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27 September 1976
SUPERSEDING
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MILITARY SPECIFICATION

VARNISH, WATERPROOFING, ELECTRICAL, IGNITION

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 This specification covers one grade of clear (unpigmented) varnish for use in protecting electrical circuits and engine parts of internal combustion engines.

2. APPLICABLE DOCUMENTS

2.1 Issues of documents. The following documents of the issue in effect on date of invitation for bids or request for proposal form a part of this specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

- TT-T-306 - Thinner: Synthetic Resin, Enamels.
- PPP-P-1892 - Paint, Varnish, Lacquer, and Related Materials; Packaging, Packing, and Marking of.
- PPP-T-60 - Tape: Packaging, Waterproof.

STANDARDS

FEDERAL

- Fed. Test Method Std. No. 141 - Paint, Varnish, Lacquer, and Related Materials; Methods of Inspection, Sampling and Testing.

(Copies of specifications and standards required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

FSC 8010

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Army Materials and Mechanics Research Center, Watertown, MA 02172 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) STANDARDS

- B117 - Salt Spray (Fog) Testing.
- D56 - Flash Point by Tag Closed Tester.
- D1014 - Conducting Exterior Exposure Tests of Paints on Steel.
- D1200 - Viscosity of Paints, Varnishes and Lacquers by Ford Viscosity Cup.
- D1307 - Phthalic Anhydride Content of Alkyd Resins and Esters Containing Other Dibasic Acids (Spectrophotometric).
- D1308 - Effect of Household Chemicals on Clear and Pigmented Organic Finishes.
- D1542 - Qualitative Test for Rosin in Varnishes.
- D1544 - Color of Transparent Liquids (Gardner Color Scale).
- D2369 - Volatile Content of Paints.
- G26 - Operating Light and Water Exposure Apparatus (Xenon ARC Type) for Exposure of Nonmetallic Materials.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

3. REQUIREMENTS

3.1 Qualification. The varnish furnished under this specification shall be a product that has been tested and passed the qualification tests specified herein and has been listed on or approved for listing on the applicable Qualified Products List (see 6.3). Any change in the formulation of a qualified product will necessitate its requalification. The material supplied under the contract shall be identical within manufacturing tolerances, to the product receiving qualification.

3.2 Composition. The resin used in the varnish shall be a copolymer type formed by the reaction of a vinyl type monomer or monomers with a phthalic alkyd resin (see 6.4). The resin shall contain not less than 14 percent phthalic anhydride and shall be no darker than 12 (Gardner Standards) at 50 percent solids in solvent. The necessary amounts of suitable aromatic or aliphatic solvents with driers shall be added to yield a product conforming to the requirements of this specification. Small amounts of antioxidants, antiskinning agents and stabilizers may be added at the discretion of the manufacturer. The varnish shall give a negative test for rosin and phenolic resin.

3.3 Quantitative requirements. The varnish shall conform to the quantitative requirements specified in Table I.

Table 1. Quantitative Requirements

Characteristics	Requirements	
	Minimum	Maximum
Total solids, percent by weight of varnish	35	...
Phthalic anhydride, percent by weight of nonvolatile vehicle $\frac{1}{13}$		...
Unsaponifiable matter, percent by weight of nonvolatile vehicle . . . . .	...	7
Color (Gardner color standards 1953) . . . . .	...	$\frac{1}{14}$
Flash point, Tag Closed Cup, °F	75	...
Viscosity, No. 4 Ford Cup, seconds	20	35
Drying time, air drying:		
Dust free, minutes . . . . .	...	15
Dry through, minutes . . . . .	...	60
After tack free, hours . . . . .	...	18

$\frac{1}{14}$ The difference in color and percent phthalic anhydride between 3.2 and Table 1 permits additions as indicated in 3.2.

3.4 Qualitative requirements.

3.4.1 Appearance. The varnish shall be clear and free from sediment and suspended matter when examined by transmitted light. It shall show no livering, curdling, gelling or skinning in a freshly opened full container.

3.4.2 Storage stability.

3.4.2.1 Partially full container. The varnish shall show no skinning when tested as in 4.4.7.1. After aging as in 4.4.7.1 the varnish shall show no cloudiness or gel formation. The varnish shall have a consistency of not more than 50 seconds when measured in the No. 4 Ford Cup and shall meet the dilution stability requirement of 3.4.3.

3.4.2.2 Full container. When tested as in 4.4.7.2 the varnish shall show no livering, thickening, curdling, gelling, cloudiness, or skinning. It shall mix readily to a smooth homogeneous state. A flow out of the product on glass shall dry to a smooth uniform film.

3.4.3 Dilution stability. The varnish shall show no cloudiness or gel formation when tested according to 4.4.8.

3.4.4 Brushing properties. The varnish shall be suitable for brushing and when tested according to 4.4.9 the brushed surface shall be free of sags, runs, and shall show a minimum of brush marks.

3.4.5 Spraying properties. The varnish shall be suitable for spraying and when tested according to 4.4.10 the coating shall present a clear, smooth, glossy finish without runs, sags or blisters and no more than a slight orange peel.

3.4.6 Knife test. When tested as specified in 4.4.11 the varnish shall adhere tightly and shall not flake, crack or powder from the metal. The cut shall show beveled edges.

3.4.7 Combustibility. A film of the varnish prepared and tested as specified in 4.4.12 shall not flash or take fire, but shall decompose gradually.

3.4.8 Flexibility.

3.4.8.1 Air dry. A film of the varnish prepared and tested as specified in 4.4.13.1 shall bend without cracking or loss of adhesion.

3.4.8.2 Baked. A film of the varnish prepared and tested as in 4.4.13.2 shall show no removal of the coating by the adhesive tape.

3.4.9 Heat Resistance. A film of the varnish prepared and tested as specified in 4.4.14 shall show no tackiness or tendency to flow, and no embrittlement or loss of adhesion.

3.4.10 Water Resistance. A film of the varnish prepared and tested as specified in 4.4.15 shall show no wrinkling or blistering and no more than slight whitening, dulling, or softening when examined immediately after removal from the water. After 2 hours air drying the portion of the panel which was immersed shall be almost indistinguishable with regard to hardness and adhesion from a duplicate unexposed panel (see 6.6).

3.4.11 Hydrocarbon resistance. A film of the varnish prepared and tested as specified in 4.4.16 shall show no whitening, dulling, wrinkling, or blistering, and no more than slight softening when examined immediately after removal from the test fluid. After 2 hours air drying, the immersed portion of the panel shall be almost indistinguishable with regard to hardness and adhesion from a duplicate unexposed panel (see 6.6).

3.4.12 Salt spray resistance. A film of varnish prepared and tested as specified in 4.4.17 and examined immediately after removal of the panels shall show no more than a trace of rusting (see 6.5) and no more than five scattered blisters. No blister shall be larger than 1/8 inch in diameter. After 2 hours air drying, the film shall be almost indistinguishable with regard to hardness, adhesion, and general appearance from a duplicate unexposed panel.

3.4.13 Accelerated weathering. A film of the varnish prepared and tested as in 4.4.18 shall be almost indistinguishable from a film that has not been exposed.

3.4.14 Drying properties over elastomers. A film of varnish prepared and tested as in 4.4.19 shall be tack-free in 24 hours.

3.4.15 Weather resistance. A film of the varnish prepared and tested as specified in 4.4.20 shall show no more than a trace of rusting (see 6.5) and no more than five scattered blisters. The film shall show no checking, cracking, flaking, peeling, marked color change or embrittlement.

3.4.16 Toxicity. The product shall contain no benzol (benzene), chlorinated compounds, or hydrolyzable chlorine derivatives when tested as in 4.4.21.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Sampling, inspection, and testing. Unless otherwise specified, sampling, inspection, and testing shall be in accordance with Method 1031 of FED. TEST METHOD STD. No. 141.

4.3 Classification of tests. Testing under this specification shall be for the purpose of:

- (a) Qualification.
- (b) Acceptance of individual lots.

4.3.1 Qualification testing shall consist of tests for all requirements specified in Section 3 (see 6.3).

4.3.2 Acceptance tests shall normally consist of tests for all requirements specified in Section 3 with the exception of storage stability in full container (3.4.2.2) and weather resistance (3.4.15).

4.4 Test methods.

4.4.1 Test conditions. The routine and referee testing conditions shall be in accordance with Section 7, FED. TEST METHOD STD. No. 141 except as otherwise specified herein.

4.4.2 The following tests shall be conducted in accordance with applicable methods of FED. TEST METHOD STD. No. 141 or as required in this specification. The right is reserved to make any additional tests deemed necessary to determine that the varnish meets the requirements of this specification.

TABLE II. Index

Tests	Test Method		Reference Paragraph of this specifi- cation giving further refer- ence	Requirements Paragraph of this specifi- cation giving requirements.
	Applica- ble method in FED. TEST METHOD STD. No. 141	Applica- ble ASTM Method		
Rosin . . . . .	...	D1542	....	3.2
Phenol . . . . .	...	...	4.4.3	3.2
Total solids. . . . .	...	D2369	....	Table I
Phthalic anhydride. . . . .	...	D1307	4.4.4	Table I
Unsaponifiable. . . . .	...	...	4.4.5	Table I
Color . . . . .	...	D1544	....	Table I
Flash point . . . . .	...	D56	....	Table I
Viscosity . . . . .	...	D1200	....	Table I
Drying time	4061	...	4.4.6	Table I
Free from after tack.	4061	...	4.4.6.1	Table I
Appearance.	4261	...	....	3.4.1
Storage stability . . . . .	...	...	4.4.7	3.4.2
Partially full container.	4141	...	4.4.7.1	3.4.2.1
Full container.	4142	...	4.4.7.2	3.4.2.2
Dilution stability.	4203	...	4.4.8	3.4.3
Brushing properties	4321	...	4.4.9	3.4.4
Spraying properties	4331	...	4.4.10	3.4.5
Knife test.	6304	...	4.4.11	3.4.6
Combustibility. . . . .	...	...	4.4.12	3.4.7
Flexibility	6221	...	4.4.13	3.4.8
Heat resistance . . . . .	...	...	4.4.14	3.4.9
Water resistance. . . . .	...	D1308	4.4.15	3.4.10
Hydrocarbon resistance. . . . .	...	D1308	4.4.16	3.4.11
Salt spray resistance . . . . .	...	B117	4.4.17	3.4.12
Accelerated weathering. . . . .	...	G26	4.4.18	3.4.13
Drying properties over elastomers . . . . .	...	...	4.4.19	3.4.14
Weather resistance. . . . .	...	D1014	4.4.20	3.4.15
Toxicity. . . . .	...	...	4.4.21	3.4.16

4.4.3 Phenol. Place in a disposable aluminum pan a sample of the vehicle representing 0.5 to 1.0 gram of nonvolatile matter and dry for 3 hours in an oven at 105°C. Tear off the sides of the pan and fold back the remainder. Immerse under 5 to 10 milliliters of chloroform in a test tube for an hour or longer. Then decant the chloroform into another test tube and add an equal volume of 5 percent aqueous sodium hydroxide solution. Immediately after an emulsion is formed by agitation, add a few crystals of 2, 6 dibromoquinone-chlorimide. Allow the test tube to stand and observe for the familiar blue streaks which indicate phenolic resin.

4.4.4 Phthalic anhydride. Determine the phthalic anhydride by ASTM Method D1307.

4.4.5 Unsaponifiable. Transfer a sample of isolated vehicle, weighing approximately 5 grams, to a 250 ml Erlenmeyer flask and dissolve in 20 ml of xylene. Add 50 ml of 1N potassium hydroxide in n-butanol and reflux for 2 hours under an air condenser in an oil bath. Then transfer the sample to a 500 ml separatory funnel, washing with water and dilute to 350 ml volume. Make three extractions with 50 ml portions of ethyl ether. Wash the combined ether layers with 25 ml portions of water until neutral, then filter through paper into a weighed beaker. Upon evaporation of the ether, dry the unsaponifiable to a constant weight in a vacuum oven at 80°C. Correct for acidic constituents by dissolving the unsaponifiable above in 50 ml of 95 percent neutralized alcohol, and titrate to the phenolphthalein end point with 0.10 N sodium hydroxide (NaOH). Calculate the unsaponifiable as follows:

$$\text{Percent unsaponifiable} = \frac{[\text{wt. of unsaponifiable} - (\text{ml NaOH} \times 0.0282)]}{(\text{wt. of vehicle sample}) \times (\text{vehicle solids fraction})} \times 100$$

4.4.6 Drying time. Draw down the package material using a 0.0025 inch (0.0050 inch gap clearance) film applicator and determine drying time in accordance with Method 4061 of FED. TEST METHOD STD. No. 141 under referee conditions.

4.4.6.1 Free from after-tack. Prepare a draw down as in 4.4.6 and determine the free from after-tack time in accordance with Method 4061, FED. TEST METHOD STD. No. 141.

4.4.7 Storage stability.

4.4.7.1 Partially full container. Determine 48 hours skinning in accordance with Method 4141 of FED. TEST METHOD STD. No. 141 and observe for compliance with 3.4.2.1. Reseal, age for 7 days at 60°C and observe for compliance with 3.4.2.1.

4.4.7.2 Full container. In accordance with Method 4142 of FED. TEST METHOD STD. No. 141 allow a full standard quart can of the varnish to stand undisturbed for 6 months and then examine the contents for compliance with 3.4.2.2.

4.4.8 Dilution stability. Reduce 1 part by volume of varnish with 1 part by volume of thinner conforming to TT-T-306 allow to stand 24 hours and examine for compliance with 3.4.3.

4.4.9 Brushing properties. Determine the brushing properties in accordance with Method 4321 of FED. TEST METHOD STD. No. 141 and examine for compliance with 3.4.4.

4.4.10 Spraying properties. Spray the varnish as packaged on a steel panel to give a dry film thickness between 0.0009 and 0.0011 inch. Observe for spraying properties in accordance with Method 4331 of FED. TEST METHOD STD. No. 141 and for compliance with 3.4.5. For referee test use automatic application per Method 2131 of FED. TEST METHOD STD. No. 141.

4.4.11 Knife test. Prepare and solvent clean a high gloss ceramic tile panel in accordance with Method 2021 and a steel panel in accordance with Method 2011 of FED. TEST METHOD STD. No. 141 using the petroleum naphtha ethylene glycol monoethyl ether mixture. Draw down a film of the varnish with a 0.0025 inch (0.0050 inch gap clearance) film applicator on each panel and air dry for 72 hours. Perform the knife test according to Method 6304 and examine for compliance with 3.4.6.

4.4.12 Combustibility. Prepare a film of the varnish on steel as in 4.4.11, air-dry for 48 hours, and then bake for 45 minutes at $121^{\circ} \pm 2^{\circ} \text{C}$ ($250^{\circ} \pm 4^{\circ} \text{F}$). Condition the panel for 1/2 hour at room temperature. In a fume hood, play the full-flame of a Meker type burner on the uncoated side of the panel until the coating decomposes, but under no circumstances allow the free-flame to curl around the panel edges. Evaluate the combustibility of the coating by the requirements of 3.4.7.

4.4.13 Flexibility.

4.4.13.1 Air dry. Determine flexibility in accordance with Method 6221 of FED. TEST METHOD STD. No. 141. Apply a 2-inch-wide film of varnish with a 0.0025 inch (0.0050 inch gap clearance) film applicator on a flat tin plate panel prepared in accordance with Method 2012 of FED. TEST METHOD STD. No. 141 using the petroleum naphtha ethylene glycol monoethyl ether cleaning mix-

ture. Air-dry 72 hours and then bend over a 1/8-inch mandrel. Using a 5 power lens, observe the panel at the bend for conformance to 3.4.8.1.

4.4.13.2 Baked. Prepare a tin plate panel as in 4.4.13.1. Air-dry 1/2 hour and then bake for 2 hours at $204^{\circ} \pm 2^{\circ} \text{ C}$ ($400^{\circ} \pm 4^{\circ} \text{ F}$). Condition at 23° C for 1/2 hour and bend over a 1/8 inch mandrel. The film shall then be taped perpendicular to and across the bend with water resistant pressure sensitive adhesive tape (3/4 inch width) conforming to the requirements of PPP-T-60 Type III, Class 1. The tape shall be pressed in firm contact with the film and extend for approximately 1 inch on each side of the bend. All air bubbles shall be rolled out by firm pressure of the thumb. Allow approximately 10 seconds for the test area to return to room temperature. Grasp a free end of the tape and at a rapid speed strip it from the specimen by pulling the tape back upon itself at 180 degrees. Observe the specimen for compliance with 3.4.8.2.

4.4.14 Heat Resistance. Prepare and heat a film of the varnish on a tin panel as in 4.4.12 except the panel shall be suspended vertically during the baking period. Examine the panel for defects as described in 3.4.9 during the baking period and after removal, perform the knife test.

4.4.15 Water resistance. Prepare a film of varnish as in 4.4.13.1. Air-dry for 72 hours and then immerse in distilled water for 16 hours in accordance with ASTM Method D1308. Upon removal, examine for compliance with 3.4.10.

4.4.16 Hydrocarbon resistance. Prepare a film of the varnish as in 4.4.13.1. Air-dry for 72 hours and then immerse in thinner conforming to TT-T-306 for 16 hours in accordance with ASTM Method D1308. Upon removal examine for compliance with 3.4.11.

4.4.17 Salt spray resistance. Spray the varnish as packaged to a dry film thickness between 0.0009 and 0.0011 inch on two 4 by 12 inch steel panels solvent cleaned in accordance with Method 2011 of FED. TEST METHOD STD. No. 141 using the petroleum naphtha ethylene glycol monoethyl ether mixture. Air-dry for 96 hours and then expose the unscored panels to salt spray for 48 hours in accordance with ASTM Method B 117. On removal, wash the panels gently in luke-warm running water until free from any visible salt deposits and examine for compliance with 3.4.12, particularly with reference to change in general appearance and loss of adhesion evidenced by rust at the interface between coating and steel.

4.4.18 Accelerated weathering. Prepare a film of the varnish on two tin-plate panels as in 4.4.13.1 and air-dry for 72 hours. Expose one panel for 300 hours to accelerated weathering in accordance with ASTM Method G 26 (xenon) Type BH. Compare the exposed panel with the unexposed one for compliance with 3.4.13.

4.4.19 Drying properties over elastomers.

4.4.19.1 Elastomer coating. The elastomer coating shall have the following composition by weight:

- 100 parts chlorosulfonated polyethylene (Hypalon¹/or equal)
- 2 parts phenyl-beta-naphthylamine (Neozone D¹/or equal)
- 2 parts phenyl-beta-naphthylamine and biphenyl-para-phenylenediamine (Akroflex CD¹/or equal).
- 2 parts petroleum wax (Heliozone¹ or equal)
- 300 parts toluene
- 125 parts ethyl acetate

¹/These materials may be obtained from E. I duPont de Nemours and Company, Organic Chemicals Department, Elastomer Division, Wilmington, DE.

4.4.19.2 Procedure. Draw down a 3-inch-wide film of the elastomer coating on a 4- by 12-inch steel panel using a 0.0030 inch (0.0060 inch gap clearance) film applicator. Air dry for 24 hours and then apply a spray coat of varnish to a dry film thickness between .0009 and 0.0011 inch over the elastomer coating. Air-dry for 24 hours and determine free from after-tack time according to Method 4061, FED. TEST METHOD STD. No. 141 for compliance with 3.4.14.

4.4.20 Weather resistance. Prepare two unscored 4- by 12-inch steel panels as in 4.4.17. Air-dry for 96 hours and place on outdoor exposure for 6 months at an angle of 45 degrees facing south in the vicinity of Washington, DC. Inspect the panels for compliance with 3.4.15.

4.4.21 Toxicity. Note the odor and other characteristics of the varnish during its examination and if there is reason to suspect the presence of any of the prohibited solvents, make appropriate confirmatory tests to comply with 3.4.16.

5. PACKAGING

5.1 Packaging requirements. The requirements for Level A, B or commercial as specified (see 6.2) shall be in accordance with PPP-P-1892.

5.1.1 Container size. The varnish shall be delivered in 2 ounce bottles (commercial type) 1 quart or 1 gallon multiple friction top containers, in 5 gallon steel pails or in 55 gallon steel drums as specified (see 6.2)

5.1.2 Marking. In addition to the marking specified in PPP-P-1892 each container shall be marked with the manufacturer Qualified Products List Designation.

6. NOTES

6.1 Intended use. The varnish covered by this specification is intended

for use primarily on electrical circuits and engine parts of internal combustion engines of military motor vehicles for protection against moisture and corrosion.

6.2 Ordering data. Procurement documents should specify the following:

- (a) Title, number, and date of this specification.
- (b) Size of containers (see 5.1.1)
- (c) Level of packaging (see Section 5).

6.3 Qualification. With respect to products requiring qualification awards will be made only for such products as have, prior to the time set for opening of bids, been tested and approved for inclusion in the applicable Qualified Products List whether or not such products have actually been so listed by that date. The attention of contractors is called to this requirement and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government, tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Coatings Group, Lab 9000, MERADCOM, Fort Belvoir, VA 22060, and information pertaining to qualification of products may be obtained from that activity.

6.4 The performance requirements of this specification are based on a copolymer type resin formed by the reaction of an acrylic type monomer and styrene with a phthalic alkyd resin.

6.5 It is intended that the maximum amount of rusting permitted in the salt-spray and weather-resistance tests (see 3.4.12 and 3.4.15) be comparable to Photo 9-1 in ASTM Standard Method of Evaluating Degree of Resistance to Rusting Obtained with Paint on Iron or Steel Surfaces D 610. This standard may be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

6.6 In the event it is difficult to detect the degree of whitening on tin panels from the water or hydrocarbon-resistance tests, make check determinations on polished black carrara glass plate which has been solvent cleaned immediately before using.

6.7 International standardization agreement. Certain provisions of this specification are the subject of International Standardization Agreement (ABC-NAVY-STD-17C). When amendment, revision, or cancellation of this specification is proposed which will affect or violate the international agreement, concerned, the preparing activity will take appropriate reconciliation action through international standardization channels including departmental standardization offices, if required.

MIL-V-13811D

Custodians:

Army - MR
Navy - YD
Air Force - 99

Preparing activity:

Army - MR

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Review activities:

Army - ME, AT, SM, EA

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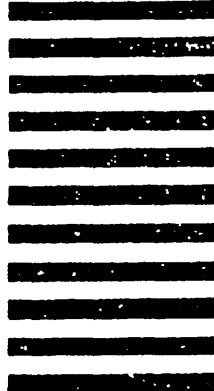


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