Designation: ~~F714 – 13 (Reapproved 2019)~~ F714 – 21

An American National Standard

Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter[1]

This standard is issued under the fixed designation F714; 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 ~~dimensions~~ three standard outside diameter sizing systems, based on outside diameters of DIPS 3, IPS 4, Metric 90 mm ~~(3.500 in.) and larger.~~and larger. For smaller sizes refer to Specification D3035. See 5.2.5 for guidelines on special sizes.

~~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.~~

1.2 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 should consult the manufacturer to ensure that any ~~damage~~ mechanical or chemical effects to the polyethylene pipe caused by the material being transported will not affect the service life beyond limits acceptable to the user. See PPI TR-19 Chemical Resistance of Thermoplastic Piping Materials for guidance on chemical effects, www.plasticpipe.org

1.3 All pipes produced under this specification are pressure-rated. See Appendix X5 for information on pressure rating.

NOTE 2—References and material descriptions for PE2406, ~~PE3406,~~ PE3408 and materials having a HDB of 1450 psi have been removed from Specification F714 due to changes in Specification D3350 and PPI TR-3. For removed designations, refer to previous editions of Specification F714, Specification D3350, PPI TR-3 and PPI TR-4. The removal of these materials does not affect pipelines that are in service. See ~~Notes 9 and 9~~Note 4 and Note 9.

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

1.5 Quality-control measures are to be taken by manufacturers. See Appendix X4 for general information on quality control.

1.6 *Units*—~~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 B36.10) and DIPS system. In all cases, the values given in parentheses are~~ 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.~~ only and are not considered standard.

[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**

~~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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*~~

1.7 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.8 *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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

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
D2321 Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
D2412 Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
D2837 Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
D3035 Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
D3350 Specification for Polyethylene Plastics Pipe and Fittings Materials
F412 Terminology Relating to Plastic Piping Systems
F585 Guide for Insertion of Flexible Polyethylene Pipe Into Existing Sewers

~~2.2 *ANSI Standard:*~~
~~B36.10 Standard Dimensions of Steel Pipe (IPS)[3]~~
~~2.3 *ISO Standards:*~~
~~161 Thermoplastic Pipe for the Transport of Fluids - Nominal Outside Diameters and Nominal Pressures[4]~~
~~3607 Polyethylene Pipe: Tolerances on Outside Diameters and Wall Thicknesses[4]~~
~~4427 Polyethylene Pipes and Fittings for Water Supply Specification[4]~~

2.2 *Federal Standard:*[3]
Fed. Std. No. 123 Marking for Shipment (Civil Agencies)
2.3 *Military Standard:*[3]
MIL-STD-129 Marking for Shipment and Storage

~~2.6 *Canadian Standard:*~~
~~CGSB 41-GP-25M Pipe, Polyethylene for the Transport of Liquids[6]~~

2.4 *NSF/ANSI Standards:*
Standard No. 14 for Plastic Piping Components and Related Materials[4]
Standard No. 61 (NSF/ANSI/CAN standard) for Drinking Water Systems Components—Health ~~Effects~~[4]

2.5 *Other Documents:*
PPI 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 Pipe[5]
PPI TR-4 HDB/SDB/PDB/MRS Listed Materials, PPI Listing of Hydrostatic Design Basis (HDB), Strength Design Basis (SDB), Pressure Design Basis (PDB), and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe[5]

[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, http://www.ansi.org.~~
~~[4] Available from International Organization for Standardization (ISO), 1 rue de Varembé, Case postale 56, CH-1211, Geneva 20, Switzerland, http://www.iso.ch.~~
[3] Available from DLA Document Services, Building 4/D, 700 Robbins Ave., Philadelphia, PA 19111-5094, http://quicksearch.dla.mil.
[4] Available from NSF International, P.O. Box 130140, 789 N. Dixboro Rd., Ann Arbor, MI 48113-0140, http://www.nsf.org.
[5] Available from Plastics Pipe Institute (PPI), 105 Decker Court, Suite 825, Irving, TX 75062, http://www.plasticpipe.org.

PPI TN-44 2015 Long Term Resistance of AWWA C906 Polyethylene (PE) Pipe to Potable Water Disinfectants
PPI TR-19 Chemical Resistance of Thermoplastic Piping Materials
APWA Uniform Color Code[6]

3. Terminology

3.1 Unless otherwise specified, definitions are in accordance with Terminology F412 and abbreviations are in accordance with Terminology D1600.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *dimension ratio, hydrostatic design stress, and pressure rating ~~relationship:~~ relationship:—*

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

where:

S = hydrostatic design stress, HDS, for water at 73 °F (23 °C), psi (or kPa or MPa),
P = pressure rating, PR, psi (or kPa or MPa),
~~D_O~~ = ~~outside diameter, in. (or mm), per Tables 3, 4, or 5~~
D_O = outside diameter, in. (or mm), per Table 3, Table 4, or Table 5
~~t~~ = ~~minimum wall thickness, in. (or mm), per Tables 6, 7, or 8~~
t = minimum wall thickness, in. (or mm), per Tables Table 6, Table 7, or Table 8
D_O/t = dimension ratio (DR).

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

NOTE 3—Hydrostatic design stress (HDS) ratings for PE compounds are in accordance with this specification and are specified in Section 4.

TABLE 1 Polyethylene Compound Requirements

Requirement	Material Designation			
	PE2708	PE3608	PE4608	PE4710
	Required Value			
~~Minimum HDB at 140ºF (60ºC), psi (MPa), per D2837and PPI TR-3~~	~~800 (5.5)[A]~~	~~800 (5.5)[A]~~	~~800 (5.5)[A]~~	~~800 (5.5)[A]~~
Minimum HDB at 140 ºF (60 ºC), psi (MPa), per D2837and PPI TR-3	800 (5.5)[A]	800 (5.5)[A]	800 (5.5)[A]	1000 (6.9)[A]
HDS for water at 73 °F (23 °C) psi (MPa), per D2837 and PPI TR-3[A]	800 (5.5)	800 (5.5)	800 (5.5)	1000 (6.9)
Melt flow rate per D1238	≤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 Cell Classification Property	Required Value			
Density (natural base resin)	2	3	4	4
SCG Resistance	7	6	6	7
~~Color and UV Stabilizer Code[B]~~	~~C or E~~	~~C or E~~	~~C or E~~	~~C or E~~
Color and UV Stabilizer Code	C or E	C or E	C or E	C or E

[A]Contact manufacturer or see PPI TR-4 for listed value.
[B]~~See 4.1.1.~~

[6] American Public Works Association (APWA) ~~1200 Main Street, Suite 1400~~2345 Grand Boulevard, Suite 700 Kansas City, MO ~~64105-2100,~~64108-2625, http://www.apwa.net

TABLE 5 Outside Diameters and Tolerances IPS Sizing System (ANSI B36.10)

Nominal Pipe Size, in.	Actual Outside Diameters, in.		Tolerance ± in.
	Equivalent, mm	Average	
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

TABLE 4 Outside Diameters and Tolerances IPS Sizing System

Nominal Pipe Size,	Actual Outside Diameters, in.	
	Average	Tolerance ± in.
4	4.500	0.020
5	5.563	0.025
6	6.625	0.030
7	7.125	0.034
8	8.625	0.039
10	10.750	0.048
12	12.750	0.057
14	14.000	0.063
16	16.000	0.072
18	18.000	0.081
20	20.000	0.090
22	22.000	0.099
24	24.000	0.108
26	26.000	0.117
28	28.000	0.126
30	30.000	0.135
32	32.000	0.144
34	34.000	0.153
36	36.000	0.162
42	42.000	0.189
48	48.000	0.216
54	54.000	0.243
60	60.000	0.270
63	63.000	0.284
65	65.000	0.293

[A] Irregular size.

4. Materials

4.1 *Polyethylene Compound*—Polyethylene compounds suitable for use in the manufacture of pipe under this specification shall meet thermoplastic materials designation codes PE2708 or PE3608 or PE4608 or PE4710, and shall meet Table 1 requirements for PE2708 or PE3608 or PE4608 or PE4710, and shall meet thermal stability, brittleness temperature and elongation at break requirements in accordance with Specification D3350.

TABLE 7 Minimum Wall Thickness
IPS Sizing System, in. (ANSI B36.10)

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
3	3.500	0.085	0.108	0.135	0.167	0.206	0.226	0.259	0.318	0.376	0.389	0.42
4	4.500	0.110	0.138	0.173	0.214	0.265	0.290	0.333	0.409	0.484	0.500	0.54
5[A]	5.375	0.131	0.165	0.207	0.256	0.316	0.347	0.398	0.489	0.578	0.597	0.64
5	5.563	0.136	0.171	0.214	0.265	0.327	0.359	0.412	0.506	0.598	0.618	0.67
6	6.625	0.162	0.204	0.255	0.315	0.390	0.427	0.491	0.602	0.712	0.736	0.79
7[A]	7.125	0.174	0.219	0.274	0.340	0.420	0.460	0.528	0.648	0.766	0.792	0.85
8	8.625	0.210	0.265	0.332	0.411	0.507	0.556	0.639	0.784	0.927	0.958	1.03
10	10.750	0.262	0.331	0.413	0.512	0.632	0.694	0.796	0.977	1.156	1.194	1.29
12	12.750	0.310	0.392	0.490	0.607	0.750	0.823	0.944	1.159	1.371	1.417	1.53
13[A]	13.375	0.326	0.412	0.514	0.637	0.787	0.863	0.991	1.216	1.438	1.486	1.61
14	14.000	0.341	0.431	0.538	0.667	0.824	0.903	1.037	1.273	1.505	1.556	1.68
16	16.000	0.390	0.492	0.615	0.762	0.941	1.032	1.185	1.455	1.720	1.778	1.92
18	18.000	0.439	0.554	0.692	0.857	1.059	1.161	1.333	1.636	1.935	2.000	2.16
20	20.000	0.488	0.615	0.769	0.952	1.176	1.290	1.481	1.818	2.151	2.222	2.40
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	...	...	...	...	...	...

TABLE 5 Minimum Wall Thickness
IPS Sizing System, in.

Nominal Pipe Size	Dimension Ratio									
	41	32.5	26	21	17	13.5	11	9	7.0	7.3
4	0.110	0.138	0.173	0.214	0.265	0.333	0.409	0.500	0.643	0.616
5	0.136	0.171	0.214	0.265	0.327	0.412	0.506	0.618	0.795	0.762
6	0.162	0.204	0.255	0.315	0.390	0.491	0.602	0.736	0.946	0.908
7	0.174	0.219	0.274	0.340	0.420	0.528	0.648	0.792	1.018	0.976
8	0.210	0.265	0.332	0.411	0.507	0.639	0.784	0.958	1.232	1.182
10	0.262	0.331	0.413	0.512	0.632	0.796	0.977	1.194	1.536	1.473
12	0.310	0.392	0.490	0.607	0.750	0.944	1.159	1.417	1.821	1.747
14	0.341	0.431	0.538	0.667	0.824	1.037	1.273	1.556	2.000	1.918
16	0.390	0.492	0.615	0.762	0.941	1.185	1.455	1.778	2.286	2.192
18	0.439	0.554	0.692	0.857	1.059	1.333	1.636	2.000	2.571	2.466
20	0.488	0.615	0.769	0.952	1.176	1.481	1.818	2.222	2.857	...
22	0.537	0.677	0.846	1.048	1.294	1.630	2.000	2.444	3.143	...
24	0.585	0.738	0.923	1.143	1.412	1.778	2.182	2.667	3.429	...
26	0.634	0.800	1.000	1.238	1.529	1.926	2.364	2.889	3.714	...
28	0.683	0.862	1.077	1.333	1.647	2.074	2.545	3.111	...	...
30	0.732	0.923	1.154	1.429	1.765	2.222	2.727	3.333	...	...
32	0.780	0.985	1.231	1.524	1.882	2.370	2.909	3.556	...	...
34	0.829	1.046	1.308	1.619	2.000	2.519	3.091	3.778	...	...
36	0.878	1.108	1.385	1.714	2.118	2.667	3.273	4.000	...	...
42	1.024	1.292	1.615	2.000	2.471	3.111	3.818	...	...	...
48	1.171	1.477	1.846	2.286	2.824	3.556	...	...	...	...
54	1.317	1.662	2.077	2.571	3.176	...	...	...	...	...
60	...	1.846	2.308	2.857	3.529	...	...	...	...	...
63	...	1.938	2.423	3.000	3.706	...	...	...	...	...
65	...	2.000	2.500	3.095	3.824	...	...	...	...	...

[A] Irregular size.

4.1.1 Polyethylene compounds suitable for use in the manufacturer of DIPS pipe per Table 2 and Table 3 are identified by thermoplastic pipe material designation code, and shall be PE4710 or PE3608 in accordance with 4.1, 4.1.2 and 4.2.

4.1.1 *Color and Ultraviolet (UV) Stabilization*—Per Table 1, polyethylene compounds shall meet Specification D3350 code C 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.

TABLE 4 Outside Diameters and Tolerances

ISO Sizing System (ISO 161/1)			
NominalPipe Size	Equivalent Outside Diameter, D_o, mm		
mm	in.	min	max[A]
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

TABLE 6 Outside Diameters and Tolerances Metric Sizing System

Nominal Pipe Size	Outside Diameter, D_o, mm	
DN	min	max
90	90	90.8
110	110	111.0
160	160	161.4
200	200	201.8
250	250	252.3
280	280	282.5
315	315	317.8
355	355	358.2
400	400	403.6
450	450	454.1
500	500	504.5
560	560	565.0
630	630	635.7
710	710	716.4
800	800	807.2
900	900	908.1
1000	1000	1009.0
1200	1200	1210.8
1400	1400	1412.6
1600	1600	1614.4
2000	2000	2018.0
2500	2500	2522.5
3000	3000	3027.0

[A] As specified in ISO 3607.

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

4.3 *Oxidative Resistance*—For pipe that is intended for use in the transport of potable water containing disinfectants, or where required by the application, customer or regulatory authority having jurisdiction, the PE compound shall have an oxidative resistance classification of CC2 or CC3 in accordance with Specification D3350.

NOTE 4—See PPI TN-44 or www.plasticpipe.org for further information on potable water disinfectants.

TABLE 8 Elevated Temperature Sustained Pressure Test Requirements

		PE2708, PE3608, PE4608		PE4710	
Condition	Test Temperature °F (°C)[A]	Test Pressure Hoop Stress[B] psi (kPa)[A]	Minimum Average Time Before Failure Hours	Test Pressure Hoop Stress[B] psi (kPa)[A]	Minimum Average Time Before Failure Hours
1	176 (80)	670 (4620)	170	750 (5170)	200
2	176 (80)	650 (4480)	340	730 (5020)	400
3	176 (80)	630 (4345)	510	705 (4870)	600
4	176 (80)	610 (4210)	680	685 (4715)	800
5	176 (80)	590 (4070)	850	660 (4565)	1000
6	176 (80)	580 (4000)	1000	640 (4415)	1200

[A]Test temperature tolerance ~~± 3.6ºF (+/- 2ºC). ±4~~ °F (±2 °C). Test pressure tolerance ± 5 psi (±35 kPa); test pressure hoop stress values are rounded to the nearest 5 psi or 5 kPa. Note: Table 1 conditions are based on PE validation requirements per PPI TR-3 with Condition 6 being ~~85%~~85 % of Condition 1 test pressure hoop stress and six times greater minimum average time before failure. Conditions 2 through 5 are linear stress and time interpolations between Conditions 1 and 6. The intent of multiple conditions is to maintain equivalent performance criteria, but provide for retest in the event of ductile failure. The test pressure hoop stress levels for Conditions 2-5 are linear interpolations for arbitrarily chosen time increments. An equivalent performance requirement, however, may be determined by arbitrarily choosing a test pressure hoop stress between Conditions 1 and 6 and linearly interpolating the minimum average time before failure. For example for PE3710 and PE4710 material, at 670 psi test pressure hoop stress, the minimum average time before failure would be 927 hours (200 + (750 – 670) · ((1200 – 200) / (750 – 640)) = 927).

[B]Calculate internal test pressure in accordance with:

$$P = \frac{2S}{\left(\frac{D_O}{t} - 1\right)}$$

~~Where:~~where:

P = test pressure, psig (kPa)
S = test pressure hoop stress, psi. (kPa)
D_o = measured outside diameter, in. (mm)
t = measured minimum wall thickness, in (mm)

TABLE 2 Outside Diameters and Tolerances-DIPS Sizing System

Nominal Size	Outside Diameter, in (mm)	Minimum Outside Diameter, in. (mm)	Maximum Outside Diameter, in. (mm)
3	3.960 (100.58)	3.942 (100.13)	3.976 (100.99)
4	4.800 (121.92)	4.778 (121.37)	4.822 (122.48)
6	6.900 (175.26)	6.869 (174.47)	6.931 (176.05)
8	9.050 (229.87)	9.009 (228.84)	9.091 (230.91)
10	11.100 (281.94)	11.050 (280.67)	11.150 (283.21)
12	13.200 (335.28)	13.141 (333.77)	13.259 (336.78)
14	15.300 (388.62)	15.231 (386.87)	15.369 (390.37)
16	17.400 (441.96)	17.322 (439.97)	17.478 (443.94)
18	19.500 (495.30)	19.412 (493.07)	19.588 (497.54)
20	21.600 (548.64)	21.503 (546.17)	21.697 (551.10)
24	25.800 (655.32)	25.684 (652.37)	25.916 (658.27)
30	32.000 (815.80)	31.856 (809.14)	32.144 (816.46)
36	38.300 (972.82)	38.128 (968.44)	38.472 (977.19)
42	44.500 (1130.30)	44.300 (1125.21)	44.700 (1135.38)
48	50.800 (1290.32)	50.571 (1284.51)	51.029 (1296.14)
54	57.560 (1462.3)	57.301 (1455.72)	57.819 (1468.88)
60	61.610 (1564.9)	61.333(1557.86)	61.887 (1571.94)

4.4 *Rework Material*—Clean polyethylene compound from the manufacturer's own pipe production that met 4.1 through ~~4.1.2~~4.3 as new compound is suitable for reextrusion into pipe, when blended with new compound of the same thermoplastic pipe material designation ~~code.~~ code and the same or greater oxidative resistance classification. Pipe containing rework material shall meet the requirements of this specification.

5. 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 PE compound) 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

TABLE 3 Minimum Wall Thickness DIPS Sizing System, in.

		PE4710[A]								PE3608[A]			
		~~PR350~~[B]	~~PR300~~[B]	~~PR250~~[B]	PR200[B]	~~PR150~~[B]	PR100[B]	~~PR350~~[B]	~~PR300~~[B]	PR250[B]	~~PR200~~[B]	~~PR150~~[B]	~~PR100~~[B]
Nominal Size	Outside Diameter in. (mm)[C]	~~350~~ psi (~~2415~~ kPa)[D]	~~300~~ psi (~~2070~~ kPa)[D]	~~250~~ psi (~~1725~~ kPa)[D]	200 psi (1380 kPa)[D]	~~150~~ psi (~~1035~~ kPa)[D]	100 psi (~~690~~ kPa)[D]	~~350~~ psi (~~2415~~ kPa)[D]	~~300~~ psi (~~2070~~ kPa)[D]	250 psi (1725 kPa)[D]	~~200~~ psi (~~1380~~ kPa)[D]	~~150~~ psi (~~1035~~ kPa)[D]	~~100 psi (690 kPa)~~[D]
		DR ~~6.7~~	DR ~~7.7~~	DR ~~9~~	DR 11	DR ~~14.3~~	DR ~~21~~	DR ~~5.6~~	DR ~~6.3~~	DR ~~7.4~~	~~DR 9~~	DR ~~11.7~~	DR ~~17~~
~~3~~	~~3.960 (100.58)~~	~~0.591 (15.01)~~	~~0.514 (13.06)~~	~~0.440 (11.18)~~	~~0.360 (9.14)~~	~~0.277 (7.04)~~	~~0.189 (4.80)~~	~~0.707 (17.96)~~	~~0.629 (15.97)~~	~~0.535 (13.59)~~	~~0.440 (11.18)~~	~~0.338 (8.59)~~	~~0.233 (5.92)~~
~~4~~	~~4.800 (121.92)~~	~~0.761 (18.20)~~	~~0.623 (15.83)~~	~~0.533 (13.54)~~	~~0.436 (11.07)~~	~~0.336 (8.53)~~	~~0.229 (5.82)~~	~~0.857 (21.77)~~	~~0.762 (19.35)~~	~~0.649 (16.48)~~	~~0.533 (13.54)~~	~~0.410 (10.41)~~	~~0.282 (7.16)~~
~~6~~	~~6.900 (175.26)~~	~~1.030 (26.16)~~	~~0.896 (22.76)~~	~~0.767 (19.48)~~	~~0.627 (15.93)~~	~~0.483 (12.27)~~	~~0.329 (8.36)~~	~~1.232 (31.30)~~	~~1.095 (27.82)~~	~~0.932 (23.67)~~	~~0.767 (19.48)~~	~~0.590 (14.99)~~	~~0.406 (10.31)~~
~~8~~	~~9.050 (229.87)~~	~~1.351 (34.31)~~	~~1.175 (29.85)~~	~~1.006 (25.55)~~	~~0.823 (20.90)~~	~~0.633 (16.08)~~	~~0.431 (10.95)~~	~~1.616 (41.05)~~	~~1.437 (36.49)~~	~~1.223 (31.06)~~	~~1.006 (25.55)~~	~~0.774 (19.66)~~	~~0.532 (13.51)~~
~~10~~	~~11.100 (281.94)~~	~~1.657 (42.08)~~	~~1.441 (36.62)~~	~~1.233 (31.32)~~	~~1.009 (25.63)~~	~~0.776 (19.71)~~	~~0.529 (13.44)~~	~~1.982 (50.35)~~	~~1.762 (44.75)~~	~~1.500 (38.10)~~	~~1.233 (31.32)~~	~~0.949 (24.10)~~	~~0.653 (16.59)~~
~~12~~	~~13.200 (335.28)~~	~~1.970 (50.04)~~	~~1.714 (43.54)~~	~~1.467 (37.26)~~	~~1.200 (30.48)~~	~~0.923 (23.44)~~	~~0.629 (15.98)~~	~~2.357 (59.87)~~	~~2.095 (53.22)~~	~~1.784 (45.31)~~	~~1.467 (37.26)~~	~~1.128 (28.65)~~	~~0.776 (19.71)~~
~~14~~	~~15.300 (388.62)~~	~~2.284 (58.00)~~	~~1.987 (50.47)~~	~~1.700 (43.18)~~	~~1.391 (35.33)~~	~~1.070 (27.18)~~	~~0.729 (18.52)~~	~~2.732 (69.40)~~	~~2.429 (61.69)~~	~~2.068 (52.53)~~	~~1.700 (43.18)~~	~~1.308 (33.22)~~	~~0.900 (22.86)~~
~~16~~	~~17.400 (441.96)~~	~~2.597 (65.96)~~	~~2.260 (57.40)~~	~~1.933 (49.10)~~	~~1.582 (39.67)~~	~~1.217 (30.91)~~	~~0.829 (21.06)~~	~~3.107 (78.92)~~	~~2.762 (70.15)~~	~~2.351 (59.72)~~	~~1.933 (49.10)~~	~~1.487 (37.77)~~	~~1.024 (26.01)~~
~~18~~	~~19.500 (495.30)~~	~~2.910 (73.93)~~	~~2.532 (64.32)~~	~~2.167 (55.04)~~	~~1.773 (45.03)~~	~~1.364 (34.65)~~	~~0.929 (23.60)~~	~~3.482 (88.45)~~	~~3.095 (78.62)~~	~~2.635 (66.93)~~	~~2.167 (55.04)~~	~~1.667 (42.34)~~	~~1.147 (29.13)~~
~~20~~	~~21.600 (548.64)~~	~~3.224 (81.89)~~	~~2.805 (71.25)~~	~~2.400 (60.96)~~	~~1.964 (49.89)~~	~~1.510 (38.35)~~	~~1.029 (26.14)~~	...	~~3.429 (87.09)~~	~~2.919 (74.14)~~	~~2.400 (60.96)~~	~~1.846 (46.89)~~	~~1.271 (32.28)~~
~~24~~	~~25.800 (655.32)~~	...	~~3.351 (85.11)~~	~~2.867 (72.82)~~	~~2.345 (59.56)~~	~~1.804 (45.82)~~	~~1.229 (31.22)~~	...	...	~~3.486 (88.54)~~	~~2.867 (72.82)~~	~~2.205 (56.01)~~	~~1.518 (38.56)~~
~~30~~	~~32.000 (815.80)~~	...	...	~~3.556 (90.32)~~	~~2.909 (73.89)~~	~~2.238 (56.85)~~	~~1.524 (38.71)~~	...	...	...	~~3.556 (90.32)~~	~~2.735 (69.47)~~	~~1.882 (47.80)~~
~~36~~	~~38.300 (972.82)~~	...	...	...	~~3.482 (88.44)~~	~~2.678 (68.02)~~	~~1.824 (46.33)~~	...	...	...	...	~~3.274 (83.16)~~	~~2.253 (57.23)~~
~~42~~	~~44.500 (1130.30)~~	...	...	...	...	~~3.112 (79.04)~~	~~2.119 (53.82)~~	...	...	...	...	...	~~2.618 (66.50)~~
~~48~~	~~50.800 (1290.32)~~	...	...	...	...	~~3.552 (90.22)~~	~~2.419 (61.44)~~	...	...	...	...	...	~~2.988 (75.90)~~

TABLE 3 Minimum Wall Thickness DIPS Sizing System, in.

		PE4710[A]								PE3608[A]			
		PR100[B]	PR125[B]	PR160[B]	PR200[B]	PR250[B]	PR335[B]	PR100[B]	PR150[B]	PR200[B]	PR250[B]	PR300[B]	PR350[B]
Nominal Size	Outside Diameter in. (mm)[C]	100 psi (690 kPa)[D]	125 psi (1035 kPa)[D]	160 psi (1100 kPa)[D]	200 psi (1380 kPa)[D]	250 psi (1725 kPa)[D]	335 psi (2070 kPa)[D]	100 psi (690 kPa)[D]	150 psi (1035 kPa)[D]	200 psi (1380 kPa)[D]	250 psi (1725 kPa)[D]	300 psi (2070 kPa)[D]	350 psi (2415 kPa)[D]
		DR 21	DR 17	DR 13.5	DR 11	DR 9	DR 7	DR 17	DR 11.7	DR 9	DR 7.4	DR 6.3	DR 5.6
3	3.960 (100.58)	0.189 (4.80)	0.233 (5.92)	0.293 (7.53)	0.360 (9.14)	0.440 (11.18)	0.605 (14.00)	0.233 (5.92)	0.338 (8.59)	0.440 (11.18)	0.535 (13.59)	0.629 (15.97)	0.707 (17.96)
4	4.800 (121.92)	0.229 (5.82)	0.282 (7.16)	0.356 (9.04)	0.436 (11.07)	0.533 (13.54)	0.686 (17.42)	0.282 (7.16)	0.410 (10.41)	0.533 (13.54)	0.649 (16.48)	0.762 (19.35)	0.857 (21.77)
6	6.900 (175.26)	0.329 (8.36)	0.406 (10.31)	0.511 (12.98)	0.627 (15.93)	0.767 (19.48)	0.986 (25.04)	0.406 (10.31)	0.590 (14.99)	0.767 (19.48)	0.932 (23.67)	1.095 (27.82)	1.232 (31.30)
8	9.050 (229.87)	0.431 (10.95)	0.532 (13.51)	0.670 (17.02)	0.823 (20.90)	1.006 (25.55)	1.293 (32.84)	0.532 (13.51)	0.774 (19.66)	1.006 (25.55)	1.223 (31.06)	1.437 (36.49)	1.616 (41.05)
10	11.100 (281.94)	0.529 (13.44)	0.653 (16.59)	0.978 (24.84)	1.009 (25.63)	1.233 (31.32)	1.586 (40.28)	0.653 (16.59)	0.949 (24.10)	1.233 (31.32)	1.500 (38.10)	1.762 (44.75)	1.982 (50.35)

Nominal Size	Outside Diameter in. (mm)[C]	PE4710[A] PR100[B] 100 psi (690 kPa)[D] DR 21	PE4710[A] PR125[B] 125 psi (1035 kPa)[D] DR 17	PE4710[A] PR160[B] 160 psi (1100 kPa)[D] DR 13.5	PE4710[A] PR200[B] 200 psi (1380 kPa)[D] DR 11	PE4710[A] PR250[B] 250 psi (1725 kPa)[D] DR 9	PE4710[A] PR335[B] 335 psi (2070 kPa)[D] DR 7	PE3608[A] PR100[B] 100 psi (690 kPa)[D] DR 17	PE3608[A] PR150[B] 150 psi (1035 kPa)[D] DR 11.7	PE3608[A] PR200[B] 200 psi (1380 kPa)[D] DR 9	PE3608[A] PR250[B] 250 psi (1725 kPa)[D] DR 7.4	PE3608[A] PR300[B] 300 psi (2070 kPa)[D] DR 6.3	PE3608[A] PR350[B] 350 psi (2415 kPa)[D] DR 5.6
12	13.200 (335.28)	0.629 (15.98)	0.776 (19.71)	0.978 (24.84)	1.200 (30.48)	1.467 (37.26)	1.886 (47.90)	0.776 (19.71)	1.128 (28.65)	1.467 (37.26)	1.784 (45.31)	2.095 (53.22)	2.357 (59.87)
14	15.300 (388.62)	0.729 (18.52)	0.900 (22.86)	1.133 (28.78)	1.391 (35.33)	1.700 (43.18)	2.186 (55.52)	0.900 (22.86)	1.308 (33.22)	1.700 (43.18)	2.068 (52.53)	2.429 (61.69)	2.732 (69.40)
16	17.400 (441.96)	0.829 (21.06)	1.024 (26.01)	1.289 (32.74)	1.582 (39.67)	1.933 (49.10)	2.486 (63.14)	1.024 (26.01)	1.487 (37.77)	1.933 (49.10)	2.351 (59.72)	2.762 (70.15)	3.107 (78.92)
18	19.500 (495.30)	0.929 (23.60)	1.147 (29.13)	1.444 (36.68)	1.773 (45.03)	2.167 (55.04)	2.789 (70.76)	1.147 (29.13)	1.667 (42.34)	2.167 (55.04)	2.635 (66.93)	3.095 (78.62)	3.482 (88.45)
20	21.600 (548.64)	1.029 (26.14)	1.271 (32.28)	1.600 (40.64)	1.964 (49.89)	2.400 (60.96)	3.086 (78.38)	1.271 (32.28)	1.846 (46.89)	2.400 (60.96)	2.919 (74.14)	3.429 (87.09)	...
24	25.800 (655.32)	1.229 (31.22)	1.518 (38.56)	1.911 (48.54)	2.345 (59.56)	2.867 (72.82)	3.686 (93.62)	1.518 (38.56)	2.205 (56.01)	2.867 (72.82)	3.486 (88.54)	...	...
30	32.000 (815.80)	1.524 (38.71)	1.882 (47.80)	2.370 (60.20)	2.909 (73.89)	3.556 (90.32)	...	1.882 (47.80)	2.735 (69.47)	3.556 (90.32)	...	...	...
36	38.300 (972.82)	1.824 (46.33)	2.253 (57.23)	2.837 (72.06)	3.482 (88.44)	...	...	2.253 (57.23)	3.274 (83.16)	...	...	...	...
42	44.500 (1130.30)	2.119 (53.82)	2.618 (66.50)	3.296 (83.72)	...	...	...	2.618 (66.50)	...	...	...	...	...
48	50.800 (1290.32)	2.419 (61.44)	2.988 (75.90)	3.763 (95.58)	...	...	...	2.988 (75.90)	...	...	...	...	...
54	57.560 (1462.3)	2.741 (69.620)	...	...	...	...	...	...	...	...	...	...	...
60	61.610 (1564.9)	2.934 (74.520)	...	...	..	...	...	...	...	...	...	...	...

[A] Thermoplastic material designation code per 4.1.1.
[B] See 9.1.7.
[C] Per Table 2
[D] Per 3.2.1. Values rounded to the nearest 5 kPa.

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 2 ~~(inch-pound units),~~ , Table 4 ~~(SI units),~~ , or Table ~~5~~6 ~~(inch-pound units) or~~ when measured in accordance with Test Method D2122 at any point not closer than 300 mm (11.8 in.) to the cut end of a length of pipe. Conditioning to standard temperature without regard to relative humidity is required.

5.2.2 *Wall Thicknesses*—The minimum thicknesses shall be in accordance with Table 3, Table ~~6~~5, or Table 7 when measured in accordance with Test Method D2122. Conditioning to standard temperature without regard to relative humidity is required.

5.2.3 *Eccentricity*—The wall thickness variability as measured and calculated in accordance with Test Method D2122 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 2, Table 4, or Table ~~5~~6.

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 2, Table 4, or Table ~~5~~6, the tolerance shall be the same percentage as that used in the corresponding table for the next smaller listed size. Minimum wall thicknesses for DRs not shown in Table 3, Table ~~6~~5, or Table 7 or shall be determined by dividing the average outside diameter by the DR and rounding to three decimal places for inch sized pipes or two decimal places for metric sized pipes, and the tolerance shall comply with 5.2.3.

5.3 *Pressure Test Performance*—All pipe shall meet the requirements of 5.3.2 and either 5.3.1 or 5.4.

NOTE 5—The requirements of 5.3.1 and 5.3.2 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 and leak testing standards or manufacturer's recommendations for field testing procedure.

5.3.1 *Short-Term Pressurization*—Quick burst or non-failure testing shall be conducted per 5.3.1.1 or 5.3.1.2. Test pressure shall be determined per 3.2.1 except that *S* shall be the prescribed hoop stress value, and *P* shall be test pressure.

TABLE 6~~7~~ Minimum Wall Thickness
~~ISO 161~~ Metric Sizing System, mm

DR Nominal Pipe ~~Size~~Size, DN	41	32.5	26	21	17	11
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	. . .	. . .	. . .	. . .

5.3.1.1 *Quick Burst*—For pipe nominal 12 in. (315 mm) and smaller diameter, rupture shall be ductile when tested in accordance with 6.1. The minimum hoop stress shall be 2520 psi (17.4 MPa) for Table 1 density cell 2 materials and 2900 psi (20.0 MPa) for Table 1 density cell 3 and 4 materials.

5.3.1.2 *Non-Failure*—When raised to test pressure and held at test pressure for five (5) seconds, pipe shall not rupture, leak, nor exhibit localized deformation when tested in accordance with 6.1 at a test pressure determined using 2500 psi hoop stress for Table 1 density cell 2 materials, and 3200 psi hoop stress for Table 1 density cell 3 and 4 materials.

5.3.2 *Elevated Temperature Sustained Pressure*—Elevated-temperature sustained-pressure test for each Table 1 polyethylene pipe material (material designation) used in production at the facility shall be conducted twice annually per 6.2.

NOTE 6—Elevated temperature sustained pressure tests are intended to verify extrusion processing and are conducted in accordance with the manufacture's quality program. See Appendix X4.

5.3.2.1 Passing results are *(1)* non-failure for all three specimens at a time equal to or greater than the Table 8 "minimum average time before failure", 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 8 Condition. If more than one ductile failure occurs before the Table 8 "minimum average time before failure", it is permissible to conduct one retest at a Table 8 Condition of lower stress and longer minimum average time before failure for the material designation except that for Table 8 Condition 6 no retest is permissible. Brittle failure of any specimen in the test sample when tested at Table 8 Condition 1 through 6 constitutes failure to meet this requirement and no retest is allowed.

5.3.2.2 *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 6.2. For the retest, any specimen failure before the "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.

5.4 *Apparent Tensile Strength at Yield*—For pipe nominal 3-in. (90-mm) diameter and larger, Short-Term Pressurization requirement, 5.3.1, may be replaced by the apparent tensile strength at yield requirement, 5.4. The minimum apparent tensile strength at yield when determined in accordance with 6.3 shall be 2520 psi (17.4 MPa) for Table 1 density cell 2 materials and 2900 (20.0 MPa) for Table 1 density cell 3 and 4 materials.

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 7—Manufacturers conduct appropriate quality control tests at a frequency appropriate to their manufacturing operations. See Appendix X4.

6. Test Methods

6.1 *Short-Term Pressurization Tests*—When tested to rupture, this test is applicable to nominal 12-in. (315-mm) and smaller pipes and is conducted in accordance with Test Method D1599. When tested for non-failure, this test is applicable to all pipe sizes and is conducted in accordance with Test Method D1598 except that no failure will have occurred when tested at the test pressure and duration per 5.3.1.2. The test shall be conducted at ~~73.4~~73 °F ± ~~3.6°F (23~~4 °F (23 °C ± ~~2°C)~~2 °C) without regard to relative humidity.

NOTE 8—**Warning:** Pressurization of specimens being tested under 6.1 should not commence until it is certain that all entrapped air has been bled from the water-filled specimens.

6.2 *Elevated Temperature Sustained Pressure Test*—The "test sample" shall be three specimens of a generally representative pipe or tubing size produced at the manufacturer's facility using the Table 1 polyethylene pipe material (material designation). Select one Table 8 Condition for the Table 1 polyethylene pipe material (material designation) and test the three specimen test sample in accordance with Test Method D1598 using water as the internal test medium.

6.3 *Apparent Tensile Properties*—The procedure and test equipment shall be as specified in Test Method D2290. Cut specimens