Designation: F1488 – 14

Standard Specification for Coextruded Composite Pipe[1]

This standard is issued under the fixed designation F1488; 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 composite pipe, produced by a coextrusion die system, in which the concentric layers are formed and combined before exiting the die.

1.1.1 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 Appendix X1, Appendix X2, Appendix X3, and Appendix X4, respectively.

1.6 The values stated in inch-pound units are to be regarded as standard. No other units of measurement are included in this standard.

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: D2661, D2665, D2729, D2750, D2751, D2949, D3034, F512, F628, F758, F789, and F891.

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:*[2]

D618 Practice for Conditioning Plastics for Testing

D696 Test Method for Coefficient of Linear Thermal Expansion of Plastics Between −30°C and 30°C with a Vitreous Silica Dilatometer

D883 Terminology Relating to Plastics

D1600 Terminology for Abbreviated Terms Relating to Plastics

D1898 Practice for Sampling of Plastics (Withdrawn 1998)[3]

D1972 Practice for Generic Marking of Plastic Products (Withdrawn 2014)[3]

D2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings

D2235 Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings

D2321 Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications

D2412 Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading

D2444 Test Method for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)

D2564 Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems

D2661 Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings

D2665 Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings

D2729 Specification for 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 F17.11 on Composite.

Current edition approved Dec. 1, 2014. Published January 2015. Originally approved in 1994. Last previous edition approved in 2009 as F1488 – 09ε1. DOI: 10.1520/F1488-14.

[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.

[3] The last approved version of this historical standard is referenced on www.astm.org.

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

D2750 Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastics Utilities Conduit and Fittings (Withdrawn 1997)[3]
D2751 Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings (Withdrawn 2014)[3]
D2855 Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
D2949 Specification for 3.25-in. Outside Diameter Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
D3034 Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
D3212 Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
D3965 Classification System and Basis for Specifications for Rigid Acrylonitrile-Butadiene-Styrene (ABS) Materials for Pipe and Fittings
D4000 Classification System for Specifying Plastic Materials
D4396 Specification for Rigid Poly(Vinyl Chloride) (PVC) and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds for Plastic Pipe and Fittings Used in Nonpressure Applications
D5033 Guide for Development of ASTM Standards Relating to Recycling and Use of Recycled Plastics (Withdrawn 2007)[3]
F402 Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings
F412 Terminology Relating to Plastic Piping Systems
F477 Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
F493 Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings
F512 Specification for Smooth-Wall Poly(Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation
F545 Specification for PVC and ABS Injected Solvent Cemented Plastic Pipe Joints (Withdrawn 2001)[3]
F628 Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe With a Cellular Core
F656 Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings
F758 Specification for Smooth-Wall Poly(Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage
F789 Specification for Type PS-46 and Type PS-115 Poly-(Vinyl Chloride) (PVC) Plastic Gravity Flow Sewer Pipe and Fittings (Withdrawn 2004)[3]
F891 Specification for Coextruded Poly(Vinyl Chloride) (PVC) Plastic Pipe With a Cellular Core
F913 Specification for Thermoplastic Elastomeric Seals (Gaskets) for Joining Plastic Pipe

2.3 *ANSI Standards:*
ANSI Z 34.1 American National Standard for Certification-Third-Party Certification Program[4]
ANSI Z 34.2 American National Standard for Certification-Self-Certification by Producer or Supplier[4]
2.4 *Federal Standard:*
Fed. Std. No. 123 Marking for Shipments (Civil Agencies)[5]
2.5 *Military Standard:*
MIL-STD-129 Marking for Shipment and Storage[5]
2.6 *Uniform Classification Committee Standard:*
Uniform Freight Classification[6]
2.7 *National Motor Freight Traffic Association Standard:*
National Motor Freight Classification[7]

3. Terminology

3.1 *Definitions:*

3.1.1 Definitions are in accordance with Terminologies D883 and F412. Abbreviations are in accordance with Terminology D1600. Plastic materials are classified in accordance with Classification System D4000. Generic marking is in accordance with Practice D1972.

3.1.2 *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.

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

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

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

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, D883)

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).

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.
[5] DLA Document Services Building 4/D 700 Robbins Avenue Philadelphia, PA 19111-5094 http://quicksearch.dla.mil/
[6] Available from the Uniform Classification Committee, Suite 1106, 222 South Riverside Plaza, Chicago, IL 60606.
[7] Available from National Motor Freight Traffic Association (NMFTA), 1001 N. Fairfax St., Alexandria, VA 22314, http://www.nmfta.org.

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.

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 (F1488) 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.

6.1.1 Materials listed in the material section are to be used in any layer of the coextruded composite pipe. When coextruded composite pipe is produced with three layers, the middle layer is to be solid or closed-cell cellular plastic.

6.2 *ABS Material Specification*—The ABS shall be virgin plastic ABS material conforming to the requirements of Specification D3965 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 D4396 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 D4396.

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 D4396 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 D4396.

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 D5033.

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 closed-cell cellular plastic 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 D2412, shall equal or exceed the value in Table 1, Table 2,

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
1¼	0.140	140	25
1½	0.145	140	25
2	0.154	140	25
2½	0.203	140	25
3	0.216	140	25
3½	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

[A] The 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

[A] The maximum wall thickness shall not be greater than 1.12 times the minimum.
[B] Special outside diameter of 3.25.

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 average, the sample meets the requirements of the Pipe

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					Minimim Impact Strength at 32°F (0°C) ft·lbf
	DR 42	DR 38	DR 34	DR 27	DR 25.5	
	Pipe Stiffness					
	PS25	PS35	PS50	PS100	PS120	
1¼	0.060	0.060	0.060	0.060	---	25
1½	0.060	0.060	0.060	0.069	0.075	25
2	0.060	0.060	0.068	0.086	0.093	25
2½	0.068	0.076	0.085	0.106	0.113	25
3	0.080	0.090	0.102	0.127	0.137	25
3½	0.093	0.103	0.116	0.145	---	25
4	0.104	0.118	0.132	0.164	0.177	25
5	0.129	0.146	0.164	0.203	0.219	25
6	0.154	0.174	0.195	0.241	0.260	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

[A] The maximum wall thickness shall not be greater than 1.12 times the minimum.

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					Minimim 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

[A] The maximum wall thickness shall not be greater than 1.12 times the minimum.

Stiffness testing. The eleven specimens include the three tested under 7.1, and an additional eight with rotation by 35°, as specified in D2412, continuing throughout the remaining specimens.

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

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

where:

$$(\mathrm{Avg.\ PS}) = [\textstyle\sum(\mathrm{PS})\}\ /\ (11)$$
$$(\mathrm{Std.\ Dev}) = [\textstyle\sum PS^2 - (\sum PS)^2/N/N-1\,]^{1/2}$$
$$\mathrm{N} = 11$$

The 15 % requirement is calculated as:

$$(\mathrm{Avg} - \mathrm{LCL})/(\mathrm{Avg}) \times 100\,\% \le 15\,\% \quad (2)$$

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 D2412. The term "crushing strength" is not applicable to plastic piping.

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 D2444, 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.

7.4 *Cellular Structure*—The closed-cell cellular plastic layer of composite pipe shall not allow the passage of water when tested at 10 ± 1 psig for a minimum of 30 min. The test sample shall be 18 ± 0.125 in. long. Create a seal on the O.D. and the I.D. of the pipe near one end in a manner that permits the exposed core to be subjected to water pressure (Note 3). Any sign of water emanating from the core at the opposite end after 30 min. is indication of an open cell structure and the sample does not meet the requirements of this specification. This test is not required for pipe produced with a solid middle layer.

NOTE 3—The method of sealing against the I.D. and O.D. of the pipe is not specified, as several acceptable methods are available. One such method uses an elastomeric no-hub adapter clamped to the O.D. and pneumatic or mechanical test plug to seal the I.D.

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 D2122. 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 D2122.

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

[A] Special outside diameter of 3.25.

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 D2412.

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 D2235.

8.4.2 *PVC*—Use solvent cement meeting the requirements of Specification D2564.

8.4.3 *CPVC*—Use solvent cement meeting the requirements of Specification F493.

8.5 *IPS Schedule 40 Series*—Coextruded composite pipe shall be joined with molded fittings meeting the requirements of Specification D2661 or F628, when the outer layer is ABS, or Specification D2665 when the outer layer is PVC, or Specification F493 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 D2750 when the outer layer is ABS and Specification F512 when the outer layer is PVC. For the 3.25-in. outside diameter use fittings meeting the requirements of Specification D2949 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 D2751, when the outer layer is ABS. Use Specification D2729, D3034, or F789 when the outer layer is PVC.

8.8 *Solvent Cement, Primers, and Cleaners*—The safety requirements of Practice F402 shall be followed when using solvent cement, primers, or cleaners and follow Practice D2855 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 F477 or F913.

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 D3034.

8.11 *Gasket Joints*—Joints using elastomeric seals shall meet the requirements of Specification D3212 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 F545 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 D1898.

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 D618, 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 ± 3.6°F (0 ± 2°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 ± 3.6°F (0 ± 2°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 ± 3.6°F (23 ±2°C) and 50 ± 5 % relative humidity, unless otherwise specified.

10.3.2 For routine quality control testing, conduct tests at the temperature and humidity of the manufacturers 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 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.

12.2 *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:

12.2.1 Manufacturer's name or trademark.
12.2.2 This designation, ASTM F1488.

12.2.3 Nominal pipe size, OD System & Application Markings:

12.2.3.1 IPS Sch 40 DWV;

12.2.3.2 IPS DR-PS DWV;

12.2.3.3 IPS DR-PS Communication Conduit;

12.2.3.4 IPS DR-PS Underground Electrical Conduit; and

12.2.3.5 Sewer and Drain DR-PS.

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

12.2.5 *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).

12.2.6 *Material Marking*—The identification of the compound shall be by abbreviations in accordance with Terminology D1600. The layers are identical in accordance with Practice D1972 as appropriate (for example, ABS/PVC/CPVC).

13. Quality Assurance

13.1 When the product is marked with this designation, ASTM F1488 it affirms that the product was manufactured, inspected, sampled, and tested under this specification and meets the requirements of this specification.

14. Keywords

14.1 ABS; CPVC; cellular; coextruded; composite; PVC

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 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*—Store coextruded composite pipe on a flat surface or supported in a manner that will prevent sagging or bending and protect it from direct sunlight.

X1.2 Use coextruded thermoplastic composite pipe on a first-in-first-out basis.

X2. JOINING

X2.1 *Field Inspection*—Before use all coextruded composite pipe shall be carefully inspected for cuts, gouges, deep scratches, damaged ends, and other major imperfections. Defective coextruded composite pipe shall be returned to the seller or the damaged sections shall be cut out.

X2.2 *Pipe Fit*—Coextruded composite pipe is manufactured to close tolerances to obtain an interference fit between the coextruded composite pipe and the fittings socket. During assembly, use only combinations of coextruded composite pipe and fittings that give a proper interference fit. The coextruded composite pipe should enter the dry fitting socket to between one half and two thirds of the fitting socket depth. The allowable tolerance ensures a forced fit and when solvent cement is used, the pipe and fitting will readily mate, thus ensuring a physical fusion. Coextruded composite pipe that is a loose fit in the socket may not properly bond.

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

X2.4 *Cleaning*—Approved chemical cleaners should be used to clean the pipe after all burrs have been removed and before assembly.

X2.5 *Safety Requirements for Solvent Cement and Primers*—Follow Practice F402 for safe use of solvent cement and primers.

X2.6 *Primers*—Primers are used to clean, soften, and dissolve the joint surfaces before application of solvent cement for joining. Primers meeting the requirements of Specification F656 are acceptable.

X2.7 *Solvent Cement*—Solvent cement for coextruded composite pipe must meet the requirements of Specification D2235 for ABS, Specification D2564 for PVC, and Specification F493 for CPVC. The recommendations of the solvent cement manufacturer shall be followed for satisfactory results.

X2.7.1 *Application of Cement*—Use the applicator supplied with the can of solvent cement, or a brush or roller with a width of about one half the pipe diameter for pipe sizes above 2 in. Apply a moderate even coating of cement in the fitting.

X2.7.2 Heavy or excessive application of solvent cement may become an obstruction in the pipe and prevent satisfactory joining. Apply a heavy coat of solvent cement to the outside of the pipe. Make sure that the coated distance on the pipe is equal to the depth of the fitting socket.

X2.8 *Assembly*—Make the joint as quickly as possible after the application of the solvent cement and before the solvent cement dries. Should the solvent cement dry partially reapply solvent cement before assembling. Insert the pipe into the fitting socket, making sure to insert the pipe to the full depth of the fitting socket. Hold the joint firmly for about 30 s for small-diameter pipe and 60 s for diameters above 6 in. to avoid push out. Remove excessive solvent cement from the exterior of the joint with a clean, dry cloth.

X2.9 *Set Time*—Do not attempt to disturb the pipe and fitting joint until after the solvent cement has set or damage to the joint and loss of fit may result. Reasonable handling of assembly is permissible within 2 min after joining. Allow 15 min for the joint to develop good handling strength and the joint will withstand the stress of normal installation. Align the pipe and fitting to avoid excessive stresses in the joint, pipe, and fittings. (See X2.7.2).

X2.10 *Cure Time*—Joint strength development is very rapid during periods of high ambient temperatures, low relative humidity, and using high interference fittings. Joint strength development is not as rapid during periods of low ambient temperatures, high relative humidity, and using loose fits. Therefore, the recommendations of the solvent cement manufacturer are to be followed for best results before leak testing.

X3. INSTALLATION

X3.1 *Underground Installation*—Underground installation of Sch 40 coextruded composite pipe shall be in accordance with the excavation, bedding and backfill provisions of the Plumbing Code having jurisdiction, except that maximum aggregate size shall be ½ in. for angular and ¾ in. for rounded particles. For special conditions and all other pipe covered by this Standard, consult ASTM Practice D2321.

X3.2 *Installation*—Coextruded composite pipe shall be installed in conformance with governing building codes. In areas not governed by codes, pipe is installed in accordance with accepted engineering practices.

X3.3 *Installation Under Freezing Conditions*—Coextruded composite pipe has good resistance to impact under freezing conditions but if installation is likely to occur under these conditions, care shall be taken particularly during handling, transportation, installation, and backfilling. Provision for expansion and contraction, in accordance with X3.13, shall be made when temperature of the pipe will vary.

X3.4 *Alignment and Grade*—Align all piping system components properly without strain. Do not bend or pull pipe into position after being solvent cemented.

X3.5 *Supports and Spacing*—Hangers and straps must not compress, distort, cut, or abrade the piping and should allow free movement. Support all piping at intervals of not more than 4 ft (1.2 m) at end of branches and at changes of direction or elevation. Supports should allow free movement. Maintain vertical piping in straight alignment. Support at each floor level or at 10-ft (3.1 m) intervals whichever is less. Support trap arms in excess of 3 ft (1 m) in length as close as possible to the trap. Securely fasten closet rings to the floor with corrosion-resistant fasteners, with the top surface ¼ in. (6 mm) above the finish floor level. Stabilize closet bends or stubs against all horizontal or vertical movement. Protect pipe exposed to damage by sharp surfaces with grommets or sleeves of rubber or plastic.

X3.6 *Threaded Connections*—Do not cut threads on coextruded composite pipe. Use molded adapter fittings with threads for transition to threaded construction. The joint between the pipe and transition fittings should be of the solvent cement type. Use only approved thread tape or thread lubricant specifically intended for use with plastic pipe. Conventional pipe thread compound, putty, linseed oil-base products, and unknown mixtures should not be used.

X3.7 *Thread Tightness*—Where threaded joints are used, tighten maximum hand-tight plus not more than one full turn with a strap wrench.

X3.8 *Connection to Nonplastic Pipe*—When connecting coextruded composite pipe to other types of piping, use only approved types of fittings and adapters designed for the specific transition.

X3.9 *Connections to Traps*—Connect traps by approved threaded adapters.

X3.10 *Connection to Closet Flanges*—Install screw-type closet flanges in the drainage system by a threaded connection. The inside diameter of the coextruded composite pipe is not to be used as a fitting socket. The 4 by 3 closet fitting will allow sewer gas to vent into the building, under some conditions.

X3.11 *Transition to Bell-and-Spigot Pipe*—Make connections or transition to bell-and-spigot cast iron soil pipe and fittings, and to bell-and-spigot pipe and fittings of other materials, with approved mechanical compression joints designed for this use, or caulk joints made in an approved manner.

X3.12 *Building Drains Under Floor Slabs*—Make trench bottoms smooth and of uniform grade with either undisturbed soil or a layer of selected and compacted-backfill so no settlement will be present. The bottom of the pipe must bear on this material throughout its entire length.

TABLE X3.1 Linear Expansion, Inch-Pound Units (ft-°F)[A]

NOTE 1— The following is the amount of expansion/contraction, inches movement per inches of pipe length per degrees Fahrenheit (temperature change).

ft	in. /°F	30	40	50	60	70	80	90	100
20	240	0.24	0.32	0.40	0.48	0.55	0.63	0.71	0.79
40	480	0.48	0.63	0.79	0.95	1.11	1.27	1.43	1.58
60	720	0.71	0.95	1.19	1.43	1.66	1.90	2.14	2.38
80	960	0.95	1.27	1.58	1.90	2.22	2.53	2.85	3.17
100	1200	1.188	1.584	1.98	2.38	2.77	3.17	3.56	3.96

[A] Composite ABS/PVC pipe coefficient of expansion: 33×10^{-6} in./in./°F = 0.000033.

TABLE X3.2 Linear Thermal Expansion, Metric Units (cm-°C)[A]

NOTE 1—The following is the amount of expansion/contraction, centimetres movement per centimetre of pipe length per degrees Celsius (temperature change).

m	cm/°C	10	20	30	40	50	60	70	80
5	500	0.3	0.6	.9	1.2	1.5	1.8	2.1	2.4
10	1000	0.6	1.2	1.8	2.4	3.0	3.6	4.2	4.8
20	2000	1.2	2.4	3.6	4.8	6.0	7.2	8.4	9.6
30	3000	1.8	3.6	5.4	7.2	9.0	10.8	12.6	14.4

[A] Composite ABS/PVC pipe coefficient of expansion: 60×10^{-6} cm/cm/°C, = 0.000060.

X3.13 *Thermal Expansion*—Allow for thermal expansion and movement in all coextruded composite piping installations by the use of approved methods. Support but do not rigidly restrain piping at branches or changes of direction. Do not anchor coextruded composite pipe rigidly in walls. Holes through framing members should allow for free movement. Buried piping installed in the crawl space under a building is normally subject to less than the ambient temperature changes.

X3.13.1 *Coefficient of Linear Expansion*—Determined by Practice D696. See Table X3.1 and Table X3.2.

X3.13.2 *Derivation of Thermal Expansion*—Thermal expansion is calculated from the coefficient of thermal expansion as determined by Practice D696. The average values are as follows:

Inch-pound units (inch/Fahrenheit) 33×10^{-6} (=0.000033) in.
Movement, per inch of pipe length per degree Fahrenheit
Temperature rise (expansion) or fall (contraction).
SI units (centimetres/Celsius) 60×10^{-6} (=0.0000060)
Centimetres movement per centimetre of pipe length per degree
Celsius temperature rise (expansion) or fall (contraction).

Note—*Examples:*	English Units	Metric Units
Highest temperature expected	100°F	60°C
Lowest temperature expected	40°F	20°C
Total temperature range	60°F	40°C
Length of pipe run		

Calculation of amount of linear expansion to be allowed for: Inch-pound units – (0.000033) × 960 (12 in. × 80 ft) × 60 (°F) = 1.9 (in.) SI units – (0.000060) × 3000 (30 m × 100 cm) × 40 (°C) = 7.2 (cm) confirm results in tables above. Tabular data may be interpolated to avoid calculation.

X3.14 *Exposed Piping*—Provide adequate support where coextruded composite piping is subjected to wind, snow, and ice loading. Plumbing vents exposed to sunlight should be protected by water-base synthetic latex paints. Where surface temperatures exceed 165°F, piping shall be protected by shielding or some type of lightweight insulation. Exposure to sunlight during normal construction periods is acceptable. (See X 1.1.)

X3.15 *Antifreeze Protection*—To protect traps and fixtures from freezing, do not use alcohol or petroleum products. Use only approved plastic pipe antifreeze packaged for this purpose or one of the following solutions:

X3.15.1 *Glycerin in Water*—60 %, by mass.

X3.15.2 *Magnesium Chloride or Common Salt in Water*—22 %, by mass.

X3.16 *Commercial and Industrial Applications:*

X3.16.1 Coextruded composite pipe will accommodate temperatures of 180°F (82°C) in nonpressure household applications, but the nature of some applications to run to higher temperatures; for example, commercial dishwashers, requires special consideration.

X3.16.2 The specific approval of the cognizant building code authority is necessary when waste disposal lines are routinely exposed to chemicals that are aggressive to coextruded composite pipe (for example, service station bay area floor drains).

X4. RATIONALE (COMMENTARY)

X4.1 *Basis for Establishing Mechanical Properties Limits of Coextruded Composite Pipe*—The mechanical properties limits of coextruded composite pipe are taken from the report of the National Bureau of Standards Special Publication 368, Volume 4: Performing Concept in Buildings.[6]

X4.2 *Mechanical Environment*—Of the many factors that could be considered to constitute the total mechanical loading environment of piping systems, those considered potentially significant include: Impact force occurring both during and after installation. Loads applied to piping installed below grade as a result of backfill soil and any load superimposed at ground surface in the vicinity of buried piping. Internal pressure exerted on piping and joints as a result of blockage of the system after installation.

X4.3 *Impact Exposure*—No meaningful upper limit is set for impact loading because in normal use extreme impact loads can occur which will break the pipe regardless of the material used. Piping needs to have a minimum resistance to impact loading to offset accidental or normally abusive treatment, or both. Impact strength is dependent on so many different and such widely varying parameters that selection of a particular value as representative of normal use is empirical. Nonetheless, an impact strength at 32°F which will offset a 5-lb weight falling a distance of 5 ft (that is, an impact strength of 25 ft. lbf) is considered a reasonable minimum requirement, in as much as this value is representative of the impact strength of piping materials which have proved capable of providing a satisfactory degree of performance.

X4.3.1 This performance requirement has been included in this specification. (7.2.)

X4.4 *Earth Burial Load Exposure:*

X4.4.1 The second factor in the mechanical loading environment, that is, earth burial loads, plus loads superimposed at ground surface in the vicinity of the buried pipe, presents a somewhat more complex problem in that the actual load experienced is a function of the reaction of the pipe material to the loads. Rigid pipe (commonly defined as having a cross-sectional shape which cannot be deflected sufficiently to change vertical or horizontal dimension by more than 0.1 % without material damage) supports earth loads through high inherent wall or ring strength. When failure occurs, it is normally by rupture or cracking with little or no deformation when the ring strength is surpassed. By contrast, flexible pipe (commonly defined as having a cross-sectional shape which can be deflected sufficiently to change vertical or horizontal dimensions more than 5.0 % without material damage) supports some earth load with inherent wall strength, but achieves maximum performance by its capacity to deform without fracture. As the pipe deflects under the load, the horizontal axis dimension increases, moving the pipe wall out against the side fills, which become increasingly compacted offer more and more resistance to further deflection, and support more of the load. Flexible pipe eventually fails by excessive deflection. Under load, once the top of the pipe passes the point of being about flat due to downward deflection and the upper half

becomes concave, complete collapse is possible, as the concavity will pull the sides of the pipe inward, thereby reducing the support of the compacted sidefill. Collapse of flexible pipe is not imminent until deflection exceeds about 20 % of the nominal diameter.

X4.4.2 It is recommended that the suitability of pipe proposed for use in buried systems be evaluated, by calculating the static earth load over the pipe, with an earth density of 120 lb/ft^3 at depths from 2 to 8 ft, plus an 8000-lb wheel load at the surface. To be deemed suitable for use in buried drainage system, the pipe should have enough resistance to crushing to sustain without cracking or rupture, the static loads shown below for the respective diameters, and sufficient resistance to deflection under the same loads to be sure that the diametral deflection does not exceed 5 %. The same pipe also should be capable of sustaining the equivalent static and dynamic loads shown below, without experiencing diametral deflection more than 15 % (or cracking or rupture). After the equivalent static and dynamic load the residual deflection within 30 min should not exceed 5 %. Loads for pipe having an outside diameter other than shown, in Table X4.1 are obtained by interpolation.

X4.4.3 *Loading (Static and Dynamic) Versus Pipe Stiffness*—Pipe should have enough resistance to crushing to sustain without cracking or rupture the static load shown above for the respective diameters and sufficient resistance to deflection under the same load to be sure that the diametral deflection does not exceed 5 %.

NOTE X4.1—For example, a range of nominal pipe sizes from 1¼ to 12 in. must have a pipe stiffness to support the loading.
For 1¼-in. Nominal Pipe:
PS = 137.54 lb/linear ft = 138.10 lbf/in./in. (See Note X4 .3.) (12 in./ft) (0.05) (1.66)
For 12-in. Nominal Pipe:
PS = 1056 lb/linear ft = 138.10 lbf/in./in. (See Note X4.3.) (12 in./ft) (0.05) (12.75)

TABLE X4.1 Static and Dynamic Loading Versus Pipe Stiffness

Pipe Size, in.	Outside Diameter, in.	Static Load, lb/linear ft	Equivalent Static and Dynamic Load, lb/linear ft
3	3.500	290	585
4	4.500	375	750
5	5.563	460	925
6	6.625	550	1100

NOTE X4.2—The same pipe should also be capable of sustaining the respective equivalent static and dynamic loads given without experiencing diametral deflection more than 15 % or cracking or rupture. For example, a range of nominal pipe sizes from 1¼ to 12 in. must have a pipe stiffness to support the loading.
For 1¼ -in. Nominal Pipe:
PS = 277 lb/linear ft = 92.8 lbf/in./in. (See Note X4.3.) (12 in./ft) (0.15) (1.66)
For 12-in. Nominal Pipe:
PS = 2131 lb/linear ft = 92.86 lbf/in./in. (See Note X4.3.) (12 in./ft) (0.15) (12.75)

NOTE X4.3—The values listed in the examples are interpolation of values listed.

X4.5 *Internal Pressure Testing:*

X4.5.1 The internal pressure testing of a system for leakage before operation, is tested with water, either in its entirety or in sections. When testing the entire system, all openings except the highest are closed and the system filled with water to the point of overflowing. If testing is done in sections, each opening except the highest in the section under test is plugged, and the section tested with not less than a 10-ft head of water. Leakage testing establishes that joint strength is satisfactory. The system shall not leak under an internal water pressure of 25 psi for a continuous period of 15 min with the water at a temperature of 73°F.

X4.5.2 Testing before and after backfilling is recommended. Internal pressure may be caused by freezing the effluent. As expansion occurs, internal pressure is applied to the inner walls.

X4.5.3 Coextruded pipe with a cellular layer separating the inner and outer layer has a heat transfer coefficient approximately 35 % less than solid pipe. This provides greater protection when the effluent is subjected to freezing conditions.

X4.6 *Chemical Resistance*—The chemical resistance of coextruded composite pipe is, for practical purposes, determined by the chemical resistance of the material used for the inner layer. The recommendations of the manufacturer should be followed to ensure good performance.[8]

[8] Proceedings of the Joint RILEM-ASTM-CIB Symposium held May 2–5, Philadelphia, Pa. (issued March 1972), *The Development of Performance Criteria and Test Procedures for the Piping of Sanitary Drain, Waste, and Vent Systems in Residential Service*, R.T. Holtz, Chairman of Task Group on Engineering Design of Sanitary Drain, Waste, and Vent Piping of ANSI Committee on Standardization of Plumbing Materials and Equipment.

SUMMARY OF CHANGES

Committee F17 has identified the location of selected changes to this standard since the last issue (F1488–09$^{\varepsilon 1}$) that may impact the use of this standard.

(1) Replaced, "thermally foamed plastic" with Terminology F412 wording, "closed-cell cellular plastic" in document.
(2) Added 7.4 for closed-cell testing.
(3) Note 3 was added.
(4) 6.1.1— formerly numbered 1.1.1, was moved from the Scope to Section 6 Materials and the definition "thermally foamed plastic" and the word "permitted" were removed.
(5) Editorially changed wording from "cellular core layer" to "closed cell cellular plastic layers" in 7.4.