Designation: D350 – 09

An American National Standard

Standard Test Methods for Flexible Treated Sleeving Used for Electrical Insulation[1]

This standard is issued under the fixed designation D350; 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 These test methods cover procedures for testing electrical insulating sleeving comprising a flexible tubular product made from a woven textile fibre base, such as cotton, rayon, nylon, or glass, thereafter impregnated, or coated, or impregnated and coated, with a suitable dielectric material.

1.2 The procedures appear in the following sections:

Procedures	Sections
Brittleness Temperature	18 to 21
Compatibility of Sleeving with Magnet Wire Insulation	45 to 59
Conditioning	6
Dielectric Breakdown Voltage	12 to 17
Dielectric Breakdown Voltage After Short-Time Aging	29 to 33
Dimensions	7 to 11
Effect of Push-Back After Heat Aging	73 to 78
Flammability	22 to 28
Hydrolytic Stability	66 to 72
Oil Resistance	34 to 37
Selection of Test Material	5
Solvent Resistance	60 to 65
Thermal Endurance	38 to 44

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

1.4 This is a fire-test-response standard. See Sections 22 through 28, which are the procedures for flammability tests.

1.5 This standard measures and describes the response of materials, products, or assemblies to heat and flame under controlled conditions, but does not by itself incorporate all factors required for fire hazard or fire risk assessment of the materials, products or assemblies under actual fire conditions.

1.6 *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.* For specific hazard statements, see 45.2 and 63.1.1.

NOTE 1—This standard resembles IEC 60684-2, Specification for Flexible Insulating Sleeving—Part 2 Methods of Test, in a number of ways, but is not consistently similar throughout. The data obtained using either standard may not be technically equivalent.

1.7 *Fire testing is inherently hazardous. Adequate safeguards for personnel and property shall be employed in conducting these tests.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D149 Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
D374 Test Methods for Thickness of Solid Electrical Insulation
D471 Test Method for Rubber Property—Effect of Liquids
D746 Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
D876 Test Methods for Nonrigid Vinyl Chloride Polymer Tubing Used for Electrical Insulation
D1711 Terminology Relating to Electrical Insulation
D2307 Test Method for Thermal Endurance of Film-Insulated Round Magnet Wire
D3487 Specification for Mineral Insulating Oil Used in Electrical Apparatus
D3636 Practice for Sampling and Judging Quality of Solid Electrical Insulating Materials
D5423 Specification for Forced-Convection Laboratory Ovens for Evaluation of Electrical Insulation
D6054 Practice for Conditioning Electrical Insulating Materials for Testing
E145 Specification for Gravity-Convection and Forced-Ventilation Ovens
E176 Terminology of Fire Standards

[1] These test methods are under the jurisdiction of ASTM Committee D09 on Electrical and Electronic Insulating Materials and are the direct responsibility of Subcommittee D09.07 on Flexible and Rigid Insulating Materials.

Current edition approved Oct. 1, 2009. Published November 2009. Originally approved in 1932. Last previous edition approved in 2008 as D350 – 08. DOI: 10.1520/D0350-09.

[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.

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

2.2 *IEEE Standard:*

IEEE 101 Guide for the Statistical Analysis of Thermal Life Test Data[3]

2.3 *IEC Standard:*

IEC 60684-2 Specification for Flexible Insulating Sleeving—Part 2 Methods of Test[4]

2.4 *ISO Standard:*

ISO 13943 Fire Safety—Vocabulary

3. Terminology

3.1 *Definitions:*

3.1.1 Use Terminology E176 and ISO 13943 for definitions of terms used in this test method and associated with fire issues. Where differences exist in definitions, those contained in Terminology E176 shall be used. Use Terminology D1711 for definitions of terms used in this test method and associated with electrical insulation materials.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *size, n*—a numerical designation which indicates that the inside diameter of the sleeving lies within the limits prescribed in Table 1.

3.2.2 *wall thickness, n*—one half the difference between the outside diameter of the sleeving mounted on a loosely fitting gage rod and the diameter of the gage rod when measured in accordance with 9.2.

4. Apparatus and Materials

4.1 Ovens used in these test methods shall meet the requirements of Specification D5423.

5. Selection of Test Material

5.1 In the case of sleeving on spools or in coils, not less than three turns of the product shall be removed before the selection of material from which test specimens are to be prepared.

5.2 In the case of sleeving offered in cut lengths, test specimens shall not be prepared from material closer than 1 in. (25 mm) from each end.

5.3 Specimens for test shall not show obvious defects unless the purpose of the test is to determine the effect of such defects.

5.4 Specimens shall be prepared from samples selected in accordance with Practice D3636. The sampling plan and acceptance quality level shall be as agreed upon between the user and the producer.

6. Conditioning

6.1 Unless otherwise specified, a standard laboratory atmosphere of 50 ± 5 % relative humidity and 23 ± 2 °C (73.4 ± 3.6 °F) shall be used in conducting all tests and for conditioning specimens for a period of at least 18 h prior to testing.

6.2 In the case of dielectric breakdown voltage tests after humidity conditioning, specimens shall be conditioned for 96 h in an atmosphere of 93 ± 3 % relative humidity and 23 ± 2 °C (73.4 ± 3.6 °F) before testing. If a conditioning cabinet is used, specimens shall be tested for dielectric breakdown voltage within 1 min after removal from the cabinet.

6.3 For details regarding conditioning, refer to Practice D6054.

DIMENSIONS

7. Apparatus

7.1 *Gage Rods*—Standard gage rods shall be made of steel and shall have smooth surfaces and rounded edges. One rod is required for each of the maximum and minimum diameters shown in Table 1 for each size. Each rod shall be within ±0.005 in. (±6.012 mm) of the values shown in Table 1.

8. Test Specimens

8.1 Five test specimens of at least 7 in. (180 mm) in length shall be cut from material obtained in accordance with Section 5.

9. Procedure

9.1 *Inside Diameter*—Pass the minimum gage rod for the size sleeving under test into the specimen for a distance of 5 in. (127 mm) without expanding the wall of the sleeving. If the rod has a snug fit, then consider the specimen as having an inside diameter equal to the diameter of the rod. If the minimum gage

TABLE 1 ASTM Standard Sizes for Flexible Sleeving

Size	Inside Diameter, in. (mm)	
	Max	Min
1 in.	1.036 (26.3)	1.000 (25.4)
⅞ in.	0.911 (23.1)	0.875 (22.2)
¾ in.	0.786 (20.0)	0.750 (19.1)
⅝ in.	0.655 (16.6)	0.625 (15.9)
½ in.	0.524 (13.3)	0.500 (12.7)
7⁄16 in.	0.462 (11.7)	0.438 (11.1)
⅜ in.	0.399 (10.1)	0.375 (9.5)
No. 0	0.347 (8.8)	0.325 (8.3)
No. 1	0.311 (7.9)	0.289 (7.3)
No. 2	0.278 (7.1)	0.258 (6.6)
No. 3	0.249 (6.3)	0.229 (5.8)
No. 4	0.224 (5.7)	0.204 (5.2)
No. 5	0.198 (5.0)	0.182 (4.6)
No. 6	0.178 (4.5)	0.162 (4.1)
No. 7	0.158 (4.0)	0.144 (3.7)
No. 8	0.141 (3.6)	0.129 (3.3)
No. 9	0.124 (3.1)	0.114 (2.9)
No. 10	0.112 (2.8)	0.102 (2.6)
No. 11	0.101 (2.6)	0.091 (2.31)
No. 12	0.091 (2.31)	0.081 (2.06)
No. 13	0.082 (2.08)	0.072 (1.83)
No. 14	0.074 (1.88)	0.064 (1.63)
No. 15	0.067 (1.70)	0.057 (1.45)
No. 16	0.061 (1.55)	0.051 (1.30)
No. 17	0.054 (1.37)	0.045 (1.14)
No. 18	0.049 (1.24)	0.040 (1.02)
No. 20	0.039 (0.99)	0.032 (0.81)
No. 22	0.032 (0.81)	0.025 (0.64)
No. 24	0.027 (0.69)	0.020 (0.51)

[3] Available from Institute of Electrical and Electronics Engineers, Inc. (IEEE), 445 Hoes Ln., P.O. Box 1331, Piscataway, NJ 08854-1331, http://www.ieee.org.

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

rod fits loosely, insert the maximum gage rod into the specimen. If the maximum gage rod passes freely into the specimen for a distance of 5 in. with a snug fit, or if it expands the wall of the specimen, then consider the sleeving to be of that size which falls within the limits of the maximum and minimum inside diameters as represented by the gage rods.

9.2 *Wall Thickness*—Insert in the specimen the largest standard gage rod that will pass freely into the sleeving. Apply a micrometer over the specimen and make thickness measurements as specified in Method C of Test Methods D374 except that the force on the pressor foot shall be 3 oz (85 g). Obtain the average of five thickness readings taking the micrometer readings at approximately 90° intervals about the circumference of the specimen and spaced lineally approximately 0.25 in. (6 mm). Methods A and B of Test Methods D374 can be used as alternative methods where agreed upon between the manufacturer and purchaser. Compute wall thickness as half the distance between the outside diameter of the mounted sleeving and the diameter of the gage rod.

10. Report

10.1 Report the following information:
10.1.1 Identification of the sleeving,
10.1.2 Method of measurement if other than Method C,
10.1.3 Size of sleeving, and
10.1.4 Wall thickness.

11. Precision and Bias

11.1 *Precision*—The overall estimates of the precision within laboratories $(Sr)_j$ and the precision between laboratories $(SR)_j$ for the determination of wall thickness are given in Table 2 for three selected materials. These estimates are based on a round robin of the three materials with six laboratories participating.[5]

11.2 *Bias*—This test method has no bias because the value for wall thickness is determined solely in terms of this test method itself.

DIELECTRIC BREAKDOWN VOLTAGE

12. Significance and Use

12.1 The dielectric breakdown voltage of the sleeving is of importance as a measure of its ability to withstand electrical stress without failure. This value does not correspond to the dielectric breakdown voltage expected in service, but is of value in comparing different materials or different lots, in controlling manufacturing processes or, when coupled with experience, for a limited degree of design work. The comparison of dielectric breakdown voltage of the same sleeving before and after environmental conditioning (moisture, heat, and the like) gives a measure of its ability to resist these effects. For a more detailed discussion, refer to Test Method D149.

13. Apparatus

13.1 *Inner Electrode*—A straight suitable metallic conductor which fits snugly into the sleeving, without stretching the wall, in such a manner that one end of the wire is exposed and can be used to support the specimen.

13.1.1 For specimens having an inside diameter greater than about size 8, it may be convenient to use either stranded conductors or a bundle of wires of smaller size, instead of a solid conductor.

13.2 *Outer Electrode*—Strips of soft metal foil 1-in. (25-mm) wide and not more than 0.001 in. (0.03 mm) in thickness.

14. Procedure A—Straight Specimens

14.1 *Test Specimens*—Ten specimens 7 in. (180 mm) long shall be prepared for each conditioning test (see Section 6) from material selected in accordance with Section 5.

14.2 *Procedure:*

14.2.1 After conditioning in accordance with 6.1, determine the dielectric breakdown voltage in accordance with Test Method D149 except as specified in 14.2.2 and 14.2.3.

14.2.2 Mount a sleeving specimen on the inner electrode. Wrap the outer electrode tightly on the outside of the sleeving at a distance of not less than 1 in. (25 mm) from the ends of the specimens. Snugly wrap the foil over the sleeving. Wind two more turns of foil over the first turn, leaving a free end of about 0.5 in. (13 mm) to which an electrical contact can be made.

14.2.3 Determine the breakdown voltage, in accordance with Test Method D149 by the short time method, increasing the voltage from zero at a rate of 0.5 kV/s. Calculate the average breakdown voltage for the ten tests.

15. Procedure B—90° Bent Specimens

15.1 *Test Specimens*—Ten specimens 4 in. (100 mm) long shall be prepared for each conditioning test (see Section 6) from material selected in accordance with Section 5.

15.2 *Procedure:*

15.2.1 Mount a sleeving specimen on the inner electrode.

15.2.2 Bend the specimen through an angle of 90 ± 2° over a smooth mandrel having a diameter of ten times the nominal inside diameter of the specimen. Arrange the bend so that it is centrally located on the specimen.

15.2.3 Condition the samples as specified in 6.1.

15.2.4 Determine the dielectric breakdown voltage of the bent specimen using the following procedure:

15.2.4.1 Carefully wrap a strip of metal foil as in 14.2.2 snugly over the specimens at the bend. In accordance with Test Method D149 apply a voltage starting at zero and increasing at a constant rate of 0.5 kV/s until breakdown. Calculate the average breakdown voltage of the ten specimens.

NOTE 2—Apply the foil electrode after exposure to conditioning.

[5] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR: RR:D09-1024.

TABLE 2 Estimated Precision of Wall Thickness Measurement

Sleeving Type	Nominal Value, in. (mm)		$(Sr)_j$, in. (mm)		$(SR)_j$, in. (mm)	
Acrylic	0.0213	(0.54)	0.0007	(0.018)	0.0017	(0.043)
PVC	0.0237	(0.60)	0.0007	(0.018)	0.0021	(0.053)
Silicone Rubber	0.0331	(0.84)	0.0012	(0.030)	0.0019	(0.048)

16. Report

16.1 Report the following information:

16.1.1 Identification of the sleeving,

16.1.2 Conditioning before test,

16.1.3 Voltage breakdown for each puncture,

16.1.4 Average, minimum, and maximum voltage breakdown,

16.1.5 Procedure used (Method A or B), and

16.1.6 Temperature and relative humidity of test, if different from 6.1.

17. Precision and Bias

17.1 *Precision*—The overall estimates of the precision within laboratories $(Sr)_j$ and the precision between laboratories $(SR)_j$ for the determination of Dielectric Breakdown Voltage by Procedure A are given in Table 3 for three selected materials. These estimates are based on a round robin of the three materials with six laboratories participating.[5]

17.2 *Bias*—This test method has no bias because the value for dielectric breakdown voltage is determined solely in terms of this test method.

BRITTLENESS TEMPERATURE

18. Significance and Use

18.1 This test method serves to measure the brittleness temperature of the sleeving. It is useful for comparative and quality control purposes.

18.2 Results of this test have not been found to correlate with those obtained by bending or flexing around mandrels at low temperatures. Brittleness temperatures determined for sleeving materials by this test are affected by differences in cross-sectional dimensions and in specimen configuration, even if the materials have the same composition.

19. Procedure

19.1 Determine the brittleness temperature in accordance with Test Method D746, except as specified in 19.1.1-19.1.4.

19.1.1 For sleeving sizes 20 through 8, cut specimens in full section and 1.5 in. (38 mm) long.

19.1.2 For sleeving sizes 7 through 1 in. inside diameter, cut specimens 0.25 in. (6.4 mm) wide and 1.5 in. (38 mm) long with the longer dimension parallel to the axis of the sleeving. Take care to avoid cutting the specimens from the edges of sleeving that has been flattened during manufacture or storage.

TABLE 3 Estimated Precision of Dielectric Breakdown Voltage Measurement

Sleeving Type	Nominal Value, Volts	$(Sr)_j$, Volts	$(SR)_j$, Volts
	Conditioned 18 h/23 °C/50 % RH		
Acrylic	8480	802	1126
PVC	10980	983	1528
Silicone Rubber	10770	904	1616
	Conditioned 96 h/23 °C/93 % RH		
Acrylic	2048	197	828
PVC	8100	1003	2137
Silicone Rubber	8540	1367	2550

19.1.3 Use only motor-driven or gravity-fall apparatus, such as described in Test Methods D876. Mount specimens so that the striking edge of the apparatus contacts the film and not the braid.

19.1.4 Failure of a specimen is indicated by cracking of the film completely through to the braid, as determined by visual examination.

20. Report

20.1 Report the following information:

20.1.1 Identification of the sleeving,

20.1.2 Brittleness temperature to the nearest °C,

20.1.3 Method of calculation (see Test Method D746),

20.1.4 Type of apparatus used, and

20.1.5 Number of specimens tested.

21. Precision and Bias

21.1 *Precision*—This test method has been in use for many years, but no information has been presented to ASTM upon which to base a statement of precision. No activity has been planned to develop such information.

21.2 *Bias*—This test method has no bias because the value for brittleness temperature is determined solely in terms of this test method.

FLAMMABILITY—METHOD A

22. Procedure

22.1 Determine the flammability in accordance with Test Methods D876. The results of this test give an indication of the tendency of the material to burn in case of fire.

FLAMMABILITY—METHOD B

23. Significance and Use

23.1 This test gives an indication of the relative rate at which materials that will burn will propagate a flame.

24. Apparatus

24.1 *Bunsen burner.*

24.2 *Stopwatch.*

25. Test Specimens

25.1 Cut at least three specimens from the material selected in accordance with Section 5.

26. Procedure

26.1 Mark a gage length of 1 in. (25 mm) on each test specimen approximately 0.5 in. (13 mm) from one end of the specimen. Using a method that will not distort the test area, close the other end to prevent passage of air through the specimen during the test.

26.2 Insert the open end of the sleeving into the side of the burner flame with the lower side of the sleeving about 0.5 in. (13 mm) above the top of the burner. Rotate the specimen in the flame to ignite it uniformly. Remove the sleeving from the flame and hold vertically in the air with the burning end uppermost.

26.3 Start the timer when the leading edge of the flame reaches the upper gage mark and observe the time in seconds for the leading edge of the flame to travel down the specimen to the lower gage mark.

27. Report

27.1 Report the following information:

27.1.1 Identification of the sleeving, and

27.1.2 For each specimen, the time in seconds required to burn 1 in. (25.4 mm).

28. Precision and Bias

28.1 No statement is made about either the precision or the bias of this test method since the result merely states whether there is conformance to the criteria for success as specified in the procedure.

DIELECTRIC BREAKDOWN VOLTAGE AFTER SHORT-TIME AGING

29. Significance and Use

29.1 This test method serves to indicate the resistance of sleeving to the effects of short-time exposure to elevated temperatures. While this test method provides a means of determining continuity of quality and is useful as a lot acceptance test, it is not intended to provide information regarding the thermal endurance of the sleeving (see Sections 38 to 44).

30. Test Specimens

30.1 Prepare five 90° bent test specimens as described in 15.2.1 and 15.2.2.

31. Procedure

31.1 Condition the test specimens in an oven for a period of 96 h at a temperature 50 °C (90 °F) higher than the nominal temperature index of the sleeving. Remove the specimens and allow to cool to room temperature. Apply the outer electrode and determine the dielectric breakdown voltage in accordance with 14.2.

32. Report

32.1 Report the following information:

32.1.1 Identification of the sleeving,

32.1.2 Temperature of conditioning, and

32.1.3 Average, minimum, and maximum voltage breakdown values.

33. Precision and Bias

33.1 *Precision*—This test method has been in use for many years, but no information has been presented to ASTM upon which to base a statement of precision. No activity has been planned to develop such information.

33.2 *Bias*—This test method has no bias because the value for dielectric breakdown voltage after short-time aging is determined solely in terms of this test method.

OIL RESISTANCE

34. Test Specimens

34.1 Cut three specimens, each 3 in. (76 mm) long, from material selected in accordance with Section 5.

35. Procedure

35.1 Immerse the specimens for 24 h in ASTM Oil No. 2 as described in Test Method D471, the oil being maintained at a temperature of 105 ± 2 °C (221 ± 3.6 °F). At the end of this period, remove the specimens from the oil, wipe off excess oil with a clean cloth, and examine the specimens for deterioration as evidenced by blistering, splitting, flaking off of the film, and other visual defects.

NOTE 3—Oil meeting Specification D3487 has been found suitable as a substitute for ASTM Oil No. 2.

35.2 Determine the degree of swelling by measurements of wall thickness as specified in 9.2.

36. Report

36.1 Report the following information:

36.1.1 Identification of the sleeving,

36.1.2 Evidence of deterioration of the sleeving,

36.1.3 Percentage of increase in wall thickness, and

36.1.4 Type of oil used (if other than ASTM No. 2).

37. Precision and Bias

37.1 *Precision*—This test method has been in use for many years, but no information has been presented to ASTM upon which to base a statement of precision. No activity has been planned to develop such information.

37.2 *Bias*—This test method has no bias because the value for oil resistance is determined solely in terms of this test method.

THERMAL ENDURANCE

38. Summary of Test Method

38.1 This test method describes preparation of specimens, aging of specimens at elevated temperatures, and periodic testing of breakdown voltage. The data obtained are used to plot a regression line on logarithmic-time versus reciprocal-absolute-temperature coordinates from which the thermal endurance in terms of a temperature index is derived.

39. Significance and Use

39.1 This test method is useful in determining the relative thermal endurance of sleeving initially capable of being bent 90° without splitting.

39.2 The criterion of failure by this test method is reduction of breakdown voltage of the sleeving below a value of 3500 V. It is believed that this embodies several modes of failure, such as cracking by embrittlement, volatilization, porosity, and crazing, which are not independently determinable.

39.3 Thermal endurance is based on the evaluation of 7.0 kV grade, size 12 sleeving, even though it is recognized that laboratory results do not necessarily agree with those obtained using other voltage grades and sizes. Future work will attempt to determine the effects of grade and size differences, if any.

40. Apparatus and Materials

40.1 *Soft Copper Wire.* AWG Size No. 12, bare.

41. Test Specimens

41.1 Obtain specimens 4 in. (100 mm) in length from size 12 sleeving having an average voltage breakdown value of between 7 and 9 kV. This size and voltage range is defined as the qualifying style.

NOTE 4—Experience has indicated that the initial breakdown voltage, which is a function of coating thickness, can be a factor affecting thermal life. A limited range of initial breakdown voltage has been set to minimize this as a possible variable.

41.2 Specimens shall be randomized with respect to position in the sample, with care being exercised to prevent damage to the sleeving during this process.

42. Procedure

42.1 Place the sleeving on a 5-in. (130-mm) straight length of copper wire, which fits snugly into the sleeving without stretching the wall, in such a manner that one end of the wire is exposed and can be used to support the specimen in the oven.

42.2 Bend the specimen through an angle of 90 ± 2° over a smooth mandrel having a diameter of 0.85 ± 0.04 in. (21.6± 1.0 mm), which is ten times the nominal inside diameter of the sleeving. Make the bend so that it is centrally located on the sleeving specimen.

42.3 Prepare at least ten sets of five specimens for each test temperature. Prepare an additional ten specimens for testing the initial breakdown voltage.

NOTE 5—Although not used to evaluate the end point, the initial value of breakdown voltage is useful in determining the shape of the plot of dielectric breakdown voltage versus time of aging.

42.4 Condition all specimens for 48 h at 23 ± 2 °C (73.4 ± 3.6 °F) and a relative humidity of 50 ± 2 % (Standard Laboratory Conditions). Subject all specimens for about 5 s to a proof voltage of 75 % of the average breakdown voltage obtained on unaged specimens prepared for initial breakdown voltage testing. Specimens failing this test are to be discarded. The foil shall be removed from the specimens before they are to be aged.

42.5 Determine the dielectric breakdown of both aged and unaged specimens by the following procedure: Apply the outer electrode over the specimen at the bend and then determine the breakdown voltage as described in 14.2.2 and 14.2.3.

42.6 Choose three or more different aging temperatures. Selection of temperatures requires an estimate of the temperature rating of the sleeving under evaluation, since extrapolation to a classification temperature from the lowest aging temperature selected must not exceed 25 °C (77 °F). Additionally, the highest aging temperature shall be selected to result in thermal endurance of not less than 100 h, preferably just over 100 h. In the case of an odd number of aging temperatures, the median shall be located midway, ± 5 °C, between the highest and lowest aging temperatures chosen. In all cases they shall be reasonably spaced evenly along the 1/K scale of temperatures.

42.7 During aging remove sets periodically from the oven and cool at least 2 h at Standard Laboratory Conditions. Determine the average breakdown voltage for each set of five specimens and plot this average against time in hours, using semilogarithmic coordinates, and with the logarithm of time as the abscissa and breakdown voltage as the ordinate. Estimate time intervals between testing of sets from the appearance of the plot, with as many tests as practical being grouped in the region of the estimated occurrence of the end point.

43. Calculation and Report

43.1 Record the time corresponding to a breakdown voltage of 3500 V as determined from the plot of 42.7 for each test temperature.

43.2 Plot these recorded times as the ordinate with test temperatures as the abscissa on graph paper arranged to show the logarithm of time against the reciprocal of the absolute temperature in kelvins. Determine the temperature from the above plot corresponding to an endurance of 20 000 h.

43.3 Report the following information:

43.3.1 Identification of the sleeving,

43.3.2 Average breakdown voltage of the unaged specimens,

43.3.3 Average breakdown voltage for each aged set of specimens, together with time and temperature of aging,

43.3.4 Time in hours, to reach an endpoint of 3500 V for each aging temperature, as determined from the plot of 42.7, and

43.3.5 Temperature corresponding to 20 000 h thermal endurance as obtained from the plot of 43.2.

NOTE 6—Calculation of the regression line can be made using the methods shown in Appendix X1 and Appendix X2 of Test Method D2307.

44. Precision and Bias

44.1 *Precision*—The precision of this test method is determinable in terms of the confidence interval for the mean logarithm of the life at a selected temperature using the procedure described in IEEE Guide 101.

44.2 *Bias*—This test method has no bias because the value for thermal endurance is determined solely in terms of this test method.

COMPATIBILITY OF SLEEVING WITH MAGNET WIRE INSULATION

45. Scope

45.1 These test methods evaluate the degrading effects, if any, of sleeving on magnet wire insulation.

45.2 **Warning**—These procedures include the hazardous operation of the use of glass test tubes in a heated oven.

PROCEDURE A—LOW PRESSURE METHOD

46. Summary of Test Method

46.1 Specimens are aged in the presence of a selected insulated wire at several elevated temperatures under confined