



Standard Specification for Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter¹

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

1. Scope

1.1 This specification covers polyethylene (PE) pipe that is outside diameter controlled, made in Schedule 40 and 80 sizes for use with socket-type fittings and butt fittings joined by heat fusion, and pressure-rated for water (see appendix). Included are criteria for classifying PE plastic pipe materials and PE plastic pipe, a system of nomenclature for PE plastic pipe, and requirements and test methods for materials, workmanship, dimensions, sustained pressure, burst pressure, and environmental stress cracking. Requirements for marking are also given.

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

1.3 The following safety hazards caveat pertains only to the test methods portion, 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:

- D 618 Practice for Conditioning Plastics for Testing²
- D 792 Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement²
- D 1238 Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer²
- D 1248 Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable³

¹ This specification is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.26 on Olefin Based Pipe.

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² *Annual Book of ASTM Standards*, Vol 08.01.

³ *Annual Book of ASTM Standards*, Vol 08.03.

D 1505 Test Method for Density of Plastics by the Density-Gradient Technique²

D 1598 Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure⁴

D 1599 Test Method for Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings⁴

D 1600 Terminology for Abbreviated Terms Relating to Plastics²

D 1603 Test Method for Carbon Black in Olefin Plastics²

D 2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings⁴

D 2837 Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials⁴

D 3350 Specification for Polyethylene Plastics Pipe and Fittings Materials³

F 412 Terminology Relating to Plastic Piping Systems⁴

2.2 NSF Standards:

Standard No. 14 for Plastic Piping Components and Related Materials⁵

Standard No. 61 for Drinking Water Systems Components—Health Effects⁵

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 polyethylene plastic is PE.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *hydrostatic design stress*—the estimated maximum tensile stress in the wall of the pipe in the circumferential orientation due to internal hydrostatic water pressure that can be applied continuously with a high degree of certainty that failure of the pipe will not occur.

⁴ *Annual Book of ASTM Standards*, Vol 08.04.

⁵ Available from the National Sanitation Foundation, P.O. Box 1468, Ann Arbor, MI 48106.

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

3.2.3 *relation among dimensions, hydrostatic design stress, and pressure rating*—the following expression, commonly known as the ISO equation,⁶ is used in this specification to relate dimensions, hydrostatic design stress, and pressure rating:

$$2S/P = (D_o/t) - 1 \quad (1)$$

where:

- S = hydrostatic design stress, psi (or MPa),
- P = pressure rating, pse (or MPa),
- D_o = average outside diameter, in. (or mm), and
- t = minimum wall thickness, in. (or mm).

3.2.4 *standard thermoplastic pipe materials designation code*—the pipe materials designation code shall consist of the abbreviation PE for the type of plastic, followed by the ASTM grade in Arabic numerals and the hydrostatic design stress in units of 100 psi with any decimal figures dropped. Where the hydrostatic design stress code contains less than two figures, a cipher shall be used before the number. Thus a complete material code consists of two letters and four figures for PE plastic pipe materials (see Section 5).

4. Pipe Classification

4.1 *General*—This specification covers PE pipe made from five PE plastic pipe materials in Schedule 40 and 80 sizes with outside diameter controlled.

5. Materials

5.1 *General*—Polyethylene 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.

5.2 *Basic Materials*—This specification covers PE pipe made from four PE plastics as defined in Specification D 1248, in which the requirements are based on short-term tests. These are Grade P14, Grade P23, Grade P24, Grade P33, and Grade P34. The PE plastics can also be described according to the appropriate cell classification in accordance with Specification D 3350. The 80°C sustained pressure performance requirements of 6.9 are not currently in PE material Specifications D 1248 or D 3350. To identify the correct pipe test category (C1 to C7), the PE material base resin density and melt index must be obtained from the PE material supplier.

NOTE 1—Committee F-17 has requested that Committee D-20 add the 80°C sustained pressure performance requirements to Specifications D 1248 and D 3350.

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

5.4 *Compound*—The PE plastic extrusion compound shall meet the requirements of either Grade P14, Class C; Grade

P23, Class C; Grade P24, Class C; Grade P33, Class C; or Grade P34, Class C material as described in Specification D 1248 or the comparable cell classification in accordance with Specification D 3350.

5.5 *Rework Material*—Clean, rework material, generated from the manufacturer’s own pipe production, may be used by the same manufacturer, as long as the pipe produced meets all the requirements of this specification.

6. Requirements

6.1 *Workmanship*—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.

6.2 *Dimensions and Tolerances*—All dimensions shall be measured in accordance with Test Method D 2122, using an acceptable length of pipe.

6.2.1 *Outside Diameters*—In accordance with Test Method D 2122, classify the pipe as roundable or nonroundable and determine the average outside diameter accordingly. For non-roundable pipe the tolerance for out-of-roundness shall apply only to pipe prior to shipment. The outside diameters and tolerances shall be as shown in Table 1.

NOTE 2—Five-inch through twelve-inch pipe sizes in Schedule 40 meet the dimensional requirements of roundable pipe and most polyethylene pipe materials meet the tensile requirements for roundable pipe.

6.2.2 *Wall Thickness*—The wall thicknesses and tolerances shall be as shown in Table 2.

6.2.3 *Wall Thickness Range*—The wall thickness range shall be within 12 %.

6.2.4 *Thickness of Outer Layer*—For pipe produced by simultaneous multiple extrusion, that is, pipe containing two or more concentric layers, the outer layer shall be at least 0.020 in. (0.51 mm) thick.

6.3 *Bond*—For pipe produced by simultaneous multiple extrusion, the bond between the layers shall be strong and uniform. It shall not be possible to separate any two layers with a probe or point of a knife blade so that the layers separate cleanly at any point.

TABLE 1 Outside Diameters and Tolerances for PE Plastic Pipe, Schedules 40 and 80, in. (mm)

| Nominal Pipe Size | Average Outside Diameter | Tolerance | |
|-------------------|--------------------------|----------------------|---|
| | | For Average Diameter | For Maximum and Minimum Diameter (Out-of-Roundness) |
| ½ | 0.840(21.34) | ±0.004(±0.10) | ±0.015(±0.38) |
| ¾ | 1.050(26.67) | ±0.004(±0.10) | ±0.020(±0.51) |
| 1 | 1.315(33.40) | ±0.005(±0.13) | ±0.025(±0.64) |
| 1¼ | 1.660(42.16) | ±0.005(±0.13) | ±0.025(±0.64) |
| 1½ | 1.900(48.26) | ±0.006(±0.15) | ±0.030(±0.76) |
| 2 | 2.375(60.33) | ±0.006(±0.15) | ±0.035(±0.89) |
| 2½ | 2.875(70.03) | ±0.007(±0.18) | ±0.035(±0.89) |
| 3 | 3.500(88.90) | ±0.008(±0.20) | ±0.040(±1.02) |
| 3½ | 4.000(101.60) | ±0.008(±0.20) | ±0.050(±1.27) |
| 4 | 4.500(114.30) | ±0.009(±0.23) | ±0.050(±1.27) |
| 5 | 5.563(141.30) | ±0.010(±0.25) | ±0.050(±1.27) |
| 6 | 6.625(168.28) | ±0.011(±0.28) | ±0.050(±1.27) |
| 8 | 8.625(219.08) | ±0.015(±0.38) | ±0.075(±1.91) |
| 10 | 10.750(273.05) | ±0.015(±0.38) | ±0.075(±1.91) |
| 12 | 12.750(323.85) | ±0.015(±0.38) | ±0.075(±1.91) |

⁶ ISO R 161-1960, Pipes of Plastics Materials for the Transport of Fluids (Outside Diameters and Nominal Pressures) Part 1, Metric Series.

TABLE 2 Wall Thicknesses and Tolerances for PE Plastic Pipe, Schedules 40 and 80, in.(mm)

| Nominal Pipe Size | Wall Thickness ^A | | | |
|-------------------|-----------------------------|---------------|--------------|---------------|
| | Schedule 40 | | Schedule 80 | |
| | Minimum | Tolerance | Minimum | Tolerance |
| 1/2 | 0.109(2.77) | +0.020(+0.51) | 0.147(3.73) | +0.020(+0.51) |
| 3/4 | 0.113(2.87) | +0.020(+0.51) | 0.154(3.91) | +0.020(+0.51) |
| 1 | 0.133(3.38) | +0.020(+0.51) | 0.179(4.55) | +0.021(+0.53) |
| 1 1/4 | 0.140(3.56) | +0.020(+0.51) | 0.191(4.85) | +0.023(+0.58) |
| 1 1/2 | 0.145(3.68) | +0.020(+0.51) | 0.200(5.08) | +0.024(+0.61) |
| 2 | 0.154(3.91) | +0.020(+0.51) | 0.218(5.54) | +0.026(+0.66) |
| 2 1/2 | 0.203(5.16) | +0.024(+0.61) | 0.276(7.01) | +0.033(+0.84) |
| 3 | 0.216(5.49) | +0.026(+0.66) | 0.300(7.62) | +0.036(+0.91) |
| 3 1/2 | 0.226(5.74) | +0.027(+0.69) | 0.318(8.08) | +0.038(+0.97) |
| 4 | 0.237(6.02) | +0.028(+0.71) | 0.337(8.56) | +0.040(+1.02) |
| 5 | 0.258(6.55) | +0.031(+0.79) | 0.375(9.53) | +0.045(+1.14) |
| 6 | 0.280(7.11) | +0.034(+0.86) | 0.432(10.97) | +0.052(+1.32) |
| 8 | 0.322(8.18) | +0.039(+0.99) | ... | ... |
| 10 | 0.365(9.27) | +0.044(+1.12) | ... | ... |
| 12 | 0.406(10.31) | +0.049(+1.24) | ... | ... |

^AThe 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.

6.4 *Carbon Black*—The polyethylene pipe extrusion compound shall contain at least 2 % carbon black when tested in accordance with Test Method D 1603. For pipe produced by simultaneous multiple extrusion, this requirement shall apply to the outer layer.

NOTE 3—There is evidence that indicates that type, particle size, and dispersion quality of the carbon black affects the weatherability of the pipe. The problem is being investigated and when reliable test methods are developed, requirements for weatherability, or other suitable requirements to cover this property, will be included in a revision of this specification.

6.5 *Density*—The polyethylene base resin (uncolored PE) in the pipe compound shall have a density in the range from 0.910 to 0.925 g/cm³ for pipe made from Grade P14 of Specification D 1248, 0.926 to 0.940 g/cm³ for pipe made from Grade P23 and Grade P24 of Specification D 1248, 0.941 to 0.965 g/cm³ for pipe made from Grade P33 of Specification D 1248, and 0.941 to 0.965 g/cm³ for pipe made from Grade P34 of Specification D 1248 when determined in accordance with 7.5.

6.6 *Burst Pressure*—The minimum burst pressure for PE plastic pipe shall be as given in Table 3, when determined in accordance with 7.8.

6.7 *Environmental Stress Cracking*— There shall be no loss of pressure in the pipe when tested in accordance with 7.7.

6.8 *Sustained Pressure*—Pipe made from PE materials designated PE2406, PE3406 or PE3408 shall meet the requirement of 6.8.1. Pipe made from other PE materials shall meet the requirements of 6.8.2 and 6.8.3.

6.8.1 The average failure time and the failure time of two of the three specimens shall meet or exceed the minimum values shown in Table 4 when tested in accordance with 7.7.1.

6.8.2 *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 5 when tested in accordance with 7.5.

6.8.3 *Elevated Temperature Sustained Pressure*—The average failure time must meet or exceed the specified minimum average failure time in Table 6 for both hoop stresses of a given pipe test category when tested in accordance with 7.7.

7. Test Methods

7.1 *Conditioning*—Condition the test specimens at 73.4 ± 3.6°F (23 ± 2°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.

7.2 *Test Conditions*—Conduct tests in the standard laboratory atmosphere of 73.4 ± 3.6°F (23 ± 2°C) and 50 ± 5 % relative humidity, unless otherwise specified in the test methods or in this specification.

7.3 *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.

7.3.1 *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.

7.4 *Density*—Determine the density of the pipe compound in accordance with Test Method D 1505 or D 792, using three specimens. Determine the percentage of carbon black by weight in accordance with 6.4. Calculate the density of the PE base resin (uncolored PE) in the pipe compound as follows:

$$D_R = D_P - 0.0044 C \quad (2)$$

where:

D_R = density of resin, g/cm³,

D_P = density of pipe compound, g/cm³, and

C = percentage by weight of carbon black.

7.5 *Sustained Pressure Test*—Select six pipe test specimens at random. Test the specimens individually with water under the pressures given in Table 5, each specimen at least 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 containing the permanent marking on the pipe. Maintain the specimens at the pressures indicated in Table 5 for the appropriate pipe size for a period of 1000 h or to failure, whichever occurs first. Hold the pressure as closely as possible,

TABLE 3 Burst Pressure Requirements for Water at 73.4°F (23°C) for PE Plastic Pipe, Schedules 40 and 80

| Nominal Pipe Size, in. | Min Burst Pressure ^A | | | | | |
|------------------------|---------------------------------|-------------|-------------|-------------|-------------|-------------|
| | PE2306, PE2406, PE3306, PE3406 | | PE2305 | | PE1404 | |
| | Schedule 40 | Schedule 80 | Schedule 40 | Schedule 80 | Schedule 40 | Schedule 80 |
| MPa | | | | | | |
| 1/2 | 5.17 | 7.38 | 4.14 | 5.86 | 2.55 | 3.65 |
| 3/4 | 4.14 | 6.00 | 3.31 | 4.76 | 2.07 | 2.96 |
| 1 | 3.93 | 5.45 | 3.10 | 4.34 | 1.93 | 2.69 |
| 1 1/4 | 3.17 | 4.48 | 2.55 | 3.59 | 1.59 | 2.21 |
| 1 1/2 | 2.90 | 4.07 | 2.28 | 3.24 | 1.38 | 2.00 |
| 2 | 2.41 | 3.52 | 1.93 | 2.76 | 1.17 | 1.72 |
| 2 1/2 | 2.62 | 3.72 | 2.07 | 2.90 | 1.31 | 1.79 |
| 3 | 2.28 | 3.24 | 1.79 | 2.55 | 1.10 | 1.59 |
| 3 1/2 | 2.07 | 2.96 | 1.65 | 2.34 | 1.03 | 1.45 |
| 4 | 1.93 | 2.83 | 1.52 | 2.21 | 0.97 | 1.38 |
| 5 | 1.65 | 2.48 | 1.31 | 2.00 | 0.83 | 1.24 |
| 6 | 1.52 | 2.41 | 1.17 | 1.93 | 0.76 | 1.17 |
| 8 | 1.38 | ... | 1.03 | ... | 0.69 | ... |
| 10 | 1.24 | ... | 0.97 | ... | 0.62 | ... |
| 12 | 1.17 | ... | 0.90 | ... | 0.55 | ... |
| psi | | | | | | |
| 1/2 | 750 | 1070 | 600 | 850 | 370 | 530 |
| 3/4 | 600 | 870 | 480 | 690 | 300 | 430 |
| 1 | 570 | 790 | 450 | 630 | 280 | 390 |
| 1 1/4 | 460 | 650 | 370 | 520 | 230 | 320 |
| 1 1/2 | 420 | 590 | 330 | 470 | 200 | 290 |
| 2 | 350 | 510 | 280 | 400 | 170 | 250 |
| 2 1/2 | 380 | 540 | 300 | 420 | 190 | 260 |
| 3 | 330 | 470 | 260 | 370 | 160 | 230 |
| 3 1/2 | 300 | 430 | 240 | 340 | 150 | 210 |
| 4 | 280 | 410 | 220 | 320 | 140 | 200 |
| 5 | 240 | 360 | 190 | 290 | 120 | 180 |
| 6 | 220 | 350 | 170 | 280 | 110 | 170 |
| 8 | 200 | ... | 150 | ... | 100 | ... |
| 10 | 180 | ... | 140 | ... | 90 | ... |
| 12 | 170 | ... | 130 | ... | 80 | ... |

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

| | |
|--------------------------------|----------------------|
| PE2306, PE2406, PE3306, PE3406 | 2520 psi (17.37 MPa) |
| PE2305 | 2000 psi (13.79 MPa) |
| PE1404 | 1250 psi (8.62 MPa) |

TABLE 4 Minimum Average Time to Failure (h) versus Test Hoop Stress

| Base Resin Density (g/cc) | Minimum Average Failure Time (h) | |
|---------------------------|----------------------------------|-----------------------|
| | S = 580 psi (4 MPa) | S = 670 psi (4.6 MPa) |
| >0.935 | 1000 | 170 |

but within ± 10 psi (± 69 kPa) (± 0.69 bar). Condition the specimens for at least 2 h to within $\pm 2^\circ\text{C}$ ($\pm 3.6^\circ\text{F}$) of the specified test temperature. Except as noted, test in accordance with Test Method D 1598. Failure of the pipe shall be as defined in Test Method D 1598.

7.6 Environmental Stress Cracking Test— Use six randomly selected 10-in. (250-mm) long specimens containing the permanent marking for this test. Connect one end of each specimen to a 600-psi (4-MPa) (40-bar) pressure gage and the other end to an air or nitrogen supply through a suitable valve. Subject the specimens to the pressures listed in Table 5 for 73.4°F (23°C), close the valve, and disconnect in such a manner that the pressure is retained in the specimen. Apply

enough pressure in excess of the listed value to compensate for the pressure lost during disconnection of the pressure source. Test the assembly for leaks by immersion in water. Eliminate leaks or substitute nonleaking specimens for those that leak. Take care to dry the test specimen completely after immersion. Apply a coating of “Igepal CO-630”⁷ to the pipe surface with a brush. Take care to keep the wetting agent at least 1/2 in. (12 mm) away from the clamps used on each end of the pipe. Use fresh reagent for each test and take care to store the reagent in closed containers because it is hygroscopic. Keep the coated pipe assembly at room temperature for 3 h and then examine. There shall be no loss of pressure in at least four of the six specimens. Discard specimens that leak at a connection and retest. Loss of pressure caused by expansion of the pipe shall not be cause for rejection.

⁷ This test method is based on the use of “Igepal CO-630,” a trademark for a nonylphenoxy poly(ethyleneoxy)ethanol, which may be obtained from the GAF Corp., Dyestuff and Chemical Div., 140 W. 51st St., New York, NY 10020.

TABLE 5 Sustained Pressure Test Conditions for Water at 23°C (73.4°F) for PE Plastic Pipe, Schedules 40 and 80

| Nominal Pipe Size, in. | Pressure ^A Required for Test | | | | | |
|------------------------------|---|-------------|-------------|-------------|-------------|-------------|
| | PE2306, PE2406, PE3306, PE3406 | | PE2305 | | PE1404 | |
| | Schedule 40 | Schedule 80 | Schedule 40 | Schedule 80 | Schedule 40 | Schedule 80 |
| MPa | | | | | | |
| 1/2 | 2.69 | 3.86 | 2.14 | 3.03 | 1.65 | 2.41 |
| 3/4 | 2.21 | 3.10 | 1.72 | 2.48 | 1.38 | 1.93 |
| 1 | 2.07 | 2.90 | 1.65 | 2.28 | 1.24 | 1.79 |
| 1 1/4 | 1.65 | 2.34 | 1.31 | 1.86 | 1.03 | 1.52 |
| 1 1/2 | 1.52 | 2.14 | 1.17 | 1.72 | 0.97 | 1.31 |
| 2 | 1.24 | 1.86 | 0.97 | 1.45 | 0.76 | 1.10 |
| 2 1/2 | 1.38 | 1.93 | 1.10 | 1.52 | 0.83 | 1.24 |
| 3 | 1.17 | 1.72 | 0.97 | 1.38 | 0.76 | 1.10 |
| 3 1/2 | 1.10 | 1.59 | 0.90 | 1.24 | 0.69 | 0.97 |
| 4 | 1.03 | 1.45 | 0.83 | 1.17 | 0.62 | 0.90 |
| 5 | 0.90 | 1.31 | 0.69 | 1.03 | 0.55 | 0.83 |
| 6 | 0.83 | 1.24 | 0.62 | 0.97 | 0.48 | 0.83 |
| 8 | 0.69 | ... | 0.55 | ... | 0.45 | ... |
| 10 | 0.62 | ... | 0.48 | ... | 0.38 | ... |
| 12 | 0.59 | ... | 0.48 | ... | 0.38 | ... |
| psi | | | | | | |
| 1/2 | 390 | 560 | 310 | 440 | 240 | 350 |
| 3/4 | 320 | 450 | 250 | 360 | 200 | 280 |
| 1 | 300 | 420 | 240 | 330 | 180 | 260 |
| 1 1/4 | 240 | 340 | 190 | 270 | 150 | 220 |
| 1 1/2 | 220 | 310 | 170 | 250 | 140 | 190 |
| 2 | 180 | 270 | 140 | 210 | 110 | 160 |
| 2 1/2 | 200 | 280 | 160 | 220 | 120 | 180 |
| 3 | 170 | 250 | 140 | 200 | 110 | 160 |
| 3 1/2 | 160 | 230 | 130 | 180 | 100 | 140 |
| 4 | 150 | 210 | 120 | 170 | 90 | 130 |
| 5 | 130 | 190 | 100 | 150 | 80 | 120 |
| 6 | 120 | 180 | 90 | 140 | 70 | 120 |
| 8 | 100 | ... | 80 | ... | 65 | ... |
| 10 | 90 | ... | 70 | ... | 55 | ... |
| 12 | 85 | ... | 70 | ... | 55 | ... |

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

| | |
|-----------------------------------|---------------------|
| PE2306, PE2406, PE3306, PE3406 | 1320 psi (9.10 MPa) |
| PE2305 | 1050 psi (7.24 MPa) |
| PE1404 | 820 psi (5.65 MPa) |

7.7 Elevated Temperature Test—Determine pipe test category in Table 6 for a given piping material. Base resin melt index is determined in accordance with Test Method D 1238 and base resin density is determined in accordance with Test Method D 1505. Prepare at least three test specimens as in 7.5. Test at 176°F (80°C) and the hoop stress (S) specified in Table 6 for the given pipe category in accordance with Test Method D 1598. Use water as the internal test medium. Two of three specimens must meet or exceed the specified minimum average failure time.

7.7.1 Prepare at least three specimens as in 7.5 for the appropriate test hoop stress given in Table 4. Test at 176°F (80°C) and the hoop stresses given in Table 4 in accordance with Test Method D 1598.

7.8 Burst Pressure—The test equipment, procedures and failure definitions shall be as specified in Test Method D 1599. In addition, the failure must be ductile.

8. Retest and Rejection

8.1 If the results of any test(s) do not meet the requirements of this specification, the test(s) may be conducted again in accordance with an agreement between the purchaser and the seller. There shall be no agreement to lower the minimum requirement of the specification by such means as omitting tests that are a part of the specifications, substituting or modifying a test method, or by changing the specification limits. In retesting the product requirements of this specification shall be met and the test methods designated in the 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 Marking on the pipe shall include the following, spaced at intervals of not more than 5 ft (1.5 m):

TABLE 6 176°F (80°C) Sustained Pressure Requirements for Water Pipe^{A,B}

| Pipe Test Category ^C | Base Resin Melt Index, D 1238 (g/10 min) | Base Resin Density, ^D D 1505 (g/cm ³) | Minimum Average Hours to Failure | | |
|---------------------------------|--|--|----------------------------------|---------------------|---------------------|
| | | | S = 725 psi (5 MPa) | S = 580 psi (4 MPa) | S = 435 psi (3 MPa) |
| C1 | <0.05 | 0.941–0.948 | 100 | 200 | — |
| C2 | <0.05 | 0.935–0.940 | 100 | 200 | — |
| C3 | 0.05–0.25 | 0.941–0.948 | 60 | 150 | — |
| C4 | 0.05–0.25 | 0.935–0.940 | 60 | 150 | — |
| C5 | >0.25 | 0.941–0.948 | 45 | 100 | — |
| C6 | >0.25 | 0.935–0.940 | 45 | 100 | — |
| C7 | >0.50 | 0.926–0.940 | — | 80 | 150 |

^AFor inside diameter controlled pipe, calculate internal pressure in accordance with the following formula:

$$P = \frac{2S}{\frac{D_i}{t} + 1}$$

^BFor outside diameter controlled pipe, calculate internal pressure in accordance with the following formula:

$$P = \frac{2S}{\frac{D_o}{t} - 1}$$

where:

- P = pressure, psig (MPa),
- S = hoop stress, psi (MPa),
- D_i = average inside diameter, in. (mm),
- D_o = average outside diameter, in. (mm), and
- t = minimum wall thickness, in. (mm).

^CSupplier to determine pipe test category appropriate for his product.

^DPipe categories for water pipe with resin density below 0.926 g/cm³ or above 0.948 g/cm³ will be added to this table when the data are available.

9.1.1 Nominal pipe size (for example, 2 in.).

9.1.2 Type of plastic pipe material in accordance with the designation code given in 3.5 (for example, PE2305).

9.1.3 Schedule size (40 or 80, whichever is applicable) and the pressure rating in pounds per square inch for water at 73.4°F (23°C) shown as the number followed by psi (for example, 100 psi). When the indicated pressure rating is lower than that calculated in accordance with 3.2.4 (see appendix), this shall be indicated by placing a star after the pressure rating.

9.1.4 This designation “ASTM D 2447” with which the pipe complies.

9.1.5 Manufacturer’s name (or trademark) and code (Note 1).

9.1.6 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 4—Manufacturers using the seal or mark of a laboratory must obtain prior authorization from the laboratory concerned.

9.1.7 Pipe test category in accordance with Table 6.

9.2 *Using Color to Identify Piping Service*—It is not mandatory to use color to identify piping service, but when color is applied expressly to identify piping service, such as with stripes, a color shell or solid color, blue is used for potable water; green is used for sewer; and purple (violet, lavender) is used for reclaimed water.

10. Quality Assurance

10.1 When the product is marked with this designation, D 2447, 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.

SUPPLEMENTARY REQUIREMENTS

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

S1. Potable Water Requirement

S1.1 Products intended for contact with potable water shall be evaluated, tested, and certified for conformance with ANSI/

NSF Standard 61 or the health effects portion of NSF Standard 14 by an acceptable certifying organization when required by the regulatory authority having jurisdiction.

APPENDIX

(Nonmandatory Information)

X1. SOURCE OF HYDROSTATIC DESIGN STRESSES

X1.1 The hydrostatic design stresses recommended by the Plastics Pipe Institute are used to pressure rate PE plastic pipe. These hydrostatic design stresses are 400 psi (2.76 MPa) (27.6 bar), 500 psi (3.45 MPa) (34.5 bar), and 630 psi (4.34 MPa) (43.4 bar) 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 PE materials are included, based on the requirements of Specification D 1248 and the PPI-recommended hydrostatic design stresses as follows:

X1.2.1 Grade P 14 with a hydrostatic design stress of 400 psi (2.76 MPa) (27.6 bar) for water at 73.4°F (23°C), designated as PE1404.

X1.2.2 Grade P23, with a hydrostatic design stress of 500 psi (3.45 MPa) (34.5 bar) for water at 73.4°F (23°C), designated as PE2305.

X1.2.3 Grade P23, with a hydrostatic design stress of 630 psi (4.34 MPa) (43.4 bar) for water at 73.4°F (23°C), designated as PE2306.

X1.2.4 Grade P24, with a hydrostatic design stress of 630 psi (4.34 MPa) (43.4 bar) for water at 73°F (23°C), designated as PE2406.

X1.2.5 Grade P33, with a hydrostatic sign stress of 630 psi (4.34 MPa) (43.4 bar) for water at 73.4°F (23°C), designated as PE3306.

X1.2.6 Grade P34, with a hydrostatic design stress of 630 psi (4.34 MPa) (43.4 bar) for water at 73.4°F (23°C), designated as PE3406.

X1.3 Information regarding the test method and other criteria used in developing these hydrostatic design stresses may be obtained from the Plastics Pipe Institute, a division of The Society of the Plastics Industry, 355 Lexington Ave., New York, NY 10017 (Note X1.1). 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 PE pipe materials made in North America exhibit a straight-line plot under these plotting conditions.

NOTE X1.1—Refer also to Test Method D 2837.

X1.4 The pipe is rated for use with water at 73.4°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 a star placed after the pressure rating shall be included in the marking. Experience of the industry indicates that PE plastic pipe meeting the requirements of this specification gives satisfactory service under normal conditions for a long period at these pressure ratings. The sustained pressure requirements (see 6.6) 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 Plastics Pipe Institute are based on tests made on pipe ranging in size from ½ to 2 in.

TABLE X1.1 Water Pressure Ratings at 73.4°F (23°C) for PE Plastic Pipe, Schedules 40 and 80

| Nominal Pipe Size, in. | Pressure Rating ^A | | | | | |
|------------------------|--------------------------------|-------------|---------------------|-------------|---------------------|-------------|
| | PE2306, PE2406, PE3306, PE3406 | | PE2305 ^B | | PE1404 ^B | |
| | Schedule 40 | Schedule 80 | Schedule 40 | Schedule 80 | Schedule 40 | Schedule 80 |
| MPa (bar) | | | | | | |
| 1/2 | 1.30(13.0) | 1.84(18.4) | 1.03(10.3) | 1.46(14.6) | 0.82(8.2) | 1.17(11.7) |
| 3/4 | 1.05(10.5) | 1.49(14.9) | 0.83(8.3) | 1.19(11.9) | 0.66(6.6) | 0.94(9.4) |
| 1 | 0.98(9.8) | 1.37(13.7) | 0.78(7.8) | 1.09(10.9) | 0.62(6.2) | 0.87(8.7) |
| 1 1/4 | 0.80(8.0) | 1.13(11.3) | 0.63(6.3) | 0.90(9.0) | 0.51(5.1) | 0.72(7.2) |
| 1 1/2 | 0.72(7.2) | 1.02(10.2) | 0.57(5.7) | 0.81(8.1) | 0.45(4.5) | 0.65(6.5) |
| 2 | 0.60(6.0) | 0.88(8.8) | 0.48(4.8) | 0.70(7.0) | 0.38(3.8) | 0.56(5.6) |
| 2 1/2 | 0.66(6.6) | 0.92(9.2) | 0.52(5.2) | 0.73(7.3) | 0.42(4.2) | 0.59(5.9) |
| 3 | 0.57(5.7) | 0.81(8.1) | 0.45(4.5) | 0.65(6.5) | 0.37(3.7) | 0.52(5.2) |
| 3 1/2 | 0.52(5.2) | 0.75(7.5) | 0.41(4.1) | 0.59(5.9) | 0.34(3.4) | 0.48(4.8) |
| 4 | 0.48(4.8) | 0.70(7.0) | 0.38(3.8) | 0.56(5.6) | NPR | 0.45(4.5) |
| 5 | 0.42(4.2) | 0.63(6.3) | 0.34(3.4) | 0.49(4.9) | NPR | 0.40(4.0) |
| 6 | 0.38(3.8) | 0.61(6.1) | NPR | 0.48(4.8) | NPR | 0.39(3.9) |
| 8 | 0.34(3.4) | ... | NPR | ... | NPR | ... |
| 10 | NPR ^C | ... | NPR | ... | NPR | ... |
| 12 | NPR | ... | NPR | ... | NPR | ... |
| psi | | | | | | |
| 1/2 | 188 | 267 | 149 | 212 | 119 | 170 |
| 3/4 | 152 | 217 | 120 | 172 | 96 | 137 |
| 1 | 142 | 199 | 113 | 158 | 90 | 126 |
| 1 1/4 | 116 | 164 | 92 | 130 | 74 | 104 |
| 1 1/2 | 104 | 148 | 83 | 118 | 66 | 94 |
| 2 | 87 | 127 | 69 | 101 | 55 | 81 |
| 2 1/2 | 96 | 134 | 76 | 106 | 61 | 85 |
| 3 | 83 | 118 | 66 | 94 | 53 | 75 |
| 3 1/2 | 75 | 109 | 60 | 86 | 50 | 69 |
| 4 | 70 | 102 | 55 | 81 | NPR | 65 |
| 5 | 61 | 91 | 50 | 72 | NPR | 58 |
| 6 | 55 | 88 | NPR | 70 | NPR | 56 |
| 8 | 50 | ... | NPR | ... | NPR | ... |
| 10 | NPR ^C | ... | NPR | ... | NPR | ... |
| 12 | NPR | ... | NPR | ... | NPR | ... |

^AThese pressure ratings apply only to unthreaded pipe. The industry does not recommend threading PE plastic pipe.

^BSee 5.2 and appendix for code designation.

^CNPR = not pressure rated. The industry does not recommend pressure ratings less than 50 psi (0.34 MPa)(3.4 bar).

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