Designation: F1499 – 12

Standard Specification for Coextruded Composite Drain, Waste, and Vent Pipe (DWV)[1]

This standard is issued under the fixed designation F1499; 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 drain, waste, and vent pipe (DWV). The pipe is produced in Schedule 40 IPS sizes by a coextrusion die system, in which the concentric layers are formed and combined before exiting the die.

1.1.1 Coextruded composite drain, waste, and vent pipe, DWV, by definition, is permitted to be produced with two or more layers. The outer layer shall be ABS. The middle layer is permitted to be thermally foamed PVC or solid PVC or a blend of rework material, as specified in the rework material section. The inner layer is permitted to be solid PVC or ABS, or a blend of rework material as specified in the rework material section.

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

1.2 DWV is permitted to be produced utilizing a two layer or three layer coextrusion die.

1.3 Materials that do not meet the requirements of the material section are excluded.

1.4 Pipe produced to this specification is permitted to be joined using molded fittings meeting the requirements of Specification D2661 or Specification F628. The fitting patterns must comply with Specification D3311.

1.5 Pipe produced to this specification is permitted to be perforated in accordance with any specified standard or by agreement between the purchaser and the supplier.

1.6 Pipe produced to this specification is permitted to be belled for joining by solvent cementing or belled for joining by an elastomeric seal (gasket), in accordance with any specified standard or by agreement between the purchaser and the supplier.

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

1.8 The values stated in inch-pound units are to be regarded as the standard. The SI units given in parentheses are for information only.

1.9 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.

1.10 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.

1.11 *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—Specifications related to this specification are as follows: Specifications D2661, D2665, F628, and F891.

2. Referenced Documents

2.1 The following standards contain provisions that, 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

D1784 Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds

[1] This specification is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.63 on DWV.

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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**

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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)
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
D3311 Specification for Drain, Waste, and Vent (DWV) Plastic Fittings Patterns
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
D5033 Guide for Development of ASTM Standards Relating to Recycling and Use of Recycled Plastics (Withdrawn 2007)[3]
E105 Practice for Probability Sampling of Materials
E122 Practice for Calculating Sample Size to Estimate, With Specified Precision, the Average for a Characteristic of a Lot or Process
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
F628 Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe With a Cellular Core
F891 Specification for Coextruded Poly(Vinyl Chloride) (PVC) Plastic Pipe With a Cellular Core

2.3 *Federal Standard:*
Fed. Std. No. 123 Marking for Shipments (Civil Agencies)[4]

2.4 *Military Standard:*
MIL-STD-129 Marking for Shipment and Storage[4]

2.5 *ANSI Standard:*
ANSI Z 34.1 American National Standard for Certification-Third-Party Program[5]
ANSI Z 34.2 American National Standard for Certification-Self-Certification by Producer or Supplier[5]

2.6 *Uniform Classification Committee Standards:*
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 Terminology D883 and F412. Abbreviations are in accordance with Terminology D1600. Plastic materials are classified in accordance with Classification D4000. Generic marking is in accordance with Practice D1972.

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

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 volatilize of a constituent. (1985)

3.1.6 *virgin plastic, (adj)*—materials 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)

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *ABS/PVC*—an acronym for a blend of acrylonitrile-butadiene-styrene and poly vinyl chloride.

3.2.2 *lot*—a lot shall consist of all pipe produced, of one size, from one extrusion line, during one designated 24-h period.

3.2.3 *rework material*—a blend of the different materials generated from coextruded composite drain, waste, and vent pipe (DWV).

4. Classification

4.1 Coextruded composite drain, waste, and vent pipe, DWV, produced in compliance this specification will provide pipe suitable for the drainage and venting of sewage and certain other liquid wastes.

NOTE 2—Before installing coextruded composite pipe in an industrial waste disposal system, the approval of the cognizant building code authority should be obtained as conditions not commonly found in normal use may be encountered and temperatures in excess of 180°F (82°C) may be encountered.

[3] The last approved version of this historical standard is referenced on www.astm.org.
[4] Available from Naval Publications and Forms Center, 5801 Tabor Ave., Philadelphia, PA 19120.
[5] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.
[6] Available from the Uniform Classification Committee, Suite 1106, 222 South Riverside Plaza, Chicago, IL 60606.
[7] 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. Ordering Information

5.1 Orders for coextruded composite drain, waste, and vent pipe, DWV, produced in compliance with this specification should include the following:

5.1.1 This ASTM designation number, and the year of issue,

5.1.2 Pipe size,

5.1.3 Footage required of each size, and

5.1.4 Materials.

6. Materials and Manufacture

6.1 *Basic Compound*—Virgin compound for use in the outer layer of coextruded composite drain, waste, and vent pipe, DWV, shall contain pigments or screening agents to provide protection against UV radiation.

6.2 *ABS Compound Specification*—The ABS compound shall be virgin ABS compound 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, in accordance with Specification D3965.

6.3 *PVC Compound Specification*—The PVC compound shall be virgin PVC compound conforming to the requirements of Specification D1784 and shall meet all of the requirements for Cell Class 12344 except that the tensile strength shall not be less than 6500 psi and the modulus of elasticity shall not be less than 380,000.

6.3.1 The color and form of the material shall be by agreement between the purchaser and the supplier in accordance with Specification D1784.

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

6.4 *Rework Material*—A blend of clean rework materials generated from the manufacturers own pipe production is permitted to be used by the same manufacturer, provided the pipe produced meets all of the requirements of this specification. Rework material is excluded from standard definitions of recycled materials in accordance with Guide D5033.

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

6.4.2 Thermally foamed layer shall not be used in the inner or outer layer.

7. Requirements

7.1 *General*—The inside and outside surfaces of pipe produced in accordance with this specification shall be free of chalking, sticky, or tacky material. The surfaces shall be free of excessive bloom. Bloom or chalking may develop in pipe exposed to 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.

7.1.1 The requirements in this section are intended only for use as quality control tests, not as simulated service tests.

7.2 *Dimensions and Tolerances:*

7.2.1 *Outside Diameter*—The outside diameter and tolerances shall meet the requirements of Table 1 when measured in accordance with Method D2122. The tolerances for out-of-roundness shall apply to the pipe at the time of manufacture.

7.2.2 *Wall Thickness*—The wall thickness and tolerances shall meet the requirements of Table 2 when measured in accordance with Method D2122.

7.2.3 *Length*—The pipe shall be in either 10 or 20-ft (3.05 or 6.1-m) lengths, unless otherwise specified. The allowable tolerance on the length shall be +½,–0 in.

7.3 *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 3. 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 7.3.1. If all three fail, the sample does not meet the requirement.

7.3.1 *Pipe Stiffness and Lower Confidence Limit*—In the event that one or two of the specimens tested in 7.3 fail to meet the minimum requirement, the average pipe stiffness of eleven specimens shall meet or exceed the minimum requirement given in Table 3. 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 3, but is not within 15 % of the average, the sample meets the requirements of the Pipe Stiffness testing. The eleven specimens include the three tested under 7.3, 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 (Note: $N = 11$):

$$\text{LCL} = (\text{Average PS}) - \{2.76\,(\text{Standard Deviation})/\sqrt{(N)}\} \quad (1)$$

where:

$$(\text{Average PS}) = \left[\sum(\text{PS}_i)\right]/(11) \quad (2)$$

$$(\text{Standard Deviation}) = \left[\frac{\sum \text{PS}^2 - (\sum \text{PS})^2/\text{N}}{N-1}\right]^{1/2} \quad (3)$$

TABLE 1 Outside Diameter and Tolerance

Outside Diameter, in. (mm)			
Nominal Pipe Sizes, in.	Average	Tolerance on Average Outside Diameter	Out-of-Roundness Maximum Diameter Minus Minimum Diameter[A]
1¼	1.660 (42.16)	+0.010, –0.000 (+0.25, –0.00)	0.024 (0.60)
1½	1.900 (48.26)	+0.010, –0.000 (+0.25, –0.00)	0.024 (0.60)
2	2.375 (60.32)	+0.010, –0.000 (+0.25, –0.00)	0.024 (0.60)
3	3.500 (88.90)	+0.015, –0.000 (+0.38, –0.00)	0.060 (1.52)
4	4.500 (114.30)	+0.015, –0.000 (+0.38, –0.00)	0.100 (2.54)
6	6.625 (168.28)	+0.016, –0.006 (+0.41, –0.15)	0.100 (2.54)
8	8.625 (219.07)	+0.022, –0.008 (+0.56, –0.20)	0.150 (3.81)

[A] Measured at time of manufacturing.

TABLE 2 Wall Thickness and Tolerance

Nominal Pipe Sizes, in.	Wall Thickness, in. (mm)	
	Minimum Wall[A]	Tolerance
1¼	0.140 (3.56)	+0.020 (+0.50)
1½	0.145 (3.68)	+0.020 (+0.50)
2	0.154 (3.91)	+0.020 (+0.50)
3	0.216 (5.42)	+0.026 (+0.66)
4	0.237 (6.02)	+0.028 (+0.71)
6	0.280 (7.11)	+0.034 (+0.86)
8	0.322 (8.18)	+0.034 (+0.86)

[A] The minimum is the lowest wall thickness of the pipe at any cross section.

TABLE 3 Pipe Stiffness

Nominal Pipe Sizes, in.	Minimum Pipe Stiffness at 5 % Deflection	
	psi	(MPa)
1¼	600	(4.13)
1½	535	(3.69)
2	300	(2.06)
3	280	(1.93)
4	175	(1.21)
6	75	(0.52)
8	75	(0.52)

The 15 % requirement is calculated as:

$$(\text{Average} - \text{LCL})/(\text{Average}) \times 100\ \% \leq 15\ \% \quad (4)$$

NOTE 3—This test is conducted at the time of manufacture.

NOTE 4—The 5 % deflection criterion 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 deflection limit.

NOTE 5—The strength and load-carrying capabilities of composite DWV pipe is measured and reported as pipe stiffness, that is determined in accordance with Test Method D2412. The term "crushing strength" is not applicable to thermoplastic piping.

7.4 *Pipe Flattening*—There shall be no evidence of rupture or cracking when deflected 25 % of the initial inside diameter when tested by Test Method D2412. Test three specimens. When all pass, accept the lot. When one fails, the lot does not meet the requirements of this specification. Failure shall be a crack or break extending entirely through the pipe wall visible to the unaided eye. Refer to 9.1 (see Note 3).

7.5 *Impact Resistance*—The minimum impact resistance, when tested at the time of manufacture, shall comply with the requirements of Table 4. Test in accordance with Test Method D2444 using Tup B and Holder B. Use a 20–lb (9.1 kg) tup for all sizes.

7.5.1 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 Impact Resistance

Nominal Pipe Sizes, in.	Minimum Impact Resistance, ft lb3 lbf (J)
	At 32°F (0°C)
1¼	15 (20)
1½	20 (27)
2	30 (41)
3	40 (54)
4	40 (54)
6	40 (54)
8	40 (54)

7.5.2 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.

7.6 *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 bond occur between layers during testing performed under the requirements of this specification. Refer to 9.1 (see Note 3).

7.7 *Inspection*—Inspection shall be made prior to installation of all pipe. Pipe that does not meet the requirements of Section 8 shall be returned to the seller.

7.8 *Solvent Cement*—In the assembly of solvent cement joints, the solvent cement shall be compatible with the material in the outer layer, as marked on the pipe, and shall meet the requirements of Specification D2235.

7.8.1 The safety requirements of Practice F402 shall be followed.

7.9 *Qualification Test:*

7.9.1 *Joint Tightness*—Join two pieces of pipe together using molded fittings and solvent cement. Use solvent cement meeting the requirements of 7.8. 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 9.1.

NOTE 6—The qualification test is designed to qualify the thickness of the outer layer, to ensure that the thickness of the outer layer is sufficient to withstand the effect of the solvent cement, and thus ensure a good leak-free joint.

8. Sampling and Conditioning for Quality Control Testing

8.1 *Sampling*—The lot shall consist of all pipe produced of one size from one extrusion line during one designated 24-h period. Take the number of specimens for each test from pipe selected at random from each lot under the random sampling plan of Practice D1898.

NOTE 7—Also see Practices E105 and E122.

8.2 *Conditioning:*

8.2.1 For referee testing at 73° F, condition the specimens prior to the test at 73.4 ± 3.6°F (23 ± 2°C) and 50 ± 5 % relative humidity in accordance with Practice D618, Procedure A.

8.2.2 For routine quality control testing at 73°F, condition the specimens at the temperature and humidity of the manufacturers testing facility for not less than 1 h or until the specimens are at room temperature.

8.2.3 For referee testing at 32°F, condition the specimens at 32 ± 3.6°F (0 ± 2°) for at least 16 h in air.

8.2.4 For quality control testing at 32°F , condition the specimens at 32 ± 3.6°F (0 ± 2°C) for at least 12 h, or in ice water for at least 1 h.

8.3 *Test Conditions:*

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

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

8.3.3 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.

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

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

8.6 *Test Conditions For Quality Control Testing*—Conduct quality control testing at the temperature and humidity of the manufacturer's testing area in accordance with Practice D618.

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

8.7.1 Outside diameter,

8.7.2 Wall thickness,

8.7.3 Length,

8.7.4 Pipe stiffness,

8.7.5 Pipe flattening,

8.7.6 Impact strength, and

8.7.7 Bond.

8.8 *Referee Testing:*

8.8.1 *Sampling*—Collect specimens in accordance with 8.1. The number of specimens shall be sufficient to obtain a complete set of test results for those properties to be measured. Prepare specimens in accordance with the applicable ASTM test method.

8.8.2 *Conditioning for Referee Testing*—Condition the specimens prior to test at 73.4 ± 3.6°F (23 ± 2°C) or 32 ± 3.6°F (0 ± 2°C) and 50 ± 5 % relative humidity in accordance with Procedure A of Practice D618.

8.8.3 *Test Conditions for Referee Testing*—Conduct tests in the standard laboratory atmosphere of 73.4 ± 3.6°F (23 ± 2°C) and 50 ± 5 % relative humidity.

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

8.9 *Responsibility for Testing and Inspection*—The producer is responsible for the performance of all test and inspection requirements specified herein. The producer is permitted to use his own or any other suitable facility for the performance of the testing and inspection requirements of this specification.

8.9.1 The testing and inspection shall be under ANSI Z 34.1 or ANSI Z 34.2.

9. Retest and Rejection

9.1 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. There shall be no agreement to lower the minimum requirement of this specification by such means as omitting test methods that are a part of the specification, 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. When failure occurs on retest, the lot of the product represented by the test(s) does not meet the requirements of this specification.

10. Product Marking

10.1 *Quality of Marking*—The marking shall be applied to the pipe in such a manner that it shall remain legible (easily read) after installation and inspection.

10.2 *Content of Marking*—The pipe is permitted to be marked on two sides, 180° apart, at not more than 5 ft (0.6 m), depending on the method of marking, in letters not less than 3⁄16 in. (5 mm) high, in a contrasting color with the following information:

10.2.1 Manufacturer's name (or trademark),

10.2.2 This designation "F1499" including the year of issue,

10.2.3 *Material Marking*—The identification of the materials shall be by abbreviations in accordance with Terminology D1600. The layers are identified in accordance with Practice D1972 as the outer layer, middle layer, and inner layer or outer layer and inner layer, depending on whether a three-layer or two-layer die system is used,

10.2.4 Coextruded composite drain, waste, and vent pipe is produced in iron pipe size (IPS) and Schedule 40 wall thicknesses and shall be marked IPS SCH40 with the appropriate composite pipe material composition as in accordance with 10.2.3,

10.2.4.1 Coextruded composite drain, waste, and vent pipe with a thermally foamed middle layer shall be marked "Cellular Core DWV",

10.2.5 Nominal pipe size, and

10.2.6 Manufacturer's code for compound, lot, and date of manufacture.

11. Quality Assurance

11.1 When the product is marked with this designation, F1499, 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.

12. Keywords

12.1 ABS; 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 the performance of all inspection and test requirements specified herein. The producer may use his own or any suitable facilities for the performance of the inspection and test requirements herein, unless disapproved by the purchaser. 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 Government contracts, the contractor is responsible for inspection.

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

S2.1 *Packing*—Unless otherwise specified in the contract, the material 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 U.S. Federal Government procurement requirements should not be construed as an indication that the U.S. Federal Government uses or endorses the products described in this specification.

APPENDIXES

(Nonmandatory Information)

X1. STORAGE

X1.1 *Outside Storage*—Coextruded composite drain, waste, and vent pipe DWV is permitted to be stored outside on a flat surface or supported in a manner that will prevent sagging or bending. Do not store coextruded composite drain, waste, and vent pipe DWV in direct sunlight for long periods.

X1.2 Inventories of coextruded composite drain, waste, and vent pipe DWV should be used on a first-in-first-out basis.

X2. JOINING

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

X2.2 *Pipe Fit*—Coextruded composite drain, waste, and vent pipe DWV is manufactured to close tolerances for "interference" fit between the coextruded composite drain, waste, and vent pipe DWV and the fitting socket. During assembly, use only combinations of coextruded composite drain, waste, and vent pipe DWV and fittings that give proper interference fit. The pipe should enter the dry fitting socket to between one half and two thirds of the fitting socket depth. The allowable tolerance assures a forced fit and when solvent cement is used, the pipe and fittings will readily mate, thus assuring physical fusion. Coextruded composite drain, waste, and vent pipe DWV that is a loose fit in the socket does not ensure a proper bond.

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

cutting plastic pipe, and their use is recommended.

X2.4 *Cleaning*—Remove burrs from inside and outside pipe edges. Wipe off all dust, dirt, and moisture from surfaces to be cemented with a clean dry rag or a paper towel. At no time should pipe or fittings be assembled that are wet or damp. Pipe and fittings must be dry before assembly to obtain good joints.

X2.5 *Safety Requirements for Solvent Cement and Primers*—Follow Practice F402.

X2.6 *Solvent Cement*—Use a solvent cement meeting the requirements of Specification D2235. The recommendations of the solvent cement manufacturer for use should be followed for best results.

X2.6.1 *Application of Solvent Cement*— Using the applicator supplied with the can of solvent cement, or a brush or roller with a width of about one half the coextruded composite drain, waste, and vent pipe DWV diameter for pipe sizes above 2 in. (51 mm), apply a moderate even coating of cement in the fitting socket to cover only the surfaces to be joined. Heavy or excessive application of solvent cement may become an obstruction in the pipe and prevent satisfactory joining. Quickly 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.

X2.7 *Assembly*—Make the joint as quickly as possible after application of the solvent cement and before the solvent cement dries. Should the solvent cement dry partially before the joint is made up, reapply solvent cement before assembling. Insert the pipe into the fitting socket, making sure that it is inserted to the full depth of the fitting socket. Hold joint together for about 30 s for small diameter pipe and 60 s for diameters above 6 in. (152 mm) to avoid push-out. Remove excessive solvent cement from the exterior of the joint with a clean, dry cloth. However, a continuous bead of solvent cement at the juncture of the pipe and socket entrance indicate sufficient solvent cement was applied.

X2.8 *Set Time*—Do not attempt to disturb the coextruded composite drain, waste, and vent pipe and fitting joint until after the solvent cement has set or damage to the joint and loss of fit could 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.

X2.9 *Alignment*—Align pipe and fittings accurately to avoid excessive stress in the pipe, and fittings joint. Misalignment constitutes a plumbing code violation and should be avoided. See X2.6.

X2.10 *Cure Time*—Joint strength development is very rapid during periods of high-ambient temperatures, lowrelative humidity, and with high-interference fittings. Joint strength development is not as rapid during periods of lowambient temperatures, high-relative humidity, and using loose fits. The recommendations of the solvent cement manufacturer should be followed for best results and leakfree joints.

X3. INSTALLATION

X3.1 *Underground Installation*—Underground installation of pipe shall be in accordance with the excavation, bedding and backfill provisions of the Plumbing Code having jurisdiction except maximum aggregate size shall be limited to ½ in. (13 mm) for angular and ¾ in. (19 mm) for rounded particles. For special conditions Design Engineers may wish to consult Practice D2321.

TABLE X3.1 Linear Thermal Expansion

Composite ABS/PVC Pipe Coefficient of Expansion: Inch-Pound Units
33×10^{-6} in./in./°F = 0.000033

Amount of Expansion/Contraction, Inches Movement per Inches of Pipe Length per Degree 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		1.19	1.58	1.98	2.38	2.77	3.17	3.56	3.96

Composite ABS/PVC Pipe Coefficient of Expansion: Metric Units
60×10^{-6} cm/cm/°C = 0.000060

Amount of Expansion/Contraction, Centimetres Movement per Centimetre of Pipe Length per Degree Celsius (Temperature Change)										
m	cm	°C	10	20	30	40	50	60	70	80
5	500		0.3	0.6	0.9	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

X3.2 *Coextruded Composite DWV Installation*—Pipe should be installed in conformance with governing building codes. In areas not governed by codes, pipe should be installed in accordance with accepted engineering practices.

X3.3 *Installation Under Freezing Conditions*—Coextruded composite drain, waste, and vent pipe DWV has a good resistance to impact under freezing conditions but if installation is likely to occur under these conditions, care should be taken, particularly during handling, transportation, installation, and backfilling. Provision for expansion and contraction, as listed in X3.13, shall be made when the 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. The grade of horizontal drainage and vent piping shall be as specified in the applicable code.

X3.5 *Support and Spacing*—Hangers and straps should not compress, distort, cut, or abrade the piping and should allow free movement of pipe. Support all piping at intervals of not more than 4 ft (1.2 m) at the 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 (0.9 m) in length as closely as possible to the trap. Securely fasten closet rings with corrosion-resistant fasteners to the floor with the top surface ¼ in. (6.4 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 pipe. Molded thread adapter fittings are used for transition to threaded construction. The joint between the pipe and transition fittings should be of the solvent-cement type. Only approved thread tape or thread lubricant specifically intended for use with ABS plastic pipe should be used. Conventional pipe thread compound, putty, linseed oil-base products, and unknown mixtures should be avoided. TFE-fluorocarbon tape should be used.

X3.7 *Thread Tightness*—Where a threaded joint is made, obtain tightness by a maximum hand tightening plus additional tightening with a strap wrench, not to exceed one full turn.

X3.8 *Connection to Nonplastic Pipe*—When connecting plastic pipe to other types of piping, use only approved types of fittings and adapters designed for the specific transition. TFE-fluorocarbon tape should be used for threaded joints.

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

X3.10 *Connections to Closet Flanges*—Install screw-type closet flanges in the drainage system by means of a threaded connection.

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 or gasketed 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 that no settlement will be encountered. Bottom of pipe must rest on this material throughout the entire length.

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

X3.14 *Coefficient of Linear Thermal Expansion as Determined by Test Method D696:*

X3.14.1 *Derivation*—Thermal expansion is calculated from the coefficient of linear thermal expansion as determined by Test Method D696. The average values are:

English units (inch/Fahrenheit) 33×10^{-6} (=0.000033)-in. movement, per inch of pipe length, per degree Fahrenheit temperature rise (expansion) or fall (contraction). Metric units (centimetre/Celsius) 60×10^{-6} (=0.000060)-cm movement, per centimetre of pipe length, per degree Celsius temperature rise (expansion) or fall (contraction).

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	80 ft	30 m

Calculation of amount of linear expansion to be allowed for:
English units – (0.000033) × 960 (12 in. × 80 ft) × 30 (°F) = 109 (in.)
Metric units – (0.000060) × 3000 (30 m × 100 cm) × 40 (°C) = 7.2 (cm)
confirms results in Table X3.1. Tabular data may be interpolated to avoid calculation.

X3.15 *Exposed Piping*—Provide adequate support where piping is exposed to wind, snow, and ice loading. Plumbing vents exposed to sunlight should be protected by painting with a water-base acrylic paint or synthetic latex paints. Where surface temperatures exceed 165°F (74°C), piping shall be protected by means of shielding or some type of lightweight insulation.

X3.15.1 Exposure to sunlight during normal construction periods is not harmful. It is good practice to store pipe and fittings under suitable cover prior to installation.

X3.16 *Antifreeze Protection*—When necessary 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:

X3.16.1 60 %, by mass, of glycerin in water, and

X3.16.2 22 %, by mass, of magnesium chloride or common salt, in water.

X3.17 *Commercial and Industrial Applications:*

X3.17.1 Coextruded composite drain, waste, and vent pipe DWV will accommodate temperatures of 180°F (71°C) in household applications. To run higher temperatures, for example, commercial dishwashers, requires special consideration.

X3.17.2 Waste disposal lines where concentrated agents and certain chemicals that are routinely present and that may be aggressive to plastic piping should only be installed with the specific approval of the cognizant building code authority. Service station bay area floor drains require special consideration.

X3.18 *Fire-rated Construction*—When the piping is to be installed within or penetrating fire-rated constructions, the cognizant building code authorities should be consulted for approved methods of construction of fire barriers.

NOTE X3.1—Fire barriers are either mechanical devices that close off penetration openings or intumescent materials that expand with heat to form a char that make a flame- and water-resistant seal.

X3.18.1 All fire barriers should bear the seal of approval and classifications of the approving laboratory recognized as qualified to perform such evaluations, for example UL.

X4. PREFABRICATED PLUMBING TREES

X4.1 When prefabricated plumbing trees are assembled, it is important that the recommendation of Appendix X2 on Joining, and Appendix X3 on Installation, where applicable, be followed for satisfactory results.

SUMMARY OF CHANGES

Committee F17 has identified the location of selected changes to this standard since the last issue (F1499–01(2008)) that may impact the use of this standard.

(1) Removed Specification D4396 from 2.2, and added Specification D1784.

(2) Removed Specification D4396 references from 6.3, and added Specification D1784.

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