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Standard Specification for Rubber Insulating Covers [1]

This standard is issued under the fixed designation D 1049; 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 Department of Defense.

1. Scope

1.1 This specification covers acceptance testing of rubber insulating covers for use as portable protective devices for protection of workers from accidental contact with live electrical conductors, apparatus, or circuits. It includes insulator hoods, dead-end protectors, line hose connectors, cable end covers, and miscellaneous covers. The electrical, physical, and chemical requirements of this specification shall apply also to any new or modified styles of covers that may be developed for specific purposes.

1.2 Three types of covers, differing in chemical and physical characteristics, are provided, and are designated as Type I, non-resistant to ozone, and Type II and Type III, resistant to ozone.

1.3 Five classes of covers, differing in electrical characteristics, are provided, and are designated as Class 0, Class 1, Class 2, Class 3, and Class 4.

1.4 Five styles of covers, differing in design characteristics, are provided, and are designated as Style A, Style B, Style C, Style D, and Style E.

NOTE 1—Because of the use requirements some covers are semi-rigid and others flexible. The flexible devices should remain suitably flexible for application and removal through normal temperatures of − 29 to 54.5°C (−20 to 130°F).

1.5 *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.* See 18.2.

2. Referenced Documents

2.1 *ASTM Standards:*

D 297 Test Methods for Rubber Products—Chemical Analysis [2]

D 412 Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers—Tension [2]

D 573 Test Method for Rubber—Deterioration in an Air Oven [2]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *breakdown*—the electrical discharge or arc occurring between the electrodes and through the equipment being tested.

3.1.2 *flashover*—the electrical discharge or arc occurring between electrodes and over or around, but not through, the equipment being tested.

3.1.3 *ozone*—a very active form of oxygen that may be produced by corona, arcing, or ultraviolet rays.

3.1.4 *ozone cutting and checking*—the cutting action produced by ozone on rubber under mechanical stress into a series of interlacing cracks.

3.1.5 *rubber*—a generic term that includes elastomers and elastomeric compounds, regardless of origin.

3.1.6 *user —as used in 4.3.1,* the entity employing the actual worker(s) using the equipment; if no separate employer, then the individual.

3.1.7 *voltage, maximum use*—the ac voltage (rms) rating of the protective equipment that designates the maximum nominal design voltage of the energized system that may be safely worked. The nominal design voltage is equal to the phase to phase voltage on multiphase circuits.

3.1.7.1 *Discussion*—If there is no multiphase exposure in a system area and the voltage exposure is limited to phase (polarity on dc systems) to ground potential, the phase (polarity on dc systems) to ground potential shall be considered to be the nominal design voltage. If electrical equipment and devices are insulated, or isolated, or both, such that the multiphase exposure on a grounded wye circuit is removed, then the nominal design voltage may be considered as the phase-to-ground voltage on that circuit.

3.1.8 *voltage, nominal design*—a nominal value consistent with the latest revision on ANSI C84.1, assigned to the circuit or system for the purpose of conveniently designating its voltage class.

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[1] This specification is under the jurisdiction of ASTM Committee F18 on Electrical Protective Equipment for Workers and is the direct responsibility of Subcommittee F18.25 on Insulating Cover-Up Equipment. This standard replaces ANSI Standard J6.2, which is no longer available.

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[2] *Annual Book of ASTM Standards,* Vol 09.01.

4. Significance and Use

4.1 This specification covers the minimum electrical, chemical, and physical properties guaranteed by the manufacturer and the detailed procedures by which such properties are to be determined. The purchaser may at his option perform or have performed any of these tests in order to verify the guarantee. Claims for failure to meet the specification are subject to verification by the manufacturer.

4.2 Insulating covers are used for personal protection; therefore, when authorizing their use, a margin of safety shall be provided between the maximum voltage at which they are used and the proof-test voltage at which they are tested. The relationship between proof-test voltage and the maximum voltage at which insulating covers shall be used is shown in Table 1.

4.3 Work practices vary from user to user, depending upon many factors. These may include, but are not limited to, operating system voltages, construction design, work procedures and techniques, weather conditions, and so forth. Therefore, except for the restrictions set forth in this specification because of design limitations, the use and maintenance of this equipment is beyond the scope of this specification.

4.3.1 It is common practice and the responsibility of the user of this type of protective equipment to prepare complete instructions and regulations to govern the correct and safe use of such equipment.

5. Classification

5.1 Covers included under this specification shall be designated as Type I, Type II, or Type III; Class 0, Class 1, Class 2, Class 3, or Class 4; Style A, Style B, Style C, Style D, or Style E.

5.1.1 *Type I*, non-resistant to ozone, made from a high-grade *cis*-1,4-polyisoprene rubber compound of natural or synthetic origin, properly vulcanized.

TABLE 1 Proof-Test/Use Voltage Relationship

NOTE 1—The ac voltage (rms) classification of the protective equipment designates the maximum nominal design voltage of the energized system that may be safely worked. The nominal design voltage is equal to:

1. The phase to phase on multiphase circuits or
2. The phase to ground voltage on single phase grounded circuits.

Class of Insulating Covers	Nominal Maximum Use Voltage,[A] Phase-Phase ac, rms	AC Proof-Test Voltage, rms V	DC Proof-Test Voltage, avg, V
0	1 000	5 000	20 000
1	7 500	10 000	40 000
2	17 000	20 000	50 000
3	26 500	30 000	60 000
4	36 000	40 000	70 000

[A] Except for Class O equipment, the maximum use voltage is based on the following formula:

$$\text{Maximum use voltage (maximum nominal design voltage)} = \frac{0.95 \times \text{proof-test voltage}}{\text{ac}} - 2000$$

5.1.2 *Type II*, ozone resistant, made of any elastomer or combination of elastomeric compounds.

5.1.3 *Type III*, ozone-resistant, made of any combination of elastomer and thermoplastic polymer, elastic in nature.

5.1.4 *Class*—The class designation shall be based on the electrical properties and design characteristics as shown in Table 2 or Table 3.

5.1.5 *Style*—The style designation shall describe the item, size, and device or apparatus covered, protected, or connected.

5.1.5.1 *Style A* designates insulator hoods.

5.1.5.2 *Style B* designates dead end protectors.

5.1.5.3 *Style C* designates line hose connectors.

5.1.5.4 *Style D* designates cable end covers.

5.1.5.5 *Style E* designates miscellaneous covers.

6. Ordering Information

6.1 Orders for covers under this specification should include the following information:

6.1.1 Type,

6.1.2 Class, and

6.1.3 Either the style and item number or the size, inside diameter, outside diameter, and length of the covers.

6.2 The listing of types, classes, styles, and item numbers is not intended to mean that all shall necessarily be available from manufacturers; it signifies only that, if made, they shall conform to the details of this specification.

7. Manufacture and Marking

7.1 Each cover shall be marked clearly and permanently with the name of the manufacturer or supplier, ANSI/ASTM D 1049, type, and class.

7.1.1 Covers may be marked by either molding the information directly into the cover or by use of a label; either method is equally acceptable. The method shall be at the discretion of the manufacturer. If a label is used, the color shall be that specified for each voltage class: Class 0—red, Class 1—white, Class 2—yellow, Class 3—green, and Class 4—orange.

8. Chemical and Physical Requirements

8.1 The cover material shall conform to the tensile strength requirements in Table 2 or Table 1, the accelerated aging in 5.1.3 and, for Type I covers, the determination of rubber polymer in accordance with 19.1.1.

9. Electrical Requirements

9.1 Each cover, when selected in accordance with Section 13 shall withstand the 60-Hz ac proof-test voltage (rms value) or the dc proof-test voltage (average value) specified in Table 2 or Table 3. The proof test shall be performed in accordance with Section 18 and shall be applied continuously for 3 min.

9.2 Type II and Type III covers shall show no visible effects from corona or ozone when tested in accordance with 18.5.

TABLE 2 Covers—Type I Specifications

Insulator Hoods—Style A

Item Number [A]	Type Insulator	Insulator Diameter, in.	Hose Size, in.	Length, mm (in.), min	Height, mm (in.), min	Tensile, MPa (psi), min	Class	ac Proof-Test Voltage, V	dc Proof-Test Voltage, V	Suggested Electrode Group [B]
1	pin	4	1	375 (14.75)	159 (6.25)	11.0 (1600)	2	20 000	30 000	2
2	pin	6	1	406 (16.0)	159 (6.25)	11.0 (1600)	2	20 000	30 000	2
3	pin	7	1¼, 1½	406 (16.0)	162 (6.375)	11.0 (1600)	2 and 3	30 000	40 000	2

Dead End Protectors—Style B

Item Number [A]	Type Insulator	Insulator Diameter, in.	Hose Size, in.	Inside Diameter, mm (in.)	Sleeve Length, mm (in.)	Tensile, MPa (psi), min	Class	ac Proof-Test Voltage, V	dc Proof-Test Voltage, V	Suggested Electrode Group [B]
1	disk or dead end	4¼	any size (adapters)	121 (4.75)	254 (10)	11.0 (1600)	2	20 000	30 000	2
2	2 disk or 2 dead end	4¼	any size (adapters)	121 (4.75)	457 (18)	11.0 (1600)	2	20 000	30 000	2
3	disk or dead end	6	1	165 (6.5)	457 (18)	11.0 (1600)	2	20 000	30 000	2

Line Hose Connectors—Style C

Item Number [A]	Hose Size, in.	Length, mm (in.)	Tensile, MPa (psi), min	Class	ac Proof-Test Voltage, V	dc Proof-Test Voltage, V	Suggested Electrode Group [B]
1	1	305 (12.0)	11.0 (1600)	2	20 000	30 000	2
2	1¼	305 (12.0)	11.0 (1600)	2	20 000	30 000	2
3	1½	305 (12.0)	11.0 (1600)	3	30 000	40 000	2

[A] Item numbers are provided for convenient referencing.
[B] Suggested electrode groups for ac tests only.

TABLE 3 Covers—Type II and Type III Specifications

Insulator Hoods—Style A

Item Number [A]	Type Insulator	Insulator Diameter, in.	Insulator Height, in.	Hose Size, in.	Length, mm (in.), min	Height, mm (in.), min	Tensile, MPa (psi), min	Class	ac Proof-Test Voltage, V	dc Proof-Test Voltage, V	Suggested Electrode Group
1	pin	4	4	1	375 (14.75)	159 (6.25)	4.82 (700)	2	20 000	30 000	2–3
2	pin	6	5	1	406 (16.0)	159 (6.25)	4.82 (700)	2	20 000	30 000	2–3
3	pin	7	6	1¼–1½	406 (16.0 (wide))	162 (6.375)	4.82 (700)	2 and 3	30 000	40 000	2–3
4	pin	10	12	2½	483 (19.0)	406 (16.0)	6.89 (1000)	4	40 000	60 000	2–3
5	pin	11	6	1½	267 (10.5 (ID))	165 (6.5)	4.82 (700)	3	30 000	40 000	2–3
6	pin	8¾	5¾	1½–2½	381 (15.0)	216 (8.5)	6.89 (1000)	4	40 000	60 000	2–3
7	post	6.5	8¾	1½–2½	317 (12.5)	298 (11.75)	6.89 (1000)	3	30 000	40 000	2–3
8	post	6.5	13	1½–2½	317 (12.5)	400 (15.75)	6.89 (1000)	4	40 000	60 000	2–3

Dead End Protectors—Style B

Item Number [A]	Type Insulator	Insulator Diameter	Hose Size, in.	Sleeve Length, mm in.	Tensile, MPa (psi), min	Class	ac Proof-Test Voltage, V	dc Proof-Test Voltage, V	Suggested Electrode Group
1	disk or dead end	4¼	any size (adapters)	254 (10.0)	4.82 (700)	2 and 3	30 000	40 000	2–3
2	disk or dead end	4¼	any size (adapters)	457 (18.0)	4.82 (700)	2 and 3	30 000	40 000	2–3
3	disk or dead end	6	1	457 (18.0)	4.82 (700)	2	20 000	30 000	2–3
4	disk or dead end	4¼	1½–2½	940 (37.0)	4.82 (700)	4	40 000	50 000	2–3
5	disk or dead end	7	1½–2½	624 (24.5)	11.0 (1600)	4	40 000	50 000	2–3
6	disk or dead end	10	1½–2½	624 (24.5)	11.0 (1600)	4	40 000	50 000	2–3

Line Hose Connectors—Style C

Item Number [A]	Hose Size, in.	Length, mm (in.)	Tensile, MPa (psi), min	Class	ac Proof-Test Voltage, V	dc Proof-Test Voltage, V	Suggested Electrode Group
1	1	305 (12.0)	4.82 (700)	2	20 000	30 000	2–3
2	1¼	305 (12.0)	4.82 (700)	2	20 000	30 000	2–3
3	1½	305 (12.0)	4.82 (700)	3	30 000	40 000	2–3
4	1½	267 (10.5)	4.82 (700)	4	40 000	50 000	2–3
5	2½	267 (10.5)	4.82 (700)	4	40 000	50 000	2–3

TABLE 3 *Continued*

Cable End Covers—Style D

Item Number [A]	Inside Diameter, mm (in.)	Length, mm (in.)	Conductor Size	Tensile, MPa (psi), min	Class	ac Proof-Test Voltage, V	dc Proof-Test Voltage, V	Suggested Electrode Group
Cable end caps size								
1	13 (0.5)	152 (6.0)	#12 to #6	10.3 (1500)	2	20 000	30 000	1
2	21 (0.81)	152 (6.0)	#4 to 4/0	10.3 (1500)	2	20 000	30 000	1
3	19 (0.75)	178 (7.0)	#10 to #4	10.3 (1500)	2	20 000	30 000	1
4	35 (1.375)	254 (10.0)	#4/0 to 500 MCM	10.3 (1500)	2	20 000	30 000	1
5	57 (2.25)	305 (12.0)	350 MCM to 750 MCM	10.3 (1500)	2	20 000	30 000	1
6	81 (3.19)	406 (16.0)	800 MCM to 1000 MCM	10.3 (1500)	2	20 000	30 000	1
Separator size								
7	25 (1.0)	76 (3.0)	...	10.3 (1500)	2	20 000	30 000	1
8	38 (1.5)	108 (4.25)	...	10.3 (1500)	2	20 000	30 000	1
9	62 (2.44)	114 (4.5)	...	10.3 (1500)	2	20 000	30 000	1
10	70 (2.75)	152 (6.0)	...	10.3 (1500)	2	20 000	30 000	1
Test caps size								
11	16 (0.63)	152 (6.0)	...	10.3 (1500)	2	20 000	30 000	1–2–3
12	24 (0.94)	152 (6.0)	...	10.3 (1500)	2	20 000	30 000	1–2–3
13	19 (0.75)	178 (7.0)	...	10.3 (1500)	2	20 000	30 000	1–2–3
14	35 (1.38)	254 (10.0)	...	10.3 (1500)	2	20 000	30 000	1–2–3
15	57 (2.25)	305 (12.0)	...	10.3 (1500)	2	20 000	30 000	1–2–3
16	76 (3.0)	406 (16.0)	...	10.3 (1500)	2	20 000	30 000	1–2–3
17	127 (5.0)	762 (30.0)	...	4.82 (700)	4	40 000	60 000	1–2–3
18	152 (6.0)	1016 (40.0)	...	4.82 (700)	4	40 000	60 000	1–2–3

Miscellaneous Covers—Style E

Item Number [A]		Length, mm (in.), min	Width, mm (in.), min	Height, mm (in.), min	Diameter or Depth, mm (in.)	Tensile, MPa (psi), min	Class	ac Proof-Test Voltage, V	dc Proof-Test Voltage, V	Suggested Electrode Group
1	Spade cover	203 (8.0)	57 (2.25)	114 (4.5)	...	6.9 (1000)	1 and 2	20 000	30 000	2–3
2	Spade cover	254 (10.0)	72 (3.0)	153 (6.0)	432 (17.0 (flat))	6.9 (1000)	1 and 2	20 000	30 000	2–3
3	Box-type cutouts	...	...	...	533 (21.0 (flat))	10.3 (1500)	2	20 000	30 000	1–2–3
4	Box-type cutouts	...	...	...	165 (6.5)	10.3 (1500)	2	20 000	30 000	1–2–3
5	Through bolt	...	...	102 (4.0)	...	10.3 (1500)	2	20 000	30 000	1–2–3
6	Crossarm shield	368 (14.5)	105 (4.125)	117 (4.625)	...	4.82 (700)	2	20 000	30 000	2–3
7	Open type cutouts	610 (24)	95 (3.75)	381 (15.0)	...	10.3 (1500)	2	20 000	30 000	1–2–3
8	Open type cutouts	763 (30)	228 (9.0)	508 (20.0)	...	10.3 (1500)	4	40 000	60 000	1–2–3
9	Stirrup cover	318 (12.5)	133 (5.25)	356 (14.0)	...	4.82 (700)	4	40 000	60 000	2–3

[A] Item numbers are provided for convenient referencing.

10. Dimensions and Permissible Variations

10.1 *Diameter*—The inside diameter, where applicable, shall indicate the measurement from one point on the inside wall to another point on the inside wall, 180° from the first point, as shown in Table 2 or Table 3. The outside diameter, where applicable, shall indicate the measurement from one point on the outside wall to another point on the outside wall, 180° from the first point, as shown in Table 2 or Table 3. The permissible variation shall be ±5 %.

10.2 *Length*—Length, where applicable, shall be the distance from end to end as shown in Table 2 or Table 3. The permissible variation in length shall be± 5 %.

11. Workmanship and Finish

11.1 The covers shall be free of harmful physical irregularities, which can be detected by thorough test or inspection.

11.1.1 *Nonharmful Irregularities*—Surface irregularities may be present on all rubber goods as a result of imperfections on forms, molds, or extruding dies, and inherent difficulties in the manufacturing process. These irregularities may appear as indentations, protuberances, or imbedded nonconductive foreign material that are acceptable provided that:

11.1.1.1 The indentation or protuberance tends to blend into a smooth slope upon stretching of the material.

11.1.1.2 Nonconductive foreign material remains in place when the cover is bent and stretches equally with the material surrounding it.

12. Guarantee

12.1 The manufacturer or supplier shall replace, without charge to the purchaser, unused covers which, at any time within a period of 9 months from date of receipt of shipment by purchaser or his designee fails to pass the tests in this specification. Acceptance tests made by the purchaser or his designee shall be performed within 2 months of receipt by the purchaser or his designee unless otherwise specified.

NOTE 2—Proper storage means that the covers are stored without distortion, and not stored directly above or in proximity to steam pipes, radiators, or other sources of artificial heat, or exposed to direct sunlight or other sources of ozone. It is desirable that the ambient storage temperature shall not exceed 35°C (95°F).

13. Sampling

13.1 Each cover in a lot or shipment may, at the option of the purchaser, be subject to inspection and test to meet the requirements of Sections 7, 10, 11, 9.1, and 15.

13.2 An original sample of two covers or 1 % of the lot or shipment, whichever is greater, shall be selected at random from the lot or shipment for the test requirements of 9.2 and Section 8. If failure occurs in the first sample, a second sample of the same quantity shall be selected and tested.

14. Rejection

14.1 Individual covers shall be rejected if they fail to meet the manufacturing and marking requirements of Section 7, the electrical requirements of 9.1, or the workmanship requirements of Section 11.

14.2 Individual covers may be rejected at the option of the purchaser if they fail to meet the requirements in 10.1, 10.2, and Section 15.

14.3 The entire lot or shipment of covers shall be rejected under any of the following conditions:

14.3.1 If 5 % or more, but not less than two covers, in a lot or shipment fail to meet the requirements of 9.1.

14.3.2 If the sample of Type II and Type III covers, using the sampling methods of 14.2, fails to meet the requirements of 9.2.

14.3.3 If one corona or ozone failure of two tests on the original and one or more corona or ozone failure of two tests on an additional specimen fail to meet the corona or ozone requirement of 9.2.

14.4 The testing shall be terminated and the manufacturer notified if, during the course of testing, 5 % or more, but not less than two covers, in a lot or shipment fail to meet the requirements of 9.1. The manufacturer may, in such a case, require the purchaser to submit proof that the test procedure and equipment conform to the appropriate paragraphs of Section 18. When such proof has been furnished, the manufacturer or supplier may request that his representative witness the testing of additional covers from the shipment.

14.5 If two of the five specimens tested fail any of the separate requirements outlined in Section 8, a second group of specimens shall be selected and tested. If one or more specimens of the second group fail, the entire lot or shipment may be rejected at the option of the purchaser.

14.6 The entire lot or shipment of covers may be rejected at the option of the purchaser if 25 % of the covers in the lot or shipment fail to meet the requirements of Sections 10 or 11.

14.7 All rejected material shall be returned as directed by the manufacturer, at his or the supplier's request, without being defaced by rubber stamp or other permanent marking. However, those punctured when tested in accordance with the requirements of 9.1 shall be stamped, punched, or cut before being returned to the supplier to indicate that they are unfit for electrical use.

15. Packaging

15.1 The covers shall be packed in individual cartons or in packaged lots and shall not be distorted mechanically while in storage or transit.

TEST METHODS

16. Sequence of Testing

16.1 The following order of procedure is suggested for testing rubber insulating covers:

16.1.1 Inspection of the inside, outside, top, and bottom surfaces in accordance with Section 11.

16.1.2 The dimensions in accordance with Section 17.

16.1.3 Electrical proof test in accordance with the appropriate paragraphs of 18.1, 18.3, or 18.4.

16.1.4 Ozone resistance tests in accordance with the appropriate paragraphs of 18.5.

16.1.5 Chemical and physical property tests in accordance with Section 19.

17. Dimension Measurements

17.1 *Thickness*—Thickness measurements are not specified because rubber insulating covers have varying thicknesses throughout their configuration as a result of the functional requirements of each device. The minimum thickness shall be sufficient to meet the proof-test voltage at which the device is tested.

17.2 *Diameter*:

17.2.1 *Apparatus*—Inside and outside diameter measurements should be made with rules, scales, or plug gages.

17.2.2 *Procedure*—Diameter measurements of each cover shall be made at not less than two points; the second measurement shall be made at a point 90° from the location of the first measurement.

17.3 *Length*:

17.3.1 *Apparatus*—Length measurements shall be made with rules or scales.

17.3.2 *Procedure*—Length measurements of each cover shall be made at any convenient point, depending on requirements for sleeve length or overall length.

18. Electrical Tests

18.1 *Electrical Proof Tests*:

NOTE 3—Both ac and dc proof-test methods are included in this section. It is intended that one method be selected for the electrical acceptance tests. The method selected shall be at the option of the purchaser, and the supplier should be so notified of the selection.

18.2 **Caution:** It is recommended that the test apparatus be designed to afford the operator full protection in the performance of his duties. Reliable means of de-energizing and grounding the high voltage circuit should be provided. It is particularly important to incorporate a positive means of grounding the high-voltage section of dc test apparatus due to the likely presence of high-voltage capacitance charges at the conclusion of the test.

18.3 *AC Proof Test*:

18.3.1 The entire area of each cover, shall be tested as nearly as practicable, between electrodes that apply the electric stress uniformly over the test area without producing corona at any point or mechanical strain in the material. The electrodes shall be of such dimensions and so placed as to avoid flashover at the edges. The inside electrode should be one of those described in Group 1, 2, or 3, depending on whether Type I, Type II, or Type III covers are to be tested. The outer electrode should be one of those described in Groups 1, 2, or 3, depending on what type covers are to be tested. Covers shall withstand the proof-test voltages shown in Table 2 or Table 3.

18.3.2 *Electrodes*—Because of the differences in design of the various covers, three groups of electrodes are recommended for ac proof tests in Table 2 or Table 3. The three groups are: *Group 1*—water as inner and outer electrodes, *Group 2*—wet sponge or wet felt inner electrode and wet sponge, wet felt, or metal foil outer electrode, and *Group 3*—fixed form metal inner or outer electrodes, or both.

NOTE 4—Group 3 electrodes should not be used with Type I materials because of the possibility of corona cutting.

18.3.3 *AC Voltage Supply and Regulation*:

18.3.3.1 The test equipment used in the proof tests shall be capable of supplying an essentially stepless and continuously variable voltage to the test specimen. Motor-driven regulating equipment is convenient and tends to provide uniform rate-of-rise to the test voltage. The test apparatus should be protected by an automatic circuit breaking device designed to open promptly on the current produced by breakdown of a specimen under test. This circuit breaking device should be designed to protect the test equipment under any conditions of short circuit.

18.3.3.2 The desired test voltage may be obtained most readily from a step-up transformer energized from a variable low-voltage source. The transformer and its control equipment shall be of such size and design that, with the test specimen in the circuit, the crest factor (ratio of maximum to mean effective) of the test voltage shall differ by not more than 5 % from that of a sinusoidal wave over the upper half of the range of test voltage.

18.3.3.3 The correct rms value of the sinusoidal voltage wave-form applied to the covers may be measured by one of the following methods: (*1*) a voltmeter used in conjunction with a calibrated instrument transformer connected directly across the high-voltage circuit, (*2*) a calibrated electrostatic voltmeter connected directly across the high-voltage circuit, or (*3*) an ac meter connected in series with appropriate high-voltage type resistors directly across the high-voltage circuit. The accuracy of the voltage-measuring circuit shall be within ±2 % of full scale.

18.3.3.4 The crest factor may be checked by the use of a peak-reading voltmeter connected directly across the high-voltage circuit; or, if an electrostatic voltmeter or an rms voltmeter in conjunction with an instrument potential transformer is connected across the high-voltage circuit, a standard sphere gap may be sparked over and the corresponding voltage compared with the reading of the rms voltmeter.

18.3.4 *Procedure*—The proof-test voltage shall be applied initially at a low value and then gradually increased at a constant rate-of-rise of approximately 1000 V/s until the prescribed test voltage level is reached, or failure occurs. The test period starts at the instant that the prescribed testing voltage is reached. The applied voltage should be reduced to at least half value, unless an electrical puncture has already occurred, at the end of the test period before opening the test circuit.

18.4 *DC Proof Test*:

18.4.1 *Electrodes*—The dc proof test may be made with dry electrodes that consist of two metallic plates or forms, at least one of which is sized so that flashover does not occur. The edges of these plates or forms shall be rounded so as to eliminate sharp nicks and protuberances.

18.4.2 *Voltage Supply and Regulation*:

18.4.2.1 The dc proof-test voltage shall be obtained from a dc source capable of supplying the required voltage. The peak to peak ac ripple component of the dc proof-test voltage shall not exceed 2 % of the average voltage value under no-load conditions.

18.4.2.2 The dc proof-test voltage shall be measured by a method that provides the average value of the voltage applied to the cover. It is recommended that this voltage be measured by the use of a dc meter connected in series with appropriate high-voltage type resistors across the high-voltage circuit. An electrostatic voltmeter of proper range may be used in place of the dc meter-resistor combination. The accuracy of the voltage-measuring circuit shall be within ±2 % of full scale.

18.4.3 The voltage should be applied at the rate of approximately 3000 V/s dc.

18.5 *Ozone Resistance Tests*:

18.5.1 The inside electrode shall be of such a design as to induce tensile stress in the outside of the cover. Twisting, bending, or folding can be a means of inducing stress. This electrode shall be grounded.

18.5.2 The outer electrodes, except for testing cable end caps, separators, test caps, box and open-type cutout covers, shall be metal foil located as nearly as possible over the area of tensile stress. The electrode shall be energized at 15 kV ac (rms) from a stable 60-Hz source. The 15-kV potential may be derived from a suitably rated potential transformer energized from its low-voltage winding through a continuously variable autotransformer. An overcurrent protective device should be incorporated into a low-voltage control circuit in case of an electrical breakdown.

18.5.3 The ozone resistance of the specimen shall be determined qualitatively, by inspection, after a 1-h exposure period in the test apparatus at the 15-kV potential. Consider any visible signs of ozone deterioration of the cover material, such as checking, cracking, breaks, pitting, etc., as evidence of failure to meet the requirements of Type II and Type III covers. At least two specimens of covers shall be selected and tested.

NOTE 5—The rate of ozone degradation is inversely proportional to the relative humidity of the surrounding air. Empirical data indicate, however, that visible ozone effects will be evident over a broad range of ambient humidities under these test conditions.

19. Chemical and Physical Tests

19.1 *Chemical Tests*:

19.1.1 The composition of the rubber hydrocarbon portion of Type I covers may be determined by using test methods prescribed in Methods D 297.

19.2 *Physical Tests*:

19.2.1 Tensile strength tests shall be performed in accordance with Test Methods D 412. The test specimen shall conform in dimensions to Die C.

19.2.2 Accelerated aging tests shall be performed in accordance with Test Method D 573. After being subjected to a temperature of 70 ± 2°C (158 ± 3.6°F) in circulating air for 7 days, the tensile strength of the specimen shall be not less than 75 % of the original.