



Designation: D3955 – 20

# Standard Specification for Electrical Insulating Varnishes<sup>1</sup>

This standard is issued under the fixed designation D3955; 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 specification covers the tests and values for electrical insulating varnishes, as supplied, which are suitable for the impregnation and treatment of electrical coils and windings applied by dip process.

1.2 Varnishes, flexible or rigid, included in this specification are:

Grade DA—Air-dry

Grade DO—Organic solvent containing, baking,

Grade DM—Reactive diluent containing,

Grade DS—Silicone,

Grade DW—Water containing, and

Grade DT—Thixotropic.

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

NOTE 1—This specification resembles IEC 60455 in title only. The content is significantly different.

1.4 *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.*

## 2. Referenced Documents

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

D93 Test Methods for Flash Point by Pensky-Martens Closed Cup Tester

D115 Test Methods for Testing Solvent Containing Varnishes Used for Electrical Insulation

D1711 Terminology Relating to Electrical Insulation

<sup>1</sup> This specification 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 Products.

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<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.

D2519 Test Method for Bond Strength of Electrical Insulating Varnishes by the Helical Coil Test

D3056 Test Method for Gel Time of Solventless Varnishes

D3145 Test Method for Thermal Endurance of Electrical Insulating Varnishes by the Helical Coil Method

D3251 Test Method for Thermal Endurance Characteristics of Electrical Insulating Varnishes Applied Over Film-Insulated Magnet Wire

D3278 Test Methods for Flash Point of Liquids by Small Scale Closed-Cup Apparatus

D4733 Test Methods for Solventless Electrical Insulating Varnishes

D4880 Test Method for Salt Water Proofness of Insulating Varnishes Over Enamelled Magnet Wire

D5637 Test Method for Moisture Resistance of Electrical Insulating Varnishes

D5638 Test Method for Chemical Resistance of Electrical Insulating Varnishes

2.2 *Military Specifications:*<sup>3</sup>

MIL-PRF-17672 Hydraulic Fluid, Petroleum, Inhibited

MIL-PRF-17331 Lubricating Oil, Synthetic Base P-D-680, Dry Cleaning Solvent

MIL-D-16791 Detergent, General Purpose, (Liquid, Non-Ionic)

2.3 *Other Standards:*<sup>3</sup>

NEMA MW1000 Magnet Wire

IEC 60455 Resin Based Reactive Compounds Used for Electrical Insulation

## 3. Terminology

3.1 *Definitions:*

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

3.1.2 *varnish, electrical insulating, n*—a liquid resin system that is applied to and cured on electrical components providing electrical, mechanical, and environmental protection.

3.1.2.1 *Discussion*—There are two types of electrical insulating varnish: solvent-containing and solventless. The solvent-containing varnish is a solution, dispersion, or emulsion of a polymer or mixture of polymers in a volatile, nonreactable

<sup>3</sup> Available from Global Engineering Documents, 15 Inverness Way, East Englewood, CO 80112-5704, <http://www.global.ihs.com>.

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

liquid. The solventless type is a liquid resin system free of volatile, nonreactable solvents.

#### 4. Flexible or Rigid Classification

4.1 This specification covers both flexible and rigid, solvent (including water) and solventless insulating varnishes.

#### 5. Thermal Classification

5.1 The thermal classification of insulating varnishes covered by this specification is determined by using Test Methods **D3145** and **D3251** in conjunction with 18 AWG magnet wire conforming to MW 35-C and MW 16-C in accordance with NEMA MW1000. Determine the temperature index at 20 000 h.

5.2 The thermal class is determined from the temperature index range as follows:

Thermal Class	Temperature Index Range
130	130.0 to 154.9
155	155.0 to 179.9
180	180.0 to 199.9
200	200.0 to 219.9
220	220.0 and above

#### 6. General Specifications and Qualification Requirements

6.1 All varnishes supplied under this specification must conform to the limits outlined in **Table 1**, and must meet, or exceed, all specification requirements.

6.2 A varnish supplied under this specification is to be manufactured from one specific formula and one specific process at one or more plants of the same company.

6.3 Changes involved solely with percent nonvolatile content or compatible solvent system, do not require requalification, if agreed upon between supplier and user.

6.4 If any formula or process changes are desired after qualification approval has been granted, conduct the tests in **Table 1**, except for thermal class.

6.5 If varnishes from different suppliers are to be mixed or used in a common tank or container, determine their compatibility by Test Methods **D115**. They must be compatible, both in the liquid and solid state, with the varnish currently being used in the system.

6.6 Varnishes containing silicone in any portion, must not be mixed with non-silicone varnishes.

6.7 The qualification requirements of the varnish shall be as mutually agreed upon between supplier and user, with tests to

be performed in accordance with the appropriate methods, and limits as shown in **Table 1**.

6.8 *Preconditioning: Grade DA Varnishes Only*—Precondition all Grade DA varnish specimens, both flexible and rigid, in air at room temperature for seven days prior to carrying out dielectric strength and bond strength tests shown in **Table 1**.

#### 7. Hazards

7.1 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.

#### 8. Sampling

8.1 Obtain varnish samples and appropriate thinner either from the manufacturer or directly from shipping containers supplied from the manufacturer. It is also acceptable to obtain suitable samples from material in process. It is important that new, or thoroughly cleaned sampling containers be used. It is acceptable to obtain suitable samples by any of a number of procedures commonly used in the industry. Normally, the sample is simply poured from the shipping container. The sample container shall have a tight fitting cover to minimize the loss of solvents. A dipping ladle is an acceptable choice, or, if it is desirable to obtain a sample from various levels, use appropriate sampling techniques.

8.2 The quantity of sample is that required as indicated in **9.1**.

#### 9. Quality Conformance Tests

9.1 *General Requirements*—From each batch of varnish, take a 2-qt (2 L) sample and test. The values must meet the limits listed for specification requirements shown in **Table 1**, or as agreed upon between supplier and user.

9.2 *Inspection and Preparation for Delivery*—Select samples and inspect to verify conformance with the requirements in **Section 6**.

#### 10. Keywords

10.1 varnish, air-dry; varnish, electrical; varnish, silicone; varnish, solvent containing; varnish, thixotropic; varnish, water containing