



Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter¹

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1. Scope

1.1 This specification covers polyethylene (PE) pipe made in dimensions based on outside diameters of 90 mm (3.500 in.) and larger.

1.2 Three standard outside diameter sizing systems are detailed: one known as the ISO metric system, one known as the IPS system, and the other known as the DIPS system. See 5.2.5 for guidelines for special sizes.

1.3 The piping is intended for new construction and insertion renewal of old piping systems used for the transport of water, municipal sewage, domestic sewage, industrial process liquids, effluents, slurries, etc., in both pressure and nonpressure systems.

NOTE 1—The user must consult the manufacturer to ensure that any damage of the polyethylene pipe caused by the material being transported will not affect the service life beyond limits acceptable to the user.

1.4 All pipes produced under this specification are pressure-rated.

1.5 This specification includes criteria for choice of raw material and test methods for evaluation of raw material, together with performance requirements and test methods for determining conformance with the requirements.

1.6 Quality-control measures to be taken by manufacturers, are outlined in the appendix as a nonmandatory part of this specification.

1.7 In referee decisions, the SI units shall be used for metric-sized pipe and inch-pound units for pipe sized in the IPS system (ANSI B 36.10) and DIPS system. In all cases, the values given in parentheses are provided for information only.

1.8 The following safety hazards caveat pertains only to the test methods portion, Section 6, 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.*

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. Referenced Documents

2.1 *ASTM Standards:*²

D 1238 Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer

D 1248 Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable

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

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 Pressure of Plastic Pipe, Tubing, and Fittings

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

D 2290 Test Method for Apparent Hoop Tensile Strength of Plastic or Reinforced Plastic Pipe by Split Disk Method

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

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

D 2837 Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products

D 3350 Specification for Polyethylene Plastics Pipe and Fittings Materials

F 412 Terminology Relating to Plastic Piping Systems

F 585 Practice for Insertion of Flexible Polyethylene Pipe Into Existing Sewers

2.2 *ANSI Standard:*

B 36.10 Standard Dimensions of Steel Pipe (IPS)³

2.3 *ISO Standards:*

161 Thermoplastic Pipe for the Transport of Fluids - Nominal Outside Diameters and Nominal Pressures⁴

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 Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

⁴ Available from International Organization for Standardization (ISO), 1 rue de Varembé, Case postale 56, CH-1211, Geneva 20, Switzerland.

3607 Polyethylene Pipe: Tolerances on Outside Diameters and Wall Thicknesses⁴

4427 Polyethylene Pipes and Fittings for Water Supply Specification⁴

2.4 *Federal Standard:*

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)⁵

2.5 *Military Standard:*

MIL-STD-129 Marking for Shipment and Storage⁵

2.6 *Canadian Standard:*

CGSB 41 GP-25M Pipe, Polyethylene for the Transport of Liquids⁶

2.7 *NSF Standards:*

Standard No. 14 for Plastic Piping Components and Related Materials⁷

Standard No. 61 for Drinking Water Systems Components—Health Effects⁷

where:

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

P = pressure rating, psi (or Pa),

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

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

D_o/t = dimension ratio.

3.2.2 *relations between hydrostatic design basis and hydrostatic design stress*—the hydrostatic design stress, *S*, is determined by multiplying the hydrostatic design basis (HDB) by the design factor, *n*. The design factor, *n*, has a value less than 1.0.

3.2.2.1 The hydrostatic pressure rating of pipes (see **Table 1(a)**) described in this specification is based on the use of a (service) design factor (see **2.3**) of 0.5 in accordance with the instruction given in Test Method **D 2837**.

NOTE 2—This factor is valid for water and domestic sewage transported at temperatures up to 23°C when the pipe is installed in accordance with the appropriate standard procedures. Smaller design factors should be applied to systems operating at higher temperatures, or high surge pressures resulting from changing velocity or where pipe is to be used for the transport of industrial effluents known to have some degrading effect on the properties of polyethylene, or where erosion of the pipe wall by the fluid being transported will adversely affect the service life of the system. The actual choice of design factor for a given installation must be reviewed by the designing engineer, taking into account the transportation and on-site handling conditions, the difficulties of site preparation, the contractual specifications for trenching, bedding, haunching, backfilling, and the possibility of deviation from operating at hydrostatic pressures or external load conditions specified for the use of the piping system. A further uncertainty factor should be applied at the designing engineer’s discretion where warranted by consideration of these conditions.

3. Terminology

3.1 *Definitions*—General terms used in this specification are as defined in Terminology **F 412**.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *relation between dimension ratio, hydrostatic design stress, and hydrostatic pressure:*

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

⁵ Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098.

⁶ Available from Canadian Standards Association (CSA), 178 Rexdale Blvd., Toronto, ON M9W1R3, Canada.

⁷ Available from NSF International, P.O. Box 130140, 789 N. Dixboro Rd., Ann Arbor, MI 48113-0140.

TABLE 1 Pressure Rating and Pressure Performance Tests^A

Table 1(a) Standard Pressure Rating (2.2)^B

| HDB | | DR41 | | DR32.5 | | DR26 | | DR21 | | DR17 | | DR15.5 | | DR11 | | DR9.3 | | DR9 | | DR7.3 | |
|-----|------|------|-----|--------|-----|------|-----|------|-----|------|-----|--------|-----|------|-----|-------|-----|------|-----|-------|-----|
| MPa | psi | kPa | psi | kPa | psi | kPa | psi | kPa | psi | kPa | psi | kPa | psi | kPa | psi | kPa | psi | kPa | psi | kPa | psi |
| 8.6 | 1250 | 215 | 31 | 275 | 40 | 345 | 50 | 430 | 63 | 540 | 78 | 595 | 86 | 860 | 125 | 1035 | 150 | 1075 | 156 | 1365 | 198 |
| 10 | 1450 | 250 | 36 | 315 | 46 | 400 | 58 | 500 | 72 | 625 | 91 | 690 | 100 | 1000 | 145 | 1205 | 175 | 1250 | 181 | 1585 | 230 |
| 11 | 1600 | 275 | 40 | 350 | 50 | 440 | 64 | 550 | 80 | 690 | 100 | 760 | 110 | 1100 | 160 | 1325 | 192 | 1380 | 200 | 1750 | 254 |

TABLE 1(b) Short-Term Pressure Test (6.2.1)

| HDB and Density | DR41 | | DR32.5 | | DR26 | | DR21 | | DR17 | | DR15.5 | | DR11 | | DR9.3 | | DR9 | | DR7.3 | | |
|-----------------|------|-----|--------|-----|------|-----|------|-----|------|-----|--------|-----|------|-----|-------|-----|------|-----|-------|-----|--|
| | kPa | psi | kPa | psi | kPa | psi | kPa | psi | kPa | psi | kPa | psi | kPa | psi | kPa | psi | kPa | psi | kPa | psi | |
| All HDB | | | | | | | | | | | | | | | | | | | | | |
| Medium density | 860 | 125 | 1095 | 159 | 1380 | 200 | 1725 | 250 | 2155 | 312 | 2380 | 345 | 3450 | 500 | 4155 | 602 | 4310 | 625 | 5475 | 794 | |
| High density | 1000 | 145 | 1270 | 184 | 1600 | 232 | 2000 | 290 | 2500 | 363 | 2760 | 400 | 4000 | 580 | 4820 | 699 | 5000 | 725 | 6350 | 921 | |

TABLE 1(c) Sustained Pressure Test, 1000 h (6.2.2)

| HDB | | DR41 | | DR32.5 | | DR26 | | DR21 | | DR17 | | DR15.5 | | DR11 | | DR9.3 | | DR9 | | DR7.3 ^{A,B} | |
|-----|------|------|-----|--------|-----|------|-----|------|-----|------|-----|--------|-----|------|-----|-------|-----|------|-----|----------------------|-----|
| MPa | psi | kPa | psi | kPa | psi | kPa | psi | kPa | psi | kPa | psi | kPa | psi | kPa | psi | kPa | psi | kPa | psi | kPa | psi |
| 8.6 | 1250 | 445 | 64 | 570 | 83 | 720 | 104 | 895 | 131 | 1125 | 162 | 1235 | 179 | 1790 | 260 | 2150 | 312 | 2240 | 325 | 2840 | 412 |
| 10 | 1450 | 520 | 75 | 655 | 96 | 830 | 121 | 1040 | 150 | 1300 | 189 | 1435 | 208 | 2080 | 302 | 2510 | 364 | 2595 | 376 | 3275 | 478 |
| 11 | 1600 | 552 | 80 | 701 | 102 | 883 | 128 | 1103 | 160 | 1379 | 200 | 1580 | 229 | 2207 | 320 | 2750 | 399 | 2870 | 416 | 3640 | 528 |

^A Pressures specified for the performance tests are derived as follows:

Table 1(b) Short-Term Pressures:

All HDB, medium-density materials – 2500 psi fiber stress

All HDB, high-density materials – 2900 psi fiber stress

Table 1(c) Sustained pressure for 1000 h is 2.08 × standard pressure rating, **Table 1 (a)** or maximum of 1600 psi fiber stress.

^B In some international standards, this rating may be expressed in “bars” (1 bar = 100 kPa). The “bar” is not a recognized unit in U.S. or Canadian Standard Codes of metric (SI) practice.

4. Materials

4.1 *Polyethylene Plastics*, used to make pipe meeting the requirements of this specification are categorized, by testing, for long-term strength and by the analysis of results of this testing to determine the hydrostatic design basis. Three categories of polyethylene plastic compounds having hydrostatic design basis of 1250 psi (8.6 MPa), 1450 psi (10 MPa), or 1600 psi (11 MPa) as categorized in **Table 2** shall be used for the manufacture of pipe under this specification.

4.2 *Compound*—The resin compounds used shall meet the general physical requirements listed in Specification **D 3350**, except that the hydrostatic design basis shall be in accordance with 4.1 and **Table 2** of this specification. The polyethylene compounds shall be color and UV stabilizer Code C (black with 2 % minimum carbon black) or Code E (colored with UV stabilizer) as specified in Specification **D 3350**.

4.2.1 The 80°C sustained pressure performance requirements of 5.3.4 (pipe test category in **Table 3**) 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 3—Committee F-17 has requested that Committee D-20 add the 80°C sustained pressure performance requirements to Specifications **D 1248** and **D 3350**.

NOTE 4—The hydrostatic design basis of 1450 psi (10 MPa) is not included in the cell classifications of Property 6, in **Table 1** of Specification **D 3350**. However, it is an internationally recognized value and is used in the form of a standardized design stress of 725 psi (5 MPa) in many national and international standards outside of the United States, including ISO 4427 and **CGSB 41-GP-25M**.

4.3 *Rework Material*—Clean polyethylene compound reclaimed from the manufacturer’s own pipe production may be reextruded into pipe, either alone or blended with new compound of the same cell classification. Pipe containing the rework material must meet all the material and product requirements of this specification.

4.4 *Cell Classification of Polyethylene Pipe Materials*—Polyethylene materials suitable for use in the manufacture of pipe under this specification shall be classified in accordance with Specification **D 3350**, and as shown in **Table 4**, for example, for a polyethylene material having a HDB of 1250 psi (8.6 MPa), the base resin density must have a cell classification of 2 or 3; the melt index cell classification must be 1, 2, or 3, etc.

5. Requirements Requirements

5.1 *Workmanship*—The pipe shall be homogeneous throughout and essentially uniform in color, opacity, density, and other properties. The inside and outside surfaces shall be semimatte or glossy in appearance (depending on the type of

plastic) and free of chalking, sticky, or tacky material. The surfaces shall be free of excessive bloom, that is, slight bloom is acceptable. The pipe walls shall be free of cracks, holes, blisters, voids, foreign inclusion, or other defects that are visible to the naked eye and that may affect the wall integrity. Holes deliberately placed in perforated pipe are acceptable. Bloom or chalking may develop in pipe exposed to direct rays of the sun (ultraviolet radiant energy) for extended periods and, consequently, these requirements do not apply to pipe after extended exposure to direct rays of the sun.

5.2 Dimensions and Tolerances:

5.2.1 *Outside Diameters*—These shall be in accordance with **Table 5** (SI units), **Table 6** (inch-pound units) or **Table 7** (inch-pound units) when measured in accordance with Test Method **D 2122** at any point not closer than 300 mm (11.8 in.) to the cut end of a length of pipe. Conditioning to standard temperature but not to standard humidity is required.

5.2.2 *Wall Thicknesses*—The minimum thicknesses shall be in accordance with **Table 8** (inches), **Table 9** (inches), or **Table 10** (inches) when measured in accordance with Test Method **D 2122**. Conditioning to standard temperature but not to standard humidity is required.

5.2.3 *Eccentricity*—The wall thickness variability as measured and calculated in accordance with Test Method **D 2122** in any diametrical cross section of the pipe shall not exceed 12 %.

5.2.4 *Toe-In*—When measured in accordance with 5.2.1, the outside diameter at the cut end of the pipe shall not be more than 1.5% smaller than the undistorted outside diameter. Measurement of the undistorted outside diameter shall be made no closer than 1.5 pipe diameters or 11.8 in. (300 mm), whichever distance is less, from the cut end of the pipe. Undistorted outside diameter shall meet specifications in **Table 5**, **Table 6**, or **Table 7**.

5.2.5 *Special Sizes*—Where existing system conditions or special local requirements make other diameters or dimension ratios necessary, other sizes or dimension ratios, or both, shall be acceptable for engineered applications when mutually agreed upon by the customer and the manufacturer, if the pipe is manufactured from plastic compounds meeting the material requirements of this specification, and the strength and design requirements are calculated on the same basis as those used in this specification. For diameters not shown in **Table 5**, **Table 6**, or **Table 7**, the tolerance shall be the same percentage as that shown in the corresponding tables for the next smaller listed size. Minimum wall thicknesses for DRs not shown in **Table 8**, **Table 9**, or **Table 10** shall comply with 3.2.2.1 and the tolerance shall comply with 5.2.3.

5.3 *Pressure Test Performance*—All grades of PE pipe shall meet the requirements of 5.3.1. Pipe made from PE materials designated PE2406, PE3406 or PE3408 shall meet the requirement of 5.3.2. Pipe made from other PE materials shall meet the requirements of 5.3.3 and 5.3.4.

NOTE 5—The requirements of 5.3.1 and 5.3.3 are for laboratory proof-testing only and should not be interpreted as applicable to in situ testing for acceptance of installed systems. See appropriate installation standards or manufacturer’s recommendations for field testing procedure.

TABLE 2 Hydrostatic Design Basis

| Minimum Calculated LTHS Value ^A | | Hydrostatic Design Basis | |
|--------------------------------------------|--------|--------------------------|--------|
| psi | MPa | psi | MPa |
| 1200 | (8.3) | 1250 | (8.6) |
| 1390 | (9.6) | 1450 | (10.0) |
| 1530 | (10.6) | 1600 | (11.0) |

^A 96 % of hydrostatic design basis.

TABLE 3 176°F (80°C) Sustained Pressure Requirements for Water Pipe^A

| Pipe Test Category ^B | Base Resin Melt Index, D 1238 (g/10 min) | Base Resin Density, ^C 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 |

^A For 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_o = average outside diameter, in. (mm), and
t = minimum wall thickness, in. (mm).

^B Supplier to determine pipe test category appropriate for his product.

^C Pipe 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.

TABLE 4 Classification of Polyethylene Pipe Materials

| For HDB of | 1250 psi (8.6 MPa) | 1450 psi (10 MPa) | 1600 psi (11 MPa) |
|---------------------------------------------------------|---------------------------|----------------------|----------------------|
| Physical Properties and Cell Classification Limits are: | | | |
| Density (base resin) | 2 or 3 | 2 or 3 | 2 or 3 |
| Melt/Index | 1, 2, or 3 | 3, 4, or 5 | 3, 4, or 5 |
| Flexural modulus | 4 or 5 | 3, 4, or 5 | 4 or 5 |
| Tensile strength | 2 or 3 | 3, 4, or 5 | 3, 4, or 5 |
| SCG | 1, 2, 3, 4, 5, or 6 | 3, 4, 5, or 6 | 3, 4, 5, or 6 |
| Color and UV stabilizer code | C or E | C or E | C or E |

TABLE 5 Outside Diameters and Tolerances

| ISO Sizing System (ISO 161/1) | | | |
|-------------------------------|------------|------------------------------------------|------------------|
| Nominal Pipe Size | Equivalent | Outside Diameter, D _o , mm | |
| | | min | max ^A |
| mm | in. | mm | mm |
| 90 | 3.543 | 90 | 90.8 |
| 110 | 4.331 | 110 | 111.0 |
| 160 | 6.299 | 160 | 161.4 |
| 200 | 7.874 | 200 | 201.8 |
| 250 | 9.843 | 250 | 252.3 |
| 280 | 11.024 | 280 | 282.5 |
| 315 | 12.402 | 315 | 317.8 |
| 355 | 13.976 | 355 | 358.2 |
| 400 | 15.748 | 400 | 403.6 |
| 450 | 17.717 | 450 | 454.1 |
| 500 | 19.685 | 500 | 504.5 |
| 560 | 22.047 | 560 | 565.0 |
| 630 | 24.803 | 630 | 635.7 |
| 710 | 27.953 | 710 | 716.4 |
| 800 | 31.496 | 800 | 807.2 |
| 900 | 35.433 | 900 | 908.1 |
| 1000 | 39.370 | 1000 | 1009.0 |
| 1200 | 47.244 | 1200 | 1210.8 |
| 1400 | 55.118 | 1400 | 1412.6 |
| 1600 | 62.992 | 1600 | 1614.4 |

^A As specified in ISO 3607.

5.3.1 *Short-Term Pressurization*—The pipe shall not rupture, leak, nor exhibit localized deformation when tested in accordance with 6.2.1 at the pressures given in Table 1(b).

**TABLE 6 Outside Diameters and Tolerances
IPS Sizing System (ANSI B36.10)**

| Nominal Pipe Size, in. | Equivalent, mm | Actual Outside Diameters, in. | |
|---------------------------|----------------|-------------------------------|--------------------|
| | | Average | Tolerance ± in. |
| 3 | 88.9 | 3.500 | 0.016 |
| 4 | 114.3 | 4.500 | 0.020 |
| 5 ^A | 136.5 | 5.375 | 0.025 |
| 5 | 141.3 | 5.563 | 0.025 |
| 6 | 168.3 | 6.625 | 0.030 |
| 7 ^A | 181.0 | 7.125 | 0.034 |
| 8 | 219.1 | 8.625 | 0.039 |
| 10 | 273.1 | 10.750 | 0.048 |
| 12 | 323.8 | 12.750 | 0.057 |
| 13 ^A | 339.7 | 13.375 | 0.060 |
| 14 | 355.6 | 14.000 | 0.063 |
| 16 | 406.4 | 16.000 | 0.072 |
| 18 | 457.2 | 18.000 | 0.081 |
| 20 | 508.0 | 20.000 | 0.090 |
| 21.5 ^A | 546.1 | 21.500 | 0.097 |
| 22 | 558.8 | 22.000 | 0.099 |
| 24 | 609.6 | 24.000 | 0.108 |
| 26 | 660.4 | 26.000 | 0.117 |
| 28 | 711.2 | 28.000 | 0.126 |
| 30 | 762.0 | 30.000 | 0.135 |
| 32 | 812.8 | 32.000 | 0.144 |
| 34 | 863.6 | 34.000 | 0.153 |
| 36 | 914.4 | 36.000 | 0.162 |
| 42 | 1066.8 | 42.000 | 0.189 |
| 48 | 1219.2 | 48.000 | 0.216 |
| 54 | 1371.6 | 54.000 | 0.243 |

^A Special sizes.

5.3.2 *Alternate Elevated Temperature Sustained Pressure Test*—The average failure time and the failure time of two of the three specimens shall meet or exceed the minimum values shown in Table 11 when tested in accordance with 6.2.3.1.

5.3.3 *Sustained Pressure*—The pipe shall not rupture, leak, nor exhibit localized deformation (ballooning) when tested in accordance with 6.2.2 for a period of 1000 h at the pressure given in Table 1(c).

5.3.4 *Elevated Temperature Sustained Pressure*—The average failure time must meet or exceed the specified minimum average failure time in Table 3 for both hoop stresses of a given pipe test category, when tested in accordance with 6.2.3.

TABLE 7 Outside Diameters and Tolerances

| Nominal DIPS Sizes, in. | DIPS Sizing System | | |
|-------------------------|--------------------|-------------------------------|---------------------|
| | Equivalent, mm | Actual Outside Diameters, in. | |
| | | Average | Tolerance \pm in. |
| 3 | 100.6 | 3.96 | 0.016 |
| 4 | 121.9 | 4.80 | 0.022 |
| 6 | 175.3 | 6.90 | 0.031 |
| 8 | 229.9 | 9.05 | 0.041 |
| 10 | 281.9 | 11.10 | 0.050 |
| 12 | 385.3 | 13.20 | 0.059 |
| 14 | 388.6 | 15.30 | 0.069 |
| 16 | 442.0 | 17.4 | 0.078 |
| 18 | 495.3 | 19.5 | 0.088 |
| 20 | 548.6 | 21.60 | 0.097 |
| 24 | 655.3 | 25.80 | 0.116 |
| 30 | 812.8 | 32.00 | 0.144 |
| 36 | 972.8 | 38.30 | 0.172 |
| 42 | 1130.3 | 44.50 | 0.200 |
| 48 | 1290.3 | 50.80 | 0.229 |

TABLE 8 Minimum Wall Thickness ISO 161 Sizing System, mm

| DR | 41 | 32.5 | 26 | 21 | 17 | 11 |
|-------------------|------|------|------|------|------|------|
| Nominal Pipe Size | | | | | | |
| 90 | ... | ... | 3.5 | 4.3 | 5.3 | 8.2 |
| 110 | ... | 3.4 | 4.2 | 5.2 | 6.5 | 10.0 |
| 160 | ... | 4.9 | 6.2 | 7.6 | 9.4 | 14.5 |
| 200 | ... | 6.2 | 7.7 | 9.5 | 11.8 | 18.2 |
| 250 | ... | 7.7 | 9.6 | 11.9 | 14.7 | 22.7 |
| 280 | ... | 8.6 | 10.8 | 13.3 | 16.5 | 25.5 |
| 315 | ... | 9.7 | 12.1 | 15.0 | 18.5 | 28.6 |
| 355 | ... | 10.9 | 13.7 | 16.9 | 20.9 | 32.3 |
| 400 | ... | 12.3 | 15.4 | 19.0 | 23.5 | 36.4 |
| 450 | ... | 13.8 | 17.3 | 21.4 | 26.5 | ... |
| 500 | ... | 15.4 | 19.2 | 23.8 | 29.4 | ... |
| 560 | ... | 17.2 | 21.5 | 26.7 | 32.9 | ... |
| 630 | ... | 19.4 | 24.2 | 30.0 | 37.1 | ... |
| 710 | ... | 21.8 | 27.3 | 33.8 | 41.8 | ... |
| 800 | ... | 24.6 | 30.8 | 38.1 | 47.1 | ... |
| 900 | ... | 27.7 | 34.6 | 42.9 | ... | ... |
| 1000 | 24.4 | 30.8 | 38.5 | 47.6 | ... | ... |
| 1200 | 29.3 | 36.9 | 46.2 | ... | ... | ... |
| 1400 | 34.1 | 43.1 | ... | ... | ... | ... |
| 1600 | 39.0 | 49.2 | ... | ... | ... | ... |

5.4 *Apparent Tensile Strength at Yield*—For pipe sizes above 3-in. (90-mm) nominal diameter, the Short-Term Pressurization Test, 6.2.1, may be replaced by the apparent ring tensile strength test (Test Method D 2290). The minimum apparent tensile strength at yield when determined in accordance with 6.2.4 shall be 2520 psi (17.4 MPa).

5.5 *Quality Control*—To determine compliance with Section 5, the number of samples specified in the test method shall be tested. For quality control purposes, not for determining compliance with Section 5, Requirements, it is acceptable to test individual samples.

NOTE 6—Manufacturers conduct appropriate quality control tests at a frequency appropriate to their manufacturing operations. See Appendix X5.

6. Test Methods

6.1 *Raw Material Categorization*—Samples of polyethylene compounds for use in the manufacture of pipe under this specification shall be converted into pipe specimens under

controlled manufacturing conditions. Specimens shall be measured in accordance with Test Method D 2122 to determine the average diameter throughout and the minimum wall thickness. Tests shall be conducted in accordance with Test Method D 1598 at 23°C in a “water inside-water outside” or “water inside-air outside” environment. The number of failure points and the period of testing shall be in accordance with Test Method D 2837.

NOTE 7—It is recommended that HDB for material categorization be calculated using hydrostatic test values obtained from the testing of specimens from 3.54 to 7.87 in. (90 to 200 mm) in diameter.

NOTE 8—The hydrostatic design basis, recommended by the Plastics Pipe Institute, may be used in pressure rating of pipe manufactured to this specification.

6.2 Product Requirements Tests:

6.2.1 *Short-Term Pressurization Tests*—These shall be conducted in accordance with Test Method D 1599 except that no failure will have occurred when the test pressure is raised to the value given in Table 1(b) in the prescribed period. The test shall be conducted at $73.4 \pm 3.6^\circ\text{F}$ ($23 \pm 2^\circ\text{C}$).

6.2.2 *Sustained Pressure Tests*—These shall be conducted in accordance with Test Method D 1598. The test pressure shall be given in Table 1(c). Tests shall be conducted in either a “water inside-water outside” or “water inside-air outside” environment at $73.4 \pm 3.6^\circ\text{F}$ ($23 \pm 2^\circ\text{C}$).

NOTE 9—**Precaution:** Pressurization of specimens being tested under 6.2.1 or 6.2.2 should not commence until it is certain that all entrapped air has been bled from the water-filled specimens.

6.2.3 *Elevated Temperature Test*—Determine pipe test category in Table 3 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 specimens as in 6.2.2. Test at 176°F (80°C) and the hoop stress (*S*) specified in Table 3 for the given pipe category in accordance with Test Method D 1598. Two or three specimens must meet or exceed the specified minimum average failure time. Use water as the internal test medium.

6.2.3.1 Prepare at least three specimens as in 7.5 for the appropriate test hoop stress given in Table 11. Test at 176°F (80°C) and the hoop stresses given in Table 11 in accordance with Test Method D 1598.

6.2.4 *Apparent Tensile Properties*—The procedure and test equipment shall be as specified in Test Method D 2290. Cut specimens from pipe. Test a minimum of five specimens. This method is applicable to all pipe of nominal 3-in. (90-mm) outside diameter and larger.

7. Retest and Rejection

7.1 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 specification, 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

**TABLE 9 Minimum Wall Thickness
IPS Sizing System, in. (ANSI B 36.10)**

| Nominal IPS Pipe Size | Actual Pipe Size | Dimension Ratio | | | | | | | | | | | |
|-----------------------|------------------|-----------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | | 41 | 32.5 | 26 | 21 | 17 | 15.5 | 13.5 | 11 | 9.3 | 9 | 8.3 | 7.3 |
| 3 | 3.500 | 0.085 | 0.108 | 0.135 | 0.167 | 0.206 | 0.226 | 0.259 | 0.318 | 0.376 | 0.389 | 0.422 | 0.479 |
| 4 | 4.500 | 0.110 | 0.138 | 0.173 | 0.214 | 0.265 | 0.290 | 0.333 | 0.409 | 0.484 | 0.500 | 0.542 | 0.616 |
| 5 ^A | 5.375 | 0.131 | 0.165 | 0.207 | 0.256 | 0.316 | 0.347 | 0.398 | 0.489 | 0.578 | 0.597 | 0.648 | 0.736 |
| 5 | 5.563 | 0.136 | 0.171 | 0.214 | 0.265 | 0.327 | 0.359 | 0.412 | 0.506 | 0.598 | 0.618 | 0.670 | 0.762 |
| 6 | 6.625 | 0.162 | 0.204 | 0.255 | 0.315 | 0.390 | 0.427 | 0.491 | 0.602 | 0.712 | 0.736 | 0.798 | 0.908 |
| 7 ^A | 7.125 | 0.174 | 0.219 | 0.274 | 0.340 | 0.420 | 0.460 | 0.528 | 0.648 | 0.766 | 0.792 | 0.858 | 0.976 |
| 8 | 8.625 | 0.210 | 0.265 | 0.332 | 0.411 | 0.507 | 0.556 | 0.639 | 0.784 | 0.927 | 0.958 | 1.039 | 1.182 |
| 10 | 10.750 | 0.262 | 0.331 | 0.413 | 0.512 | 0.632 | 0.694 | 0.796 | 0.977 | 1.156 | 1.194 | 1.295 | 1.473 |
| 12 | 12.750 | 0.310 | 0.392 | 0.490 | 0.607 | 0.750 | 0.823 | 0.944 | 1.159 | 1.371 | 1.417 | 1.536 | 1.747 |
| 13 ^A | 13.375 | 0.326 | 0.412 | 0.514 | 0.637 | 0.787 | 0.863 | 0.991 | 1.216 | 1.438 | 1.486 | 1.611 | 1.832 |
| 14 | 14.000 | 0.341 | 0.431 | 0.538 | 0.667 | 0.824 | 0.903 | 1.037 | 1.273 | 1.505 | 1.556 | 1.687 | 1.918 |
| 16 | 16.000 | 0.390 | 0.492 | 0.615 | 0.762 | 0.941 | 1.032 | 1.185 | 1.455 | 1.720 | 1.778 | 1.928 | 2.192 |
| 18 | 18.000 | 0.439 | 0.554 | 0.692 | 0.857 | 1.059 | 1.161 | 1.333 | 1.636 | 1.935 | 2.000 | 2.169 | 2.466 |
| 20 | 20.000 | 0.488 | 0.615 | 0.769 | 0.952 | 1.176 | 1.290 | 1.481 | 1.818 | 2.151 | 2.222 | 2.409 | ... |
| 21.5 ^A | 21.500 | 0.524 | 0.662 | 0.827 | 1.024 | 1.265 | 1.387 | 1.593 | ... | ... | ... | ... | ... |
| 22 | 22.000 | 0.537 | 0.677 | 0.846 | 1.048 | 1.294 | 1.419 | 1.630 | 2.000 | 2.366 | 2.444 | ... | ... |
| 24 | 24.000 | 0.585 | 0.738 | 0.923 | 1.143 | 1.412 | 1.548 | 1.778 | 2.182 | 2.581 | 2.667 | ... | ... |
| 26 | 26.000 | 0.634 | 0.800 | 1.000 | 1.238 | 1.529 | 1.677 | 1.926 | 2.364 | 2.796 | ... | ... | ... |
| 28 | 28.000 | 0.683 | 0.862 | 1.077 | 1.333 | 1.647 | 1.806 | 2.074 | 2.545 | 3.011 | ... | ... | ... |
| 30 | 30.000 | 0.732 | 0.923 | 1.154 | 1.429 | 1.765 | 1.935 | 2.222 | 2.727 | 3.226 | ... | ... | ... |
| 32 | 32.000 | 0.780 | 0.985 | 1.231 | 1.524 | 1.882 | 2.065 | 2.370 | 2.909 | ... | ... | ... | ... |
| 34 | 34.000 | 0.829 | 1.046 | 1.308 | 1.619 | 2.000 | 2.194 | 2.519 | 3.091 | ... | ... | ... | ... |
| 36 | 36.000 | 0.878 | 1.108 | 1.385 | 1.714 | 2.118 | 2.323 | 2.667 | 3.273 | ... | ... | ... | ... |
| 42 | 42.000 | 1.024 | 1.292 | 1.615 | 2.000 | 2.471 | 2.710 | ... | ... | ... | ... | ... | ... |
| 48 | 48.000 | 1.171 | 1.477 | 1.846 | 2.286 | 2.824 | 3.097 | ... | ... | ... | ... | ... | ... |
| 54 | 54.000 | 1.317 | 1.662 | 2.077 | 2.571 | 3.176 | ... | ... | ... | ... | ... | ... | ... |

^A Special sizes.

TABLE 10 Minimum Wall Thickness

| DIPS Sizing System, in. | | Dimension Ratio | | | | | | |
|-------------------------|----------------------------------|-----------------|-------|-------|-------|-------|-------|-------|
| Nominal DIPS Pipe Size | Actual OD ^A Pipe Size | 41 | 32.5 | 26 | 21 | 17 | 13.5 | 11 |
| 3 | 3.96 | ... | 0.122 | 0.153 | 0.189 | 0.233 | 0.294 | 0.360 |
| 4 | 4.80 | 0.117 | 0.148 | 0.185 | 0.229 | 0.283 | 0.356 | 0.437 |
| 6 | 6.90 | 0.168 | 0.213 | 0.266 | 0.329 | 0.406 | 0.512 | 0.628 |
| 8 | 9.05 | 0.221 | 0.279 | 0.348 | 0.431 | 0.533 | 0.670 | 0.823 |
| 10 | 11.10 | 0.236 | 0.342 | 0.427 | 0.529 | 0.653 | 0.823 | 1.009 |
| 12 | 13.20 | 0.322 | 0.407 | 0.508 | 0.629 | 0.777 | 0.978 | 1.200 |
| 14 | 15.30 | 0.373 | 0.471 | 0.589 | 0.729 | 0.900 | 1.134 | 1.391 |
| 16 | 17.40 | 0.424 | 0.536 | 0.670 | 0.829 | 1.024 | 1.289 | 1.582 |
| 18 | 19.50 | 0.463 | 0.600 | 0.750 | 0.929 | 1.147 | 1.445 | 1.773 |
| 20 | 21.60 | 0.527 | 0.665 | 0.831 | 1.029 | 1.271 | 1.600 | 1.964 |
| 24 | 25.80 | 0.629 | 0.794 | 0.993 | 1.229 | 1.518 | 1.912 | 2.346 |
| 30 | 32.00 | 0.780 | 0.985 | 1.231 | 1.524 | 1.883 | 2.371 | 2.909 |
| 36 | 38.30 | 0.934 | 1.179 | 1.473 | 1.824 | 2.253 | 2.837 | 3.482 |
| 42 | 44.50 | 1.085 | 1.370 | 1.712 | 2.119 | 2.618 | 3.297 | 4.046 |
| 48 | 50.80 | 1.239 | 1.563 | 1.954 | 2.419 | 2.989 | 3.763 | 4.619 |

^A In accordance with Table 7.

TABLE 11 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 | 1 000 | 170 |

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.

8. Certification

8.1 When specified in the purchase order or contract, a manufacturer's certification shall be furnished to the purchaser that the material was manufactured, sampled, tested, and

inspected in accordance with this specification, and has been found to meet the requirements. When specified in the purchase order or contract, a report of the test results shall be furnished. Each certification so furnished shall be signed by an authorized agent of the manufacturer.

9. Marking

9.1 Marking on the pipe shall include the following and shall be placed at least at each end of each shipped length of pipe or spaced at intervals of not more than 5 ft (1.5 m).

9.1.1 The letters ASTM followed by the designation number of this specification.

9.1.2 The letters PE followed by the cell classification number (D 3350) of the raw material compound used. Where the option of use of the 1450-psi (10-MPa) HDB classification has been taken, the position of the sixth digit shall be filled with a dash (-) followed by the notation 10 MPa. Where applicable, the standard thermoplastic pipe materials designation code (Appendix X4) may be used as an alternative marking.

9.1.3 Nominal pipe outside diameter in mm or inches in accordance with Table 5, Table 6, or Table 7, and the designated sizing system: "XX mm ISO," or "XX in IPS," or "XX in DIPS." For metric outside diameter pipe, "ISO" may be omitted, and for inches outside diameter pipe, "in" may be replaced with a double-quotation mark ("").

9.1.4 Dimensional ratio or pressure rating, or both, kilopascals or pound-force per square inch shown as "XXX kPa" or "XXX psi".

9.1.5 Name or trademark of the manufacturer.

9.1.6 Production code from which location and date of manufacturer can be identified.