



Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings¹

This standard is issued under the fixed designation D 2661; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This specification covers fittings and single and coextruded acrylonitrile-butadiene-styrene (ABS) plastic drain, waste, and vent pipe (DWV) made to Schedule 40 iron pipe sizes (IPS). Plastic which does not meet the material requirements specified in Section 5 is excluded from single layer and all coextruded layers.

1.2 Specification for fittings for use with pipe meeting the requirements of this specification are given in Annex A1.

1.3 Acrylonitrile-butadiene-styrene plastic, which does not meet the definition of virgin ABS plastic as given in 3.2.2, is excluded, as performance of plastic other than those defined as virgin was not determined. ABS rework plastic, which meets the requirements of rework plastic as given in 5.3, is acceptable.

1.4 Reprocessed plastic or recycled plastic as defined in Terminology D 883 is excluded.

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

1.6 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 the specification.

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

2. Referenced Documents

2.1 ASTM Standards:

D 618 Practice for Conditioning Plastics for Testing²

D 883 Terminology Relating to Plastics²

D 1600 Terminology for Abbreviated Terms Relating to Plastics²

D 1898 Practice for Sampling of Plastics²

D 2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings³

D 2135 Specification for Molded Drain, Waste, and Vent (DWV) Short-Pattern Plastic Fittings²

D 2235 Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings³

D 2321 Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications³

D 2412 Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Pipe Loading³

D 2444 Test Method for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)³

D 3311 Specification for Drain, Waste, and Vent (DWV) Plastic Fittings Patterns³

D 3965 Specification for Rigid Acrylonitrile-Butadiene-Styrene (ABS) Materials for Pipe and Fittings⁴

E 105 Practice for Probability Sampling of Materials⁵

E 122 Practice for Calculating Sample Size to Estimate, With a Specified Tolerable Error, the Average for a Characteristic of a Lot or Process⁵

F 402 Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings³

F 412 Terminology Relating to Plastic Piping Systems³

F 1498 Specification for Taper Threads 60° for Thermoplastic Pipe and Fittings³

F 2135 Specification for Molded Drain, Waste, and Vent (DWV) Short-Pattern Plastic Fittings³

2.2 Federal Standard:

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)⁶

2.3 Military Standard:

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.

Current edition approved May 10, 2002. Published July 2002. Originally published as D 2661 – 67. Last previous edition D 2661 – 01.

² Annual Book of ASTM Standards, Vol 08.01.

³ Annual Book of ASTM Standards, Vol 08.04.

⁴ Annual Book of ASTM Standards, Vol 08.02.

⁵ Annual Book of ASTM Standards, Vol 14.02.

⁶ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

MIL-STD-129 Marking for Shipment and Storage⁶

3. Terminology

3.1 *Definitions*—Definitions are in accordance with Terminology F 412, and abbreviations are in accordance with Terminology D 1600, unless otherwise specified. The abbreviation for acrylonitrile-butadiene-styrene is ABS.

3.1.1 *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.

3.1.2 *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 *room temperature*—a temperature in the range from 68 to 85 ± 3.6°F (20 to 30 ± 2°C).

3.2 *Definitions of Terms Specific to This Standard:*

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

3.2.2 *recycled plastic*—a plastic prepared from discarded articles that have been cleaned and reground.

3.2.3 *reprocessed plastic*—a thermoplastic usually prepared from melt processed scrap or reject parts by a plastics processor, or from nonstandard or nonuniform virgin material.

3.2.4 *virgin ABS plastic*—plastic 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.

4. Classification

4.1 The requirements of this specification are intended to provide pipe suitable for the drainage and venting of sewage and certain other liquid wastes.

NOTE 1—Industrial waste disposal lines should be installed only with the specific approval of the cognizant building code authority since chemicals not commonly found in drains and sewers and temperatures in excess of 180°F (82°C) may be encountered.

5. Materials

5.1 *Material Specification*—Virgin black ABS plastic shall conform to the requirements prescribed in Specification D 3965 with a cell classification of 4-2-2-2-2. The form of the material shall be as agreed upon between the seller and the purchaser in accordance with Specification D 3965.

5.2 The ABS plastic shall conform to the following requirements:

5.2.1 *Acrylonitrile-Butadiene-Styrene (ABS) Plastic*—Plastic containing polymers or blends of polymers shall contain a minimum of 15 % acrylonitrile, 6 % butadiene, and 15 % styrene or substituted styrene, or both. ABS plastic shall contain no more than 10 % of other monomeric or polymeric components plus other necessary compounding ingredients.

5.3 *Rework Material*—The manufacturer shall use only his own clean pipe or fitting rework material conforming with these cell class requirements. The pipe or fittings produced shall meet all the requirements of this specification.

6. Requirements

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

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

6.2 *Dimensions and Tolerances:*

6.2.1 *Outside Diameter*—The outside diameter and tolerances shall meet the requirements of Table 1 when measured in accordance with Test Method D 2122. The tolerance for out-of-roundness shall apply to pipe prior to shipment.

6.2.2 *Wall Thickness*—The wall thickness and tolerances shall meet the requirements of Table 2 when measured in accordance with Test Method D 2122.

6.2.3 *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 length shall be +½, -0 in. (+12, -0 mm).

6.3 *Performance Requirements:*

6.3.1 *Pipe Stiffness*—The minimum pipe stiffness values at 5 % deflection when measured in accordance with Test Method D 2412, shall equal or exceed the values 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 6.3.1.1. If all three fail, the sample does not meet the requirement.

6.3.1.1 *Pipe Stiffness and Lower Confidence Limit*—In the event that one or two of the specimens tested in 6.3.1 fail to meet the minimum requirement, the average pipe stiffness of

TABLE 1 Outside Diameters and Tolerances for ABS Schedule 40 Plastic Drain, Waste, and Vent Pipe

Nominal Pipe Size, in.	Outside Diameter		
	Average, in. (mm)	Tolerance on Average, in. (mm)	Out-of-Roundness Maximum Diameter Minus Minimum Diameter, in. (mm) ^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)	0.030 (0.76)
4	4.500 (114.30)	+0.015, -0.000 (+0.38, -0.00)	0.030 (0.76)
6	6.625 (168.28)	+0.011, -0.011 (+0.28, -0.28)	0.050 (1.27)

^AMeasured at time of manufacturing.

TABLE 2 Wall Thickness and Tolerance for ABS Schedule 40 Drain, Waste, and Vent Pipe

Nominal Pipe Size, in.	Wall Thickness ^A	
	Minimum Wall, in. (mm)	Tolerance, in. (mm)
1¼	0.140 (3.56)	+0.015 (+0.38) –0.000 (–0.00)
1½	0.145 (3.68)	+0.015 (+0.38) –0.000 (–0.00)
2	0.154 (3.91)	+0.015 (+0.38) –0.000 (–0.00)
3	0.216 (5.42)	+0.020 (+0.51) –0.000 (–0.00)
4	0.237 (6.02)	+0.024 (+0.61) –0.000 (–0.00)
6	0.280 (7.11)	+0.030 (+0.76) –0.000 (–0.00)

^AThe minimum is the lowest wall thickness of the pipe at any cross section.

TABLE 3 Pipe Stiffness of ABS Schedule 40 Plastic Drain, Waste, and Vent Pipe

Nominal Pipe Size, in.	Minimum Pipe Stiffness at 5 % Deflection	
	psi	(MPa)
1¼	870	(6.00)
1½	630	(4.34)
2	370	(2.55)
3	320	(2.20)
4	190	(1.31)
6	95	(0.65)

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. 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 6.3.1, and an additional eight with rotation by 35°, as specified in Test Method D 2412, continuing throughout the remaining specimens.

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

$$\text{LCL} = (\text{avg PS}) - \{2.76(\text{std. dev.})/\sqrt{(N)}\} \quad (1)$$

where:

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

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

$$N = 11.$$

6.3.1.3 The 15 % requirement is calculated as follows:

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

NOTE 2—For quality control testing, a single specimen may be used

with the thinnest wall at the top.

NOTE 3—The 5 % deflection criteria is arbitrarily selected for testing convenience. It should not be considered as a limitation with respect to in-use deflection. The engineer is responsible for establishing the acceptable deflection limit.

NOTE 4—The strength and load-carrying capabilities of plastic pipe are measured and reported as pipe stiffness, which is determined in accordance with Test Method D 2412. The term “crush strength” is not applicable to plastic piping because the values obtained can be significantly different, depending on the bedding, loading, or testing technique used, and because the term derives from rigid pipe and refers to its ultimate strength at rupture.

6.3.2 *Pipe Flattening*—There shall be no evidence of rupture when pipe is deflected 40% of the initial inside diameter when tested in accordance with Test Method D 2412. The rate of head approach shall be 0.20 to 0.25 in./min (5.1 to 6.3 mm/min). Three specimens shall be tested. All shall meet the requirements. Failure shall be a crack or break extending entirely through the pipe wall visible to the unaided eye.

6.3.3 *Impact Resistance*—The minimum impact resistance, when tested at the time of manufacture, shall comply with Table 4. Test in accordance with Test Method D 2444 using Tup B and Holder B. Use a 30-lb (13.6 kg) tup for testing all pipe sizes.

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

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

6.4 Coextruded Pipe:

6.4.1 *Thickness of Outer Layer*—For pipe produced by the coextrusion process, that is, pipe containing two or more concentric layers, the outer layer shall be at least 0.020 in. (0.50 mm) thick and shall contain pigments or screening agents to provide protection against UV radiation.

6.4.2 *Bond*—For pipe produced by the coextrusion process, that is, pipe containing two or more concentric layers, the bond between the 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 so 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.

TABLE 4 Impact Resistance of ABS Schedule 40 Plastic Drain, Waste, and Vent Pipe

Nominal Pipe Size, in.	Minimum Impact Resistance, ft-lbf (J)	
	At 73°F	(23°C)
1¼	20	(27)
1½	30	(41)
2	40	(54)
3	60	(81)
4	60	(81)
6	100	(136)

6.5 Other Requirements:

6.5.1 *Inspection*—Before installation the pipe shall be inspected. Pipe which does not meet the requirements of this specification shall be returned to the seller.

6.5.2 *Joining*—ABS schedule 40 drain, waste, and vent (DWV) are joined using molded fittings meeting the requirements of Annex A1 of this specification.

6.5.3 *Solvent Cement*—In the assembly of solvent cement joints, the safety requirements of Practice F 402 shall be followed using solvent cement meeting the requirements of Specification D 2235.

7. Sampling and Conditioning

7.1 *Sampling*—For the purpose of testing, the lot shall consist of all pipe produced of one size, from one extrusion line, during one designated 24-h period. The number of specimens designated for each test shall be taken from pipe selected at random from each lot in accordance with the random sampling plan of Practice D 1898.

NOTE 5—Refer to Practices E 105 and E 122.

7.2 *Number of Tests for Quality Control*—When evaluating the product against this specification, the following minimum number of specimens shall be tested for each lot.

7.2.1 *Outside Diameter*—One specimen per extrusion line.

7.2.2 *Wall Thickness*—One specimen per extrusion line.

7.2.3 *Length*—One specimen per extrusion line.

7.2.4 *Pipe Stiffness*—A minimum of three specimens per extrusion line. (See Note 2.)

7.2.5 *Pipe Flattening*—A minimum of three specimens per extrusion line.

7.2.6 *Impact Strength*—A minimum of ten specimens and a maximum of 40.

7.2.7 *Bond*—One specimen for each extrusion line.

7.3 *Conditioning*:

7.3.1 For referee purposes, condition the specimens prior to test at $73.4 \pm 3.6^{\circ}\text{F}$ ($23 \pm 2^{\circ}\text{C}$) and $50 \pm 5\%$ relative humidity in accordance with Practice D 618, Procedure A.

7.3.2 For routine quality control testing, 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.

7.4 *Test Conditions*:

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

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

7.5 *Test Methods*—Use only the specified ASTM test methods.

8. Retest and Rejection

8.1 If the results of any test(s) do not meet the requirements of this specification, the test(s) shall be conducted again only by agreement between the purchaser and the seller. Under such agreement, minimum requirements shall not be lowered, changed, or modified, nor shall specification limits be changed. If, upon retest, failure occurs, the quantity of product represented by the test(s) does not meet the requirements of this specification.

9. Product Marking

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

9.2 *Content of Marking*—The pipe shall be marked on two sides 180° apart at least every 2 ft (0.6 m) in letters not less than $\frac{3}{16}$ in. (5 mm) high, in a contrasting color with the following information:

9.2.1 The manufacturer's name (or trademark).

9.2.2 The designation "ASTM D 2661".

9.2.3 Nominal pipe size (for example, 2 in. (51 mm)).

9.2.4 The manufacturer's code for resin manufacturer, lot number, and date of manufacture.

9.2.5 *Single Extrusion Pipe*—The pipe produced by single extrusion process shall be marked "ABS DWV".

9.2.6 *Coextruded Pipe*—The pipe produced by the coextrusion process shall be marked "COEXTRUDED ABS DWV".

10. Quality Assurance

10.1 When the product is marked with this designation, D 2661, the manufacturer affirms that the product was manufactured, inspected, sampled, and tested in accordance with this specification and has been found to meet the requirements of this specification.

11. Keywords

11.1 ABS; DWV; fittings; pipe; plastic; Schedule 40; thermoplastic

SUPPLEMENTARY REQUIREMENTS

GOVERNMENT/MILITARY PROCUREMENT

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

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

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

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

S2.1 Packaging—Unless otherwise specified in the contract, the 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 S1.1—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.

ANNEX

(Mandatory Information)

A1. ABS FITTINGS

A1.1 The pattern, dimension, and laying length of fittings shall meet the requirements of Specification D 3311 and Table A1.1 when determined in accordance with Test Method D 2122.

A1.2 The pattern, dimension, and laying length of Short-Pattern fittings shall meet the requirements of Specification F 2135.

A1.3 Fittings produced by any molding process shall be made of virgin black ABS plastic which shall conform to the requirements prescribed in Specification D 3965 with a cell classification of 3-2-2-2. The form of the material shall be as agreed upon between the seller and the purchaser in accordance with Specification D 3965.

A1.4 Rework Material—The manufacturer shall use only his own clean rework fitting material and the fittings produced shall meet all the requirements of this specification.

A1.5 The spigot dimensions of the fittings shall meet the

requirements of Table 1 and Table 2.

A1.6 For all fittings having taper pipe threads, threads shall conform to and be gaged in accordance with Specification F 1498.

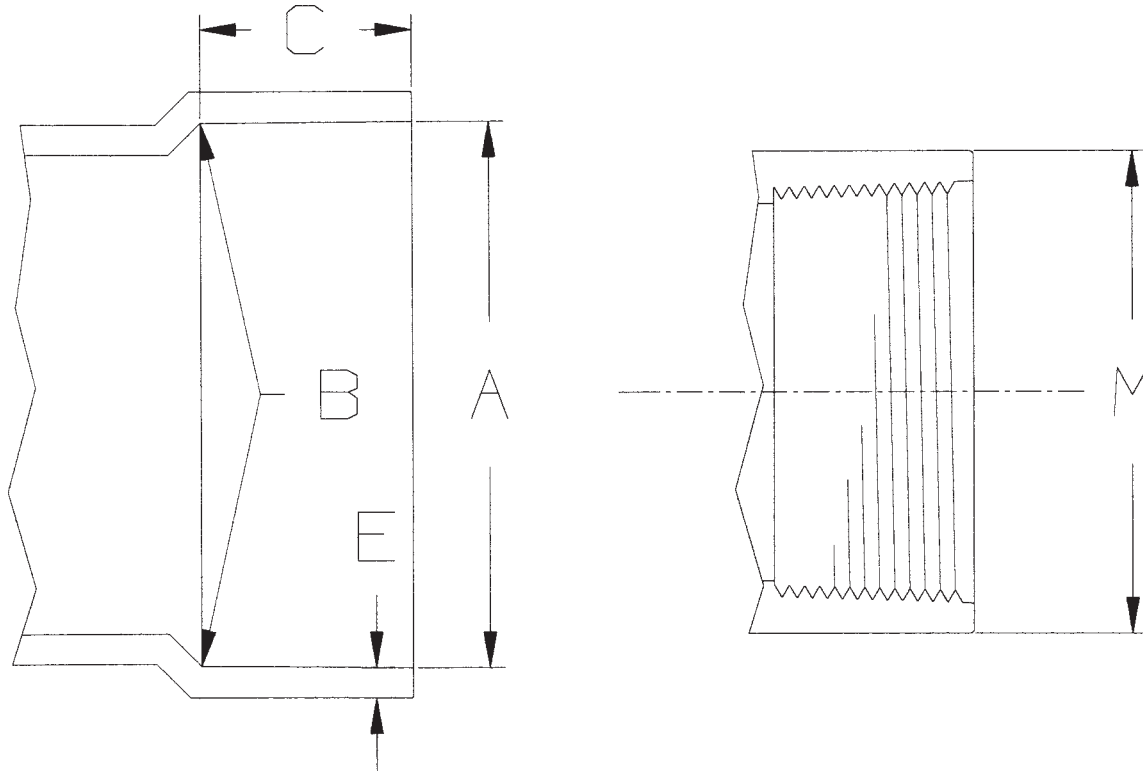
A1.7 Individual fittings unassembled shall withstand a minimum load of 750 lbf/ft (11 kN/m) of centerline length without visible evidence of failure when tested in accordance with Test Method D 2412.

A1.8 Individual fittings unassembled shall meet a minimum impact of 20 ft·lbf (27 J) when tested in accordance with Test Method D 2444 at 73°F (23°C) using a 12-lb (5-kg) Tup C and Holder B. Test inline couplings cemented to short pieces of pipe and allow to dry for at least 24 h.

A1.9 Solvent cement meeting the requirements of Specification D 2235 shall be used to join pipe and fittings.

A1.10 Fittings shall be marked on the body or hub with the manufacturer's name or trademark, and the symbol "ABS".

TABLE A1.1 Dimensions and Tolerances for ABS Schedule 40 Drain, Waste, and Vent Fittings



Nominal Pipe Size	A Socket Entrance Diameter			B Socket Bottom Diameter ^A			C Socket Depth, ^B min	E Wall Thickness ^C		Internal Threads	
	Average	Tolerance on Diam- eter	Out-of- Roundness (maximum minus minimum)	Average	Tolerance on Diam- eter	Out-of- Roundness (maximum minus minimum)		Average, min	Minimum After Core Shift	M Outside Diameter of Hub, min	Thread Length, min
1¼	1.670	+0.010 -0.005	0.024	1.655	±0.005	0.024	0.687	0.156	0.140	1.871	0.687
1½	1.910	+0.010 -0.005	0.024	1.895	±0.005	0.024	0.687	0.156	0.140	2.127	0.687
2	2.385	+0.010 -0.005	0.024	2.370	±0.005	0.024	0.750	0.156	0.140	2.634	0.750
3	3.515	+0.010 -0.005	0.030	3.495	+0.005 -0.010	0.030	1.500	0.218	0.196	3.841	1.187
4	4.515	+0.010 -0.005	0.030	4.495	+0.005 -0.010	0.030	1.750	0.250	0.225	4.907	1.281
6	6.647	±0.011	0.060	6.614	±0.011	0.060	3.000	0.281	0.253	7.203	1.500

^A Measure at the intersection of pipe stop cone with socket cylinder.

^B Measure from socket entrance to intersection of pipe stop cone with socket cylinder.

^C The average wall thickness is the minimum wall thickness plus the opposite wall thickness divided by 2. The average shall equal or exceed that shown in Table A1.1. The minimum wall thickness, due to core shift, shall equal or exceed the value shown in the table. The minimum wall thickness is determined by allowing a 10 % variation due to core shift.

APPENDIXES

(Nonmandatory Information)

X1. STORAGE

X1.1 *Outside Storage*—Plastic pipe should be stored on a flat surface or supported in a manner that will prevent sagging or bending. Do not store pipe in direct sunlight for long periods.

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

X2. JOINING

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

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

X2.3 *Cutting*—Pipe can be easily cut with an ordinary hacksaw or carpenter’s saw. Fine-tooth blades with little or no set should be used for best results. The pipe should be cut square and all burrs removed with a sharp knife, a fine-tooth file, or other suitable 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 ABS 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 F 402.

X2.6 *Solvent Cement*—Use only solvent cement designed for ABS. Use a solvent cement meeting the requirements of Specification D 2235.

X2.6.1 *Application of Cement*—Using the applicator supplied with the can of solvent cement, or a brush or roll with a width of about one half the pipe 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 the pipe is inserted to the full depth of the fitting socket. Hold the joint together firmly 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.

X2.8 *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 stresses of normal installation. A badly misaligned installation will cause excessive stresses in the joint, pipe, and fittings and constitutes a plumbing code violation and should be avoided. The recommendation of the solvent cement manufacturer should be followed for best results.

X2.9 *Cure Time*—Joint strength development is very rapid during periods of high ambient temperatures, low relative humidity, and using interference-type 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 should be followed for best results prior to leak testing.

X3. INSTALLATION

X3.1 Underground Installation—Underground installations of pipe shall be in accordance with the Plumbing Code, 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 D 2321.

X3.2 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—Plastic pipe has decreased resistance to impact under freezing conditions. Increased care should be exercised if installation is likely to occur under these conditions, particularly during handling, transportation, installation, and backfilling. Where possible, installation should be avoided during freezing conditions. Allowance shall be made for expansion that will occur when the temperature of the pipe is raised.

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 Supports and Spacing—Hangers and straps should not compress, distort, cut, or abrade the piping and should allow free movement of pipe. Support horizontal 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 with supports 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 close as possible to the trap. Securely fasten closed flanges 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 threads on adapter fittings for transition to threaded construction are necessary except in the case of cleanout plugs. 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.

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.

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

X3.10 Connection 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 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 undis-turbed 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 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. Thermal expansion for installations subject to temperature changes may be determined from Table X3.1. The linear expansion shown is independent of the diameter of the pipe. Buried piping or piping installed in the crawl space under a building is normally subject to less than the ambient temperature changes.

TABLE X3.1 Thermal Expansion Table of ABS Schedule 40 Drain, Waste, and Vent Pipe

Length, ft	Temperature Change, °F ^A						
	40	50	60	70	80	90	100
Length of Change, in. ^B							
20	0.5	0.7	0.8	0.9	1.0	1.2	1.3
40	1.1	1.3	1.6	1.9	2.0	2.4	2.7
60	1.6	2.0	2.4	2.8	3.2	3.6	4.0
80	2.1	2.7	3.2	3.8	4.3	4.8	5.4
100	2.7	3.4	4.0	4.7	5.4	6.0	6.7
Length, m	Temperature Change, °C						
	20	30		40		50	
Length of Change, mm							
10	20		30		40		50
20	40		60		80		100
30	60		90		120		150

^AExample of Temperature Change:

Highest temperature expected 100°F

Lowest temperature expected 50°F

Total variation 50°F

^BFor a length of run of 60 ft (20 m) the chart indicates that the installation should provide for a linear expansion of 2 in. (51 mm).

X3.14 Exposed Piping—Provide adequate support where piping is exposed 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 (74°C), piping shall be protected by means of shielding or some type of lightweight insulation. 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.

X3.15 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:

X3.15.1 Sixty percent, by mass, of glycerin in water.

X3.15.2 Twenty-two percent, by mass, of magnesium chloride in water. Strong solutions of common table salt (sodium chloride) may also be used.

X3.16 Commercial and Industrial Applications—The DWV pipe will accommodate temperature of 180°F (82°C) encountered in household applications, but the nature of some

applications to run to higher temperatures; for example, commercial dishwashers, require special consideration.

X3.17 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 or 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.

X3.17.1 All fire barriers should bear the seal of approval and classification of the approving laboratory recognized as qualified to perform such evaluations, for example UL.

NOTE X3.2—Use fire barrier products meeting this requirement.⁷

⁷ Fire barrier products that have been found satisfactory for this purpose are: “Flamarest,” available from AVCO Systems Division, Lowell Industrial Park, Lowell, MA 01851; “Flameseal,” available from Nelson Electric, P.O. Box 726, Tulsa, OK 74101; “Firebarrier,” available from 3M Electrical Products Division, 225-4N 3M Center, St. Paul, MN 55144; and “Fire Stop Foam,” available from Dow Corning, Dept. A6009, Midland, MI 48686.

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.

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