



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

This standard is issued under the fixed designation D3035; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This specification covers polyethylene (PE) pipe made in thermoplastic pipe dimension ratios based on outside diameter IPS $\frac{1}{2}$ to 3, for both non-pressure and pressure rated for water (see Appendix X1). Included are requirements for polyethylene compounds and PE plastic pipe, a system of nomenclature for PE plastic pipe, and requirements and test methods for materials, workmanship, dimensions, sustained pressure, and burst pressure. Methods of marking are also given.

NOTE 1—Significant changes have been made to this specification to remedy duplication of sizes with other specifications, for DIPS sizes and larger sizes refer to the appropriate standard specification such as Specification F714 or AWWA C906.

1.2 For pipes produced under this specification that are intended for use in the distribution and transmission of potable water without oxidizing disinfectants, potable and non-potable water, grey water, reclaimed water, wastewater, force main and gravity municipal sewage, etc., the user should consult the manufacturer to determine whether the material fluid being transported is compatible with polyethylene pipe and will not affect the service life beyond limits acceptable to the user.

1.3 For pipes produced under this specification that are intended for use in the distribution and transmission of potable water or other fluids containing oxidizing disinfectants (for example, Hypochlorous acid or chloramines), special requirements for PE compounds are specified in 5.2 and 5.3, and DR limitations are specified in 6.2.1.1 and 6.2.2.1.

NOTE 2—Refer to specification AWWA C901 for other suitable potable water options.

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.5 The following safety hazards caveat pertains only to the test methods portion, Section 7, of this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

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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*A Summary of Changes section appears at the end of this standard

2. Referenced Documents

2.1 ASTM Standards:²

- D618 Practice for Conditioning Plastics for Testing
- D1238 Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
- D1598 Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure
- D1599 Test Method for Resistance to Short-Time Hydraulic Pressure of Plastic Pipe, Tubing, and Fittings
- D1600 Terminology for Abbreviated Terms Relating to Plastics
- D2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings
- D2290 Test Method for Apparent Hoop Tensile Strength of Plastic or Reinforced Plastic Pipe
- D2837 Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
- D3350 Specification for Polyethylene Plastics Pipe and Fittings Materials
- F412 Terminology Relating to Plastic Piping Systems
- F714 Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter

2.2 NSF International Standards:³

- NSF/ANSI Standard 14 for Plastic Piping Components and Related Materials
- NSF/ANSI/NSF/ANSI/CAN Standard 61 for Drinking Water System Components—Health Effects

2.3 Other Documents:

- TR-3 Policies and Procedures for Developing Hydrostatic Design Basis (HDB), Pressure Design Basis (PDB), Strength Design Basis (SDB), and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe⁴
- TR-4 Listing of Hydrostatic Design Bases (HDB), Strength Design Bases (SDB), Pressure Design Bases (PDB) and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe⁴
- TN-49 Recommendations for AWWA C901 Service Tubes in Potable Water Applications
- APWA Uniform Color Code⁵
- AWWA C901 Polyethylene (PE) Pressure Pipe and Tubing, ¾ in. (19 mm) through 3 in. (76 mm), for Water Service
- AWWA C906 Polyethylene (PE) Pressure Pipe and Fittings, 4 in. (100 mm) through 65 in. (1650 mm), for Water Works

3. Terminology

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

3.2 Definitions of Terms Specific to This Standard: [ASTM D3035-21](https://standards.iteh.ai/ASTM-D3035-21)

<https://standards.iteh.ai/catalog/standards/sist/c6dc8f3e-6d16-48af-badb-dec12dad208a/astm-d3035-21>

3.2.1 *relation between dimension ratio, hydrostatic design stress, and pressure rating*—the following expression, commonly known as the ISO equation,⁶ is used in this specification to relate dimension ratio, hydrostatic design stress, and pressure rating:

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

where:

- S = hydrostatic design stress for water at 73°F (23°C), psi (MPa),
- \underline{S} = hydrostatic design stress for water at 73 °F (23 °C), psi (MPa),
- P = pressure rating, psi (MPa),
- D_o = average outside diameter, in. (mm)
- t = minimum wall thickness, in. (mm), and,
- DR = thermoplastic pipe dimension ratio (D_o/t for PE pipe).

4. Pipe Classification

4.1 *General*—This specification covers PE pipe made from PE plastic pipe materials in various dimension ratios and water pressure ratings.

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 NSF International, P.O. Box 130140, 789 N. Dixboro Rd., Ann Arbor, MI 48113-0140, <http://www.nsf.org>.

⁴ Available from Plastics Pipe Institute (PPI), 105 Decker Court, Suite 825, Irving, TX 75062, <http://www.plasticpipe.org>.

⁵ APWA, 2345 Grand Boulevard, Suite 500, Kansas City, MO 64018-2641, <http://www.apwa.net>.

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

TABLE 1 Polyethylene Compound Requirements

| Requirement | Material Designation | | | | |
|-----------------------------------------------------------------------------------------------------------------|----------------------|--------------------------------------------------------------|--------------------------------------------------------------|--------------------------------------------------------------|--------------------------------------------------------------|
| | PE1404 | PE2708 | PE3608 | PE4608 | PE4710 |
| HDB at 140°F (60°C), psi (MPa), per ASTM D2837 and PPI TR-3 | ^A | 800 (5.5) ^B | 800 (5.5) ^B | 800 (5.5) ^B | 800 (5.5) ^B |
| HDB at 140 °F (60 °C), psi (MPa), in accordance with ASTM D2837 and PPI TR-3 | ^A | 800 (5.5) ^B | 800 (5.5) ^B | 800 (5.5) ^B | 1000 (6.9) ^B |
| HDS for water at 73°F (23°C) psi (MPa), per ASTM D2837 and PPI TR-3 ^C | 400 (2.76) | 800 (5.5) | 800 (5.5) | 800 (5.5) | 1000 (6.9) |
| HDS for water at 73°F (23°C) psi (MPa), in accordance with ASTM D2837 and PPI TR-3 ^C | 400 (2.76) | 800 (5.5) | 800 (5.5) | 800 (5.5) | 1000 (6.9) |
| Melt flow rate per ASTM D1238 | 1.0 to 0.4 g/10 min | ≤0.40 g/10 min Cond. 190/2.16 or ≤20 g/10 min Cond. 190/21.6 | ≤0.15 g/10 min Cond. 190/2.16 or ≤20 g/10 min Cond. 190/21.6 | ≤0.15 g/10 min Cond. 190/2.16 or ≤20 g/10 min Cond. 190/21.6 | ≤0.15 g/10 min Cond. 190/2.16 or ≤20 g/10 min Cond. 190/21.6 |
| Melt flow rate in accordance with ASTM D1238 | 1.0 to 0.4 g/10 min | ≤0.40 g/10 min Cond. 190/2.16 or ≤20 g/10 min Cond. 190/21.6 | ≤0.15 g/10 min Cond. 190/2.16 or ≤20 g/10 min Cond. 190/21.6 | ≤0.15 g/10 min Cond. 190/2.16 or ≤20 g/10 min Cond. 190/21.6 | ≤0.15 g/10 min Cond. 190/2.16 or ≤20 g/10 min Cond. 190/21.6 |
| Specification D3350 | Required Value | | | | |
| Cell Classification Property | Required Value | | | | |
| Density (natural base resin) | 1 | 2 | 3 | 4 | 4 |
| SCG Resistance | 4 | 7 | 6 | 6 | 7 |
| Color and UV Stabilizer Code ^D | C | C, D, or E | C, D, or E | C, D, or E | C, D, or E |

^AHDB at 140°F (60°C) 140 °F (60 °C) not required. Contact manufacturer about pipe use at temperatures other than 73°F (23°C) 73 °F (23 °C).

^B Minimum value.

^CContact manufacturer or see PPI TR-4 for listed value.

^DSee [5.1.1](#).

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<https://standards.iteh.ai/catalog/standards/sist/c6dc83e-6d16-48af-badb-dec12dad208a/astm-d3035-21>

4.2 Thermoplastic Pipe Dimension Ratios (DR)—This specification covers PE pipe in various dimension ratios such as, but not limited to, DR 11, DR 13.5, DR 17, and DR 21 ratios. The pressure rating is uniform for all nominal sizes of pipe for a given PE pipe material and DR. (See [Table X1.1](#).) See [4.3](#), Special sizes for dimension ratios not listed.

4.3 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 in engineered products when mutually agreed upon by the customer and manufacturer if (1) the pipe is manufactured from plastic compounds meeting the material requirements of this specification and (2) the strength and design requirements are calculated on the same basis as those used in this specification.

4.3.1 Piping systems smaller than IPS 4 intended for applications using oxidizing disinfectants shall not utilize a DR numerically greater than (have a wall thickness thinner than) DR 9. Refer to [1.3](#), [5.4](#), [6.2.1.1](#) and [6.2.2.1](#).

5. Materials

5.1 Polyethylene Compounds—Polyethylene compounds suitable for use in the manufacture of pipe under this specification shall meet thermoplastic materials designation codes PE1404 or PE2708 or PE3608 or PE4608 or PE4710, and shall meet [Table 1](#) requirements for PE1404 or PE2708 or PE3608 or PE4608 or PE4710, and shall meet thermal stability, brittleness temperature and elongation at break requirements in accordance with Specification [D3350](#)

5.1.1 Color and Ultraviolet (UV) Stabilization—Per [Table 3](#), polyethylene compounds shall meet Specification [D3350](#) code C, D

TABLE 2 IPS Pipe-Outside Diameter^A and Tolerance

| IPS Size | Outside Diameter, in. (mm) | Tolerances, in. (mm) |
|----------|----------------------------|----------------------|
| ½ | 0.840 (21.34) | ±0.004 (0.10) |
| ¾ | 1.050 (26.7) | ±0.004 (0.10) |
| 1 | 1.315 (33.4) | ±0.005 (0.13) |
| 1¼ | 1.660 (42.2) | ±0.005 (0.13) |
| 1½ | 1.900 (48.3) | ±0.006 (0.15) |
| 2 | 2.375 (60.3) | ±0.006 (0.15) |
| 3 | 3.500 (88.9) | ±0.008 (0.20) |
| 4 | 4.500 (114.3) | ±0.009 (0.23) |
| 6 | 6.625 (168.28) | ±0.011 (0.28) |
| 8 | 8.625 (219.09) | ±0.013 (0.33) |
| 10 | 10.750 (273.05) | ±0.015 (0.38) |
| 12 | 12.750 (323.85) | ±0.017 (0.43) |
| 14 | 14.000 (355.60) | ±0.063 (1.60) |
| 16 | 16.000 (406.40) | ±0.072 (1.83) |
| 18 | 18.000 (457.20) | ±0.081 (2.06) |
| 20 | 20.000 (508.00) | ±0.090 (2.29) |
| 22 | 22.000 (558.80) | ±0.099 (2.51) |
| 24 | 24.000 (609.60) | ±0.108 (2.74) |
| 26 | 26.000 (660.4) | ±0.117 (2.97) |
| 28 | 28.000 (711.2) | ±0.126 (3.20) |
| 30 | 30.000 (762.0) | ±0.135 (3.43) |
| 32 | 32.000 (812.8) | ±0.144 (3.66) |
| 34 | 34.000 (863.6) | ±0.153 (3.89) |
| 36 | 36.000 (914.4) | ±0.162 (4.11) |
| 42 | 42.000 (1066.8) | ±0.189 (4.80) |
| 48 | 48.000 (1219.2) | ±0.216 (5.49) |
| 54 | 54.000 (1371.6) | ±0.243 (6.17) |
| 63 | 63.000 (1600.2) | ±0.284 (6.71) |
| 65 | 65.000 (1651.0) | ±0.293 (7.44) |

^AFor a distance to the cut end of the pipe that is the lesser of 11.8-in (300 mm) or 1.5 times the outside diameter, a diameter reduction of up to 1.5% shall be acceptable.

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or E. In addition, Code C polyethylene compounds shall have 2 to 3 percent carbon black, and Code E polyethylene compounds shall have sufficient UV stabilizer to protect pipe from deleterious UV exposure effects during unprotected outdoor shipping and storage for at least eighteen (18) months.

5.1.2 Colors for solid color, a color shell layer, or color stripes used to identify pipe service or pipe DR—Colors for solid color, a color shell layer, or color stripes—In accordance with the APWA Uniform Color Code, blue shall identify potable water service; green shall identify sewer service; purple (lavender) shall identify reclaimed water service. Yellow identifies gas service and shall not be used. Colors used to identify DR may be used in accordance with end user specifications.

5.2 Potable Water Requirement—Health Effects Requirements—When required by the regulatory authority having jurisdiction, products intended for contact with potable water shall be evaluated, tested, and water, or when otherwise required, shall be certified for conformance with NSF/ANSI Standard No. 61 or the health effects portion of NSF/ANSI/CAN Standard No. 14 by an acceptable certifying organization.

5.3 Oxidative Resistance—For pipe that is intended for use in the transport of potable water or other fluids containing oxidizing disinfectants (for example, Hypochlorous acid or chloramines), or where required by the application, customer or regulatory authority having jurisdiction, the PE compound shall have an oxidative resistance classification of CC3 in accordance with Specification D3350. The oxidative resistance classification of CC3 is used in conjunction with pipe dimensions in accordance with 6.2.1.1 and 6.2.2.1 to ensure intended pipe service life is met with respect to oxidative resistance (see Note 3). When the pipe meets these requirements, it shall be marked CC3 in accordance with 9.1.7. When the pipe does not meet the compound and dimensional requirements as above it shall not be marked CC3. An oxidative resistance classification is not required for other potable water service or other fluids that do not contain oxidizing disinfectants or when it is not required by the application, customer or regulatory authority having jurisdiction.

NOTE 3—See PPI TN-49 or www.plasticpipe.org for further information on potable water disinfectants in small diameter PE pipe and the use of oxidative resistance classification for specific applications.

5.4 Rework Material—Clean, rework material from the manufacturer’s own pipe production that met 5.1 through 5.25.3 as new

TABLE 3 IPS Pipe^A Minimum Wall Thickness and Tolerance

| IPS Size | DR 32.5 | | DR 26 | | DR 21 | | DR 17 | | DR 15.5 | | DR 13.5 | | DR 11 | | DR 9 | | DR 7 | |
|----------|---------------|-------------------|---------------|-------------------|---------------|-------------------|---------------|-------------------|---------------|-------------------|---------------|-------------------|---------------|-------------------|---------------|-------------------|---------------|-------------------|
| | Min. | Tol. ^B | Min. | Tol. ^B | Min. | Tol. ^B | Min. | Tol. ^B | Min. | Tol. ^B | Min. | Tol. ^B | Min. | Tol. ^B | Min. | Tol. ^B | Min. | Tol. ^B |
| | in. (mm) | in. (mm) | in. (mm) | in. (mm) | in. (mm) | in. (mm) | in. (mm) | in. (mm) | in. (mm) | in. (mm) | in. (mm) | in. (mm) | in. (mm) | in. (mm) | in. (mm) | in. (mm) | in. (mm) | in. (mm) |
| 1/2 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 0.062 (1.57) | 0.020 (0.51) | 0.076 (1.93) | 0.020 (0.51) | 0.093 (2.36) | 0.020 (0.51) | 0.120 (3.05) | 0.020 (0.51) |
| 3/4 | ... | ... | ... | ... | ... | ... | 0.062 (1.57) | 0.020 (0.51) | 0.068 (1.73) | 0.020 (0.51) | 0.078 (1.98) | 0.020 (0.51) | 0.095 (2.41) | 0.020 (0.51) | 0.117 (2.97) | 0.020 (0.51) | 0.150 (3.81) | 0.020 (0.51) |
| 1 | ... | ... | 0.062 (1.57) | 0.020 (0.51) | 0.063 (1.60) | 0.020 (0.51) | 0.077 (1.96) | 0.020 (0.51) | 0.085 (2.16) | 0.020 (0.51) | 0.097 (2.46) | 0.020 (0.51) | 0.120 (3.05) | 0.020 (0.51) | 0.146 (3.71) | 0.020 (0.51) | 0.188 (4.78) | 0.023 (0.58) |
| 1 1/4 | | | 0.064 (1.63) | 0.020 (0.51) | 0.079 (2.01) | 0.020 (0.51) | 0.098 (2.49) | 0.020 (0.51) | 0.107 (2.72) | 0.020 (0.51) | 0.123 (3.12) | 0.020 (0.51) | 0.151 (3.84) | 0.020 (0.51) | 0.184 (4.67) | 0.022 (0.56) | 0.237 (6.02) | 0.028 (0.71) |
| 1 1/2 | 0.062 (1.57) | 0.020 (0.51) | 0.073 (1.85) | 0.020 (0.51) | 0.090 (2.29) | 0.020 (0.51) | 0.112 (2.84) | 0.020 (0.51) | 0.123 (3.12) | 0.020 (0.51) | 0.141 (3.58) | 0.020 (0.51) | 0.173 (4.39) | 0.021 (0.53) | 0.211 (5.36) | 0.025 (0.64) | 0.271 (6.88) | 0.033 (0.84) |
| 2 | 0.073 (1.85) | 0.020 (0.51) | 0.091 (2.31) | 0.020 (0.51) | 0.113 (2.87) | 0.020 (0.51) | 0.140 (3.56) | 0.020 (0.51) | 0.153 (3.89) | 0.020 (0.51) | 0.176 (4.47) | 0.021 (0.53) | 0.216 (5.49) | 0.026 (0.66) | 0.264 (6.71) | 0.032 (0.81) | 0.339 (8.61) | 0.041 (1.04) |
| 3 | 0.108 (2.74) | 0.020 (0.51) | 0.135 (3.43) | 0.020 (0.51) | 0.167 (4.24) | 0.020 (0.51) | 0.206 (5.23) | 0.025 (0.64) | 0.226 (5.74) | 0.027 (0.69) | 0.259 (6.58) | 0.031 (0.79) | 0.318 (8.08) | 0.038 (0.97) | 0.389 (9.88) | 0.047 (1.19) | 0.500 (12.70) | 0.060 (1.52) |
| 4 | 0.138 (3.51) | 0.020 (0.51) | 0.173 (4.39) | 0.021 (0.53) | 0.214 (5.44) | 0.026 (0.66) | 0.265 (6.73) | 0.032 (0.81) | 0.290 (7.37) | 0.035 (0.89) | 0.333 (8.46) | 0.040 (1.02) | 0.409 (10.39) | 0.049 (1.24) | 0.500 (12.70) | 0.060 (1.52) | 0.643 (16.33) | 0.077 (1.96) |
| 6 | 0.204 (5.18) | 0.024 (0.61) | 0.255 (6.48) | 0.031 (0.79) | 0.315 (8.00) | 0.038 (0.97) | 0.390 (9.91) | 0.047 (1.19) | 0.427 (10.85) | 0.051 (1.30) | 0.491 (12.47) | 0.059 (1.50) | 0.602 (15.29) | 0.072 (1.83) | 0.736 (18.69) | 0.088 (2.24) | 0.946 (24.03) | 0.114 (2.90) |
| 8 | 0.265 (6.73) | 0.032 (0.81) | 0.332 (8.43) | 0.040 (1.02) | 0.411 (10.44) | 0.049 (1.24) | 0.507 (12.88) | 0.061 (1.55) | 0.556 (14.12) | 0.067 (1.70) | 0.639 (16.23) | 0.077 (1.96) | 0.784 (19.91) | 0.094 (2.39) | 0.958 (24.32) | 0.115 (2.92) | 1.232 (31.29) | 0.148 (3.76) |
| 10 | 0.331 (8.41) | 0.040 (1.02) | 0.413 (10.49) | 0.050 (1.27) | 0.512 (13.00) | 0.061 (1.55) | 0.632 (16.05) | 0.076 (1.93) | 0.694 (17.63) | 0.083 (2.11) | 0.796 (20.22) | 0.096 (2.44) | 0.977 (24.82) | 0.117 (2.97) | 1.194 (30.33) | 0.143 (3.63) | 1.536 (39.01) | 0.184 (4.67) |
| 12 | 0.392 (9.96) | 0.047 (1.19) | 0.490 (12.45) | 0.059 (1.50) | 0.607 (15.42) | 0.073 (1.85) | 0.750 (19.05) | 0.090 (2.29) | 0.823 (20.90) | 0.099 (2.51) | 0.944 (23.98) | 0.113 (2.87) | 1.159 (29.44) | 0.139 (3.53) | 1.417 (35.99) | 0.170 (4.32) | 1.821 (46.25) | 0.219 (5.56) |
| 14 | 0.431 (10.95) | 0.052 (1.32) | 0.538 (13.67) | 0.065 (1.65) | 0.667 (16.94) | 0.080 (2.03) | 0.824 (20.93) | 0.099 (2.51) | 0.903 (22.94) | 0.108 (2.74) | 1.037 (26.34) | 0.124 (3.15) | 1.273 (32.33) | 0.153 (3.89) | 1.556 (39.52) | 0.187 (4.75) | 2.000 (50.80) | 0.240 (6.10) |
| 16 | 0.492 (12.50) | 0.059 (1.50) | 0.615 (15.62) | 0.074 (1.88) | 0.762 (19.35) | 0.091 (2.31) | 0.941 (23.90) | 0.113 (2.87) | 1.032 (26.21) | 0.124 (3.15) | 1.185 (30.10) | 0.142 (3.61) | 1.455 (36.96) | 0.175 (4.45) | 1.778 (45.16) | 0.213 (5.41) | 2.286 (58.06) | 0.274 (6.96) |
| 18 | 0.554 (14.07) | 0.066 (1.68) | 0.692 (17.58) | 0.083 (2.11) | 0.857 (21.77) | 0.103 (2.62) | 1.059 (26.90) | 0.127 (3.23) | 1.161 (29.49) | 0.139 (3.53) | 1.333 (33.86) | 0.160 (4.06) | 1.636 (41.55) | 0.196 (4.98) | 2.000 (50.80) | 0.240 (6.10) | 2.571 (65.30) | 0.309 (7.85) |
| 20 | 0.615 (15.62) | 0.074 (1.88) | 0.769 (19.53) | 0.092 (2.34) | 0.952 (24.18) | 0.114 (2.90) | 1.176 (29.87) | 0.141 (3.58) | 1.290 (32.77) | 0.155 (3.94) | 1.481 (37.62) | 0.178 (4.52) | 1.818 (46.18) | 0.218 (5.54) | 2.222 (56.44) | 0.267 (6.78) | 2.857 (72.57) | 0.343 (8.71) |
| 22 | 0.677 (17.20) | 0.081 (2.06) | 0.846 (21.49) | 0.102 (2.59) | 1.048 (26.62) | 0.126 (3.20) | 1.294 (32.87) | 0.155 (3.94) | 1.419 (36.04) | 0.170 (4.32) | 1.630 (41.40) | 0.196 (4.98) | 2.000 (50.80) | 0.240 (6.10) | 2.444 (62.08) | 0.293 (7.44) | 3.143 (79.83) | 0.377 (9.58) |
| 24 | 0.738 (18.75) | 0.089 (2.26) | 0.923 (23.44) | 0.111 (2.82) | 1.143 (29.03) | 0.137 (3.48) | 1.412 (35.86) | 0.169 (4.29) | 1.548 (39.32) | 0.186 (4.72) | 1.778 (45.16) | 0.213 (5.41) | 2.182 (55.42) | 0.262 (6.65) | 2.667 (67.74) | 0.320 (8.13) | 3.429 (87.10) | 0.411 (10.44) |
| 26 | 0.800 (20.32) | 0.096 (2.44) | 1.000 (25.40) | 0.120 (3.05) | 1.238 (31.45) | 0.149 (3.78) | 1.529 (38.84) | 0.183 (4.65) | 1.677 (42.60) | 0.201 (5.11) | 1.926 (48.92) | 0.231 (5.87) | 2.364 (60.05) | 0.284 (7.21) | 2.889 (73.38) | 0.347 (8.81) | ... | ... |
| 28 | 0.862 (21.89) | 0.103 (2.62) | 1.077 (27.36) | 0.129 (3.28) | 1.333 (33.86) | 0.160 (4.06) | 1.647 (41.83) | 0.198 (5.03) | 1.806 (45.87) | 0.217 (5.51) | 2.074 (52.68) | 0.249 (6.32) | 2.545 (64.64) | 0.305 (7.75) | 3.111 (79.02) | 0.373 (9.47) | ... | ... |
| 30 | 0.923 (23.44) | 0.111 (2.82) | 1.154 (29.31) | 0.138 (3.51) | 1.429 (36.30) | 0.171 (4.34) | 1.765 (44.83) | 0.212 (5.38) | 1.935 (49.15) | 0.232 (5.89) | 2.222 (56.44) | 0.267 (6.78) | 2.727 (69.27) | 0.327 (8.31) | 3.333 (84.66) | 0.400 (10.16) | ... | ... |
| 32 | 0.985 (25.02) | 0.118 (3.00) | 1.231 (31.27) | 0.148 (3.76) | 1.524 (38.71) | 0.183 (4.65) | 1.882 (47.80) | 0.226 (5.74) | 2.065 (52.45) | 0.248 (6.30) | 2.370 (60.20) | 0.284 (7.21) | 2.909 (73.89) | 0.349 (8.86) | 3.556 (90.32) | 0.427 (10.85) | ... | ... |
| 34 | 1.046 (26.57) | 0.126 (3.20) | 1.308 (33.22) | 0.157 (3.99) | 1.619 (41.12) | 0.194 (4.93) | 2.000 (50.80) | 0.240 (6.10) | 2.194 (55.73) | 0.263 (6.68) | 2.519 (63.98) | 0.302 (7.67) | 3.091 (78.51) | 0.371 (9.42) | ... | ... | ... | ... |
| 36 | 1.108 (28.14) | 0.133 (3.38) | 1.385 (35.18) | 0.166 (4.22) | 1.714 (43.54) | 0.206 (5.23) | 2.118 (53.80) | 0.254 (6.45) | 2.323 (59.00) | 0.279 (7.09) | 2.667 (67.74) | 0.320 (8.13) | 3.273 (83.13) | 0.393 (9.98) | ... | ... | ... | ... |
| 42 | 1.292 (32.82) | 0.155 (3.94) | 1.615 (41.02) | 0.194 (4.93) | 2.000 (50.80) | 0.240 (6.10) | 2.471 (62.76) | 0.297 (7.54) | 2.710 (68.83) | 0.325 (8.26) | 3.111 (79.02) | 0.373 (9.47) | ... | ... | ... | ... | ... | ... |
| 48 | 1.477 (37.52) | 0.177 (4.50) | 1.846 (46.89) | 0.222 (5.64) | 2.286 (58.06) | 0.274 (6.96) | 2.824 (71.73) | 0.339 (8.61) | 3.097 (78.66) | 0.372 (9.45) | 3.556 (90.32) | 0.427 (10.85) | ... | ... | ... | ... | ... | ... |
| 54 | 1.662 (42.21) | 0.199 (5.05) | 2.077 (52.76) | 0.249 (6.32) | 2.571 (65.30) | 0.309 (7.85) | 3.176 (80.67) | 0.381 (9.68) | 3.484 (88.49) | 0.418 (10.62) | ... | ... | ... | ... | ... | ... | ... | ... |
| 63 | 1.938 (49.23) | 0.233 (5.92) | 2.423 (61.54) | 0.291 (7.39) | 3.000 (76.20) | 0.360 (9.14) | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 65 | 2.000 (50.80) | 0.240 (6.10) | 2.500 (63.50) | 0.300 (7.62) | 3.095 (78.61) | 0.371 (9.42) | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |

^ASee 1.1 and 4.3 for sizes and DRs not shown.

^BFor IPS sizes greater than 24, tolerance applies to the minimum wall thickness obtained when measuring pipe.

psi (MPa)

PE 3608, PE 4608, PE 4710 2900 (20.00)

PE 2708 2520 (17.37)

PE 1404 1250 (8.62)

²Applies to PE4710 only. See [Table 7](#).

TABLE 5 Apparent Tensile Strength at Yield of Ring Specimens Cut from Pipe

| Material | psi | (MPa) |
|---------------------------------|------|---------|
| PE 2708 | 2520 | (17.37) |
| PE 3608; PE 4608; PE 4710 | 2900 | (20.00) |
| PE 1404 | 1250 | (8.62) |

compound is suitable for use when blended with new compound of the same material ~~designation~~ designation and oxidative resistance classification. Pipe containing the rework material shall meet 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:

6.2.1 *Outside Diameters*—The outside diameters and tolerances shall be as shown in [Table 2](#) ~~or Table 7~~ when measured in accordance with Test Method [D2122](#). For diameters not shown in [Table 2](#) ~~or Table 7~~, the tolerances shall be the same percentage of the outside diameter as those for the closest listed diameter.

6.2.1.1 Pipe intended for potable water or other fluids containing oxidizing disinfectants or that require an oxidative resistance classification as outlined in [5.3 Oxidative Resistance](#) shall be pipe size $\frac{3}{4}$ or greater, in accordance with [Table 2](#) in order to meet the expected service life of the pipe in these specific conditions. (See [Note 3](#).)

6.2.2 *Wall Thicknesses*—The wall thicknesses and tolerances shall be as shown in [Table 3](#) ~~or Table 7~~ when measured in accordance with Test Method [D2122](#). For wall thicknesses (DRs) not shown in [Table 3](#) ~~or Table 7~~, the tolerances shall be the same percentage of the calculated minimum wall as for the closest listed minimum wall thickness.

6.2.2.1 Pipe intended for potable water or other fluids containing oxidizing disinfectants in accordance with [5.3](#) shall be DR9 or DR 7 in accordance with [Table 3](#), in order to meet the expected service life of the pipe in these specific conditions. (See [Note 3](#).)

6.2.3 *Wall Thickness Range*—The wall thickness range shall be within 12 % when measured in accordance with Test Method [D2122](#).

6.3 *Short-term Properties*—Specimens of pipe shall be tested in accordance with either ~~Test Method [D1599](#) or Test Method [D2290](#)~~. The test method used, ~~Test Method [D1599](#) or Test Method [D2290](#)~~, is determined by the pipe size and the availability of appropriate test equipment. ~~Test Method [D1599](#) is generally used for 4 in. (114 mm) and smaller sizes and Test Method [D2290](#) for 2 in. (60 mm) and larger sizes. Short-term hoop stress and failure mode data is provided by either test.~~

6.3.1 *Burst Pressure*—The minimum burst ~~pressure~~ hoop stress for PE plastic pipe shall be ~~as given in~~; 2900 psi (20.00MPa) for [Table 4](#), PE3608, PE4608, PE4710; 2520 psi(17.37 MPa) for PE2708; and 1250psi (8.62 MPa) for PE1404 when determined in accordance with Test Method [D1599](#) and [7.6](#). The failure mode shall be ductile.

6.3.2 *Apparent Ring Tensile Strength*—The minimum apparent ring tensile strength at yield shall be 1250 psi (8.62 MPa) for PE 1404, 2520 psi (17.37 MPa) for [Table 1](#) density cell 2 polyethylene pipe materials, and 2900 psi (20.00 MPa) for [Table 1](#) density cell 3 and 4 polyethylene pipe materials when tested in accordance with Test Method [D2290](#), Procedure B and [7.7](#). The failure shall be ductile.

6.4 *Sustained Pressure at Ambient and Elevated Temperature for PE1404*—PE1404 pipes shall be tested in accordance with [7.4](#) at the stresses and temperatures specified in [Table 64](#). Tests may be conducted on any pipe size, but tests conducted on 6 in. (168 mm) nominal size pipe shall be considered representative of all pipe sizes. At ~~176°F (80°C)~~ 176 °F (80 °C) pipes shall be tested at ~~either any~~ [Table 4](#) stress. If ductile failures occur at ~~the~~ higher stress at ~~176°F (80°C)~~ 176 °F (80 °C), testing shall be repeated at ~~the~~ lower stress. Acceptable results are non-failure at the minimum average test time, or brittle failure at times exceeding the minimum average test time.

TABLE 64 Stress and Time Requirements for Sustained Pressure Test^A

| Pipe Material | Minimum Hours Before Failure at 73°F (23°C) 73 °F (23 °C) | Minimum Average Hours to Failure at 176°F (80°C) 176 °F (80 °C) | | |
|---------------|--------------------------------------------------------------|-----------------------------------------------------------------|------------------------|------------------------|
| | S = 800 psi (5.5 MPa) | S = 670 psi (4.6 MPa) | S = 580 psi (4 MPa) | S = 435 psi (3 MPa) |
| PE 1404 | 1000 | | 80 | 150 |

^A 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).

6.5 *Elevated Temperature Sustained Pressure for Pipes Other Than PE1404*—Elevated temperature sustained pressure tests for each **Table 1** polyethylene pipe material (material designation) used in production at the facility shall be conducted twice annually per-in accordance with 7.5.

NOTE 4—Elevated temperature sustained pressure tests are intended to verify extrusion processing and are conducted in accordance with the manufacture’s quality program.

6.5.1 Passing results are (1) non-failure for all three specimens at a time equal to or greater than the **Table 85** “minimum average time before failure” for the selected **Table 85** Condition, or (2) not more than one ductile specimen failure and the average time before failure for all three specimens shall be greater than the specified “minimum average time before failure” for the selected **Table 85** Condition. If more than one ductile failure occurs before the “minimum average time before failure”, it is permissible to conduct one retest at a **Table 85** Condition of lower stress and longer minimum average time before failure for the material designation except that for **Table 85** Condition 6 no retest is permissible. Brittle failure of any specimen in the test sample when tested at **Table 85** Condition 1 through 6 constitutes failure to meet this requirement and no retest is allowed.

6.5.2 *Provision for retest (if needed)*—The retest sample shall be three specimens of the same pipe or tubing size and material designation from the same time frame as the test sample per-in accordance with 7.5. For the retest, any specimen failure before the **Table 85** “minimum average time before failure” at the retest condition of lower stress and longer minimum average time before failure constitutes failure to meet this requirement.

7. Test Methods

7.1 *Conditioning*—Condition the test specimens for not less than 40 h prior to test in accordance with Procedure A of Practice **D618**, for those tests where conditioning is required.

7.2 *Test Conditions*—Conduct tests in the standard laboratory atmosphere of 73°F ± 3.6°F (23°C ± 2°C), 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, random samples as selected by the testing laboratory shall be deemed adequate.

7.4 *Sustained Pressure Test at Ambient and Elevated Temperature*—Select three specimens of pipe at random and test each specimen individually with water at controlled temperatures under the stresses given in **Table 65**. Each specimen shall be 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. Condition the specimens for at least 2 h at test temperature ± 3.6°F (2°C) 4 °F (2 °C) prior to test. Test for the minimum failure time specified in **Table 65** in accordance with Test Method **D1598**, at the stress and temperature values given in **Table 65**. Maintain the specimens at the test pressures ± 10 psi (± 70 kPa) and the test temperatures ± 3.6°F 4 °F (± 2°C) 2 °C. Failure of one of the three specimens tested is cause for retest of three additional specimens. Failure of one of three specimens tested in retest constitutes failure in the test. Test and retest specimens shall be from the same production