



Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)¹

This standard is issued under the fixed designation D 2241; 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 poly(vinyl chloride) (PVC) pipe made in standard thermoplastic pipe dimension ratios and pressure rated for water (see appendix). Included are criteria for classifying PVC plastic pipe materials and PVC plastic pipe, a system of nomenclature for PVC plastic pipe, and requirements and test methods for materials, workmanship, dimensions, sustained pressure, burst pressure, flattening, and extrusion quality. Methods of marking are also given.

1.2 The products covered by this specification are intended for use with the distribution of pressurized liquids only, which are chemically compatible with the piping materials. Due to inherent hazards associated with testing components and systems with compressed air or other compressed gases, some manufacturers do not allow pneumatic testing of their products. Consult with specific product/component manufacturers for their specific testing procedures prior to pneumatic testing.

NOTE 1—Pressurized (compressed) air or other compressed gases contain large amounts of stored energy which present serious safety hazards should a system fail for any reason.

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

1.5 The following safety hazards caveat pertains only to the test methods portion, Section 8, 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. A specific precautionary statement is given in Note 7.*

NOTE 2—CPVC plastic pipe (SDR-PR), which was formerly included in this specification, is now covered by Specification F 442/F 442M.

NOTE 3—The sustained and burst pressure test requirements, and the pressure ratings in the appendix, are calculated from stress values obtained from tests made on pipe 4 in. (100 mm) and smaller. However, tests conducted on pipe as large as 24 in. (600 mm) in diameter have shown these stress values to be valid for larger diameter PVC pipe.

NOTE 4—PVC pipe made to this specification is often belled for use as line pipe. For details of the solvent cement bell, see Specification D 2672 and for details of belled elastomeric joints, see Specifications D 3139 and D 3212.

2. Referenced Documents

2.1 ASTM Standards:²

- D 618 Practice for Conditioning Plastics for Testing
- D 1598 Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure
- D 1599 Test Method for Resistance to Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings
- D 1600 Terminology for Abbreviated Terms Relating to Plastics
- D 1784 Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
- D 2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings
- D 2152 Test Method for Adequacy of Fusion of Extruded Poly(Vinyl Chloride) (PVC) Pipe and Molded Fittings by Acetone Immersion
- D 2444 Test Method for Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)
- D 2672 Specification for Joints for IPS PVC Pipe Using Solvent Cement
- D 2837 Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials
- D 3139 Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals

¹ This specification is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.25 on Vinyl Based Pipe.

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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.

D 3212 Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals

F 412 Terminology Relating to Plastic Piping Systems

F 442/F 442M Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)

2.2 *NSF Standards*:³

Standard No. 14 for Plastic Piping Components and Related Materials

Standard No. 61 for Drinking Water Systems Components—Health Effects

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 poly(vinyl chloride) plastic is PVC.

3.2 *Definitions of Terms Specific to This Standard*:

3.2.1 *hydrostatic design stress*—the estimated maximum tensile stress the material is capable of withstanding continuously with a high degree of certainty that failure of the pipe will not occur. This stress is circumferential when internal hydrostatic water pressure is applied.

3.2.2 *pressure rating (PR)*—the estimated maximum water pressure the pipe is capable of withstanding continuously with a high degree of certainty that failure of the pipe will not occur.

3.2.3 *relation between standard dimension ratio, hydrostatic design stress, and pressure rating*—The following expression, commonly known as the ISO equation,⁴ is used in this specification to relate standard dimension ratio, hydrostatic design stress, and pressure rating:

$$2S/P = R - 1 \text{ or } 2S/P = (D_o/t) - 1 \quad (1)$$

where:

S = hydrostatic design stress, psi (or MPa),

P = pressure rating, psi (or MPa),

D_o = average outside diameter, in. (or mm),

t = minimum wall thickness, in. (or mm), and

R = standard thermoplastic pipe dimension ratio (D_o/t for PVC pipe), also known as SDR.

3.2.4 *standard thermoplastic pipe dimension ratio (SDR)*—the ratio of pipe diameter to wall thickness. For PVC pipe it is calculated by dividing the average outside diameter of the pipe in inches or millimetres by the minimum wall thickness in inches or millimetres. If the wall thickness calculated by this formula is less than 0.060 in. (1.52 mm), it shall be arbitrarily increased to 0.060 in. (1.52 mm). The SDR values shall be rounded to the nearest 0.5.

3.2.5 *standard thermoplastic pipe materials designation code*—The pipe materials designation code shall consist of the abbreviation PVC for the type of plastic, followed by the ASTM type and grade in Arabic numerals and the design stress in units of 100 psi (0.7 MPa) with any decimal figures dropped. When the design stress code contains less than two figures, a cipher shall be used before the number, thus a complete

material code shall consist of three letters and four figures for PVC plastic pipe materials.

4. Classification

4.1 *General*—This specification covers PVC pipe made and marked with one of six Type/Grade/Design Stress designations (see X1.2) in seven standard dimension ratios.

4.2 *Standard Thermoplastic Pipe Dimension Ratios (SDR)*—This specification covers PVC pipe in seven standard dimension ratios, namely, 13.5, 17, 21, 26, 32.5, 41, and 64 which are uniform for all nominal pipe sizes for each material and pressure rating. These are referred to as SDR13.5, SDR21, SDR17, SDR26, SDR32.5, SDR41, and SDR64, respectively. The pressure rating is uniform for all nominal pipe sizes for a given PVC pipe material and SDR (see Table X1.1).

4.3 *Hydrostatic Design Stresses*—This specification covers pipe made from PVC plastics defined by four hydrostatic design stresses developed on the basis of long-term tests (appendix).

5. Materials

5.1 *General*—Poly(vinyl chloride) plastics used to make pipe meeting the requirements of this specification are categorized by means of two criteria, namely, (1) short-term strength tests, and (2) long-term strength tests.

NOTE 5—The PVC pipe intended for use in the transport of potable water should be evaluated and certified as safe for this purpose by a testing agency acceptable to the local health authority. The evaluation should be in accordance with requirements for chemical extraction, taste, and odor that are no less restrictive than those included in NSF Standard No. 14. The seal or mark of the laboratory making the evaluation should be included on the pipe. See pipe marking requirement for reclaimed water systems.

5.2 *Basic Materials*—This specification covers pipe made from PVC plastics having certain physical and chemical properties as described in Specification D 1784.

5.3 *Compound*—The PVC compounds used for this pipe shall equal or exceed one of the following classes described in Specification D 1784: PVC 12454 or 14333.

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

6. Requirements

6.1 *Dimensions and Tolerances*:

6.1.1 *Outside Diameters*—The outside diameters and tolerances shall be as shown in Table 1 when measured in accordance with Test Method D 2122. The tolerances for out-of-roundness shall apply only on pipe prior to shipment.

6.1.2 *Wall Thickness*—The wall thicknesses and tolerances shall be as shown in Table 2 when measured in accordance with Test Method D 2122.

6.2 *Sustained Pressure*—The pipe shall not fail, balloon, burst, or weep as defined in Test Method D 1598 at the test pressures given in Table 3 when tested in accordance with 8.4.

6.2.1 *Accelerated Regression Test*—The accelerated regression test shall be used in place of both the sustained and burst pressure tests, at the option of the manufacturer. The test shall

³ Available from NSF International, P.O. Box 130140, 789 N. Dixboro Rd., Ann Arbor, MI 48113-0140.

⁴ ISO R161–1960, Pipes of Plastics Materials for the Transport of Fluids (Outside Diameters and Nominal Pressures) Part 1, Metric Series.

TABLE 1 IPS PVC Pipe—Outside Diameters and Tolerances

Nominal Pipe Size, in.	Average Outside Diameter, in. (mm)	For Average	Tolerances, in. (mm)	
			Maximum Out-of-Roundness (Maximum – Minimum Diameter)	
			SDR64, SDR41, SDR32.5, SDR26, SDR21	SDR17, SDR13.5
1/8	0.405 (10.29)	±0.004 (0.10)	0.030 (0.76)	0.016 (0.41)
1/4	0.540 (13.72)	±0.004 (0.10)	0.030 (0.76)	0.016 (0.41)
3/8	0.675 (17.14)	±0.004 (0.10)	0.030 (0.76)	0.016 (0.41)
1/2	0.840 (21.34)	±0.004 (0.10)	0.030 (0.76)	0.016 (0.41)
3/4	1.050 (26.67)	±0.004 (0.10)	0.030 (0.76)	0.020 (0.51)
1	1.315 (33.40)	±0.005 (0.13)	0.030 (0.76)	0.020 (0.51)
1 1/4	1.660 (42.16)	±0.005 (0.13)	0.030 (0.76)	0.024 (0.61)
1 1/2	1.900 (48.26)	±0.006 (0.15)	0.060 (1.52)	0.024 (0.61)
2	2.375 (60.32)	±0.006 (0.15)	0.060 (1.52)	0.024 (0.61)
2 1/2	2.875 (73.02)	±0.007 (0.18)	0.060 (1.52)	0.030 (0.76)
3	3.500 (88.90)	±0.008 (0.20)	0.060 (1.52)	0.030 (0.76)
3 1/2	4.000 (101.60)	±0.008 (0.20)	0.100 (2.54)	0.030 (0.76)
4	4.500 (114.30)	±0.009 (0.23)	0.100 (2.54)	0.030 (0.76)
5	5.563 (141.30)	±0.010 (0.25)	0.100 (2.54)	0.060 (1.52)
6	6.625 (168.28)	±0.011 (0.28)	0.100 (2.54)	0.070 (1.78)
8	8.625 (219.08)	±0.015 (0.38)	0.150 (3.81)	0.090 (2.29)
10	10.750 (273.05)	±0.015 (0.38)	0.150 (3.81)	0.100 (2.54)
12	12.750 (323.85)	±0.015 (0.38)	0.150 (3.81)	0.120 (3.05)
14	14.000 (355.60)	±0.015 (0.38)	0.200 (5.08)	0.150 (3.81)
16	16.000 (406.40)	±0.019 (0.48)	0.320 (8.13)	0.160 (4.06)
18	18.000 (457.20)	±0.019 (0.48)	0.360 (9.14)	0.180 (4.57)
20	20.000 (508.00)	±0.023 (0.58)	0.400 (10.2)	0.200 (5.08)
24	24.000 (609.60)	±0.031 (0.79)	0.480 (12.2)	0.240 (6.10)
30	30.000 (762.00)	±0.041 (1.04)	0.600 (15.2)	0.300 (7.62)
36	36.000 (914.40)	±0.050 (1.27)	0.720 (18.3)	0.360 (9.14)

be conducted in accordance with 8.4.1. The pipe shall demonstrate a hydrostatic design basis projection at the 100 000-h intercept that meets the hydrostatic design basis category requirement (see the table for “Hydrostatic Design Basis Categories” of Test Method D 2837) for the PVC material used in its manufacture. (*Example:* PVC 1120 pipe must have a minimum 100 000-h projection of 3830 psi and 85 % lower confidence limit (LCL).)

6.3 Burst Pressure—The minimum burst pressures for PVC plastic pipe shall be as given in Table 4, when determined in accordance with 8.5.

6.4 Flattening—There shall be no evidence of splitting, cracking, or breaking when the pipe is tested in accordance with 8.6.

6.5 Extrusion Quality—The pipe shall not flake or disintegrate when tested in accordance with Test Method D 2152.

6.6 Impact Resistance—The minimum impact resistance for PVC plastic pipe shall be as given in Table 5, when determined in accordance with 8.7.

NOTE 6—The impact resistance test is intended for use only as a quality control test, not as a simulated service test. This test has been found to have no quality control significance in sizes over 12 in. (305 mm).

7. Workmanship, Finish, and Appearance

7.1 The pipe shall be homogeneous throughout and free from 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.

NOTE 7—Color and transparency or opacity should be specified in the contract or purchase order.

8. Test Methods

8.1 Conditioning—Condition the test specimens at $73.4 \pm 3.6^{\circ}\text{F}$ ($23 \pm 2^{\circ}\text{C}$) and 50 ± 5 % relative humidity for not less than 40 h prior to test in accordance with Procedure A of Practice D 618 for those tests where conditioning is required.

8.2 Test Conditions—Conduct the tests in the standard laboratory atmosphere of $73.4 \pm 3.6^{\circ}\text{F}$ ($23 \pm 2^{\circ}\text{C}$) and 50 ± 5 % relative humidity, unless otherwise specified in the test methods or in this specification.

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

8.3.1 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.

8.4 Sustained Pressure Test—Select the test specimens at random. Test individually with water at the internal pressures given in Table 3, six specimens of pipe, each specimen at least

TABLE 2 Wall Thicknesses and Tolerances for PVC Plastic Pipe with IPS Outside Diameters

Nominal Pipe Size, in.	Wall Thickness, ^A in. ^B													
	SDR64		SDR41		SDR32.5		SDR26		SDR21		SDR17		SDR13.5	
	Mini- mum	Toler- ance	Mini- mum	Toler- ance	Mini- mum	Toler- ance	Mini- mum	Toler- ance	Mini- mum	Toler- ance	Mini- mum	Toler- ance	Mini- mum	Toler- ance
1/8	...	...	...	...	...	...	...	...	...	...	...	...	0.060	+0.020
1/4	...	...	...	...	...	...	...	...	...	...	...	...	0.060	+0.020
3/8	...	...	...	...	...	...	...	...	...	...	...	...	0.060	+0.020
1/2	...	...	...	...	...	...	...	...	...	...	...	...	0.062	+0.020
3/4	...	...	...	...	...	...	...	...	0.060	+0.020	0.062	+0.020	0.078	+0.020
1	...	...	...	...	...	...	0.060	+0.020	0.063	+0.020	0.077	+0.020	0.097	+0.020
1 1/4	...	...	...	...	0.060	+0.020	0.064	+0.020	0.079	+0.020	0.098	+0.020	0.123	+0.020
1 1/2	...	...	...	...	0.060	+0.020	0.073	+0.020	0.090	+0.020	0.112	+0.020	0.141	+0.020
2	...	...	...	...	0.073	+0.020	0.091	+0.020	0.113	+0.020	0.140	+0.020	0.176	+0.020
2 1/2	...	...	...	...	0.088	+0.020	0.110	+0.020	0.137	+0.020	0.169	+0.020	0.213	+0.026
3	...	...	0.085	+0.020	0.108	+0.020	0.135	+0.020	0.167	+0.020	0.206	+0.025	0.259	+0.031
3 1/2	...	...	0.098	+0.020	0.123	+0.020	0.154	+0.020	0.190	+0.023	0.235	+0.028	0.296	+0.036
4	0.070	+0.020	0.110	+0.020	0.138	+0.020	0.173	+0.020	0.214	+0.026	0.265	+0.032	0.333	+0.040
5	0.087	+0.020	0.136	+0.020	0.171	+0.021	0.214	+0.027	0.265	+0.032	0.327	+0.039	0.412	+0.049
6	0.104	+0.020	0.162	+0.020	0.204	+0.024	0.255	+0.031	0.316	+0.038	0.390	+0.047	0.491	+0.059
8	0.135	+0.020	0.210	+0.025	0.265	+0.032	0.332	+0.040	0.410	+0.049	0.508	+0.061	...	...
10	0.168	+0.020	0.262	+0.031	0.331	+0.040	0.413	+0.050	0.511	+0.061	0.632	+0.076	...	...
12	0.199	+0.024	0.311	+0.037	0.392	+0.047	0.490	+0.059	0.606	+0.073	0.750	+0.090	...	...
14	...	...	0.341	+0.048	0.430	+0.052	0.538	+0.064	0.666	+0.080	0.823	+0.099	...	...
16	...	...	0.390	+0.055	0.492	+0.059	0.615	+0.074	0.762	+0.091	0.941	+0.113	...	...
18	...	...	0.439	+0.061	0.554	+0.066	0.692	+0.083	0.857	+0.103	1.059	+0.127	...	...
20	...	...	0.488	+0.068	0.615	+0.074	0.769	+0.092	0.952	+0.114	1.176	+0.141	...	...
24	...	...	0.585	+0.082	0.738	+0.088	0.923	+0.111	1.143	+0.137	1.412	+0.169	...	...
30	...	...	0.732	+0.102	0.923	+0.111	1.154	+0.138	1.428	+0.171	1.765	+0.212	...	...
36	...	...	0.878	+0.123	1.108	+0.133	1.385	+0.166	1.714	+0.205	2.118	+0.254	...	...

^A The minimum is the lowest wall thickness of the pipe at any cross section. The maximum permitted wall thickness, at any cross section, is the minimum wall thickness plus the stated tolerance. All tolerances are on the plus side of the minimum requirement.

^B 1 in. = 25.4 mm (exact).

TABLE 3 Sustained Pressure Test Conditions for Water at 73°F (23°C) for PVC Plastic Pipe

SDR	Pressure ^A Required for Test							
	PVC 1120, PVC 1220, PVC 2120		PVC 2116		PVC 2112		PVC 2110	
	psi	MPa (bar)	psi	MPa (bar)	psi	MPa (bar)	psi	MPa (bar)
13.5	670	4.62 (46.2)	540	3.72 (37.2)	450	3.10 (31.0)	370	2.55 (25.5)
17	530	3.65 (36.5)	420	2.90 (29.0)	350	2.41 (24.1)	290	2.00 (20.0)
21	420	2.90 (29.0)	340	2.34 (23.4)	280	1.93 (19.3)	230	1.59 (15.9)
26	340	2.34 (23.4)	270	1.86 (18.6)	220	1.52 (15.2)	180	1.24 (12.4)
32.5	270	1.86 (18.6)	210	1.45 (14.5)	180	1.24 (12.4)	150	1.03 (10.3)
41	210	1.45 (14.5)	170	1.17 (11.7)	140	0.97 (9.7)	120	0.83 (8.3)
64	130	0.90 (9.0)	110	0.76 (7.6)	90	0.62 (6.2)	70	0.48 (4.8)

^A The fiber stresses used to derive these test pressures are as follows:

	psi	MPa (bar)
PVC 1120, PVC 1220, PVC 2120	4200	29.0 (290)
PVC 2116	3360	23.2 (232)
PVC 2112	2800	19.3 (193)
PVC 2110	2300	15.9 (159)

Some minor adjustments have been made to keep the test pressures uniform to simplify testing.

ten times the nominal diameter in length, but not less than 10 in. (250 mm) or more than 3 ft (1000 mm) between end closures and bearing the permanent marking on the pipe. Maintain the specimens at the pressure indicated for a period of 1000 h. Hold the pressure as closely as possible, but within ± 10 psi (± 70 kPa). Condition the specimens at the test temperature of 73.4°F (23°C) to within $\pm 3.6^\circ\text{F}$ (2°C). Maintain the test temperature at $73.4 \pm 3.6^\circ\text{F}$ ($23 \pm 2^\circ\text{C}$). Test in accordance with Test Method D 1598, except maintain the pressure at the values given in Table 3 for 1000 h. Failure of two of the six specimens tested shall constitute failure in the test. Failure of one of the six specimens tested is cause for

retest of six additional specimens. Failure of one of the six specimens tested in retest shall constitute failure in the test. Evidence of failure of the pipe shall be as defined in Test Method D 1598.

8.4.1 Accelerated Regression Test—Test in accordance with procedures in Test Method D 1598, using either free end or restrained end fittings. A minimum of six specimens shall be tested. Test three specimens at a single pressure that result in failures at or below 0.10 h. Test an additional three specimens at a single pressure that will result in failures at about 200 h. Generating additional data points to improve the LTHS or LCL, or both, is acceptable. No points shall be excluded unless

**TABLE 4 Burst Pressure Requirements for Water at 73°F (23°C) for PVC Plastic Pipe**

SDR	Minimum Burst Pressure ^A			
	PVC 1120, PVC 1220, PVC 2120		PVC 2116, PVC 2112, PVC 2110	
	psi	MPa (bar)	psi	MPa (bar)
13.5	1000	6.89 (68.9)	800	5.52 (55.2)
17	800	5.52 (55.2)	630	4.34 (43.4)
21	630	4.34 (43.4)	500	3.45 (34.5)
26	500	3.45 (34.5)	400	2.76 (27.6)
32.5	400	2.76 (27.6)	315	2.17 (21.7)
41	315	2.17 (21.7)	250	1.72 (17.2)
64	200	1.38 (13.8)	160	1.10 (11.0)

^A The fiber stresses used to derive these test pressures are as follows:

	psi	MPa (bar)
PVC 1120, PVC 1220, PVC 2120	6400	44.1 (441)
PVC 2116, PVC 2112, PVC 2110	5000	34.5 (345)

TABLE 5 Impact Resistance at 73°F (23°C) for PVC Plastic Pipe

Size, in.	Impact Resistance, ft-lbf (J) All SDRs	Size, in.	Impact Resistance, ft-lbf (J) All SDRs
¼	10 (13.6)	2½	40 (54.2)
½	10 (13.6)	3	60 (81.3)
¾	15 (20.3)	3½	70 (94.9)
1	20 (27.1)	4	90 (122.0)
1¼	20 (27.1)	5	100 (135.6)
1½	30 (40.7)	6	120 (162.7)
2	30 (40.7)	8 or larger	160 (216.9)

an obvious defect is detected in the failure area of the test sample, or there was a malfunction of test equipment. Characterize the data using the least squares regression described in Test Method D 2837.

8.5 Burst Pressure—Determine the minimum burst pressure with at least five specimens in accordance with Test Method D 1599, having the lengths specified in 8.4. The time of testing of each specimen shall be not less than 60 s.

NOTE 8—Times greater than 60 s may be needed to bring large size specimens to the burst pressure. The test is more difficult to pass using greater pressurizing times.

8.6 Flattening—Flatten three specimens of the pipe, 2 in. (50 mm) long, between parallel plates in a suitable press until the distance between the plates is 40 % of the outside diameter of the pipe. The rate of loading shall be uniform and such that the compression is completed within 2 to 5 min. On removal of the load, examine the specimens for evidence of splitting, cracking, or breaking.

8.7 Impact Resistance—Determine the impact resistance in accordance with the specification requirement section of Test Method D 2444. Test at $73.4 \pm 3.6^\circ\text{F}$ ($23 \pm 2^\circ\text{C}$) using a Tup B and flat plate support. Use a 20-lb (9-kg) tup.

8.7.1 Test Specimens—Specimens of pipe for impact testing shall be cut to lengths required in Test Method D 2444.

8.7.2 Test Requirements (¼ to 12 in.)—For pipe sizes ¼ in. (6 mm) through 12 in. (300 mm), ten specimens shall be tested. If nine or more pass, the lot passes. If two or more fail, the lot fails.

9. Retest and Rejection

9.1 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 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.

10. Product Marking

10.1 Marking on the pipe shall include the following, spaced at intervals of not more than 5 ft (1.5 m):

10.1.1 Nominal pipe size (for example, 2 in. (50 mm)),

10.1.2 The outside diameter system (IPS or PIP) on sizes 14 in. (350 mm) and over (for example, IPS 14 in. (350 mm) or PIP 21 in. (500 mm)),

10.1.3 Type of plastic pipe material in accordance with the designation code given in 3.2.5 (for example, PVC1120),

10.1.4 Standard thermoplastic pipe dimension ratio in accordance with the designation code given in 3.2.4 (for example, SDR21), or the pressure rating in pounds per square inch for water at 73°F (23°C) shown as the number followed by psi (for example, 200 psi (1.4 MPa)), except that when intended for pressure applications, the pressure rating shall be shown (for example, 200 psi (1.4 MPa)). When the indicated pressure rating is lower than that calculated in accordance with 3.2.3 (see appendix), the SDR shall also be included in the marking code,

10.1.5 ASTM designation D 2241, with which the pipe complies,

10.1.6 Manufacturer's name (or trademark) and code (Note 10), and

10.1.7 Pipe intended for the transport of potable water shall also include the seal or mark of the laboratory making the evaluation for this purpose, spaced at intervals specified by the laboratory.

NOTE 9—Manufacturers using the seal or mark of a laboratory must obtain prior authorization from the laboratory concerned.

NOTE 10—Manufacturer's code to include year, month, day, shift, plant, and extruder of manufacturer.

11. Quality Assurance

11.1 When the product is marked with this designation, D 2241, the manufacturer affirms that the product was manufactured, inspected, sampled, and tested in accordance with this specification and has been found to meet the requirements of this specification.

12. Keywords

12.1 pressure pipe; pressure rated; PVC; SDR



SUPPLEMENTARY REQUIREMENTS

This requirement applies whenever a regulatory authority or user calls for product to be used to convey or to be in contact with potable water.

S1. Potable Water Requirement—Products intended for contact with potable water shall be evaluated, tested, and certified for conformance with ANSI/NSF Standard No. 61 or

the health effects portion of NSF Standard No. 14 by an acceptable certifying organization when required by the regulatory authority having jurisdiction.

This requirement applies only to pipe to be used in systems that have not established other provisions for identification.

S2. Pipe Marking Requirement for Reclaimed Water Systems—Color Identification of pipe shall be by: (1) use of purple (violet) PVC material or (2) by use of continuous purple

stripes printed lengthwise on opposite sides of the pipe. The pipe shall be marked RECLAIMED WATER at intervals of 5 ft. or less.

ANNEX

(Mandatory Information)

A1. PVC PRESSURE RATED PIPES HAVING OTHER THAN IPS OUTSIDE DIAMETERS

A1.1 As the use of PVC pipe has expanded, a need for pipe diameters and dimension ratios other than those listed in the main body of this specification has developed. These include small diameter (2-in. and under) CTS sizes and large diameter (over 12-in.) PIP sizes. The IPS outside diameter pipes and the standard dimension ratios included in the body of this specification provide the format onto which these additional sizes are fitted.

A1.2 Pipe sizes listed in this Annex shall be tested to verify they meet the requirements shown in Tables A1.1-A1.7 and all

TABLE A1.1 CTS Outside Diameters and Tolerance for PVC Plastic Pipe

Nominal Tube Size, in.	Average Outside Diameter, in. (mm)	Tolerances, in. (mm)	
		Average	Maximum Out-of-Roundness
1/2	0.625 (15.9)	± 0.003 (0.08)	0.008 (0.20)
3/4	0.875 (22.2)	± 0.003 (0.08)	0.010 (0.26)
1	1.125 (28.6)	± 0.003 (0.08)	0.012 (0.30)
1 1/4	1.375 (34.9)	± 0.003 (0.08)	0.014 (0.36)
1 1/2	1.625 (41.3)	± 0.004 (0.10)	0.016 (0.40)
2	2.125 (54.0)	± 0.004 (0.10)	0.020 (0.50)

TABLE A1.2 PIP Outside Diameters and Tolerance for PVC Plastic Pipe

Nominal Tube Size, in.	Average Outside Diameter, in. (mm)	Tolerances, in. (mm)	
		Average	Maximum Out-of-Roundness
15	15.300 (388.62)	± .016 (0.41)	0.294 (7.46)
18	18.701 (475.00)	± .020 (0.51)	0.360 (9.14)
21	22.047 (559.99)	± .025 (0.64)	0.420 (10.66)
24	24.803 (629.99)	± .032 (0.81)	0.480 (12.20)
27	27.953 (710.00)	± .038 (0.96)	0.540 (13.72)

TABLE A1.3 Sustained Pressure Test Conditions for Water 73.4°F (23°C) for PVC Plastic Pipe^A

SDR	Pressure Required for Test—PVC 1120		
	psi	MPa	Bars
11	840	5.79	57.9
35	247	1.70	17.0
51	168	1.16	11.6
81	105	0.725	7.25

^A The fiber stress used to derive this test was 4200 psi (29.0 MPa).

other requirements of the specification.



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TABLE A1.4 Burst Pressure Test Conditions for Water at 73.4°F (23°C) for PVC Plastic Pipe^A

SDR	Pressure Required for Test—PVC 1120		
	psi	MPa	Bars
11	1280	8.82	88.2
35	380	2.62	26.2
51	260	1.79	17.9
81	160	1.085	10.85

^A The fiber stress used to derive this test was 6400 psi (44.1 MPa).

TABLE A1.5 Water Pressure Ratings (PR) at 73°F (23°C) for Nonthreaded PVC Plastic Pipe

SDR	PVC 1120 PVC 1220 PVC 2120		
	psi	MPa	Bars
11	400	2.75	27.5
35	118	0.81	8.1
51	80	0.55	5.5
81	50	0.34	3.4

TABLE A1.6 Wall Thicknesses and Tolerances for PVC Plastic pipe with CTS Outside Diameters^A

Nominal Tube Size, in.	Wall Thickness, in. (mm) ^B							
	SDR 21		SDR 17		SDR 13.5		SDR 11	
	Minimum Tolerance		Minimum Tolerance		Minimum Tolerance		Minimum Tolerance	
1/2	...	...	...	...	0.060	+0.020	0.060	+0.020
3/4	...	...	0.060	+0.020	0.065	+0.020	0.080	+0.020
1	0.060	+0.020	0.066	+0.020	0.083	+0.020	0.102	+0.020
1 1/4	0.065	+0.020	0.081	+0.020	0.102	+0.020	0.125	+0.020
1 1/2	0.077	+0.020	0.096	+0.020	0.120	+0.020	0.148	+0.020
2	0.101	+0.023	0.125	+0.023	0.157	+0.023	0.193	+0.023

^A The minimum is the lowest wall thickness of the pipe at any cross section. The maximum permitted wall thickness, at any cross-section, is the minimum wall thickness plus the stated tolerance. All tolerances are on the plus side of the minimum tolerance.

^B 1 in. = 25.4 mm (exact).

TABLE A1.7 Wall Thicknesses and Tolerances for PVC Plastic Pipe with PIP Outside Diameters^A

Nominal Pipe Size, in.	Wall Thickness, in. (mm) ^B													
	SDR81		SDR51		SDR41		SDR35		SDR32.5		SDR26		SDR21	
	Mini- mum	Toler- ance	Mini- mum	Toler- ance	Mini- mum	Toler- ance	Mini- mum	Toler- ance	Mini- mum	Toler- ance	Mini- mum	Toler- ance	Mini- mum	Toler- ance
6	0.076	+0.020	...	...	...	...	...	...	...	...	...	...	...	...
8	0.101	+0.020	...	...	...	...	...	...	...	...	...	...	...	...
10	0.126	+0.020	...	...	...	...	...	...	...	...	...	...	...	...
12	0.151	+0.020	...	...	...	...	...	...	...	...	...	...	...	...
15	0.189	+0.023	0.300	+0.042	0.373	+0.052	0.437	+0.052	0.471	+0.056	0.588	+0.070	0.728	+0.087
18	...	...	0.366	+0.051	0.456	+0.064	0.534	+0.064	0.575	+0.069	0.719	+0.086	...	...
21	...	...	0.432	+0.060	0.538	+0.075	0.630	+0.076	0.678	+0.081	0.848	+0.102	...	...
24	...	...	0.486	+0.068	0.605	+0.085	0.709	+0.085	0.763	+0.092	0.954	+0.115	...	...
27	...	...	0.548	+0.077	0.682	+0.095	0.799	+0.096	0.860	+0.103	1.075	+0.129	...	...

^A 1 in. = 25.4 mm (exact).

^B The minimum is the lowest wall thickness of the pipe at any cross section. The maximum permitted wall thickness, at any cross section, is the minimum wall thickness plus the stated tolerance. All tolerances are on the plus side of the minimum requirement.

APPENDIX

(Nonmandatory Information)

X1. SOURCE OF HYDROSTATIC DESIGN STRESSES

TABLE X1.1 Standard Thermoplastic Pipe Dimension Ratios (SDR) and Water Pressure Ratings (PR) at 73°F (23°C) for Nonthreaded PVC Plastic Pipe^A

SDR	Pressure Rating of PVC Pipe Materials ^A							
	PVC 1120, PVC 1220, PVC 2120		PVC 2116		PVC 2112		PVC 2110	
	psi	MPa (bar)	psi	MPa (bar)	psi	MPa (bar)	psi	MPa (bar)
13.5	315	2.17 (21.7)	250	1.72 (17.2)	200	1.38 (13.8)	160	1.10 (11.0)
17	250	1.72 (17.2)	200	1.38 (13.8)	160	1.10 (11.0)	125	0.86 (8.6)
21	200	1.38 (13.8)	160	1.10 (11.0)	125	0.86 (8.6)	100	0.69 (6.9)
26	160	1.10 (11.0)	125	0.86 (8.6)	100	0.69 (6.9)	80	0.55 (5.5)
32.5	125	0.86 (8.6)	100	0.69 (6.9)	80	0.55 (5.5)	63	0.43 (4.3)
41	100	0.69 (6.9)	80	0.55 (5.5)	63	0.43 (4.3)	50	0.34 (3.4)
64	63	0.43 (4.3)	50	0.34 (3.4)	NPR ^C	NPR ^C	NPR ^C	NPR ^C
Pressure Rating ^{ABC}								
psi		MPa (bar)		Standard Dimension Ratio of PVC Pipe Materials				
315		2.17 (21.7)		13.5	...	...	...	...
250		1.72 (17.2)		17	13.5	...	...	...
200		1.38 (13.8)		21	17	13.5	...	...
160		1.10 (11.0)		26	21	17	13.5	...
125		0.86 (8.6)		32.5	26	21	17	...
100		0.69 (6.9)		41	32.5	26	21	...
80		0.55 (5.5)		...	41	32.5	26	...
63		0.43 (4.3)		64	...	41	32.5	...
50		0.34 (3.4)		...	64	...	41	...

^A These pressure ratings do not apply for threaded pipe.

^B See 3.2.5 and 5.3 for code designation.

^C NPR = not pressure rated.

X1.1 The hydrostatic design stresses recommended by the Plastics Pipe Institute are used to pressure rate PVC plastic pipe. These hydrostatic design stresses are 2000 psi (14 MPa), 1600 psi (11.0 MPa), 1250 psi (8.6 MPa), and 1000 psi (6.9 MPa) for water at 73.4°F (23°C). These hydrostatic design stresses apply only to pipe meeting all the requirements of this specification.

X1.2 Six PVC pipe materials are included based on the requirements of Specification D 1784 and the PPI-recommended hydrostatic design stresses as follows:

X1.2.1 Type I, Grade 1 (12454-B), with a hydrostatic design stress of 2000 psi (14 MPa), designated as PVC1120.

X1.2.2 Type I, Grade 2 (12454-C), with a hydrostatic design stress of 2000 psi (14 MPa), designated as PVC1220.

X1.2.3 Type II, Grade 1 (14333-D), with a hydrostatic design stress of 2000 psi (14 MPa), designated as PVC2120.

X1.2.4 Type II, Grade 1 (14333-D), with a hydrostatic design stress of 1600 psi (11.0 MPa), designated as PVC2116.

X1.2.5 Type II, Grade 1 (14333-D), with a hydrostatic design stress of 1250 psi (8.6 MPa), designated as PVC2112.

X1.2.6 Type II, Grade 1 (14333-D), with a hydrostatic design stress of 1000 psi (7 MPa), designated as PVC2110.

X1.3 The standard method for obtaining hydrostatic basis for thermoplastic pipe materials is Test Method D 2837. Additional information regarding the criteria used in develop-

ing these hydrostatic design stresses may be obtained from the Plastics Pipe Institute.⁵ These hydrostatic design stresses may not be suitable for materials that show a wide departure from a straight line plot of log stress versus log time to failure. All the data available to date on PVC pipe materials made in the United States exhibit a straight-line plot under these plotting conditions.

X1.4 The pipe is rated for use with water in 73°F (23°C) at the maximum internal pressures shown in Table X1.1. Lower pressure ratings than those calculated in accordance with 3.2.3 may be recommended, at the option of the pipe manufacturer, in which case the SDR shall be included in the marking. Experience of the industry indicates that PVC plastic pipe meeting the requirements of this specification give satisfactory service under normal conditions for a long period at these pressure ratings. The sustained pressure requirements (6.3) are related to these ratings through the slopes of the strength-time plots of these materials in pipe form.

X1.5 The hydrostatic design stresses recommended by the Plastic Pipe Institute are based on tests made on pipe ranging in size from ½ to 2½ in. (12.5 to 50 mm).

⁵ The Plastics Pipe Institute is a division of The Society of the Plastics Industry, 355 Lexington, Ave., New York, NY 10017.

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