, catalysts, processing aids, lubricants, modifiers, pigments, or curing agents.

3.1.3 *dimension ratio*—the average specified diameter of a pipe divided by the minimum specified wall thickness.

3.1.4 *out-of-roundness*—the allowed difference between the maximum measured diameter and the minimum measured diameter (stated as an absolute deviation).

3.1.5 *thermally foamed plastic*—a cellular plastic produced by applying heat to effect gaseous decomposition or volatilization of a constituent. (1985)

3.1.6 *virgin plastic, adj*—material in the form of pellets, granules, powder, floc, or liquid that has not been subjected to use or processing other than that required for its initial manufacture. (1985, D 883)

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *coextruded composite pipe*—pipe consisting of two or more concentric layers of the same or different material bonded together in processing by any combination of temperature, pressure, grafting, crosslinking, or adhesion with a specific purpose to serve as pipe.

3.2.2 *IPS-DR-PS Series*—coextruded pipe produced to an iron pipe outside diameter (OD) with a dimension ratio (DR) and pipe stiffness (PS).

3.2.3 *IPS Schedule 40 Series*—coextruded composite pipe produced to an iron pipe outside diameter (OD) with a Schedule 40 wall thickness.

3.2.4 *lot*—all pipe produced of one size and from one extrusion line, during one designated 24-h period.

3.2.5 *qualification test*—an evaluation, generally nonrepetitive, conducted on an existing, altered, or new product to determine acceptability.

⁸ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

⁹ Available from the Uniform Classification Committee, Suite 1106, 222 South Riverside Plaza, Chicago, IL 60606.

¹⁰ Available from the National Motor Freight Traffic Association, Inc., National Motor Freight Classification, American Tracking Association, Inc. Traffic Dept., 1616 P St., NW, Washington, DC 20036.

⁵ Annual Book of ASTM Standards, Vol 08.02.

⁶ Annual Book of ASTM Standards, Vol 08.03.

⁷ Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

3.2.6 *rework composite pipe material*—a blend of the different materials used in the different layers of the coextruded composite pipe.

3.2.7 *Sewer and Drain DR-PS Series*—coextruded composite pipe produced to a sewer and drain outside diameter (OD) with a dimension ratio (DR) and pipe stiffness (PS).

4. Classification

4.1 Coextruded composite pipe produced in compliance with this specification in different dimension ratios (DR) and pipe stiffness (PS) is used for different applications.

4.1.1 *IPS Schedule 40 Series*—Coextruded composite pipe is used for above or below ground installation for communication conduit, electrical conduit, drain, waste, and vent pipe, and plastic underdrain systems for highway, airport, and similar drainage, where a Schedule 40 IPS is required.

4.1.2 *IPS-DR-PS Series*—Coextruded composite pipe is used for above or below ground installation for communication conduit, electrical conduit, and drain, waste, and vent pipe.

4.1.3 *Sewer and Drain DR-PS Series*—Coextruded composite pipe is used for gravity flow sewer and drain pipe, and plastic underdrain systems for highway, airport, and similar drainage.

4.2 Before installing coextruded composite pipe in an industrial waste disposal system, the approval of the cognizant building code authority is required. Some coextruded composite pipe is designed for temperature use in excess of 180°F (82°C). Consult the manufacturer for recommendations on use.

5. Ordering Information

5.1 Orders for coextruded composite pipe produced in compliance with this specification shall include the following:

- 5.2 ASTM designation (F 1488) and year of issue,
- 5.3 Series size,
- 5.4 Footage of each size, and
- 5.5 Materials.

6. Material

6.1 *Basic Materials*—The outer layer shall be made of virgin material that contains pigments or screening agents to provide protection against UV radiation. The material shall conform to the requirements prescribed in the material specification.

6.2 *ABS Material Specification*—The ABS shall be virgin plastic ABS material conforming to the requirements of Specification D 3965 and shall meet all of the requirements for Cell Class 4-2-2-2-2.

6.2.1 The color and form of the material shall be by agreement between the purchaser and the supplier.

6.3 *PVC Material Specification*—The PVC shall be virgin plastic material conforming to the requirements of Specification D 4396 and shall meet all of the requirements for Cell Class 1-1-4-3-2.

6.3.1 The color and form of the material shall be by agreement between the purchaser and the supplier in accordance with Specification D 4396.

6.3.2 Individual cell class values are permitted to be greater than those listed.

6.4 *CPVC Material Specification*—The CPVC shall be

virgin plastic material conforming to the requirements of Specification D 4396 and shall meet all of the requirements for Cell Class 2-2-4-2-4.

6.4.1 The color and form of the material shall be by agreement between the purchaser and the supplier in accordance with Specification D 4396.

6.4.2 Individual cell class values are permitted to be greater than those listed.

6.5 *Rework Material*—A blend of clean rework material generated from the manufacturer's own pipe production may be used by the same manufacturer, provided the pipe produced meets all of the requirements of this specification.

6.5.1 Rework material is excluded from standard definitions of recycled materials in accordance with Guide D 5033.

6.5.2 Rework material generated from composite pipe shall not be used in the outer layer.

6.5.3 Rework material generated from composite pipe with a thermally foamed layer shall not be used in the inner or outer layer.

7. Performance Requirements

7.1 *Pipe Stiffness*—The minimum pipe stiffness at 5 % deflection when measured in accordance with Test Method D 2412, shall equal or exceed the value in Table 1, Table 2, Table 3 or Table 4, as applicable. The rate of crosshead motion shall be 0.20 to 0.25 in./min. (5.1 to 6.3 mm/min). 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 7.1.1. If all three fail, the sample does not meet the requirement.

7.1.1 *Pipe Stiffness and Lower Confidence Limit*—In the event that one or two of the specimens tested in 7.1 fail to meet the minimum requirement, the average pipe stiffness of eleven specimens shall meet or exceed the minimum requirement given in Table 1, Table 2, Table 3, or Table 4 as applicable. 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 Table 1, Table 2, Table 3 or Table 4 as applicable, but is not within 15 % of the

TABLE 1 Minimum Wall Thickness Required for Pipe Stiffness and Impact Strength for IPS Schedule 40 Series^A

Nominal Pipe Size, in.	Minimum Wall Thickness, in.	Minimum Pipe Stiffness, lbf/in./in. at 5 % Deflection	Minimum Impact Strength at 32°F (0°C), ft-lbf
1/4	0.140	140	25
1/2	0.145	140	25
2	0.154	140	25
2 1/2	0.203	140	25
3	0.216	140	25
3 1/2	0.226	140	25
4	0.237	140	40
5	0.258	140	40
6	0.280	140	40
8	0.322	90	60
10	0.365	90	60
12	0.460	90	60

^AThe maximum wall thickness shall not be greater than 1.12 times the minimum.

TABLE 2 Minimum Wall Thickness Required for Pipe Stiffness and Impact Strength for IPS-DR-PS DWV^A

Nominal Pipe Size, in.	Dimension Ratio		Minimum Impact Strength at 32°F (0°C), ft·lbf
	DR 24	DR 22	
	Pipe Stiffness		
	PS140	PS200	
1¼	0.067	0.075	25
1½	0.077	0.086	25
2	0.099	0.108	25
2½	0.120	0.130	25
3 ^B	0.135	0.148	25
3	0.142	0.159	25
3½	0.162	0.182	25
4	0.183	0.204	25
5	0.226	0.252	25
6	0.269	0.301	25
8	0.350	0.392	25
10	0.437	0.488	25
12	0.518	0.579	25

^AThe maximum wall thickness shall not be greater than 1.12 times the minimum.
^B Special outside diameter of 3.25.

TABLE 3 Minimum Wall Thickness Required for Pipe Stiffness and Impact Strength for IPS-DR-PS Communication Conduit or Underground Electrical Conduit^A

Nominal Pipe Size, in.	Dimension Ratio				Minimum Impact Strength at 32°F (0°C) ft·lbf
	DR 42	DR 38	DR 34	DR 27	
	Pipe Stiffness				
	PS25	PS35	PS50	PS100	
1¼	0.060	0.060	0.060	0.060	25
1½	0.060	0.060	0.060	0.069	25
2	0.060	0.060	0.068	0.086	25
2½	0.068	0.076	0.085	0.106	25
3	0.080	0.090	0.102	0.127	25
3½	0.093	0.103	0.116	0.145	25
4	0.104	0.118	0.132	0.164	25
5	0.129	0.146	0.164	0.203	25
6	0.154	0.174	0.195	0.241	25
8	0.201	0.227	0.254	0.314	25
10	0.250	0.283	0.316	0.372	25
12	0.297	0.335	0.375	0.465	25

^AThe maximum wall thickness shall not be greater than 1.12 times the minimum.

average, the sample meets the requirements of the Pipe Stiffness testing. The eleven specimens include the three tested under 7.1, 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:

$$LCL = (\text{Avg. PS}) - \{ 2.76(\text{Std. Dev}) / \sqrt{N} \} \quad (1)$$

where:

$$(\text{Avg. PS}) = [\sum(\text{PS})] / (11)$$

$$(\text{Std. Dev}) = \left[\frac{\sum \text{PS}^2 - (\sum \text{PS})^2 / N}{N - 1} \right]^{1/2}$$

$$N = 11$$

The 15 % requirement is calculated as:

$$(\text{Avg} - LCL) / (\text{Avg}) \times 100 \% \leq 15 \% \quad (2)$$

7.1.2 The strength and load-carrying capabilities of plastic pipe is measured and reported as pipe stiffness and determined in accordance with Test Method D 2412. The term “crushing strength” is not applicable to plastic piping.

TABLE 4 Minimum Wall Thickness Required for Pipe Stiffness and Impact Strength for Sewer and Drain-DR-PS^A

Nominal Pipe Size, in.	Dimension Ratio					Minimum Impact Strength at 32°F (0°C), ft·lbf
	DR38	DR34	DR27	DR24	DR22	
	Pipe Stiffness					
	PS35	PS50	PS100	PS140	PS200	
2	0.060	0.066	0.083	0.089	0.102	25
3	0.085	0.095	0.120	0.135	0.148	25
4	0.110	0.124	0.156	0.175	0.191	25
6	0.165	0.184	0.232	0.261	0.285	25
8	0.221	0.247	0.311	0.350	0.381	25
9	0.248	0.277	0.350	0.393	0.429	25
10	0.276	0.308	0.389	0.437	0.477	25
12	0.328	0.367	0.463	0.520	0.568	25

^AThe maximum wall thickness shall not be greater than 1.12 times the minimum.

NOTE 2—The 5 % deflection criteria is arbitrarily selected for testing convenience. It is not to be considered as a limitation with respect to in-use deflection. The engineer is responsible for establishing the acceptable deflection limit.

7.2 *Impact Resistance*—The minimum impact resistance, when tested at the time of manufacture, shall comply with the requirements of Table 1, Table 2, Table 3, or Table 4. Test in accordance with Test Method D 2444, using Tup B and Holder B. Use a 6-lb (2.5-kg) tup for all sizes.

7.2.1 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.

7.2.2 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.

7.3 *Bond*—The bond between layers shall be strong and uniform. It shall not be possible to separate any two layers with a probe or point of a knife blade so that the layers separate cleanly or the probe or knife blade moves freely between the layers; nor shall separation of the layers occur during other tests in this specification. Refer to 10.1. (See 7.3.1.)

7.3.1 The bond test is conducted at the time of manufacture.

8. Other Requirements

8.1 Dimensions and Tolerances:

8.1.1 *Outside Diameter*—The outside diameter and tolerance shall meet the requirements of Table 5 when measured in accordance with Test Method D 2122. The tolerance for out-of-roundness shall apply to the pipe at the time of manufacturer.

8.1.2 *Wall Thickness*—The wall thickness shall meet the requirements of Table 1, Table 2, Table 3, or Table 4 when measured in accordance with Test Method D 2122.

8.1.3 *Length*—The pipe shall be in 10 or 20-ft lengths, unless otherwise specified. The tolerance on length shall be +½, -0 in.

8.2 *Pipe Flattening*—There shall be no evidence of cracking or rupture when deflected 25 % of the initial inside diameter when tested in accordance with Test Method D 2412.

TABLE 5 Outside Diameter and Tolerance

Nominal Pipe Size, in.	IPS Schedule 40 Series and IPS-DR-PS Series	Sewer and Drain-DR-PS Series	Tolerance on Average Outside Diameter, in.	Out of Roundness Maximum Diameter Minus Minimum Diameter, in.
1¼	1.660	...	+0.008 -0.002	0.060
1½	1.900	...	+0.010 -0.002	0.060
2	2.375	2.25	+0.010 -0.002	0.060
2½	2.875	...	+0.010 -0.002	0.060
3 ^A	3.250	...	+0.012 -0.004	0.060
3	3.500	3.25	+0.012 -0.004	0.060
3½	4.000	...	+0.012 -0.004	0.100
4	4.500	4.215	+0.014 -0.004	0.100
5	5.563	...	+0.015 -0.005	0.100
6	6.625	6.275	+0.016 -0.006	0.100
8	8.625	8.400	+0.024 -0.006	0.150
9	...	9.440	+0.020 -0.005	0.150
10	10.750	10.500	+0.024 -0.006	0.150
12	12.750	12.500	+0.024 -0.006	0.150

^ASpecial outside diameter of 3.25.

8.2.1 Test three specimens. When all pass, accept the lot. When one specimen fails, the lot does not meet the requirements of this specification.

8.2.2 Failure shall be a crack or break extending entirely through the pipe wall visible to the unaided eye. Refer to 10.1. (See 8.2.3.)

8.2.3 The pipe flattening test is conducted at the time of manufacture.

8.3 *Inspection*—Coextruded composite pipe shall be inspected before installation and pipe that does not meet the requirements of Section 9 shall be rejected and returned to the seller.

8.4 *Solvent Cement*—When solvent cement is used to join coextruded composite pipe, it shall be for use with the material in the outer layer, as marked on the pipe.

8.4.1 *ABS*—Use solvent cement meeting the requirements of Specification D 2235.

8.4.2 *PVC*—Use solvent cement meeting the requirements of Specification D 2564.

8.4.3 *CPVC*—Use solvent cement meeting the requirements of Specification F 493.

8.5 *IPS Schedule 40 Series*—Coextruded composite pipe shall be joined with molded fittings meeting the requirements of Specification D 2661 or F 628, when the outer layer is ABS, or Specification D 2665 when the outer layer is PVC, or Specification F 493 when the outer layer is CPVC.

8.6 *IPS-DR-PS Series*—Coextruded composite pipe shall be joined with fittings meeting the requirements of Specification D 2750 when the outer layer is ABS and Specification F 512

when the outer layer is PVC. For the 3.25-in. outside diameter use fittings meeting the requirements of Specification D 2949 when the outer layer is PVC.

8.7 *Sewer and Drain DR-PS Series*—Coextruded composite pipe shall be joined with fittings meeting the requirements of Specification D 2751, when the outer layer is ABS. Use Specification D 2729, D 3034, or F 789 when the outer layer is PVC.

8.8 *Solvent Cement, Primers, and Cleaners*—The safety requirements of Practice F 402 shall be followed when using solvent cement, primers, or cleaners and follow Practice D 2855 when making solvent joints when the outer layer is PVC.

8.9 *Elastomeric Seals*—When coextruded composite pipe is joined using elastomeric seals (gaskets), the elastomeric seal shall meet the requirements of Specification F 477 or F 913.

8.10 *Gasket Fittings*—When Sewer and Drain DR-PS Series coextruded composite pipe is joined using gasketed fittings, the gasket fittings shall meet the requirements of Specification D 3034.

8.11 *Gasket Joints*—Joints using elastomeric seals shall meet the requirements of Specification D 3212 when used to join pipes made in accordance with this specification.

8.12 *Injected Solvent Cemented Joints*—Injected solvent cemented joints for ABS or PVC shall meet the requirements of Specification F 545 when used to join pipes made in accordance with this specification.

8.13 *Qualification Test*—This test is designed to qualify the thickness of the outer layer—as being thick enough to withstand the effect of the solvent cement on the outer layer and to provide a good leak-free joint.

8.13.1 *Joint Tightness*—Join two pieces of pipe together using molded fittings and solvent cement. Use solvent cement meeting the requirements of 7.5. Cure the solvent cement joints 24 h at room temperature before testing. Joints shall not leak when tested at an internal water pressure of 25 psi (170 kPa), for 1 h, using water at 73°F (23°C). Refer to 11.1.

9. Workmanship

9.1 The inside and outside surfaces of pipe produced under this specification, shall be free of chalking, sticky, or tacky material. The surface shall be free of excessive bloom. Bloom or chalking may develop in pipe exposed to the direct rays of the sun (ultraviolet radiant energy) for extended periods and consequently, these requirements do not apply to pipe after extended exposure to direct rays of the sun. The inside and outside surfaces of pipe shall be free of foreign inclusion, or other defects that are visible to the naked eye, and may affect the wall integrity.

10. Sampling and Conditioning

10.1 *Sampling*—A lot shall consist of all pipe produced, of one size, from one extrusion line, during one designated 24-h period. The number of specimens for each test is taken from the pipe selected at random from each lot, under the random sampling plan of Practice D 1898.

10.2 *Conditioning*:

10.2.1 For referee testing at 73°F, 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.

10.2.2 For routine quality control testing at 73°F, 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.

10.2.3 For referee testing at 32°F, condition the specimens at $32 \pm 3.6^\circ\text{F}$ ($0 \pm 2^\circ\text{C}$) for at least 16 h in air.

10.2.4 For quality control testing at 32°F, condition the specimens in air at $32 \pm 3.6^\circ\text{F}$ ($0 \pm 2^\circ\text{C}$) for at least 2 h, or in ice water for at least 1 h.

10.3 Test Conditions:

10.3.1 For referee purposes, conduct tests in the standard laboratory atmosphere of $73.4 \pm 3.6^\circ\text{F}$ ($23 \pm 2^\circ\text{C}$) and $50 \pm 5\%$ relative humidity, unless otherwise specified.

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

10.3.3 For testing at 32°F, complete the test as soon as possible after removal from the conditioning atmosphere, but in any case within 15 s.

10.4 *Frequency of Test*—The frequency of testing shall be established by the manufacturers, consistent with good quality control practices.

10.5 *Number of Tests*—The number of tests for quality control shall be under the manufacturer's established quality control program.

10.6 *Quality Control Test*—The quality control program shall include testing for compliance with this specification of the following:

10.6.1 Outside diameter,

10.6.2 Wall thickness,

10.6.3 Length,

10.6.4 Pipe stiffness,

10.6.5 Pipe flattening,

10.6.6 Impact strength, and

10.6.7 Bond.

10.7 *Test Methods*—Only the ASTM test methods specified are to be used.

10.8 *Responsibility for Testing and Inspection*—The producer shall be responsible for the performance of all tests, inspections, and requirements specified herein. The producer is permitted to use his own or any third-party certified testing facility for the performance of the testing and inspection requirements of this specification. The testing and inspection shall be in accordance with ANSI Z 34.1 or ANSI Z 34.2.

11. Retest and Rejection

11.1 When the results of any test(s) do not meet the

requirements of this specification, the test(s) are permitted to be conducted again under an agreement between the purchaser and the supplier.

11.2 There shall be no agreement to lower the minimum requirement of this specification, by such means as omitting tests that are a part of the specification, or substituting or modifying a test method, or by changing the specification limits. In retesting, the product requirements of this specification shall be met. The test methods specified in the specification shall be used.

11.3 When failure occurs on retest, the lot of product represented by the test(s) does not meet the requirements of this specification.

12. Product Marking

12.1 *Quality Assurance*—When the product is marked with this designation, "ASTM F 1488" and the year of issue, it affirms that the product was manufactured, inspected, sampled, and tested under this specification and meets the requirements of this specification.

12.2 *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.

12.3 *Content of Marking*—The pipe shall be marked at least every 5 ft in letters not less than $\frac{3}{16}$ in. high on two sides, 180 apart, and in a color that contrasts with the color of the pipe, and shall contain the following information:

12.3.1 Manufacturer's name or trademark.

12.3.2 This designation, ASTM F 1488, including the year of issue.

12.3.3 Nominal pipe size, for example, 3 in.

12.3.4 Manufacturer's code for resin manufacture, lot number, and date of manufacture.

12.3.5 *Series Marking*—The identification of each series with the applicable dimension ratio (DR), and pipe stiffness (PS) values (for example, PS DR35/PS50 or sewer and drain series DR35/PS50).

12.3.6 *Material Marking*—The identification of the compound shall be by abbreviations in accordance with Terminology D 1600. The layers are identical in accordance with Practice D 1972 as appropriate (for example, ABS/PVC/CPVC).

13. Keywords

13.1 ABS; CPVC; cellular; coextruded; composite; PVC