Designation: D2665 – 14

Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings[1]

This standard is issued under the fixed designation D2665; 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 U.S. Department of Defense.

1. Scope*

1.1 This specification covers requirements and test methods for materials, dimensions and tolerances, pipe stiffness, crush resistance, impact resistance, and solvent cement for poly(vinyl chloride) plastic drain, waste, and vent pipe and fittings. A form of marking is also included. Plastic which does not meet the material requirements specified in Section 5 is excluded. Installation procedures are given in the Appendix.

1.2 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.

1.3 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.

1.4 The following safety hazards caveat pertains only to the test methods portion, Section 7, of this specification: *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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D618 Practice for Conditioning Plastics for Testing

D1600 Terminology for Abbreviated Terms Relating to Plastics

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

D2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings

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

D3311 Specification for Drain, Waste, and Vent (DWV) Plastic Fittings Patterns

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

F1498 Specification for Taper Pipe Threads 60° for Thermoplastic Pipe and Fittings

F1866 Specification for Poly (Vinyl Chloride) (PVC) Plastic Schedule 40 Drainage and DWV Fabricated Fittings

F2135 Specification for Molded Drain, Waste, and Vent (DWV) Short-Pattern Plastic Fittings

3. Terminology

3.1 Definitions are in accordance with Terminology F412, and abbreviations are in accordance with Terminology D1600, unless otherwise specified.

4. Significance and Use

4.1 The requirements of this specification are intended to provide pipe and fittings 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 (82.2°C) may be encountered.

NOTE 2—This specification does not include requirements for pipe and fittings intended to be used to vent combustion gases.

5. Materials

5.1 *Basic Materials*—The pipe shall be made of virgin PVC compounds meeting or exceeding the requirements of Class

[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**

12454 as defined in Specification D1784. The fittings shall be made of virgin PVC compounds meeting or exceeding the requirements of Class 12344 as defined in Specification D1784, but with a tensile strength of not less than 6500 psi and a modulus of elasticity for not less than 380,000 psi. These plastics contain stabilizers, lubricants, and pigments.

5.2 *Rework Material*—The manufacturer shall use only his own clean pipe or fitting rework material, and the pipe or fittings produced shall meet all the requirements of this specification.

5.3 *Solvent Cement*—The solvent cement used to join pipe and fittings made to this specification shall meet the requirements of Specification D2564.

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 *Method*—All dimensions shall be determined in accordance with Test Method D2122.

6.2.2 *Dimensions:*

6.2.2.1 The outside diameter and wall thicknesses of pipe shall meet the requirements of Table 2. The pipe shall be in either 10 or 20-ft (3.05 or 6.1-m) lengths, unless otherwise specified, with an allowable tolerance of +½, −0 in. (+13, −0 mm).

6.2.2.2 The patterns, dimensions, and laying lengths of fittings, including adaptors, shall meet the requirements of Specification D3311 and Table 1.

6.2.2.3 Reducer bushings of sizes 2 by 1¼ and 4 by 3 shall be permitted to have the socket wall thickness and spigot wall thickness below the minimum requirements defined in Table 1, but not less than 0.098 in. (2.5 mm), provided the inner socket and outer spigot are reinforced by a minimum of four ribs. The thickness of the supporting ribs shall not be less than 0.098 in. (2.5 mm).

6.2.2.4 The patterns, dimensions, and laying lengths of Short-Pattern fittings shall meet the requirements of Specification F2135.

6.2.2.5 For all fittings having taper pipe threads, threads shall conform to Specification F1498 and be gaged in accordance with 7.5. Fittings of nominal sizes not given in Specification F1498 shall not have threads.

6.2.2.6 Fabricated DWV fittings shall comply with Specification F1866.

6.3 *Pipe Stiffness, Deflection Load and Flattening:*

6.3.1 *Pipe*—The minimum pipe stiffness at 5 % deflection shall be in accordance with Table 3. The pipe shall deflect by 60 % of the nominal outside diameter (flattening) without cracking, rupture, or other visible evidence of failure when tested in accordance with 7.4.

6.3.1.1 *Pipe Stiffness (PS)*—Three specimens shall be tested. If all three meet the PS requirement, the sample meets the PS requirement. If one or two fail, additional testing shall be conducted in accordance with 6.3.1.2. If all three fail, the sample does not meet the PS requirement.

6.3.1.2 *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 PS 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. 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 D2412, continuing throughout the remaining specimens.

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

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

where:

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

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

N = 11

6.3.1.4 The 15 % requirement is calculated as follows:

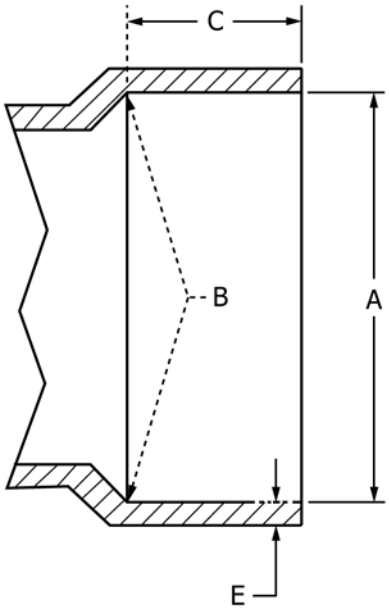
$$(Avg - LCL)/(Avg) \times 100 \leq 15\,\% \quad (3)$$

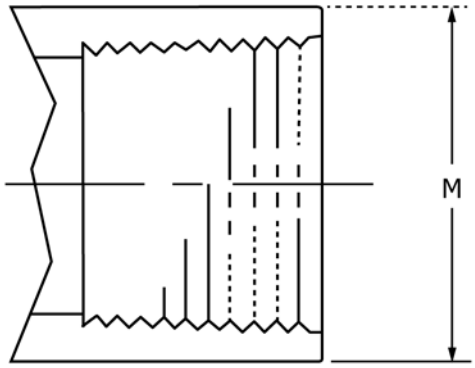
NOTE 3—The 5 % deflection criterion, which was arbitrarily selected for testing convenience, should not be considered as a limitation with respect to in-use deflection. The engineer is responsible for establishing the acceptable deflection.

6.3.2 *Fittings*—Individual fittings unassembled shall withstand a minimum load of 750 lbf/ft (11 kN/m) of centerline length without cracking or other visible evidence of failure when tested in accordance with 7.4.

6.4 *Impact Resistance*—The minimum impact resistance of pipe and fittings, when tested at the time of manufacture, shall comply with Table 4. Test in accordance with Test Method D2444 using Tup C and Holder A for pipe and Tup A and Holder B for fittings. Use a 12-lb (5-kg) tup for testing pipe sizes 4 in. and smaller and a 20-lb (10-kg) tup for pipe larger than 4 in. Test fittings with a 12-lb (5-kg) Tup. Test couplings cemented to short pieces of pipe and allowed to dry for 24 h. For fittings larger than 4-in, a symmetric section cut from the hub or body with a minimum centerline length of 2 in. shall be permitted to be used rather than the entire fitting.

TABLE 1 Dimensions and Tolerances for Fitting Sockets for PVC Schedule 40 Drain, Waste and Vent Pipe Fittings





Nominal Pipe Size	A			B			C	E	M	
	Socket Entrance Diameter			Socket Bottom Diameter			Socket Depth, min	Wall thickness min.[A]	Internal Threads	
	Average	Tolerance on Avg.	Out-of -Roundness	Average	Tolerance on Avg.	Out-of –Roundness			Outside Diameter of Hub, M. min.	Thread length min.
	in. (mm)									
1¼	1.675 (42.54)	+0.010/-0.005 (+0.25/-0.13)	0.024 (0.61)	1.655 (42.04)	±0.005 (±0.13)	0.024 (0.61)	0.687 (17.44)	0.156 (3.96)	1.871 (47.52)	0.687 (17.44)
1½	1.915 (48.64)	+0.010/-0.005 (+0.25/-0.13)	0.024 (0.61)	1.894 (48.11)	±0.006 (±0.15)	0.024 (0.61)	0.687 (17.44)	0.156 (3.96)	2.127 (54.03)	0.687 (17.44)
2	2.390 (60.71)	+0.010/-0.005 (+0.25/-0.13)	0.024 (0.61)	2.369 (60.17)	±0.006 (±0.15)	0.024 (0.61)	0.750 (19.05)	0.156 (3.96)	2.634 (66.90)	0.750 (19.05)
3	3.520 (89.41)	+0.010/-0.005 (+0.25/-0.13)	0.030 (0.76)	3.492 (88.70)	±0.008 (±0.20)	0.030 (0.76)	1.500 (38.10)	0.219 (5.56)	3.841 (97.56)	1.187 (30.15)
4	4.520 (114.8)	+0.010/-0.005 (+0.25/-0.13)	0.030 (0.76)	4.491 (114.1)	±0.009 (±0.23)	0.030 (0.76)	1.750 (44.45)	0.250 (6.35)	4.907 (124.6)	1.28 (32.54)
6	6.647 (168.8)	+0.015/-0.010 (+0.38/-0.25)	0.060 (1.52)	6.614 (168.0)	±0.011 (±0.28)	0.060 (1.52)	3.000 (76.20	0.281 (7.14)	7.203 (183.0)	1.500 (38.10)
8	8.655 (219.8)	+0.030/-0.000 (+0.76/-0.00)	0.090 (2.29)	8.610 (218.7)	±0.015 (±0.38)	0.090 (2.29)	4.000 (101.6)	0.328 (8.33)	[B]	[B]
10	10.780 (273.8)	+0.025/-0.020 (+0.64/-0.51)	0.120 (3.05)	10.737 (272.7)	±0.015 (±0.38)	0.120 (3.04)	5.000 (127.0)	0.365 (9.28)	[B]	[B]
12	12.780 (324.6)	+0.030/-0.025 (+0.76/-0.64)	0.150 (3.81)	12.736 (323.5)	±0.015 (±0.38)	0.150 (3.81)	6.000 (152.4)	0.406 (10.3)	[B]	[B]

[A] The value for wall thickness shown in Table 1 is an averaged minimum. An averaged minimum is derived by adding two wall thicknesses that are directly opposite each other and dividing the result by 2. The reason for an averaged minimum wall thickness is due to core shift which is a normal occurrence found in fittings that are injection molded. When core shift occurs, the result is a pair of high and low wall thickness readings. The average of the high and the low wall thickness readings must equal or exceed the averaged minimum value shown in Table 1. The low wall thickness reading shall not be more than 10% below the averaged minimum value shown in Table 1. This applies to any point on the fitting (hub, body, or spigot). In cases where there is no opposite side (as in the case of a portion of the branch of a wye fitting) then the single wall thickness reading shall not be more than 10% below the averaged minimum value shown in Table 1.
[B] Not applicable for these nominal sizes.

6.4.1 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 tested 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.

6.4.2 Failure in the test specimens shall be shattering or any crack or break extending entirely through the pipe wall and visible to the unaided eye.

TABLE 2 Dimensions and Tolerances for Outside Diameters and Thicknesses of PVC Plastic Drain, Waste, and Vent Pipe

Nominal Pipe Size	Outside Diameter			Wall Thickness	
	Average	Tolerance on Average	Out-of-Roundness (maximum minus minimum)	Minimum	Tolerance
			in. (mm)		
1¼	1.660 (42.16)	±0.005 (0.13)	0.024 (0.61)	0.140 (3.56)	+0.020 (0.51) −0.000
1½	1.900 (48.26)	±0.006 (0.15)	0.024 (0.61)	0.145 (3.68)	+0.020 (0.51) −0.000
2	2.375 (60.33)	±0.006 (0.15)	0.024 (0.61)	0.154 (3.91)	+0.020 (0.51) −0.000
3	3.500 (88.90)	±0.008 (0.20)	0.030 (0.76)	0.216 (5.49)	+0.026 (0.66) −0.000
4	4.500 (114.30)	±0.009 (0.23)	0.100(2.54)	0.237 (6.02)	+0.028 (0.71) −0.000
6	6.625 (168.28)	±0.011 (0.28)	0.100 (2.54)	0.280 (7.11)	+0.034 (0.86) −0.000
8	8.625 (219.08)	±0.015 (0.38)	0.150 (3.81)	0.322 (8.18)	+0.039 (0.99) −0.000
10	10.750 (273.05)	±0.015 (0.38)	0.150 (3.81)	0.365 (9.27)	+0.044 (1.12) −0.000
12	12.750 (323.85)	±0.015 (0.38)	0.150 (3.81)	0.406 (10.31)	+0.049 (1.24) −0.000
14	14.000 (355.60)	±0.015 (±0.38)	0.200 (5.08)	0.437 (11.1)	+0.053 (1.35) −0.000
16	16.000 (406.40)	±0.019 (±0.48)	0.320 (8.13)	0.500 (12.7)	+0.060 (1.52) −0.000
18	18.000 (457.20)	±0.019 (±0.48)	0.360 (9.20)	0.562 (14.27)	+0.067 (1.71) −0.000
20	20.000 (508.00)	±0.023 (±0.58)	0.400 (10.20)	0.593 (15.06)	+0.071 (1.81) −0.000
24	24.000 (609.60)	±0.031 (±0.79)	0.480 (12.20)	0.687 (17.45)	+0.082 (2.09) −0.000

TABLE 3 Pipe Stiffness Requirements for PVC DWV Pipe[A]

Nominal Pipe Size, in.	Pipe Stiffness, min, psi (kPa)
1¼	1400 (9650)
1½	1010 (6960)
2	600 (4140)
3	510 (3520)
4	310 (2140)
6	150 (1030)
8	100 (690)
10	78 (530)
12	63 (430)
14	60 (415)
16	60 (415)
18	60 (415)
20	51 (350)
24	45 (315)

[A] Measured at 5 % deflection.

TABLE 4 Impact Resistance of PVC Plastic Drain, Waste and Vent Pipe and Fittings

Description	Impact Resistance, min., ft-lbf (J) 73°F (23°C)
All pipe sizes	60 (81)
Fitting sizes and types (larger than 2 in. nominal OD)	15 (20)
Fitting sizes and types (2 in. and smaller nonimal OD)	7.5 (10)

6.4.3 Bushings increasers and closet flanges are exempt from this requirement.

7. Test Methods

7.1 *Sampling*—A sample of the pipe and fittings sufficient to determine conformance with this specification shall be taken at random from each lot or shipment. About 40 ft (12 m) of pipe are required to make the tests prescribed. The number of fittings required varies depending on the size and type of fitting.

7.1.1 *Test Specimens*—Not less than 50 % of the test specimens required for any pressure test shall have at least a part of the marking in their central sections. The central section is that portion of pipe which is at least one pipe diameter away from an end closure.

7.2 *Conditioning:*

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

7.2.2 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 the room temperature.

7.3 *Test Conditions:*

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

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

7.4 *Pipe Stiffness, Deflection Load, and Flattening*—Measure the pipe stiffness, the flattening of pipe and the deflection load of fittings in accordance with Test Method D2412. In the test for pipe, note the load when the initial diameter is reduced 5 % (pipe stiffness). Continue test until the diameter is deflected by 60 % of its original value (flattening). The rate of head approach shall be a minimum of 0.5 in./min (12.5 mm/min). In case of disagreement, the referee test speed shall be 0.50 ± 0.02 in./min (12.5 ± 0.05 mm/min).

7.4.1 *Pipe*—Three specimens, each 6 ± ¼ in. (150 ± 3 mm) long, shall be tested. The ends shall be cut square and free of burrs and jagged edges. Each specimen shall meet the requirements of 6.3.1.

7.4.2 *Fittings*—Test three complete fittings. Each specimen shall meet the requirement of 6.3.2. Shim fittings to give full centerline contact with platens. Fittings having nonuniform diameters, such as reducers, shall be considered acceptable when the wall thickness at all points is equal to or greater than the wall thickness of pipe of the same material and diameter that meets the crush resistance requirements.

7.4.3 *Procedure*—Terminate the test when the diameter of pipe test specimens is reduced to 40 % of its original value or the pipe cracks or shows other evidence of visible failure. Terminate the test on fittings when the load reaches 750 lbf/ft (11 kN/m) of centerline length. Observe the load and deflection at the first evidence of cracking, if any. Record location and type of failure.

7.4.4 *Calculations*—For pipe, divide the load at failure (flattening) if such occurred, by the length of the pipe test specimen to obtain the flattening resistance. Express results in N/m or lbf/ft. Calculate the values for each specimen of pipe and fittings for conformance to the requirements of 6.3.1 and 6.3.2. For calculation of pipe stiffness, refer to the Calculation Section and the Appendix of Test Method D2412. Calculate the values for each specimen separately. Examine the results for each specimen of pipe for conformance to the requirements of Table 3.

7.5 *Threads*—All taper pipe threads shall be gaged in accordance with Specification F1498.

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 *Pipe*—The pipe shall be marked in letters not less than 3⁄16 in. (5 mm) high, in a contrasting color, and shall at least consist of the manufacturer's name or trademark, the designation ASTM D2665, the nominal pipe size, the symbol PVC, and the symbol DWV, spaced at intervals of not more than 5 ft (1.5 m).

NOTE 4—It is common practice to dual mark Schedule 40 DWV and potable water piping in which compliance with each applicable standard is met. This is NOT an acceptable practice when external recycled material is used in the manufacture of the pipe.

9.2 *Fittings*—Fittings shall be marked on the body or hub with the manufacturer's name or trademark, and the symbol PVC.

10. Quality Assurance

10.1 When the product is marked with this designation, D2665, 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 DWV; fittings; pipe; plastic; PVC; Schedule 40; thermoplastic

APPENDIX

(Nonmandatory Information)

X1. STORAGE AND INSTALLATION PROCEDURES FOR PVC PLASTIC DRAIN, WASTE, AND VENT PIPING

X1.1 *Storage*—Do not store pipe and fittings in direct sunlight for long periods. Store pipe in such a manner as to prevent sagging or bending. See X1.11.

X1.2 *Visibility of Marking*—Always position pipe and fittings so that identifying markings are readily visible to inspection when installed.

X1.3 *Solvent Cement*—Use solvent cements meeting the requirements of Specification D2564 and packaged in containers suitable for size of pipe being joined. Do not thin the cement. Discard cement that has thickened. Solvent cements are flammable. Keep away from heat, spark, and open flame. Avoid prolonged breathing of vapors. Prolonged contact with skin is harmful. Use with adequate ventilation and avoid contact with eyes and skin. For further information, see Practice F402.

X1.4 *Socket Fit*—PVC pipe and fittings are manufactured to close tolerances. Close tolerances are required to ensure satisfactory" interference" fit between the pipe and fitting during the solvent cement joining. Use only pipe and fitting combinations that give interference fits. Pipe loose in the socket may not properly fuse chemically. The allowable tolerances assure a forced fit and when solvent is applied will readily mate, thus assuring a chemical fusion equal in strength

to pipe or fitting. Attempting to correct a loose fit after assembly by additional cement may result in an unsatisfactory joint.

X1.5 *Joining Technique:*

X1.5.1 *Cutting the Pipe*—Cut the pipe square with saws or pipe cutters designed specifically for this material; protect pipe and fittings from serrated holding devices and abrasion.

X1.5.2 *Deburring Pipe*—Remove burrs from inside and outside pipe edges.

X1.5.3 *Cleaning Joining Surfaces* —Wipe off all dust, dirt, and moisture from surfaces to be cemented with a clean, dry rag or paper towel. Remove gloss and any oily film from the pipe and mating socket with clean steel wool, fine abrasive paper, chemical cleaner, or primer. In case of conflicting solvent cementing instructions, the instructions of the cement manufacturer should be followed.

X1.5.4 *Application of Cement*—Use a natural bristle or nylon brush of adequate size (usually at least ½ the pipe diameter) or an applicator supplied with the can of cement. Apply a moderate even coating of cement in the fitting socket completely covering the pipe joining surfaces only. Heavy or excessive applications of cement may become an obstruction inside of the piping. Quickly apply a heavy even coat of 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.

X1.5.5 *Assembly*—Make the joint as quickly as possible after application of the cement and before the cement dries. Insert the pipe into the fitting socket turning the pipe slightly to ensure even distribution of cement. Make sure that the pipe is inserted to the full depth of the socket. Remove excess solvent cement from the exterior of the joint with a clean, dry cloth. Reasonable handling of the assembly is permissible after 2 min. Do not attempt to disturb the pipe-fitting joint until after the cement has set; damage to the joint and loss of fit may result. Should the cement dry partially before joint is made up, reapply cement before assembling. Allow 15 min for joint to develop good handling strength.

X1.6 *Joints:*

X1.6.1 *Threaded Connection*—Do not cut threads on PVC drain, waste, and vent pipe. Molded threads are permitted. Use of adapter fittings for transition to threaded construction is necessary except in the case of cleanout plugs. The joint between the PVC pipe and transition fitting should be of the solvent cement type. Only approved thread tape or thread lubricant specifically intended for use with PVC plastic pipe should be used. Conventional pipe thread compounds, putty linseed oil base products, and unknown mixtures shall be avoided.

X1.6.2 *Connections to Traps*—Connect traps by means of approved threaded trap adapters.

X1.6.3 *Connection to Closet Flanges*—Install screw-type closet flanges in the drainage system by means of a threaded connection. Install caulk-type closet flanges in accordance with the procedure outlined in X1.6.6.

X1.6.4 *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 intended.

X1.6.5 *Thread Tightness*—Where a threaded joint is made, obtain tightness by maximum hand tightening plus additional tightening with a strap wrench not to exceed one full turn.

X1.6.6 *Transition to Bell-and-Spigot Pipe*—Make connections or transitions to bell–and–spigot cast–iron soil pipe and fittings, and to bell–and–spigot pipe and fittings of other materials, with approved elastomeric or mechanical compression joints designed for this use, or by utilizing caulked joints made with caulking materials designed and approved for these types of applications.

X1.7 *Alignment and Grade*—Align all piping system components properly without strain. Do not bend or pull pipe into position after being solvent welded. Grade of horizontal drainage and vent piping shall be as specified for other materials in the applicable code.

X1.8 *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 closet rings with corrosion-resistant fasteners to the floor with top surface ¼ in. (6.4 mm) above the finish floor level. Stabilize the closet bends or stubs against all horizontal or vertical movement. Protect the pipe exposed to damage by sharp surfaces with grommets or sleeves of rubber or plastic.

X1.9 *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 X1.1. 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 change. Do not install piping except vent piping through roofs, so as to be exposed to direct sunlight after installation.

X1.10 *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. Pipe must bear on this material throughout the entire length of its barrel.

X1.11 *Exposed Piping*—Provide adequate support where piping is exposed to wind, snow, and ice loading. Plumbing vents exposed to sunlight shall be protected by water-base

TABLE X1.1 Thermal Expansion Table for PVC Plastic Pipe and Fittings

Length, ft	Temperature Change, °F (°C)						
	40 (22.2)	50 (27.8)	60 (33.3)	70 (38.8)	80 (44.4)	90 (50)	100 (55.6)
	Length change, in. (mm)						
20	0.28 (7.11)	0.35 (8.89)	0.42 (10.68)	0.49 (12.46)	0.56 (14.25)	0.63 (16.03)	0.70 (17.81)
40	0.56 (14.22)	0.70 (17.78)	0.84 (21.37)	0.97 (24.68)	1.11 (28.24)	1.25 (31.80)	1.39 (35.36)
60	0.84 (21.34)	1.04 (26.42)	1.25 (31.80)	1.46 (37.14)	1.67 (42.48)	1.88 (47.83)	2.09 (53.17)
80	1.13 (28.70)	1.39 (35.31)	1.67 (42.48)	1.95 (49.61)	2.23 (56.73)	2.51 (63.85)	2.78 (70.72)
100	1.39 (35.31)	1.74 (44.20)	2.09 (53.17)	2.44 (62.07)	2.78 (70.72)	3.13 (79.63)	3.48 (88.53)

synthetic latex paints. Where surface temperatures exceed 140°F (60°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.

X1.12 *Antifreeze Protection*—When necessary to protect traps and fixtures from freezing do not use petroleum products. Use only approved plastic pipe antifreeze packaged for this purpose or one of the following solutions:

X1.12.1 A60 weight % of glycerin in water mixed at 74°F (23°C).

X1.12.2 A22 weight % of magnesium chloride in water. Strong solutions of common table salt (sodium chloride) may also be used.

SUMMARY OF CHANGES

Committee F17 has identified the location of selected changes to this standard since the last issue (D2665–12) that may impact the use of this standard. (Approved May 1, 2014.)

(1) Table 4 was revised.

(2) 6.4.3 was added.