



Standard Specification for Electrical Insulating Varnishes¹

This standard is issued under the fixed designation D 3955; 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 This specification ~~lists~~ 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 the standard. The values given in parentheses are for information only.

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

¹ This specification is under the jurisdiction of ASTM Committee ~~D-9~~ D09 on Electrical and Electronic Insulating Materials and is the direct responsibility of Subcommittee D09.01 on Electrical Insulating Varnishes, Powders, and Encapsulating Compounds.

Current edition approved March ~~10, 1999~~, 1, 2004. Published ~~May 1999~~, March 2004. Originally published as ~~D 3955—80~~, approved in 1980. Last previous edition approved in 1999 as ~~D 3955—95~~, 99.

2. Referenced Documents

2.1 *ASTM Standards:*²

D 93 Test Methods for Flash-Point by Pensky-Martens Closed Cup Tester

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

D 1711 Terminology Relating to Electrical Insulation

D 2519 Test Method for Bond Strength of Electrical Insulating Varnishes by the Helical Coil Test

D 3056 Test Method for Gel Time of Solventless Varnishes

D 3145 Test Method for Thermal Endurance of Electrical Insulating Varnishes by the Helical Coil Method

D 3251 Test Method for ~~Thermal-Aging~~ Thermal Endurance Characteristics of Electrical Insulating Varnishes Applied over Film-Insulated Magnet Wire

D 3278 Test Methods for Flash Point of Liquids by ~~Set~~ Small Scale Closed-Cup Apparatus

D 4733 Test Methods for Solventless Electrical Insulating Varnishes

D 4880 Test Method for Salt Water Proofness of Insulating Varnishes Over Enamelled Magnet Wire

D 5637 Test Method for Moisture Resistance of Electrical Insulating Varnishes

D 5638 Test Method for Chemical Resistance of Electrical Insulation Varnishes

2.2 *Military Specifications:*³

MIL-~~H~~PRF-17672 Hydraulic Fluid, Petroleum, Inhibited

MIL-~~L~~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:*³

NEMA MW1000— Magnet Wire

IEC 60455 —Resin Based Reactive Compounds Used for Electrical Insulation

3. Terminology

3.1 ~~Definitions~~ Definitions:—For definitions of terms used in this specification refer to Terminology D 1711.

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 D 3145 and D 3251 in conjunction with ~~18-awg~~ 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.

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*, Vol 05.01, volume information, refer to the standard's Document Summary page on the ASTM website.

³ Available from Global Engineering Documents, 15 Inverness Way, East Englewood, CO 80112.

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 ~~purchaser~~ 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 D 115. 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 ~~purchaser~~ 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. Safety Precautions 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. Suitable samples may also be obtained from material in process. It is important that new, or thoroughly cleaned sampling containers be used. The sample may be obtained 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 should have a tight fitting cover to minimize the loss of solvents. A dipping ladle may be used, 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, or 2-L~~ 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 ~~purchaser~~ user .

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

10. Keywords

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

TABLE 1 Specification Requirements

Grade			Minimum Thermal Class					
Class	Type of Magnet-wire Over which Varnish is Applied	ASTM Test Method	DA	DO	DM	DS	DW	DT
			130	MW 35-C and MW 16-C	D 3251 and D 3145	Class 130 for both wire types and both test methods		
155	MW 35-C and MW 16-C	D 3251 and D 3145	Class 155 for both wire types and both test methods					
180	MW 35-C and MW 16-C	D 3251 and D 3145	Class 180 for both wire types and both test methods					
200	MW 35-C and MW 16-C	D 3251 and D 3145	Class 200 for both wire types and both test methods					
220	MW 35-C and MW 16-C	D 3251 and D 3145	Class 220 for both wire types and both test methods					
220	MW 35-C and MW 16-C	D 3251 and D 3145	Class 220 for both wire types and both test methods					
Dielectric strength, V/mil, min, on metal panels			D 115/D 4733					
—24/23/50			1500	2000	1500	1800	2000	1500
24/23/50 and 50 % RH			1500	2000	1500	1800	2000	1500
—24/23/96			975	1500	1125	1350	1500	1125
24/23/96 and 96 % RH			975	1500	1125	1350	1500	1125
—24/23/water			900	1500	1125	1350	1500	1125
24/23/water in deionized water			900	1500	1125	1350	1500	1125
Bond strength (minimum pounds) over 18 AWG			D 2519					
MW16C or MW35C								
Flexible at 25°C/150°C			5/0	10/1	10/1	6/0.5	20/1	15/2
Rigid at 25°C/150°C			NA ^A	20/3	25/4	NA	25/3	30/5
Salt water proofness over MW35C or MW16C			D 4880					
			100 ^B	100 ^B	100 ^B	100 ^B	100 ^B	100 ^B
Moisture resistance percent retained, min			D 5637					
			50	50	50	50	50	50
Chemical resistance minimum percent retained after 168 h at 23°C			D 5638					
Hydraulic fluid ^C			50	50	50	50	50	50
Lubricating oil ^D			50	50	50	50	50	50
Cleaning fluid ^E			50	50	50	50	50	50
Distilled water			50	50	50	50	50	50
Detergent solution ^F			50	50	50	50	50	50
Storage life, months min ^G			12	12	6	6	6	6
Viscosity (cps at 25°C)			D 115/D 4733					
			80–1200	100–1200	100–1300	80–240	100–1300	15 000 ^H
Viscosity (cps at 77°F (25°C))			D 115/D 4733					
			80–1200	100–1200	100–1300	80–240	100–1300	5000 ^I
Thixotropic index, min			D 4733					
			NA	NA	NA	NA	NA	1.1
% Nonvolatile matter, min			D 115					
			30	40	NA	40	35	NA
Variation in specific gravity/density (% of reported value)			D 115/D 4733					
			±1.0	±1.0	±1.0	±1.0	±1.0	±1.0
Build as received (mils, min)			D 115/D 4733					
			0.9	0.9	0.3	0.5	0.8	1.1
Flash point (°C, min)			D 93/D 3278					
			23 ^J	23 ^J	93 ^J	23 ^J	90 ^J	93 ^J
Flash point (°F (°C), min)			D 93/D 3278					
			73 (23) ^J	73 (23) ^J	200 (93) ^J	73 (23) ^J	194 (90) ^J	200 (93) ^J
Drying time (h at °C) max			D 115					
			3 at 110	2 at 150	NA	6 at 200	2 at 150	NA
Drying time (h at °F (°C)) max			D 115					
			3 at 230 (110)	2 at 300 (150)	NA	6 at 390 (200)	2 at 300 (150)	NA
Variation in gel time (% of reported value)			D 3056					
			NA	NA	±10.0	NA	NA	±10.0

^A Not applicable.

^B Passing is defined as 7 of 9 specimens still passing at specified time.

^C In accordance with MIL-HPRF-17672.

^D In accordance with MIL-LPRF-17331.

^E In accordance with P-D-680[1,1,2-trichloro 1,2,2-trifluoroethane].

^F Detergent per MIL-D-16791, non-ionic detergent (1 lb per 2¼ gal water).

^G As warranted by the manufacturer.

^H Maximum at 2 r/min.

^I Maximum at 20 r/min.

^J Or as agreed to by manufacturer and user.

ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org).