



Designation: D 3251 – 03<sup>4</sup>

An American National Standard

## Standard Test Method for Thermal Endurance Characteristics of Electrical Insulating Varnishes Applied Over Film-Insulated Magnet Wire<sup>1</sup>

This standard is issued under the fixed designation D 3251; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This test method covers the determination of the thermal endurance characteristics of electrical insulating varnishes and film-insulated magnet wire in combination.

1.2 The values stated in SI units are to be regarded as the standard.

1.3 *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 Section 6. use.*

NOTE 1—This test method is equivalent to IEC 60172.

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<sup>1</sup> This test method is under the jurisdiction of ASTM Committee D09 on Electrical and Electronic Insulating Materials and is the direct responsibility of Subcommittee D09.01 on Electrical Insulating Varnishes, Powders, and Encapsulating Compounds.

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## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

D 115 Test Methods for Testing Solvent Containing Varnishes Used for Electrical Insulation

D 1711 Terminology Relating to Electrical Insulation

D 2307 Test Method for ~~Relative~~ Thermal Endurance of Film-Insulated Round Magnet Wire

### 2.2 IEC Standard:

IEC 60172 Test Procedure for the determination of the temperature index of enameled winding wires<sup>3</sup>

## 3. Terminology

### 3.1 Definitions:

3.1.1 For definitions of terms used in this test method refer to Terminology D 1711.

## 4. Summary of Test Method

4.1 A varnish is applied to twisted pairs of film-insulated magnet wire and exposed to elevated temperatures. Life test results are compared to those of unvarnished twisted pairs.

## 5. Significance and Use

### 5.1 Individual

5.1 Different combinations of varnishes ~~may~~ and film-insulated magnet wire behave differently when ~~applied~~ exposed to elevated temperatures. This includes different varnishes tested with the same film-insulated magnet wire and ~~aged at elevated temperatures. Likewise, a single varnish may not behave the same when applied to~~ tested with different types of film-insulated magnet wires and ~~aged at elevated temperatures. wire.~~

5.2 This test method is used to determine the effect on the electrical properties of a varnish applied to film-insulated magnet wire when the combination is exposed to prescribed elevated temperatures.

## 6. ~~Safety Precautions Hazards~~

6.1 It is unsafe to use varnish at temperatures above the flash point without adequate ventilation, especially if the possibility exists that flames or sparks are present. Store varnish in sealed containers. This also applies to specified reagents and solvents. (**Warning**—Lethal voltages are a potential hazard during the performance of this test. It is essential that the test apparatus, and all associated equipment electrically connected to it, be properly designed and installed for safe operation. Solidly ground all electrically conductive parts which it is possible for a person to contact during the test. Provide means for use at the completion of any test to ground any parts which were at high voltage during the test or have the potential for acquiring an induced charge during the test or retaining a charge even after disconnection of the voltage source. Thoroughly instruct all operators as to the correct procedures for performing tests safety. When making high voltage tests, particularly in compressed gas or in oil, it is possible for the energy released at breakdown to be sufficient to result in fire, explosion, or rupture of the test chamber. Design test equipment, test chambers, and test specimens so as to minimize the possibility of such occurrences and to eliminate the possibility of personal injury. If the potential for fire exists, have fire suppression equipment available.)

## 7. Sampling

7.1 Sample the varnish in accordance with Test Methods D 115.

## 8. Test Specimen

8.1 Twist two pieces of film-insulated magnet wire in accordance with Table 1 on Tension and Number of Twists for Twisted Pair Construction in Test Method D 2307.

8.2 Use the specimen holder described in Test Method D 2307.

8.3 Use one set, consisting of a minimum of ten varnished and ten unvarnished test specimens, for each test temperature (Note 2). Eleven specimens are recommended if calculations are to be in accordance with the median calculation method of Test Method D 2307.

NOTE 2—If several varnishes are being evaluated, it is necessary to run only one set of unvarnished specimens at each temperature.

## 9. Procedure

9.1 Condition all specimens 30 to 60 min at  $150 \pm 2^\circ\text{C}$  and proof test in accordance with Test Method D 2307.

9.2 Coat all of the specimens as follows:

9.2.1 *Solvent Varnishes:*

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

<sup>3</sup> Available from American National Standards Association, 25 W. 43rd St., 4th Floor, New York, NY 10036.

9.2.1.1 Adjust the consistency of solvent based varnishes to give a  $0.025 \pm 0.0005$  mm ( $0.001 \pm 0.0002$  in.) build on a  $0.127 \pm 0.008$  mm ( $0.005 \pm 0.0003$  in.) copper strip withdrawn at a rate of approximately ~~100~~ 90 to 110 mm/min (3.5 to 4.3 in./min). Drain for 10 min and bake according to the supplier's recommendations. Refer to Test Methods D 115 for a more detailed procedure.

9.2.1.2 Immerse the specimens in the adjusted varnish, and withdraw them at a rate of approximately 100 mm/min (4 in./min). Drain for 10 min and bake according to the supplier's recommendations.

9.2.1.3 Reverse the specimens end for end and repeat 9.2.1.2.

9.2.2 *Solventless Varnishes:*

9.2.2.1 Test solventless varnishes in the "as made" condition.

9.2.2.2 The number of dips used for a solventless varnish is to be agreed upon between the interested parties. Report the number of dips used. If multiple dips are used, reverse specimens end for end before dipping.

9.3 Place an equal number of the coated and uncoated specimens in the holders as described in Test Method D 2307.

9.4 After coating with varnish, proof test all specimens in accordance with Test Method D 2307. The proof voltage is based on the thickness of the film insulation on the magnet wire and is not dependent on the thickness of the varnish coating.

9.5 Choose at least three different test temperatures from Table 43 of Test Method D 2307; age one set each of coated and uncoated specimens at each temperature. Choose the exposure time in accordance with Test Method D 2307.

9.6 Test the specimens and then age them in accordance with Test Method D 2307.

## 10. Calculation

10.1 Perform the necessary calculations in accordance with Test Method D 2307.

## 11. Report

11.1 Report the data as required in Test Method D 2307.

## 12. Precision and Bias

12.1 *Precision*—The precision of this test method for measuring the thermal-aging characteristics of varnishes applied over film-insulated magnet wire is essentially equal to the precision stated in Test Method D 2307.<sup>4</sup>

12.2 *Bias*—This test method has no bias because the thermal-aging characteristics of varnishes applied over film-insulated magnet wire is determined solely in terms of this test method itself.

## 13. Keywords

13.1 magnet wire; thermal endurance; twisted pair; varnish

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<sup>4</sup> Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR: D09-1011.

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