



Designation: D115 – 17 (Reapproved 2024)

Standard Test Methods for Testing Solvent Containing Varnishes Used for Electrical Insulation¹

This standard is issued under the fixed designation D115; 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.

1. Scope

1.1 These test methods cover tests for solvent containing varnishes primarily intended to provide electrical, mechanical, and chemical protection for electrical equipment. These test methods include tests for control and performance as follows:

Procedure	Section
Build	38 – 42
Dielectric Strength	43 – 48
Drainage	26 – 32
Flash Point	18 – 20
Nonvolatile Matter	21 – 25
Oil Resistance	54 – 56
Preparation of Test Specimens	7
Specific Gravity	9 – 12
Temperature Index	49 – 50
Time of Drying	33 – 37
Varnish Compatibility	51 – 53
Viscosity	13 – 17

1.2 Where the entire test method is included in this standard, the precision and bias are not known unless given in the stated method.

1.3 The values stated in SI units are to be regarded as standard. The values given in parentheses are for information only.

1.4 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* For specific hazard statements, see Section 5.

NOTE 1—There is no equivalent IEC standard.

1.5 *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 These test methods are under the jurisdiction of ASTM Committee D09 on Electrical and Electronic Insulating Materials and are the direct responsibility of Subcommittee D09.01 on Electrical Insulating Products.

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2. Referenced Documents

2.1 ASTM Standards:²

- D56 Test Method for Flash Point by Tag Closed Cup Tester
- D93 Test Methods for Flash Point by Pensky-Martens Closed Cup Tester
- D149 Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
- D202 Test Methods for Sampling and Testing Untreated Paper Used for Electrical Insulation
- D287 Test Method for API Gravity of Crude Petroleum and Petroleum Products (Hydrometer/Method)
- D295 Test Methods for Varnished Cotton Fabrics Used for Electrical Insulation (Withdrawn 2020)³
- D374/D374M Test Methods for Thickness of Solid Electrical Insulation
- D580/D580M Practice for Greige Woven Glass Tapes and Webbing
- D1475 Test Method for Density of Liquid Coatings, Inks, and Related Products
- D1932 Test Method for Thermal Endurance of Flexible Electrical Insulating Varnishes
- D2518 Specification for Woven Glass Fabrics for Electrical Insulation (Withdrawn 2013)³
- D2519 Test Method for Bond Strength of Electrical Insulating Varnishes by the Helical Coil Test
- D3145 Test Method for Thermal Endurance of Electrical Insulating Varnishes by 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
- D3487 Specification for Mineral Insulating Oil Used in Electrical Apparatus
- D5032 Practice for Maintaining Constant Relative Humidity by Means of Aqueous Glycerin Solutions

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 The last approved version of this historical standard is referenced on www.astm.org.

D5423 Specification for Forced-Convection Laboratory Ovens for Evaluation of Electrical Insulation
E104 Practice for Maintaining Constant Relative Humidity by Means of Aqueous Solutions

3. Terminology

3.1 Definitions:

3.1.1 *dielectric strength, n*—the voltage gradient at which dielectric failure of the insulating material occurs under specific conditions of test.

3.1.2 *drainage, n—of an insulating varnish*, a measure of the variation in thickness from top to bottom of a varnish film obtained on the surface of a vertically dip-coated panel after a specified time and temperature.

3.1.3 *flash point, n*—the lowest temperature of the specimen, corrected to a pressure of 760 mm Hg (101.3 kPa), at which application of an ignition source causes any vapor from the specimen to ignite under specified conditions of test.

3.1.4 *nonvolatile matter, n—in insulating varnish*, that portion of a varnish which is not volatilized when exposed to specified conditions; the value obtained is not necessarily equal to the calculated solids incorporated during compounding.

3.1.4.1 *Discussion*—For example, the theoretical chemical solids are often assumed to be the solid phase materials incorporated in the varnish at the time of compounding. Many of these solid phase intermediate materials will lose volatile fractions due to the specified conditions of the nonvolatile matter procedure. An example is phenolic resin.

3.1.5 *oil resistance, n—of insulating varnish*, a measure of the retention of properties after exposure to a specified oil under specified conditions of test.

3.1.6 *time of drying, n—of insulating varnish*, the time required for a film of varnish to dry to a tackfree state under specified conditions.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *build, n—of an insulating varnish on copper*, the average thickness of varnish film on one side of a copper panel that has received a single coat of the varnish applied and measured under specified conditions.

3.2.2 *build, n—of an insulating varnish on glass cloth*, the average overall thickness of strips of glass cloth that have received two dips of the varnish applied and measured under specified conditions.

3.2.3 *tack-free, adj*—condition when a varnish has reached the point that the surface can be touched lightly without a sensation of stickiness.

3.2.4 *varnish, air-drying, n*—a liquid resin system that forms a dry, tack-free coating, without the application of heat, either through evaporation of solvent or by reaction with atmospheric oxygen.

3.2.5 *varnish, baking, n*—a liquid resin system that forms a dry, tack-free coating when exposed to elevated temperatures.

4. Significance and Use

4.1 *Control*—The following tests are useful for control purposes during the manufacture and use of varnishes, and for determining the uniformity of batches:

- 4.1.1 Specific gravity,
- 4.1.2 Viscosity,
- 4.1.3 Flash point, and
- 4.1.4 Nonvolatile matter by weight.

4.2 *Performance*—The following tests are useful for determining the performance of varnishes during application and use:

- 4.2.1 Drainage,
- 4.2.2 Time of drying,
- 4.2.3 Build,
- 4.2.4 Dielectric strength,
- 4.2.5 Thermal endurance,
- 4.2.6 Varnish compatibility,
- 4.2.7 Salt water proofness, and
- 4.2.8 Oil resistance.

5. Hazards

5.1 **Warning**—Do not use varnish at temperatures above the flash point when inadequate ventilation and the possibility of flames or sparks exist. Store varnish in sealed containers. The precautions shall also apply to the handling of the reagents and solvents called for herein.

6. Sampling

6.1 For all tests the sample shall be taken from a representative lot of the varnish under study. To avoid skin formation and escape of solvents, protect the sample by keeping it at room temperature in a nearly filled, tightly sealed container.

7. Preparation of Test Specimens

7.1 *Selection of Substrate*—The selection of the substrate is determined in part by application and in part by thermal class. Two types of substrates are suitable for use: copper strip or glass cloth. Copper strip is generally not used for applications over 180 °C (356 °F), due to oxidation.

7.2 *Copper Base*—For tests that are to be performed upon the varnish as a film on a copper base, copper strips 38 mm (1½ in.) in width, 200 mm (8 in.) in length, and 0.127 mm ± 0.08 mm (0.005 in. ± 0.0003 in.) in thickness shall be used, unless otherwise specified. Measure the thickness of these strips to the nearest 0.002 mm (0.0001 in.). Clean the strips with a suitable solvent (**Note 2**), then polish thoroughly with No. 000 steel wool. Wipe the strips free of any fingerprints or metal particles with the solvent and a lint-free cloth. If the strips are not to be used immediately, store in a noncorrosive varnish solvent.

NOTE 2—Xylene and denatured alcohol (1:1) have been found to be suitable cleaning solvents. V.M.&P. naphtha is a suitable solvent in which to store the strips.

7.2.1 Prepare all varnish films for tests at 23 °C ± 1 °C (73.5 °F ± 2 °F) and 50 % ± 5 % relative humidity. The air of the room shall be relatively free of dust by some satisfactory method of filtering.

7.2.2 After the strips have been wiped clean and dry, prepare the test specimens by dipping them into a tank of the varnish that has been adjusted to a proper consistency and allowed to stand covered until free of bubbles (not to exceed