Designation: D1248 – 16

Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable[1]

This standard is issued under the fixed designation D1248; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

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

1. Scope*

1.1 This specification provides for the identification of polyethylene plastics extrusion materials for wire and cable in such a manner that the seller and the purchaser can agree on the acceptability of different commercial lots or shipments. The tests involved in this specification are intended to provide information for identifying materials according to the types, classes, categories, and grades covered. It is not the function of this specification to provide specific engineering data for design purposes.

1.2 This specification does not allow for the use of recycled plastics (see Note 3).

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

1.4 The following safety hazards caveat pertains only to the test method portion, Section 12, 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.*

NOTE 1—There is no known ISO equivalent to this standard.

NOTE 2—This standard has undergone major revision from the reapproval of 1989 and now covers only polyethylene for wire and cable applications. For information regarding molding and extrusion materials, see Specification D4976. For information regarding plastic pipe materials, see Specification D3350.

NOTE 3—See Guide D7209and 3.1.2 of this standard for information and definitions related to recycled plastics.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D150 Test Methods for AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulation

D257 Test Methods for DC Resistance or Conductance of Insulating Materials

D618 Practice for Conditioning Plastics for Testing

D638 Test Method for Tensile Properties of Plastics

D746 Test Method for Brittleness Temperature of Plastics and Elastomers by Impact

D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement

D1238 Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer

D1505 Test Method for Density of Plastics by the Density-Gradient Technique

D1531 Test Methods for Relative Permittivity (Dielectric Constant) and Dissipation Factor by Fluid Displacement Procedures (Withdrawn 2012)[3]

D1603 Test Method for Carbon Black Content in Olefin Plastics

D1693 Test Method for Environmental Stress-Cracking of Ethylene Plastics

D2565 Practice for Xenon-Arc Exposure of Plastics Intended for Outdoor Applications

D2633 Test Methods for Thermoplastic Insulations and Jackets for Wire and Cable

D2839 Practice for Use of a Melt Index Strand for Determining Density of Polyethylene

D2951 Test Method for Resistance of Types III and IV Polyethylene Plastics to Thermal Stress-Cracking (Withdrawn 2006)[3]

[1] This specification is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.15 on Thermoplastic Materials.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

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

D3182 Practice for Rubber—Materials, Equipment, and Procedures for Mixing Standard Compounds and Preparing Standard Vulcanized Sheets
D3349 Test Method for Absorption Coefficient of Ethylene Polymer Material Pigmented with Carbon Black
D3350 Specification for Polyethylene Plastics Pipe and Fittings Materials
D3636 Practice for Sampling and Judging Quality of Solid Electrical Insulating Materials
D3892 Practice for Packaging/Packing of Plastics
D4329 Practice for Fluorescent Ultraviolet (UV) Lamp Apparatus Exposure of Plastics
D4703 Practice for Compression Molding Thermoplastic Materials into Test Specimens, Plaques, or Sheets
D4976 Specification for Polyethylene Plastics Molding and Extrusion Materials
D6360 Practice for Enclosed Carbon-Arc Exposures of Plastics
D7209 Guide for Waste Reduction, Resource Recovery, and Use of Recycled Polymeric Materials and Products (Withdrawn 2015)[3]
E1131 Test Method for Compositional Analysis by Thermogravimetry
G151 Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources
G153 Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials
G154 Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials
G155 Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials

2.2 *Federal Specification:*[4]
L-P-390C Plastic, Molding, and Extrusion Materials, Polyethylene and Copolymers (Low, Medium, and High Density)

NOTE 4—In accordance with the DOD: "L-P-390C, dated 10 August 1971, is inactivated for new design and is no longer used, except for replacement purposes. Future acquisition for this product, when used in new design, should refer to ASTM D4976, 'STANDARD SPECIFICATION FOR POLYETHYLENE PLASTICS MOLDING AND EXTRUSION MATERIALS.'"

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *polyethylene plastics, n*—plastics or resins prepared by the polymerization of no less than 50 % ethylene and no less than 95 weight % of total olefins.

3.1.2 *recycled plastics, n*—plastics feedstocks or products composed of recovered plastic material that sometimes includes a percentage of post-consumer material, but not including those materials and by-products generated from, and commonly reused, within an original manufacturing process and, reworked, reprocessed, and regrind plastic and purge from the same manufacturing process.

[4] Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, http://dodssp.daps.dla.mil.

3.2 Historical usage and user group conventions have resulted in inconsistent terminology used to categorize and describe polyethylene resins and compounds. The following terminology is in use in ASTM specifications pertaining to polyethylene:

3.2.1 *Specification D1248:*

3.2.1.1 Type (0, I, II, III, IV) = density ranges (same, respectively, as Class in Specification D4976).

3.2.1.2 Class (A, B, C, D) = composition and use.

3.2.1.3 Category (1, 2, 3, 4, 5) = melt index ranges (same as Grade in Specification D4976).

3.2.1.4 Grade (E, J, D, or W followed by one or two digits) = specific requirements from tables.

3.2.2 *Specification:* D3350

3.2.2.1 Type (I, II, III) = density ranges (same as Types I, II, and III in Specification D1248 and Classes 1, 2, and 3 in Specification D4976).

3.2.2.2 Class = a line callout system consisting of "PE" followed by six cell numbers from Table 1 plus a letter (A, B, C, D, E) denoting color and UV stabilizer.

3.2.2.3 Grade = simplified line callout system using "PE" followed by density and slow crack growth cell numbers from Table 1.

3.2.3 *Specification:* D4976

3.2.3.1 Group (1, 2) = branched or linear polyethylene.

3.2.3.2 Class (5, 1, 2, 3, 4) = density ranges (same, respectively, as Type in Specification D1248).

3.2.3.3 Grade (1, 2, 3, 4, 5) = melt index ranges (same as Category in Specification D1248).

4. Classification

4.1 This specification recognizes that polyethylene plastics are identified primarily on the basis of two characteristics, namely, density and flow rate (previously identified as melt index). The former is the criterion for assignment as to type, the latter for designation as to category. Other attributes important to the user for certain applications are covered by three general classes and by specifying in greater detail, by grades, a minimum number of key characteristics covered too broadly or not at all by the type, class, and category designations.

4.1.1 *Types:*

4.1.1.1 This specification provides for the identification of five types of polyethylene plastics extrusion materials for wire and cable by density in accordance with 10.1 and 12.1.1, and the requirements prescribed in Table 1 and Note 5, Note 6, and Note 12.

NOTE 5—It is recognized that some high-density polyethylene plastics

TABLE 1 Classification of Polyethylene Plastics Extrusion Materials for Wire and Cable According to Type

Type	Nominal Density,[A] g/cm^3
0	<0.910
I	0.910 to 0.925
II	>0.925 to 0.940
III	>0.940 to 0.960
IV	>0.960

[A] Uncolored, unfilled material (see Note 12).

of very high molecular weight and typically is a density slightly less than 0.960 yet in all other respects they are characteristic of Type IV materials. Similarly, there are other polyethylene plastics of very high molecular weight having densities slightly less than 0.941 which in all other respects are more characteristic of Type III than of Type II materials.

NOTE 6—While the original Type III now has been divided into two ranges of density (Types III and IV), both are still described by the term *high density*.

4.1.1.2 Material supplied under these types shall be of such nominal density, within the ranges given, as agreed upon between the manufacturer and the purchaser subject to the tolerances specified in 4.1.1.3 (Note 12).

4.1.1.3 In view of production, sampling, and testing variables, a commercial lot or shipment for which a nominal density has been agreed upon between the seller and the purchaser shall be considered as conforming and commercially acceptable when the density value found on a sample from the lot or shipment falls within the tolerance range of ±0.004 of the nominal value.

4.1.1.4 If the nominal value is unknown or unspecified, classification shall be based on the tested value without tolerance consideration.

4.1.2 *Classes*—Each of the five types is subdivided into four classes according to composition and use as follows:

4.1.2.1 *Class A*—Natural color only, with or without any antioxidants or other additives in such proportions as agreed upon between the seller and the purchaser.

4.1.2.2 *Class B*—Colors including white and black, with or without any antioxidants or other additives in such proportions as agreed upon between the manufacturer and the purchaser.

4.1.2.3 *Class C*—Black (weather-resistant), containing not less than 2 % carbon black of a kind and particle size (Note 7), dispersed by such means and to such degree as necessary to impart weather resistance with or without any antioxidants or other additives in such proportions as agreed upon between the seller and the purchaser.

NOTE 7—Carbon black 35 nm or less in average particle diameter is used as required in black electrical and jacketing materials (Grades E and J) to impart maximum weather resistance.

4.1.2.4 *Class D*—Colored (UV resistant), including black and white, with antioxidants and UV stabilizers to allow electrical insulation and jackets to meet the requirements outlined in 12.1.12.

NOTE 8—The expected service lifetime of Class D materials is very dependent upon the specific material formulation including selected colorants. Contact your supplier for additional information regarding this issue.

4.1.3 *Categories:*

4.1.3.1 The four classes of each type are divided into five categories on the basis of broad ranges of flow rate in accordance with the requirements prescribed in Table 2.

NOTE 9—Some Type II and Type III polyethylene plastics of very high molecular weight cannot be categorized by flow rate. Solution viscosity is recommended as a means of distinguishing such materials.

4.1.3.2 Material supplied under these categories shall be of such nominal flow rate, within the ranges given, as agreed upon between the seller and the purchaser subject to the tolerances specified in 4.1.3.3.

TABLE 2 Classification of Polyethylene Plastics Extrusion Materials for Wire and Cable According to Category

Category	Nominal Flow Rate, g/10 min (190°C, 2.16 kg load)
1	>25
2	>10 to 25
3	>1.0 to 10
4	>0.4 to 1.0
5	0.4 max

4.1.3.3 In view of production, sampling, and testing variables, a commercial lot or shipment for which a nominal flow rate has been agreed upon between the seller and the purchaser shall be considered as conforming and commercially acceptable when the flow rate value found on a sample from the lot or shipment falls within the tolerance range of ±20 % of the nominal flow rate.

4.1.3.4 If the nominal value is unknown or unspecified, classification shall be based on the tested value without tolerance consideration.

4.1.4 *Grades:*

4.1.4.1 If further definition is necessary, one of the grades given in Tables 3-5 shall be selected.

NOTE 10—Tables 4 and 5, are included to correspond with the grades specified in Federal Specification L-P-390C.

NOTE 11—The grade shall be associated with the appropriate type, class, and category designations; for example, IA5-E4 or IC5-J3 as required. Other grades are added as necessary by revision of this specification in established manner. Also, it is anticipated that additional requirements are added as necessary under a given grade designation by future revision to provide more meaningful characterization of the material covered by such designation.

4.1.4.2 If additional requirements specific to the application are necessary, these shall be specified by the purchaser with the agreement of the seller.

5. Basis of Purchase

5.1 The purchase order or inquiry for these materials shall state the specification number, type, class, category, and, if needed, the appropriate grade, for example, D1248–IA5-E4.

5.2 It is acceptable for further definition to be agreed upon between the seller and the purchaser as follows:

5.2.1 Nominal density.

NOTE 12—For Class B, Class C, and Class D material, the nominal density of the base resin will be identified by the manufacturer upon request.

5.2.2 Nominal flow rate.

5.2.3 *Antioxidant(s) or Other Additive(s) and Proportions:*

5.2.3.1 *Class A*—As stated in 4.1.2.1,

5.2.3.2 *Class B*—As stated in 4.1.2.2,

5.2.3.3 *Class C*—As stated in 4.1.2.3, and

5.2.3.4 *Class D*—As stated in 4.1.2.4.

5.2.4 Contamination level (see 6.2).

5.2.5 Other supplementary definition, unless grade is sufficient and is identified (see 4.1.4.1 and 4.1.4.2).

5.3 Inspection (see 13.1).

TABLE 3 Detail Requirements for Molded Test Specimens

Property and Unit	Grade[A]									
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10
Tensile stress, min:[B]										
MPa	8	10	10	12	12	17	17	19	19	22
(psi)	(1200)	(1500)	(1500)	(1800)	(1800)	(2400)	(2400)	(2800)	(2800)	(3200)
Elongation, min, %[B]	300	400	400	500	500	400	400	400	400	400
Brittleness temperature, max, °C	–50	–60	–60	–75	–75	–45	–75	–75	–75	–75
Environmental stress-crack resistance,[C,D] min, f_{20} h	. . .	. . .	. . .	48	48	. . .	. . .	48	48	48
Thermal stress-crack resistance, h without cracking, min	. . .	. . .	. . .	. . .	. . .	. . .	. . .	96	96	168
Dissipation factor,[E] max:										
Class A										
Before milling	0.0005	0.0002	0.0005	0.0002	0.0005	0.0002	0.0005	0.0002	0.0005	0.0002
After milling	0.0005	0.0003	0.0005	0.0003	0.0005	0.0003	0.0005	0.0003	0.0005	0.0003
Class B	0.001	0.0005	0.001	0.0005	0.001	0.0005	0.001	0.0005	0.001	0.0005
Class C	0.01	0.005	0.01	0.005	0.01	0.005	0.01	0.005	0.01	0.005
Dielectric constant[E] max increase over nominal[F]:										
Class A	0.05	0.01	0.05	0.01	0.05	0.01	0.05	0.01	0.05	0.01
Class B	0.12	0.04	0.12	0.04	0.12	0.04	0.12	0.04	0.12	0.04
Class C	0.52	0.30	0.52	0.30	0.52	0.30	0.50	0.30	0.50	0.30
Volume resistivity, min, Ω·cm:										
Classes A, B	10^{15}	10^{15}	10^{15}	10^{15}	10^{15}	10^{15}	10^{15}	10^{15}	10^{15}	10^{15}
Water immersion stability	G	G	G	G	G	G	G	G	G	G

	E11	J1	J3	J4	J5
Tensile stress, min:[B]					
MPa	22	10	12	19	22
(psi)	(3200)	(1500)	(1800)	(2800)	(3200)
Elongation, min, %	400	400	500	400	400
Brittleness temperature, max, °C	–75	–60	–75	–75	–75
Environmental stress-crack resistance,[C,D] min, f_{20} h	48	. . .	24	24	24
Thermal stress-crack resistance, h without cracking, min	168	. . .	. . .	. . .	. . .
Dissipation factor,[E] max:					
Class A					
Before milling	0.0005	. . .	. . .	. . .	. . .
After milling	0.0005	. . .	. . .	. . .	. . .
Class B	0.001	. . .	. . .	. . .	. . .
Class C	0.01	. . .	0.01	0.01	. . .
					. . .
Dielectric constant[E] max increase over nominal[F]:					
Class A	0.05	. . .	. . .	. . .	. . .
Class B	0.12	. . .	. . .	. . .	. . .
Class C	0.50	. . .	0.52	0.52	. . .
Volume resistivity, min, Ω·cm:					
Classes A, B	10^{15}	. . .	. . .	. . .	. . .
Water immersion stability	G	. . .	. . .	. . .	. . .

[A]The letters associated with these grades identify areas of potential applicability as indicated below:
E = Electrical Insulation (in some instances these materials also have the potential to serve as jacketing).
J = Jacketing (in some instances these materials also have the potential to serve as primary insulation).
[B]At break.
[C]f_{20} is the time required for failure of 20 % of the samples tested in accordance with Test Method D1693 as further directed by 12.1.6.1 – 12.1.6.4 of this specification.
[D]Requirements for environmental stress-crack resistance apply only to Class B, Class C, and Class D compounds unless otherwise specified (see 5.2.5).
[E]At any frequency from 1 kHz through 1 MHz (see also 12.1.8.1 – 12.1.8.3).
[F]Dielectric constant is a function of density; hence, the nominal value will be different for each type. Based on published information, the nominal values for the five types covered by this specification are as follows: Type 0-2.28, Type I-2.28, Type II-2.31, Types III and IV-2.35 (Lanza, V. L., and Herrmann, D. B., *Journal of Polymer Science*, JPSCA, Vol 28, 1958, p. 622). To illustrate the manner in which the maximum limit for the dielectric constant of a particular, grade is determined, assume that a Type I, Class A material is to be supplied under Grade E2, then its maximum limit for dielectric constant will be 2.28 + 0.01 = 2.29.
[G]Dissipation factor and dielectric constant must not exceed the limits specified above after immersion of the test specimens in water as described in 12.1.9. However, because this test is lengthy, it need not be performed on every lot of material. Rather, the material is to be checked initially for compliance with this requirement and, after that, as often as necessary to assure continued compliance. This requirement is not applicable to weather resistant (Class C and Class D) compounds (see Note 12).

6. Materials and Manufacture

6.1 The extrusion material for wire and cable shall be polyethylene plastic in the form of powder, granules, or pellets.

6.2 The extrusion materials for wire and cable shall be as uniform in composition and size and as free of contamination as can be achieved by good manufacturing practice. If necessary, the acceptable level of contamination shall be agreed upon between the seller and the purchaser.

TABLE 4 Special Grades—Dielectric—Natural and Colors

	Very Low Density, Specification D1248, Type 0	Low Density, Specification D1248, Type I				Medium Density, Specification D1248, Type II		High Density,[A] Specification D1248, Types III & IV				
		Natural	Colors	Natural	Colors	Natural	Colors					
Grade	D0	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11
Tensile Stress, min:[B]												
MPa	6.9	9.7	9.7	9.7	9.7	12.4	12.4	19.3	19.3	24.1	24.1	27.6
(psi)	1000	(1400)	(1400)	(1400)	(1400)	(1800)	(1800)	(2800)	(2800)	(3500)	(3500)	(4000)
Elongation, min, %[B]	500	400	400	400	400	400	400	400	400	400	400	400
Brittleness temperature, max, °C	–60	–60	–55	–60	–55	–60	–55	–55	...	–55	...	...
Dielectric constant, max, 1 MHz	2.28	2.35	2.35	2.35	2.35	2.35	2.35	2.38	2.38	2.38	2.38	2.38
Dissipation factor, max, 1 MHz	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Environmental stress crack resistance, min:												
f_{20}h (100 % Igepal)	. . .	. . .	. . .	24	24	. . .	. . .	. . .	. . .	. . .	. . .	. . .
f_{20}h (10 % Igepal)	>24	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Thermal stress crack resistance, min, f_{45}h	. . .	. . .	. . .	. . .	. . .	. . .	. . .	96	. . .	96	. . .	. . .
Milling stability	. . .	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
After milling, dissipation factor, max												

[A] Grades D7 through D11 apply to both natural and colors, including black.
[B] At break.

TABLE 5 Special Grades—Weather Resistant—Black

	Very Low Density, Specification D 1248, Type 0	Low Density, Specification D1248, Type 1				Medium Density, Specification D1248, Type II			High Density, Specification D1248, Types III & IV	
Grade	W0	W1	W2	W3	W4	W5	W6	W7	W8	W9
Tensile Stress, min:[A]										
MPa	6.9	9.7	9.7	9.7	9.7	12.4	12.4	12.4	19.3	24.1
(psi)	(1000)	(1400)	(1400)	(1400)	(1400)	(1800)	(1800)	(1800)	(2800)	(3500)
Elongation, min, %[A]	500	400	400	400	400	400	400	400	400	400
Brittleness temperature, max, °C	–60	–50	–50	–50	–50	–50	–50	–50	–55	–55
Dielectric constant, max, 1 MHz	2.28	2.50	2.75	2.75	2.80	2.50	2.75	2.80	2.75	2.75
Dissipation factor, max, 1 MHz	0.0005	0.003	0.007	0.007	0.01	0.003	0.007	0.01	0.005	0.007
Environmental stress crack resistance, min:										
f_{20}h (100 % Igepal)		. . .	. . .	24	. . .	. . .	. . .	. . .	. . .	. . .
f_{20}h (10 % Igepal)	>24	. . .	. . .	. . .	24	. . .	. . .	. . .	. . .	. . .
Thermal stress crack resistance, min, f_{45}h		. . .	. . .	. . .	. . .	. . .	. . .	. . .	96	96
Milling stability										
After milling, dissipation factor, max		0.003	0.007	0.007	0.01	0.003	0.007	0.01	0.005	0.007
Carbon content, range, %	2.0-3.0	0.4-0.6	2.0-3.0	2.0-3.0	2.0-3.0	0.4-0.6	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0
Absorption coefficient, min	320	. . .	320	320	320	. . .	320	320	320	320

[A] At break.

6.3 Unless controlled by requirements specified elsewhere (see 4.1.4.1 and 4.1.4.2), the color and translucence of extruded pieces formed under conditions recommended by the manufacturer of the material, shall be comparable within commercial match tolerances to the color and translucence of standard molded or extruded samples of the same thickness supplied in advance by the manufacturer of the material.

7. Physical Requirements

7.1 Test specimens of the material prepared as specified in 10.1, and tested in accordance with 12.1, shall conform to the requirements prescribed by the material designation for type in Table 1, for class in 4.1.2, for category in Table 2, and for grade in Tables 3-5.

8. Sampling

8.1 Sampling shall be statistically adequate to satisfy the requirements of 13.4.

8.2 A batch or lot shall be constituted as a unit of manufacture as prepared for shipment and can consist of a blend of two or more production runs.

9. Testing

9.1 The requirements identified by the material designation and otherwise specified in the purchase order (see 5.1 and 5.2) shall be verified by tests made in accordance with the directions given in 12.1.

10. Specimen Preparation

10.1 Unless otherwise specified in 12.1, the test specimens shall be molded in accordance with Procedure C as found in Annex A1 of Practice D4703.

11. Conditioning

11.1 *Conditioning*—Once specimens are molded, they shall be moved to a standard laboratory atmosphere or a controlled laboratory atmosphere. For unfilled polyethylene plastics the controlled laboratory atmosphere shall be 23 ± 2°C. Specimens shall be stored in boxes, paper bags or envelopes, plastic bags or on racks, whichever is the most practical for the laboratory. Specimens shall be conditioned for a minimum of 40 h immediately prior to testing. It is recommended that specimens be allowed to cool for about 30 min on a bench or a rack before they are placed in any container where the specimens might come into contact with each other. For filled and reinforced polyethylene plastics or polyethylene blends, which contain a hydrophilic pigment, hydrophilic co-monomer or modifier, the specimens shall be conditioned in a standard laboratory atmosphere of 23 ± 2°C and 50 ± 10 % (Note 13) relative humidity (see Practice D618, Procedure A). For all materials to be conditioned for electrical testing, conditioning shall comply with the requirements of the standard test methods for electrical testing. In all cases the laboratory shall report both the temperature and humidity conditions during the conditioning period.

NOTE 13—The plus/minus (±) tolerances given for irradiance, temperature and relative humidity are the maximum allowable operational fluctuations of the parameter set point value under equilibrium conditions. This does not mean that the value can be set by plus/minus the amount indicated from the value specified. If the deviations are greater than the maximum allowable after the equipment has stabilized, discontinue the test and correct the cause of the problem before continuing.

11.2 *Test Conditions*—Unfilled polyethylene plastics shall be tested in a controlled laboratory atmosphere of 23 ± 2°C. For filled and reinforced polyethylene plastics and polyethylene plastic blends, which contain a hydrophilic pigment, hydrophilic co-monomer or modifier, the specimens shall be tested in a standard laboratory atmosphere of 23 ± 2°C and 50 ± 10 % relative humidity. For all materials to be tested for electrical properties, the laboratory shall comply with the requirements of the standard test methods for electrical testing. In all cases the laboratory shall report both the temperature and humidity conditions during testing.

11.3 *Dispute*—In cases of dispute, conditioning and testing shall be conducted at 23 ± 1°C and 50 ± 5 % relative humidity dependent on the material and test requirements.

12. Test Methods

12.1 Determine the properties enumerated in this specification in accordance with the following test methods:

12.1.1 *Density*—Test Method D1505 or alternative methods of suitable accuracy, such as Practice D2839 or Methods A or B of Test Methods D792. Make duplicate determinations using two separate portions of the same specimen or from two specimens. The specimen geometry and conditioning requirements shall meet the requirements of the specific method or practice used to determine the density. Any departure from the specified geometry or conditioning shall be reported.

12.1.2 *Flow Rate*—Test Method D1238, using Condition 190/2.16 unless otherwise directed (Note 14). Make duplicate determinations on the material in the form of powder, granules, or pellets. No conditioning is required.

NOTE 14—Although the flow rate of polyethylene plastics are measured under any of the conditions listed for it in Test Method D1238, only measurements made at Condition 190/2.16 (190°C, 2.16 kg load) are usually identified as "melt index." This method of test serves to indicate the degree of uniformity of the flow rate of the polymer of a single manufacturer as made by an individual process and in this case is typically indicative of the degree of uniformity of other properties. However, uniformity of flow rate among various polymers of various manufacturers as made by various processes does not, in the absence of other tests, indicate uniformity of other properties and vice versa. The melt viscosity of polyethylene plastics, in common with that of most high polymers, is non-Newtonian, that is, dependent on the rate of shear. The degree of departure from Newtonian behavior depends on the nature and molecular constitution of the individual sample. Additional characterization of the sample can be obtained if other conditions are used. Especially recommended as an adjunct to Condition 190/2.16 is Condition 190/10.0.

12.1.3 *Carbon Black Content*—Test Method D1603 or E1131. If Test Method D1603 is used, it must be known that no inorganic pigments or fillers are present in the material. Make duplicate determinations from a sample of the material in the form of powder, granules, or pellets.

12.1.3.1 If it is known or suspected that the material contains moisture, the sample shall be dried prior to being tested, but otherwise no conditioning is required.

12.1.4 *Tensile Stress at Break and Elongation at Break*—Test Method D638, except that speed of grip separation shall be 500 mm (20 in.)/min for Types 0 and I and 50 mm (2 in.)/min for Types II, III, and IV. Specimens shall conform to the dimensions given for Type IV in Test Method D638 with their thickness to be 1.9 ± 0.2 mm (0.075 ± 0.008 in.). Specimens shall be either die cut or machined to the specified dimensions. Bench marks or a high range extensometer shall be used for the determination of elongation at break. The initial distance between the bench marks or extensometer grips shall be 25.4 ± 0.4 mm (1.00 ± 0.02 in.). The initial grip separation shall be 63.5 ± 5 mm (2.5 ± 0.2 in.). Test results for specimens that break outside the gage-marks after extensive cold drawing need not be discarded unless the break occurs between the contact surfaces of a grip.

12.1.5 *Brittleness Temperature*—Procedure A of Test Method D746.

12.1.6 *Environmental Stress-Crack Resistance Test*—Test Method D1693, with the following provisions:

12.1.6.1 Type 0 materials shall be tested under Condition B, as defined in Table 1 of Test Method D1693.

12.1.6.2 Type I materials shall be tested under Condition A, as defined in Table 1 of Test Method D1693.

12.1.6.3 Unless otherwise specified, test materials of Types II, III, and IV under Condition B, as defined in Table 1 of Test Method D1693.

12.1.6.4 Test Grades E4, E5, E8, E9, E10, E11, and W3 in undiluted Igepal CO-630.[5] Test Grades J3, J4, J5, and W4 in a solution of 10 weight % Igepal CO-630 in water.

NOTE 15—There are environmental concerns regarding the disposal of Nonylphenoxy poly(ethyleneoxy) ethanol (CAS 68412-54-4), for example, Igepal CO-630. Users are advised to consult their supplier or local environmental office and follow the guidelines provided for the proper disposal of this chemical.

12.1.7 *Thermal Stress-Crack Resistance of Types III and IV Polyethylenes*—Test Method D2951.

12.1.8 *Dissipation Factor and Dielectric Constant*—Test Method D1531 or Test Method D150, with the former to be the referee method. The following additional instructions and the precautions of 12.1.3.1 shall be observed:

12.1.8.1 *Milling Stability*—This procedure is intended for application to materials to be used for electrical insulation. For such materials, the milling procedure described in 12.1.8.2 can be performed as a preconditioning step prior to the determination of dissipation factor and dielectric constant as provided in 12.1.8. Its purpose is to establish that a suitable antioxidant is present in adequate quantity. After being milled as prescribed, the material shall meet the dielectric requirements prescribed in Table 3.

12.1.8.2 Process approximately 400 g of material for 3 h ± 5 min on a two-roll laboratory mill meeting the requirements prescribed in Practice D3182 at a temperature of 160 ± 5°C with the distance between the rolls so adjusted that the charge maintains a uniform rolling bank. Any other size two-roll laboratory mill is acceptable provided the charge is adequate to maintain a uniform rolling bank on the rolls and to furnish sufficient material for test specimens.

12.1.8.3 Due to the time-consuming nature of this preconditioning procedure, the frequency with which it is applied shall be established by sound statistical quality control practices by the individual manufacturer. However, the specified electrical tests shall be performed on every batch or run, using the normal conditioning procedure (11.1) plus the precautions of 12.1.3.1.

12.1.9 *Water Immersion Stability*—Immerse the test specimen in distilled water at 23 ± 2°C for 14 days after which remove, wipe dry, and immediately test for dissipation factor and dielectric constant in accordance with 12.1.8.

12.1.10 *Volume Resistivity*—Test Methods D257, using the electrodes shown in Fig. 4 (Flat Specimen for Measuring Volume and Surface Resistances or Conductances) or Fig. 5 (Tubular Specimen for Measuring Volume and Surface Resistances or Conductances). Conditioning and test conditions shall be as specified in 11.1 and 11.2.

12.1.10.1 Test specimens, particularly those molded of compounds containing carbon black, shall be tested immediately after conditioning and their storage under humid conditions shall be avoided.

12.1.11 *Absorption Coefficient*—Test Method D3349.

12.1.12 *Weatherability for Colored Materials* (Including *White and Black:*

12.1.12.1 *Carbon Arc*—See Appendix X1 for this test.

12.1.12.2 *Xenon Arc*—The material shall retain a minimum of 50 % of its unexposed elongation after 4000 h (Note 16) of exposure in a xenon-arc apparatus. Prepare the specimens in accordance with Test Methods D2633 for physical tests of insulations and jackets. Perform the tests in accordance with Practices D2565, G151 and G155 using daylight filters (Note 17) and an irradiance of 0.70 ± 0.02 W/(m^2.nm) at 340 nm (see Note 18). The exposure cycle consists of a light cycle of 10 h with 18 minutes water spray on the front surface during each 2 h period followed by a dark period of 2 h with continuous water spray on the back surface. The insulated black panel temperature is 70 ± 2°C with the light on and 55 ± 2°C with the light off. The chamber air temperature is adjusted to 48 ± 2°C during the light cycle and 55 ± 2°C during the dark cycle. The relative humidity requirements are 50 ± 10 % during the light cycle and 95 +5 %/–10 % when the light is off.

NOTE 16—The 4000 h exposure period specified cannot be extrapolated to service life under environmental conditions without data to estimate an acceleration factor for the materials exposed.

NOTE 17—The previous revision of D1248 specified filters that met the requirements of Test Method G155 daylight filters, while reducing the infrared irradiance, resulting in a lower specimen temperature. When testing materials that are temperature sensitive, or when comparing to historical results, similar filters can be used. Consult with the instrument manufacturer for selection of filters that meet this criterion

NOTE 18—Longer periods of exposure will be required for xenon-arc machines operated at irradiance of 0.35 W/(m^2.nm) at 340 nm.

12.1.12.3 *Fluorescent UV Condensation Device*—The material shall retain a minimum of 50 % of its unexposed elongation after 4000 h (Note 16) of exposure in a fluorescent UV condensation apparatus operated with fluorescent UVA-340 lamps. Prepare the specimens in accordance with Methods D2633 for physical tests of insulations and jackets. Perform the tests in accordance with Practices G151, G154, and D4329 using the following exposure conditions: 20 h exposure to UVA-340 fluorescent lamps with uninsulated black panel temperature maintained at the control point at 70 ± 3°C followed by 4 h darkness with condensation at an uninsulated black panel temperature maintained at the control point at 55 ± 3°C. Irradiance at the control point shall be maintained at 0.70 ± 0.02 W/(m^2.nm) at 340 nm when using the irradiance controlled apparatus.

NOTE 19—The degradation rate of polyethylene has been found to be more variable in the non irradiance controlled device than in the device in which the irradiance is controlled. However, the non irradiance controlled machine can be used for relative weatherability comparison among different materials exposed at the same time.

NOTE 20—Because of differences in emission properties of the radiation sources and test conditions in the xenon arc, fluorescent UV lamp and carbon arc devices, the effects of the exposures described in 12.1.12.1, 12.1.12.2, and 12.1.12.3 are not equivalent. Therefore, the devices cannot be used interchangeably without supporting data that demonstrates equivalency for the materials tested.

13. Inspection and Certification

13.1 Inspection and certification of the material supplied with reference to a specification based on this classification system shall be for conformance to the requirements specified herein.

[5] This method is based on the use of Igepal CO-630, a trademark for a nonylphenoxy poly(ethyleneoxy)ethanol, which is CAS 9016-45-9.

13.2 Lot acceptance shall be based on verification of the conformance of the lot to the requirements identified by the material designation and otherwise specified in the purchase order (see 5.1 and 5.2) and verified by tests made in accordance with the directions given in 12.1.

13.3 Periodic check inspection with reference to a specification based upon this classification system shall consist of the tests for all requirements of the material under the specification. Inspection frequency shall be adequate to ensure the material is certifiable in accordance with 13.4.

13.4 Certification shall be that the material was manufactured by a process in statistical control, sampled, tested, and inspected in accordance with this classification system, and that the average values for the lot meet the requirements of the specification (line callout).

13.5 A report of the test results shall be furnished when requested. The report shall consist of results of the lot acceptance inspection for the shipment and the results of the most recent periodic-check inspection.

14. Retest and Rejection

14.1 If any failure occurs, it is acceptable for the materials to be retested to establish conformity in accordance with agreement between the purchaser and the seller.

15. Packaging and Package Marking

15.1 *Packaging*—The material shall be packaged in standard commercial containers, so constructed as to ensure acceptance by common or other carriers for safe transportation at the lowest rate to the point of delivery, unless otherwise specified in the contract or order.

15.2 *Package Marking*—Unless otherwise agreed between the seller and the purchaser, shipping containers shall be marked with the name of the material, type, and quantity contained therein, as defined by the contract or order under which shipment is made and the name of the manufacturer.

15.3 All packing, packaging, and marking provisions of Practice D3892 shall apply to this specification.

16. Keywords

16.1 polyethylene classification system; polyethylene for wire and cable; polyethylene plastics; wire and cable insulations and jackets

SUPPLEMENTARY REQUIREMENTS

QUALITY ASSURANCE PROVISIONS FOR GOVERNMENT/MILITARY PROCUREMENT

These requirements apply only to Federal/Military procurement, not domestic sales or transfers.

S1. Sampling for inspection and testing shall be carried out in accordance with the recommendations of Practice D3636.

S2. Selection of acceptable quality level (AQL) and of inspection level (IL) shall be made, with consideration of the specific use requirements. This is discussed in Practice D3636.

S3. In the absence of contrary requirements, the following values shall apply:

	IL	AQL
Defects of appearance and workmanship	II	2.5
Defects of preparation for delivery	S-2	2.5
Testing (products)	S-1	1.5
Testing (polymer, unfabricated)	S-1[A]	. . .

[A] Samples shall be drawn from the required number of units, and pooled for preparation of molded samples for mechanical properties evaluation.

APPENDIX

(Nonmandatory Information)

X1. CARBON-ARC APPARATUS

X1.1 The radiation from a twin enclosed carbon-arc has no similarity to solar radiation. Therefore, this type of unit is not recommended as a laboratory accelerated weathering test to qualify materials for outdoor applications. Agreement of the parties involved may allow use of this device. However, no information is available on the relation between exposure times and service life under use conditions for wire and cable.

X1.2 If a twin enclosed carbon-arc apparatus must be used, the following will apply.

X1.3 The material shall retain a minimum of 50 % of its unexposed elongation after 4000 h (Note 16) of exposure in a twin enclosed carbon-arc apparatus, or a time agreed upon by the parties involved. Prepare the specimens in accordance with Test Methods D2633 for physical tests of insulation and jackets. Perform the test in accordance with Practices D6360, G151, and G153 using an exposure cycle of 102 minutes light only at 63 ± 3°C (uninsulated black panel) and 55 ± 10 % relative humidity followed by 18 min of light plus water spray on the front surface of the specimen (air temperature not controlled).

SUMMARY OF CHANGES

Committee D20 has identified the location of selected changes to this standard since the last issue (D1248 - 12) that may impact the use of this standard. (November 15, 2016)

(1) Corrected 3.1.2, Note 5, Note 11 and Note 13, which contained permissive language.
(2) Corrected Footnote 5 for permissive language and also the supplier is deleted and replaced by the CAS number of the Igepal CO 630.
(3) Corrected 11.1 and 11.2 to harmonize with PP conditioning of Standard D4101.