



Designation: D2656 – 20

Standard Specification for Crosslinked Polyethylene Insulation for Wire and Cable Rated 2001 to 35 000 V¹

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1. Scope*

1.1 This specification covers a crosslinked polyethylene insulation for electrical wires and cables for conductor sizes 8 AWG (8.37 mm²) and larger. The base polymer of this insulation consists substantially of polyethylene.

1.2 This type of insulation is suitable for use on power cables in wet and dry locations at conductor temperatures not exceeding 90 °C for continuous operation, 130 °C for emergency overload conditions, and 250 °C for short-circuit conditions. It is considered suitable for all sizes and voltage classifications of single- and multiple-conductor power cables at voltage ratings of 2001 to 35 000 V phase-to-phase at the 100 % insulation level and at voltage ratings of 2001 to 25 000 V at the 133 % insulation level as listed in Table 1C of Test Methods D470.

1.3 Materials covered by this specification are not sunlight- and weather-resistant unless they are carbon black pigmented or contain an additive system designed for this protection.

1.4 In many instances the insulation cannot be tested unless it has been formed around a conductor. Therefore, tests are done on insulated wire in this standard solely to determine the relevant property of the insulation and not to test the conductor or completed cable.

1.5 Whenever two sets of values are stated, in different units, the values in the first set are regarded as standard, while the values in parentheses are provided for information only and are not considered standard.

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 D09 on Electrical and Electronic Insulating Materials and is the direct responsibility of Subcommittee D09.07 on Electrical Insulating Materials.

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2. Referenced Documents

2.1 *ASTM Standards*:²

D470 Test Methods for Crosslinked Insulations and Jackets for Wire and Cable

D1248 Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable

D1711 Terminology Relating to Electrical Insulation

D2765 Test Methods for Determination of Gel Content and Swell Ratio of Crosslinked Ethylene Plastics

2.2 *ICEA Standard*:³

ICEA T-28-562 Test Method for Measurement of Hot Creep of Polymeric Insulation

2.3 *UL Standard*:⁴

UL 2556 Wire and Cable Test Methods

3. Terminology

3.1 *Definitions*:

3.1.1 For definitions of terms used in this specification refer to Terminology D1711.

4. Physical Properties

4.1 The requirements for the insulation are listed in Table 1.

5. Electrical Requirements

5.1 *Order of Testing*—Perform the partial-discharge, ac voltage, insulation resistance, and dc voltage tests in that order when any of these tests are specified. The sequence for other testing is not specified.

5.2 *Partial Discharge (Corona) Extinction Voltage*—Each length of completed power cable with shielded conductors shall comply with the minimum level specified in Table 2. Conduct the tests in accordance with Test Methods D470.

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 The Insulated Cable Engineers Association, Inc. (ICEA), P.O. Box 1568, Carrollton, GA 30112, http://www.icea.net.

⁴ Available from Underwriters Laboratories (UL), 2600 N.W. Lake Rd., Camas, WA 98607-8542, http://www.ul.com.

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

TABLE 1 Physical Properties for Crosslinked Polyethylene Insulation

Unaged Requirements:	
Tensile strength, minimum, psi (MPa)	1800 (12.4)
Elongation at rupture, minimum %	250
Aged Requirements:	
After Air Oven Test at 121 ± 1 °C for 168 h:	
Tensile strength, minimum, % of unaged value	75
Elongation at rupture, minimum, % of unaged value	75
Heat Distortion:	
At 121 ± 1 °C, maximum, % of unaged value:	
4/0 Awg (107 mm ²) and smaller (insulation on cable)	30
Larger than 4/0 Awg (107 mm ²) (buffed sample of insulation)	15
Percent Hot Creep, Maximum	
Filled ^A	100
Unfilled ^B	175
Percent hot set, maximum	
Filled ^A	5
Unfilled ^B	10

^A Filled indicates a crosslinked polyethylene insulation that contains 10 % or greater carbon black and/or mineral fillers.

^B Unfilled indicates a crosslinked polyethylene insulation that contains less than 10 % carbon black and/or mineral fillers.

TABLE 2 Partial Discharge (Corona) Extinction Voltage Requirements

Rated Circuit Voltage Phase to Phase, V	Minimum Level, kV	
	Grounded Neutral	Ungrounded Neutral
	Shielded	
2 001 to 5 000	4	5 ^A
5 001 to 8 000	6	8
8 001 to 15 000	11	15
15 001 to 25 000	19	26
25 001 to 28 000	21	
28 001 to 35 000	26	

^A Unless otherwise indicated the cable shall be rated grounded neutral.

5.3 AC Voltage Test—Subject the wires and cables to an ac test voltage for a period of 5 min. Unless otherwise specified, omit this test if the dc voltage test described in 5.5 is to be performed. Test at a voltage of 125 V/mil (5 kV/mm) based on the specified nominal thickness of insulation for the rated circuit voltage, phase to phase. Conduct the test in accordance with Test Methods D470.

5.4 Insulation Resistance—The insulated conductor shall have an insulation resistance equal to or greater than that corresponding to a constant of 20 000 at 60 °F (15.6 °C). When the temperature of the water in which the insulation is tested differs from 60 °F, apply a correction factor. Table 2 of Test Methods D470 contains the correction factors. Each insulation manufacturer can furnish the 1 °F coefficient for the insulation material by using the procedure given in Test Methods D470. Multiply the measured value by the correction factor to obtain the insulation-resistance value corrected to 60 °F.

5.4.1 Where a nonconducting separator is applied between the conductor and insulation or where an insulated conductor is covered with a nonmetallic jacket so that the insulation resistance can be measured only on the completed assembly, the required insulation resistance shall be at least 60 % of that

required for the primary insulation based on the nominal thickness of that insulation.

5.5 DC Voltage Test—After the insulation resistance test has been completed, subject wires and cables rated 5001 V and above to a dc voltage test for a period of 15 min. Use a dc voltage three times the ac voltage based on the specified nominal thickness of insulation for the rated circuit voltage, phase to phase. Conduct the tests in accordance with Test Methods D470.

5.5.1 Upon completion of the insulation resistance test, each nonshielded insulated conductor rated up to 5000 V shall withstand for 5 min a dc test voltage that is three times the ac test voltage specified in 5.3. Unless otherwise specified, omit this test if the ac voltage test described in 5.3 has been performed.

5.6 Accelerated Water Absorption Requirements—The insulation shall meet the requirements of Table 3 when tested in accordance with the Accelerated Water Absorption Tests in Test Methods D470. Conduct the Electrical Method Test at 60 Hz with the water temperature at 75 ± 1 °C.

5.7 Permittivity and Dissipation Factor—This test applies to insulation rated 5001 V and above. Measure the permittivity and dissipation factor on suitable 60-Hz equipment after the test specimen has been immersed in water at room temperature for at least 24 h. Make the measurements at a voltage corresponding to an average stress of 40 V/mil (1.6 kV/mm), based upon the specified nominal thickness of insulation for the rated circuit voltage, phase to phase. The insulation shall meet the following requirements:

Permittivity at room temperature, maximum 3.5
Dissipation factor at room temperature, maximum, 0.020

5.8 U-Bend Discharge—Perform this test only on single-conductor nonshielded cables rated 2001 through 5000 V. At the end of the test period no cable dielectric failures or cracks in the cable surface are permitted. Conduct the test in accordance with Test Methods D470.

5.9 Surface Resistivity—Perform this test only on single-conductor nonshielded cables rated 2001 through 5000 V. The surface resistivity shall exceed 200 000 MΩ. Conduct the test in accordance with Test Methods D470.

6. Heat Distortion

6.1 The requirements for heat distortion are given in Table 1 of this Specification. The test is conducted in accordance with Test Methods D470.

TABLE 3 Accelerated Water Absorption Test Requirements

Electrical Method:	
Permittivity after one day, maximum	3.5
Increase in capacitance, maximum, %:	
From 1 to 14 days	3.0
From 7 to 14 days	1.5
Stability factor after 14 days, maximum	1.0
Alternative to stability factor:	
Stability factor difference, 1 to 14 days, maximum	0.5