Designation: F3128 – 15

Standard Specification for Poly(Vinyl Chloride) (PVC) Schedule 40 Drain, Waste, and Vent Pipe with a Cellular Core[1]

This standard is issued under the fixed designation F3128; 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 poly(vinyl chloride) (PVC) plastic drain, waste and vent pipe made to Schedule 40 iron pipe sizes (IPS) and produced by the coextrusion process with concentric inner and outer solid PVC layers and the core consisting of closed-cell cellular PVC. Plastic which does not meet the material requirements specified in Section 5 is excluded from single layer and all coextruded layers.

1.2 Fittings meeting the requirements of Specification D2665 and D3311 are suitable for use with pipe meeting the requirements of this specification.

1.3 Poly(vinyl chloride) plastic which does not meet the definitions of virgin PVC plastic as given in 5.1 is excluded, as performance of plastic other than those defined as virgin was not determined. PVC rework plastic which meets the requirements of rework plastic as given in 5.2 is acceptable.

1.4 Reprocessed plastic or recycled plastic as defined in Terminology D883 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 appendices 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 standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.8 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D618 Practice for Conditioning Plastics for Testing

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

D2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings

D2152 Test Method for Adequacy of Fusion of Extruded Poly(Vinyl Chloride) (PVC) Pipe and Molded Fittings by Acetone Immersion

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

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

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

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

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

D2855 Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings

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

D4396 Specification for Rigid Poly(Vinyl Chloride) (PVC) and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds for Plastic Pipe and Fittings Used in Nonpressure Applications (Withdrawn 2015)[3]

F402 Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings

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

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

F412 Terminology Relating to Plastic Piping Systems
F656 Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings
2.2 *Federal Standard:*[4]
Fed. Std. No. 123 Marking for Shipment (Civil Agencies)
2.3 *Military Standard:*[4]
MIL-STD-129 Marking for Shipment and Storage
2.4 *ANSI Standards:*[5]
Z34.1 American National Standard for Certification-Third-Party Certification Program
Z34.2 American National Standard for Certification-Self-Certification by Producer or Supplier
2.5 *Plastic Pipe Institute*[6]
PPI-TR-7 Recommended Method For Calculation of Nominal Weight of Plastic Pipe

3. Terminology

3.1 *Definitions*—Definitions are in accordance with Terminology F412 and abbreviations are in accordance with Terminology D1600, unless otherwise specified. The abbreviations for poly(vinyl chloride) plastic is PVC.

3.2 *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.

3.3 *Definitions of Terms Specific to This Standard:*
3.3.1 *IPS schedule 40 series*—Pipe pipe produced to an iron pipe outside diameter with a Schedule 40 wall thickness.

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

4. Classification

4.1 Pipe produced in accordance with this specification is intended to provide pipe suitable for the drainage and venting of sewage and certain other liquid wastes.

NOTE 1—Before installing pipe for waste disposal use, 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 140ºF (60ºC) may be encountered.

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

5. Materials

5.1 *Material Specification*—The PVC material shall conform to the requirements prescribed in Specification D4396 with a cell classification of 11432. PVC material which has a higher cell class than that listed is acceptable.

5.2 *Rework Material*—The manufacturer shall use only his own clean rework pipe material conforming with these cell class requirements. It shall be used only in the core layer if it contains any residual blowing agent. The pipe produced shall meet all requirements of this specification.

5.3 *Cellular Material*—Cellular PVC used in the core layer shall be of a closed cell structure when tested in accordance with 6.3.6.

6. Requirements

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

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 D2122. The tolerances 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 D2122.
6.2.3 *Length*—The pipe length may be 7, 10, 12, or 20 ft with a tolerance on length of +½, -0 in., unless otherwise specified.

6.3 *Performance Requirements:*
6.3.1 *Pipe Stiffness*—The minimum pipe stiffness values at 5% deflection when measured in accordance with Test Method D2412 shall equal or exceed the values in Table 2. Three specimens shall be tested. If all three meet this requirement, the sample meets this requirement. If one or two fail, additional

[4] DLA Document Services Building 4/D 700 Robbins Avenue Philadelphia, PA 19111-5094 http://quicksearch.dla.mil/
[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 Plastics Pipe Institute (PPI), 105 Decker Court, Suite 825, Irving, TX 75062, http://www.plasticpipe.org.

TABLE 1 Outside Diameter and Tolerances

Nominal Pipe Size, in.	Outside Diameter, in. (mm)	Tolerance on Average Outside Diameter, in. (mm)	Out-of-Roundness in. (mm)
1¼	1.660 (42.16)	±0.005 (0.13)	0.060 (1.52)
1½	1.900 (48.26)	±0.006 (0.15)	0.060 (1.52)
2	2.375 (60.32)	±0.006 (0.15)	0.060 (1.52)
3	3.500 (88.90)	±0.008 (0.20)	0.060 (1.52)
3 ½	4.000 (101.60)	±0.008 (0.20)	0.100 (2.54)
4	4.500 (114.30)	±0.009 (0.23)	0.100 (2.54)
5	5.563 (141.30)	±0.010 (0.25)	0.100 (2.54)
6	6.625 (168.28)	±0.011 (0.28)	0.100 (2.54)
8	8.625 (219.08)	±0.015 (0.38)	0.150 (3.81)
10	10.750 (273.05)	±0.015 (0.38)	0.150 (3.81)
12	12.750 (323.85)	±0.015 (0.38)	0.150 (3.81)

TABLE 2 Minimum Wall Thickness[A], Pipe Stiffness and Impact Strength

Nominal Pipe Size in.	Minimum Wall Thickness in.	Pipe Stiffness lbf/in.^{2}(MPa)	Impact Strength ft.lb$_f$ (J)
1 ¼	0.140 (3.56)	600 (4.13)	40 (54)
1 ½	0.145 (3.68)	600 (4.13)	50 (68)
2	0.154 (3.91)	300 (2.07)	80 (109)
3	0.216 (5.49)	300 (2.07)	100 (136)
3½	0.226 (5.74)	250 (1.72)	100 (136)
4	0.237 (6.02)	200 (1.38)	100 (136)
5	0.258 (6.55)	120 (0.83)	100 (136)
6	0.280 (7.11)	120 (0.83)	120 (163)
8	0.322 (8.18)	100 (0.69)	120 (163)
10	0.365 (9.27)	60 (0.41)	120 (163)
12	0.406 (10.31)	50 (0.34)	120 (163)

[A] The maximum wall thickness shall not be greater than 1.25 times the minimum wall thickness.

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 11 specimens shall meet or exceed the minimum requirement given in Table 2. 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 the applicable table but is not within 15% of the average, the sample meets the requirements of the pipe stiffness testing. The 11 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.

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

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

where:

$$N = 11$$
$$(avg\ PS) = [\Sigma\ (PS_i)]/(11)$$
$$std.\ dev. = \left[\frac{\Sigma PS^2 - (\Sigma\ PS)^2/N}{N-1}\right]^{1/2}$$

The 15% requirement is calculated as follows:

$$(avg - LCL)/(avg) \times 100 \leq 15\%$$

NOTE 3—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 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 D2412. The term "crushing strength" is not applicable to plastic piping.

6.3.2 *Pipe Flattening*—There shall be no evidence of cracking, delamination or rupture when pipe is deflected 60 % of the initial inside diameter, when tested in accordance with Test Method D2412. Three specimens shall be tested and all shall pass.

NOTE 5—This test is intended only for use as a quality control test and not as a simulated service test.

6.3.3 *Impact Resistance*—The minimum impact resistance, when tested at the time of manufacture, shall comply with Table 2. Test in accordance with Test Method D2444, using Tup B and Holder B. Use a 20-lb (9.1-kg) tup for testing pipe sizes 4 in. and smaller and a 30-lb 232 (13.6-kg) tup for pipe sizes larger than 4 in.

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.

6.3.4 *Bond*—The bond between layers shall be strong and uniform. It shall not be possible to separate any two layers with a probe or the point of a knife blade so that the layers separate cleanly, nor shall separation of the bond occur between layers during testing performed under the requirements of this specification.

6.3.5 *Extrusion Quality*—The pipe shall meet the requirements of Test Method D2152.

6.3.6 Cellular Structure-The core layer of cellular core pipe shall not allow the passage of water when tested at 10 ± 1 psig for a minimum of 30 minutes. The test sample shall be 18 ± 0.1 in. (457 ± 3 mm) long. Create a seal on the O.D. and the I.D. of the pipe near one end in a manner that permits the exposed core to be subjected to water pressure (Note 6). Any sign of water emanating from the core at the opposite end after 30 minutes is indication of an open cell structure and the specimen does not meet the requirements of this specification.

NOTE 6—The method of sealing against the I.D. and O.D. of the pipe is not specified, as several acceptable methods are available. One such method uses an elastomeric no-hub adapter clamped to the O.D. and pneumatic or mechanical test plug to seal the I.D.

6.4 *Other Requirements:*

6.4.1 *Joining*—Coextruded poly(vinyl chloride) PVC Cellular Core DWV Pipe is joined using fittings meeting the requirements of Specification D2665 and D3311

6.4.2 *Solvent Cement*—In the assembly of solvent cement joints, the safety requirements of Practice F402 shall be

followed and the joint shall be assembled following Practice D2855, using a cleaner or primer.

7. Sampling and Conditioning

7.1 *Sampling*—The selection of the sample or samples of pipe shall be as agreed upon by the purchaser and seller. In case of no prior agreement, any sample selected by the testing lab shall be deemed adequate.

7.2 *Conditioning:*

7.2.1 For referee purposes, condition the specimens prior to test at 73.4 ± 3.6ºF (23 ± 2ºC) and 50 ± 10% 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 manufacturer's 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 ± 3.6ºF (23 ± 2ºC) and 50 ± 10% relative humidity.

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

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

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 in accordance with an agreement between the purchaser and the seller. There shall be no agreement to lower the minimum requirements of the specifications by such means as omitting test methods that are part of the specification, substitution, or modifying test methods, or by changing the specification limits. In retesting, the product requirements of this specification shall be met, and the test methods designated in this specification shall be followed. If, upon retest, failure occurs, the quantity of product represented by the test(s) does not meet the requirements of this specification.

9. Marking

9.1 *Quality of Marking*—The marking shall be applied to the pipe for end-use application in such a manner that it remains legible (easily read) after installation and inspection.

9.2 *Content of Marking*—The pipe shall be marked at least every 5 ft (1.52 m) in letters not less than 3⁄16 in. (4.76 mm) high and in a color that contrasts with the color of the pipe, and shall contain the following information:

9.2.1 Manufacturer's name or trademark.

9.2.2 This designation, ASTM F3128.

9.2.3 The wording "COEXTRUDED CELLULAR CORE PVC DWV PIPE".

9.2.4 Nominal pipe size (for example: 2 in. IPS Schedule 40).

9.2.5 Manufacturer's code for identifying lot number, date and year of manufacture, or other information as needed.

10. Quality Assurance

10.1 When the product is marked with this designation, F3128, 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 cellular core; coextruded; DWV; PVC; Schedule 40; thermoplastic

SUPPLEMENTARY REQUIREMENTS

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.

S2.1 *Packaging*—Unless otherwise specified in the contract, the materials shall be packaged in accordance with the supplier's standard practice in a manner ensuring arrival at destination in satisfactory condition and which will be acceptable to the carrier at lowest rates. Containers and packing shall comply with Uniform Freight Classification rules or National Motor Freight Classification rules.

S2.2 *Marking*—Marking for shipment shall be in accordance with Fed. Std. No. 123 for civil agencies and MIL-STD-129 for military agencies.

NOTE S2.1—The inclusion of the U.S. Government procurement requirements should not be construed as an indication that the U.S. Government uses or endorses the products described in this specification.

APPENDIXES

(Nonmandatory Information)

X1. STORAGE

X1.1 *Outside Storage*—Plastic pipe should be stored on a flat surface or supported in a manner that will prevent sagging or bending.

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, and other major imperfections. Defective pipe should be rejected, and 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 a physical fusion. 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 device. A miter box is recommended to ensure square cut ends. Standard steel pipe or tubing cutters are not recommended for cutting PVC pipe since they may cause excessive heat and pressure, which can result in cracked or irregular pipe ends. There are special cutters available with extra wide rollers and thin cutting wheels that have been designed for cutting plastic pipe, and their use is recommended.

X2.4 *Cleaning*—Chemical or mechanical cleaners should be used to clean the pipe after all burrs have been removed and prior to assembly.

X2.5 *Safety Requirements for Solvent Cement and Primers*—Practice F402 should be followed.

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

X2.7 *Solvent Cement*—Use only solvent cement designated for PVC. A solvent cement meeting the requirements of Specification D2564, when used in accordance with the manufacturer's recommendations, should provide satisfactory results; or follow Practice D2855.

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

X2.8 *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. to avoid push out. Remove excessive solvent cement from the exterior of the joint with a clean, dry cloth.

X2.9 *Set Time*—Do not attempt to disturb the pipe and fitting joint until after the solvent cement has set or damage to the joint and loss of fit may result. Reasonable handling of the 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 should be avoided. The recommendation of the solvent cement manufacturer should be followed for best results.

X2.10 *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 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 and all other pipe covered by this standard consult Practice D2321.

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*—PVC pipe has decreased resistance to impact under freezing conditions and 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 all piping at intervals of not more than 4 ft (1.2 m) at end of branches and at changes of direction or elevation. Supports should allow free movement. Maintain vertical piping in straight alignment with supports at each floor level or at 10-ft (3.1m) 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 is 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 PVC plastic pipe should be used. Conventional pipe thread compound, putty, linseed oil-based 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 adaptors.

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 of transition to bell-and- spigot cast iron soil pipe and fittings, and to bell-and-spigot pipe and fittings of other materials with approved mechanical compression joints designed for this use, or caulk joints made in an approved manner.

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

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

TABLE X3.1 Thermal Expansion Table for PVC Plastic Pipe

	Temperature Change, °F[A]						
Length, ft	40	50	60	70	80	90	100
	Length of Change, in.[B]						
20	0.28	0.35	0.42	0.49	0.56	0.63	0.70
40	0.56	0.70	0.84	0.97	1.11	1.25	1.39
60	0.84	1.04	1.25	1.46	1.67	1.88	2.09
80	1.13	1.39	1.67	1.95	2.23	2.51	2.78
100	1.39	1.74	2.09	2.44	2.78	3.13	3.48

[A] Example of temperature change:

Highest temperature expected 100°F
Lowest temperature expected 50°F
Total variation 50°F

[B] For a length of run of 60 ft and a 50°F temperature variation, the chart indicates that the installation should provide for a linear expansion of 1.04 in.

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.

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-based synthetic latex paints. Where surface temperatures exceed 140°F (60ºC), piping shall be protected by means of shielding or some type of light-weight 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 at 74ºF (23ºC).

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:*

X3.16.1 The DWV pipe in this specification is intended for use in applications with maximum operating temperatures of up to 140°F (60°C).

X3.16.2 Waste disposal lines, where concentrated agents and certain chemicals that are routinely present and that may be aggressive to PVC, should only be installed with the specific approval of the responsible local building code authority. Service station bay area floor drains require special consideration.

X4. PIPE STIFFNESS CALCULATIONS

X4.1 The formula for pipe stiffness in a circular specimen is:

$$\text{Pipe Stiffness} = 0.559\,E\left(\frac{t}{r}\right)^3 \qquad \text{(X4.1)}$$

where:

t = wall thickness,
r = mean radius,
E = flexural modulus of elasticity

X4.2 The pipe stiffness formula applies to specimens with uniform wall thickness, uniform mean radius, and a uniform flexural modulus of elasticity. Individual plastic pipe specimens vary in wall thickness and in out-of-roundness defined as "Maximum O.D. Minus Minimum O.D.'' The flexural modulus of a coextruded product depends on the thickness of each of the layers, the modulus of the material, and the total thickness of the wall. Therefore, flexural modulus is based on a measured value for typical thicknesses and extrusion conditions.

X4.3 There are several methods for treating the variables which exist. The two methods used in ASTM standards for plastic pipe are as follows:

X4.3.1 *Method One:*

X4.3.1.1 Use the nominal wall thickness.

X4.3.1.2 Use the nominal mean radius.

X4.3.1.3 Determine E experimentally for the compound by making pipe specimens, performing pipe stiffness tests at 5 % deflection, determining nominal wall thickness, and then calculating the materials flexural modulus.

X4.3.1.4 The flexural modulus used in calculating the minimum pipe stiffness is chosen as the mean of the several values less two standard deviations.

X4.3.2 *Method Two:*

X4.3.2.1 Use minimum wall thickness as listed

X4.3.2.2 Use the nominal mean radius.

X4.3.2.3 Use the required minimum flexural modulus published for that material and cell class. If there is no minimum flexural modulus requirement, use the tensile modulus requirements as published.

NOTE X4.1—The Plastic Pipe Institute in its Technical Report PPI-TR-7 of March 1968 titled "Recommended Method For Calculation of Nominal Weight of Plastic Pipe," under Definitions 3.1, Nominal Weight is defined as the weight which is calculated by using the nominal or stated diameter, without consideration of tolerance, and the nominal wall thickness of the pipe. The diameter and wall thickness values shall be obtained from the applicable standard or specification which shall be reported. The nominal wall thickness is the minimum plus 6 % rounded to the nearest 0.001 in.

NOTE X4.2—Experience has shown that Method One provides pipe which will reliably meet or exceed the minimum pipe stiffness values published in this specification when the pipe is in conformance with the minimum wall thickness requirements.

NOTE X4.3—Experience with Method Two has shown that by using the minimum wall and minimum modulus, both factors introduce conservative bias; therefore, the measured pipe stiffnesses for these products are well above the minimum pipe stiffness requirements listed in this specification.

X4.4 The calculated pipe stiffness for a nominal 4-in. sewer pipe with an outside diameter of 4.215 in., a minimum wall thickness of 0.156 in. and a value of E equal to 330 000 is as follows using Method One:

$$(0.156\ \text{in.}) \times (1.06) = 0.1654\text{in.} \qquad \text{(X4.2)}$$

$$(4.215\ \text{in.} - 0.1654\ \text{in.})/2 = 2.0248\text{in.} = r$$

$$\text{PS} = (0.559)(330000)(0.1654\ \text{in.}/2.0248\ \text{in.})^3 = 100.55\text{psi}$$