

MILITARY SPECIFICATION
INSULATING COMPOUND, ELECTRICAL
(FOR COATING PRINTED CIRCUIT ASSEMBLIES)

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

1. SCOPE

1.1 Scope. This specification covers conformal coatings which are suitable for application to printed circuit assemblies by dipping, brushing, spraying, or vacuum deposition.

1.2 Classification. This specification covers the following types of conformal coatings (see 6.1 and 6.2):

Type AR - Acrylic resin
Type ER - Epoxy resin
Type SR - Silicone resin
Type UR - Polyurethane resin
Type XY - Paraxylylene 1/

2. APPLICABLE DOCUMENTS

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

SPECIFICATIONS

FEDERAL

QQ-S-571 - Solder, Tin Alloy, Tin-Lead Alloy; and Lead Alloy.
TT-I-735 - Isopropyl Alcohol.
PPP-C-96 - Cans, Metal, 28 Gage and Lighter.
PPP-C-300 - Chemical, Liquid, Packaging and Packing of.
PPP-D-729 - Drum, Metal, 55-Gallon (for Shipment of Noncorrosive Material).
PPP-P-704 - Pail, Shipping, Steel (1 through 12 Gallon).

MILITARY

MIL-P-13949 - Plastic Sheet, Laminated, Metal-Clad (for Printed Wiring).
MIL-F-14256 - Flux, Soldering, Liquid (Rosin Base).
MIL-R-39008/4 - Resistor, Fixed, Composition (Insulated), Established Reliability, Style RCR05.
MIL-C-45662 - Calibration System Requirements.
MIL-R-55182/7 - Resistors, Fixed, Film, Established Reliability, Style RNR50.
MIL-C-81302 - Cleaning Compound, Solvent, Trichlorotrifluoroethane.

1/ This type coating is controlled by a proprietary process. Patents and expiration dates are as follows:

U. S. 3,221,068 - 30 November 1982
U. S. 3,342,754 - 19 September 1981
U. S. 3,288,728 - 29 November 1983

The Government does not have a royalty free license.

STANDARDS

FEDERAL

- FED-STD-141 - Paint, Varnish, Lacquer and Related Materials; Methods of Inspection, Sampling, and Testing.
- FED-STD-406 - Plastics, Methods of Testing.

MILITARY

- MIL-STD-129 - Marking for Shipment and Storage.
- MIL-STD-202 - Test Methods for Electronic and Electrical Component Parts.
- MIL-STD-275 - Printed Wiring for Electronic Equipment.

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

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 the date of invitation for bids or request for proposal, shall apply.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- D 150 - Methods of Test for AC Capacitance, Dielectric Constant and Loss Characteristics of Electrical Insulating Materials.
- G 21 - Recommended Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

(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 coating materials furnished under this specification shall be products which are qualified for listing on the applicable qualified products list at the time set for opening of bids (see 4.5 and 6.3).

3.2 Materials. The materials shall be free from deleterious substances and formulated with synthetic resins, elastomers, plasticizers, catalysts, and other ingredients which meet the requirements of this specification. The materials shall be fluorescent for examination by ultra violet illumination and shall meet the requirements specified herein. Acceptance or approval of any constituent material shall not be construed as a guaranty of the acceptance of the finished product.

3.2.1 Composite coating system. A composite coating system under this specification shall be evaluated as a single material. Primer and coating shall be prepared in accordance with the supplier's recommendations. Precoating surface treatments shall be considered part of the coating system. When tests are made on panels, the entire coating system shall be tested.

3.3 Compatibility. The coating materials shall be suitable for application and use on printed-circuit assemblies and shall be compatible with materials used therein (see 6.2); the coatings shall not cause deterioration of materials used in the printed-circuit assemblies or components connected thereon (see 6.1.6).

3.4 Curing time and temperature. When coating materials are tested as specified in 4.8.1, the material shall be cured to full hardness in the time and temperature recommended by the supplier (see 6.1 and 6.2). Unless otherwise specified (see 6.2), the curing time shall not exceed 4 hours for type AR, 8 hours for type ER, and 24 hours for types SR and UR. Unless otherwise specified (see 6.2), the curing temperature shall not exceed 125°C. Type XY coating is formed in the cured state by the vacuum deposition method.

3.5 Appearance. When coating materials are tested as specified in 4.8.2, the coating shall be smooth, homogeneous, transparent, unpigmented, and shall be free from bubbles, pinholes, whitish spots, blistering, wrinkling, cracking, and peeling. The coating shall not mask or obliterate the identification markings on electronic components. The coating shall not discolor the printed conductors and base materials greater than the discoloration caused by conditioning when uncoated. The coating shall not corrode any metals being coated.

3.6 Coating thickness on test specimens. When measured as specified in 4.8.3, the coating thickness for types AR, ER, and UR shall be 0.002 ± 0.001 inch. For type SR, the coating thickness shall 0.005 ± 0.003 inch. For type XY, the coating thickness shall be 0.0006 ± 0.0001 inch.

3.7 Fungus resistance. When coating materials are tested as specified in 4.8.4, the cured film shall resist the growth of fungi and shall have a rating of "0".

3.8 Shelf life. When coating materials are tested in accordance with 4.8.5, the appearance, insulation resistance, and dielectric withstanding voltage shall meet the requirements of 3.5, 3.9, and 3.10, respectively.

3.9 Insulation resistance. When coating materials are tested as specified in 4.8.6, the average of the insulation resistance of all coated specimens shall be a minimum of 2,500,000 megohms (2.5×10^{12} ohms), unless otherwise specified. The insulation resistance for each coated specimen shall be not less than 1,500,000 megohms (1.5×10^{12} ohms), unless otherwise specified.

3.10 Dielectric withstanding voltage. When coating materials are tested as specified in 4.8.7, there shall be no disruptive discharge evidenced by flashover (surface discharge), sparkover (air discharge), or breakdown (puncture discharge). The leakage rate shall not exceed 10 microamperes.

3.11 Q (resonance). When coating materials are tested as specified in 4.8.8, the average percentage change in Q shall not exceed the values specified below. The minimum Q value for uncoated type GF laminates (MIL-P-13949) at frequencies of 1, 50, and 100 megahertz (MHz) shall be 50, 70, and 70, respectively (see 6.1.8).

Conditioning	Measurement frequency	Maximum allowable percentage change in Q				
		Type AR	Type ER	Type SR	Type UR	Type XY
Before and after coating	1 MHz	9	8	8	5	9
	50 MHz	19	10	12	8	7
	100 MHz	9	14	12	10	11
Before and after immersion (condition in distilled water, D-24/23)	1 MHz	9	12	10	10	11
	50 MHz	5	15	12	10	7
	100 MHz	7	20	16	10	7

3.12 Thermal shock. When coating materials are tested as specified in 4.8.9, the appearance and dielectric withstanding voltage shall meet the requirements of 3.5 and 3.10, respectively.

3.13 Moisture resistance. When coating materials are tested as specified in 4.8.10, the appearance and dielectric withstanding voltage shall meet the requirements of 3.5 and 3.10, respectively; and the average of the insulation resistance of all coated specimens shall be a minimum of 10,000 megohms (1.0×10^{10} ohms) for types AR, SR, UR, and XY; and 1,000 megohms (1.0×10^9 ohms) for type ER. The insulation resistance for each coated specimen shall be not less than 5,000 megohms (5.0×10^9 ohms) for types AR, SR, UR, and XY; and 500 megohms (5.0×10^8 ohms) for type ER.

3.14 Flexibility. When coating materials are tested as specified in 4.8.11, there shall be no evidence of cracking or crazing.

3.15 Hydrolytic stability. When coating materials are tested as specified in 4.8.12, there shall be no evidence of softening, chalking, blistering, cracking, tackiness, loss of adhesion, or reversion to liquid state; and the clarity of the coating must remain suitable for the viewing of identification marking and color codes used to identify components over which the coating will be applied.

3.16 Flame resistance. When coating materials are tested as specified in 4.8.13, the coating shall be self-extinguishing or non-burning.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier 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.

4.1.1 Test equipment and inspection facilities. Test and measuring equipment and inspection facilities of sufficient accuracy, quality and quantity to permit performance of the required inspection shall be established and maintained by the supplier. The establishment and maintenance of a calibration system to control the accuracy of the measuring and test equipment shall be in accordance with MIL-C-45662.

4.2 Classification of inspection. The inspections specified herein are classified as follows:

- (a) Materials inspection (see 4.3).
- (b) Qualification inspection (see 4.5).
- (c) Quality conformance inspection (see 4.6).

4.3 Materials inspection. Materials inspection shall consist of certification supported by verifying data that the materials used in formulating the coating are in accordance with 1.2, 3.2, and 3.2.1. The basic material and the main subgroup(s) shall be identified for each component and primer (eg., polyurethane-polyether).

4.4 Inspection conditions. Unless otherwise specified herein, all inspections shall be performed in accordance with the test conditions specified in the "GENERAL REQUIREMENTS" of MIL-STD-202.

4.5 Qualification inspection. Qualification inspection shall be performed at a laboratory acceptable to the Government (see 6.3) on sample lots produced with equipment and procedures normally used in production.

4.5.1 Sample size. Coating materials shall be furnished in sealed containers in sufficient quantity to prepare 28 test specimens (see 4.7) and to perform the tests specified in table I. The test specimens shall be as follows: Four glass panels, 16 copper-clad laminate panels, four tin-plated panels, and four copper-clad laminate strips. For type XY, because of the vacuum deposition method of application, the material to be tested shall be furnished by the supplier as coated board specimens.

4.5.2 Inspection routine. The sample specimens shall be subjected to the inspections specified in table I. The specimens shall be divided as specified in table I for groups I to VII inclusive and subjected, in the order shown, to the inspections for their particular group.

4.5.3 Failures. One or more failures shall be cause for refusal to grant qualification approval.

TABLE I. Qualification inspection.

Examination or test	Requirement paragraph	Method paragraph	Number and type of sample units to be inspected
<u>Group I</u>			
Curing time and temperature - - -	3.4	4.8.1	4 (glass)
Appearance - - - - -	3.5	4.8.2	
Coating thickness - - - - -	3.6	4.8.3	
Fungus resistance - - - - -	3.7	4.8.4	
<u>Group II</u>			
Shelf life - - - - -	3.8	4.8.5	4 (figure 1)
Appearance - - - - -	3.5	4.8.2	
Insulation resistance - - - - -	3.9	4.8.6	
Dielectric withstanding voltage -	3.10	4.8.7	
<u>Group III</u>			
Q (resonance) - - - - -	3.11	4.8.8	4 (figure 1)
Thermal shock - - - - -	3.12	4.8.9	
Appearance - - - - -	3.5	4.8.2	
Dielectric withstanding voltage -	3.10	4.8.7	
<u>Group IV</u>			
Appearance - - - - -	3.5	4.8.2	4 (figure 1)
Insulation resistance - - - - -	3.9	4.8.6	
Moisture resistance - - - - -	3.13	4.8.10	
Appearance - - - - -	3.5	4.8.2	
Insulation resistance - - - - -	(see 3.13)	4.8.6	
Dielectric withstanding voltage -	3.10	4.8.7	
<u>Group V</u>			
Flexibility - - - - -	3.14	4.8.11	4 (tin plate)
<u>Group VI</u>			
Hydrolytic stability - - - - -	3.15	4.8.12	4 (figure 1)
<u>Group VII</u>			
Flame resistance - - - - -	3.16	4.8.13	4 (strip)

4.5.4 Retention of qualification. To retain qualification, the supplier shall forward a report at 24-month intervals to the qualifying activity. The qualifying activity shall establish the initial reporting date. The report shall consist of:

- (a) A summary of the results of the tests performed for inspection of product for delivery, groups A and B, indicating as a minimum the number of lots that have passed and the number that have failed. The results of tests of all reworked lots shall be identified and accounted for.
- (b) A summary of the results of tests performed for qualification verification inspection, group C, including the number and mode of failures. The summary shall include results of all qualification verification inspection tests performed and completed during the 24-month period. If the summary of the test results indicates nonconformance with specification requirements, and corrective action acceptable to the qualifying activity has not been taken, action may be taken to remove the failing product from the qualified products list.

Failure to submit the report within 30 days after the end of each 24-month period may result in loss of qualification for the product. In addition to the periodic submission of inspection data, if at any time the inspection data indicates failure of the qualified product to meet the requirements of this specification, the supplier shall immediately (within 24 hours) notify the qualifying activity.

In the event that no production occurred during the reporting period, a report shall be submitted certifying that the company still has the capabilities and facilities necessary to produce the item. If during two consecutive reporting periods there has been no production, the manufacturer may be required, at the discretion of the qualifying activity, to submit the product to testing in accordance with the qualification inspection requirements.

4.6 Quality conformance inspection.

4.6.1 Inspection of product for delivery. Inspection of product for delivery shall consist of groups A and B.

4.6.1.1 Inspection lot. An inspection lot shall consist of all containers of coating materials, produced from the same batch and offered for inspection at one time.

4.6.1.1.1 Batch. A batch, as far as practicable, shall consist of all coating materials, produced by one continuous production run or by a blend of two or more continuous production runs.

4.6.1.1.2 Specimens. The preparation and number of specimens required shall be as specified in 4.7 to 4.7.3, inclusive.

4.6.1.2 Group A inspection. Group A inspection shall consist of the examinations and test specified in table II, in the order shown.

TABLE II. Group A inspection.

Examination or test	Requirement paragraph	Method paragraph
Curing time and temperature- - - -	3.4	4.8.1
Appearance - - - - -	3.5	4.8.2
Coating thickness - - - - -	3.6	4.8.3

4.6.1.2.1 Sampling plan. From each lot, one container of each ingredient necessary to form the compound shall be selected. From each of these containers, a sufficient amount of the ingredients shall be taken for performance of tests shown in table II.

4.6.1.2.2 Failures. If the sample fails any test, this shall be cause for rejection of the lot.

4.6.1.2.3 Rejected lots. If an inspection lot is rejected, the supplier may rework it to correct the defects, or screen out the defective units, and resubmit for reinspection. Such lots shall be separate from new lots, and shall be clearly identified as reinspected lots.

4.6.1.3 Group B inspection. Group B inspection shall consist of the examination and tests specified in table III, in the order shown. The sample specimens shall be prepared from coating materials obtained from inspection lots which have passed group A inspection.

TABLE III. Group B inspection.

Examination or test	Requirement paragraph	Method paragraph
Dielectric withstanding voltage - - -	3.10	4.8.7
Q (resonance) - - - - - - - - - - -	3.11	4.8.8
Thermal shock- - - - - - - - - - -	3.12	4.8.9
Appearance- - - - - - - - - - - - -	3.5	4.8.2
Dielectric withstanding voltage - -	3.10	4.8.7
Insulation resistance - - - - - - - -	3.9	4.8.6
Moisture resistance- - - - - - - - -	3.13	4.8.10
Appearance- - - - - - - - - - - - -	3.5	4.8.2
Insulation resistance- - - - - - - - -	(see 3.13)	4.8.6
Dielectric withstanding voltage - -	3.10	4.8.7
Flexibility - - - - - - - - - - - - -	3.14	4.8.11
Flame resistance - - - - - - - - - - -	3.16	4.8.13

4.6.1.3.1 Sampling plan. One container of each ingredient necessary to form the compound shall be selected from the first production lot and thence from one production lot in every 50 production lots, or once each 12 months, whichever is less frequent. From each of these containers, a sufficient amount of the ingredients shall be taken for performance of tests shown in table III.

4.6.1.3.2 Failures. One or more failures shall be cause for rejection of the lot.

4.6.1.3.3 Rejected lots. If an inspection lot is rejected, the supplier may rework it to correct the defects, or screen out the defective units, and resubmit for reinspection. Resubmitted lots shall be inspected using tightened inspection. Such lots shall be separate from new lots, and shall be clearly identified as reinspected lots.

4.6.1.3.4 Disposition of sample containers. Sample containers which have passed all the group B inspection may be delivered on the contract or purchase order, if the lot is accepted.

4.6.2 Qualification verification inspection. Qualification verification inspection shall consist of group C. Except where the results of these inspections show noncompliance with the applicable requirements (see 4.6.2.1.4), delivery of products which have passed groups A and B shall not be delayed pending the results of this qualification verification inspection.

4.6.2.1 Group C inspection. Group C inspection shall consist of the examinations and tests specified in table IV, in the order shown. Group C inspection shall be made on sample specimens prepared from coating materials obtained from inspection lots which have passed groups A and B inspections.

4.6.2.1.1 Sampling plan. One container of each ingredient necessary to form the compound shall be selected once in each 24-month period. From each of these containers a sufficient amount of the ingredients shall be taken for performance of the tests shown in table IV.

4.6.2.1.2 Failures. If there are one or more failures, the sample shall be considered to have failed.

4.6.2.1.3 Disposition of sample containers. Sample containers which have passed all the group C inspection may be delivered on the contract or purchase order.

TABLE IV. Group C inspection.

Examination or test	Requirement paragraph	Method paragraph
Hydrolytic stability - - - - -	3.15	4.8.12
Shelf life - - - - -	3.8	4.8.5
Appearance - - - - -	3.5	4.8.2
Insulation resistance - - - - -	3.9	4.8.6
Dielectric withstanding voltage - -	3.10	4.8.7
Fungus resistance - - - - -	3.16	4.8.13

4.6.2.1.4 Noncompliance. If a sample fails to pass group C inspection, the supplier shall take corrective action on the materials or processes, or both, as warranted, and on all units of product which can be corrected and which were manufactured under essentially the same conditions, with essentially the same materials, processes, etc., and which are considered subject to the same failure. Acceptance of the product shall be discontinued until corrective action, acceptable to the Government, has been taken. After the corrective action has been taken, group C inspection shall be repeated on additional sample units (all inspection, or the inspection which the original sample failed, at the option of the Government). Groups A and B inspections may be reinstated; however, final acceptance shall be withheld until the group C reinspection has shown that the corrective action was successful. In the event of failure after reinspection, information concerning the failure and corrective action taken shall be furnished to the cognizant inspection activity and qualifying activity.

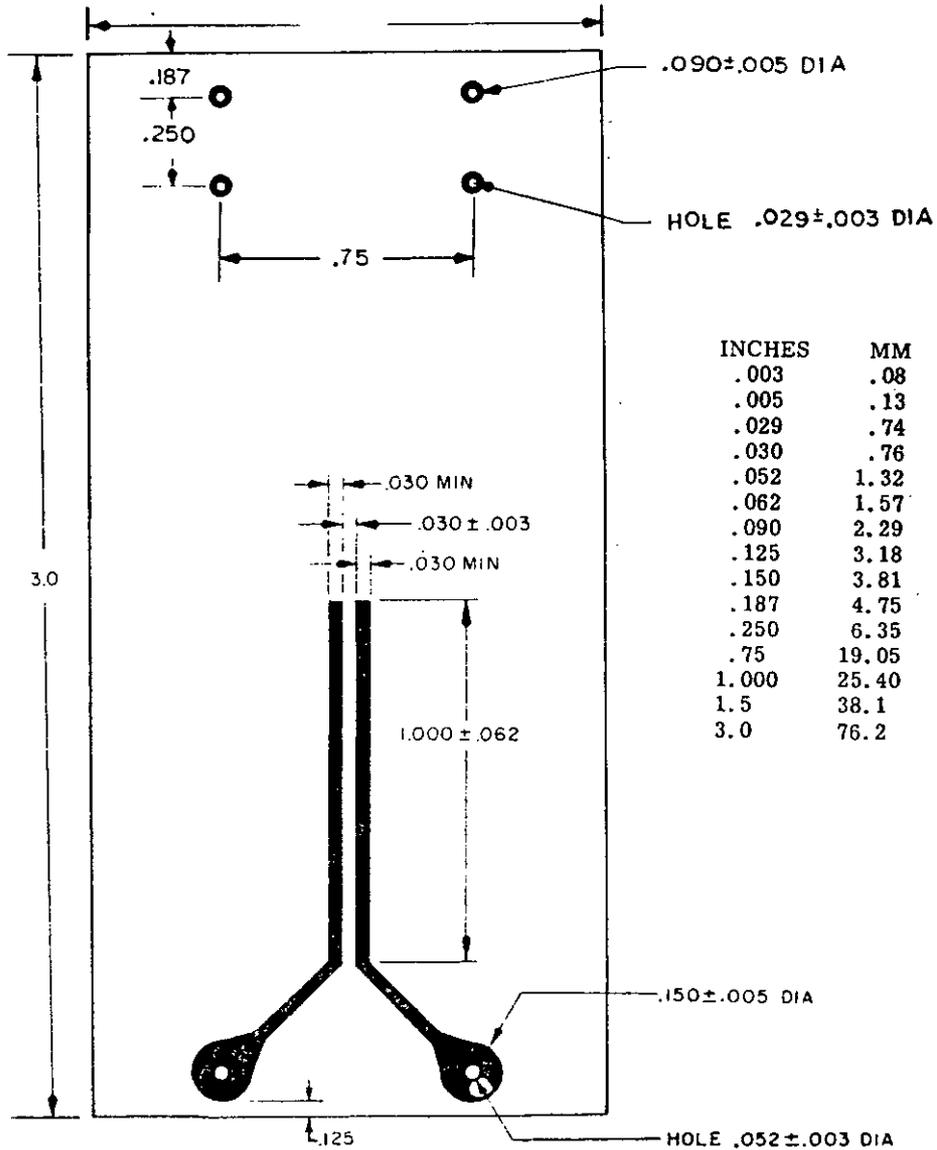
4.6.3 Inspection of preparation for delivery. Sample packages and packs and the inspection of the preservation-packaging, packing and marking for shipment and storage shall be in accordance with the requirements of PPP-C-300.

4.7 Preparation of specimens for test.

4.7.1 Preparation prior to coating.

4.7.1.1 Figure 1 test pattern. The specimens shall be made from 2-ounce, single-sided, copper-clad, glass-epoxy laminate, type GF (FLGFN062C2/OB1A) in accordance with MIL-P-13949. For the hydrolytic stability test only, the specimens shall be plated with 60-40 tin-lead in accordance with MIL-STD-275. The test pattern specimens shall be prepared as follows:

- (a) The printed circuit pattern shall be etched in accordance with figure 1 and MIL-P-13949. After etching, the test panels shall be cleaned as follows:
 - (1) Immerse in trichloroethylene at room temperature.
 - (2) Dry at room temperature.
 - (3) Immerse for 10 seconds in hydrochloric acid which has a specific gravity of 1.033 at 23° C (made by diluting 1 volume of 1.180 specific gravity hydrochloric acid with 4 volumes of water).
 - (4) Rinse in distilled water.
 - (5) Dry with clean air of inert gas.
- (b) Wire leads shall be inserted from the unclad side of the laminate and soldered to the terminal pads of the test panels using solder, composition Sn63 or Sn60, type S, or flux cored solder, type R or RMA, conforming to QQ-S-571. Soldering flux shall conform to MIL-F-14256 when type S solder is used. For the hydrolytic stability test only, one resistor type RCRC05G102 in accordance with MIL-R-39008/4 and one resistor type RNR50 in accordance with MIL-R-55182/7 shall be soldered to each of the test panels.



NOTES:

1. Dimensions are in inches.
2. Metric equivalents (to the nearest .01 mm) are given for general information only and are based upon 1 inch = 25.4 mm.

FIGURE 1. Test pattern.

- (c) Once soldered, the test panels shall be cleaned of all traces of rosin flux and other contaminants by scrubbing in any of the following solutions, dependent upon the degree and type of contamination:
 - (1) Isopropyl alcohol (TT-I-735).
 - (2) Mixture of 35 percent by weight of isopropyl alcohol (TT-I-735) and 65 percent by weight of trichlorotrifluoroethane (MIL-C-81302).
 - (3) Mixture of 15 percent by weight of isopropyl alcohol (TT-I-735) and 85 percent by weight of trichlorotrifluoroethane (MIL-C-81302).
- (d) Test panels are then placed in a circulating-air oven for 1 hour at $123^{\circ} \pm 2^{\circ} \text{C}$. Room conditioning shall be in accordance with 4.4.

4.7.1.2 Strips. The specimens shall be made from 2-ounce, single-sided, copper-clad, glass-epoxy laminate, type GF (FLGFN062C2/OB1A) in accordance with MIL-P-13949. The test strips shall be prepared as follows:

- (a) All the copper shall be etched from the 5-inch by 0.5-inch strip in accordance with MIL-P-13949.
- (b) Test strips shall then be placed in a circulating-air oven for 1 hour at $123^{\circ} \pm 2^{\circ} \text{C}$. Room conditioning shall be in accordance with 4.4.

4.7.1.3 Glass. Clear plate glass shall be prepared in accordance with method 2021 of FED-STD-141.

4.7.1.4 Tin-plate. Tin plate panels shall conform to method 2012 of FED-STD-141. Electroplated tin is acceptable.

4.7.2 Coating (see 3.2.1). The coating shall be applied to the specimens (both sides and all edges) and cured for the time and temperature recommended by the supplier. Thickness shall be as specified in 3.6.

4.7.3 Number. The number of specimens required shall be as specified in table I and 4.5.1.

4.8 Methods of examinations and tests.

4.8.1 Curing time and temperature (see 3.4). Coating materials shall be tested under the applicable conditions in accordance with method 4061 of FED-STD-141.

4.8.2 Appearance (see 3.5). Appearance shall be observed visually with the aid of a 10-power magnification viewer under ultra-violet illumination. Normal or corrected 20/20 vision shall be used to examine for bubbles. The coating material shall be examined for evidence of pinholes, whitish spots, blistering, wrinkling, cracking, peeling, masking or obliteration of identification markings, discoloration of printed conductors and base materials, and corrosion.

4.8.3 Coating thickness (see 3.6). The coating thickness shall be measured using the glass panels specified in 4.7.1.3. Thickness shall be measured in accordance with method 6183 of FED-STD-141, or by any micrometer or indicator accurate to 0.0005 inch. For type XY, the thickness shall be measured optically.

4.8.4 Fungus resistance (see 3.7). The fungus resistance of the cured film shall be determined in accordance with ASTM G-21. Specimens shall be prepared by curing coatings on clean glass panels approximately 1-1/2 inches square. Exposure shall be for 28 days.

4.8.5 Shelf life (see 3.8). The container of coatings (one and two components) shall be stored at a temperature of $25^{\circ} \pm 5^{\circ} \text{C}$ for 6 months. Specimens shall be prepared using this stored material as specified in 4.7.1.1 and 4.7.2. These specimens shall be tested in accordance with 4.8.2, 4.8.6, and 4.8.7.

4.8.6 Insulation resistance (see 3.9). The coating materials shall be measured in accordance with method 302, test condition B, of MIL-STD-202. All test measurements shall be made on a megohm bridge after an electrification time of 1 minute, using the panels specified in 4.7.1.1.

4.8.7 Dielectric withstanding voltage (see 3.10). The coating materials shall be tested in accordance with method 301 of MIL-STD-202. All electrical measurements on the coated panels shall be made using a test voltage of 1,500 volts, alternating current, root mean square, at 60 hertz (Hz). The leakage current shall be measured.

4.8.8 Q (resonance) (see 3.11). Measurements made to determine percentage change in Q shall be performed on a bridge or other instrument capable of providing reproducible readings to within 1 percent. A bridge shall be used as referee. The Q of the test panels shall be measured at 1, 50, and 100 MHz before coating and the values averaged. The coating material shall then be applied to the test panels as specified in 4.7.1.1. The Q of the coated test panels shall be measured and the values averaged at 1, 50, and 100 MHz and again after immersion in distilled water for a period of 24 +2, -0 hours at a temperature of 23 ± 2° C. All tests shall be completed within a period of 5 hours after removing the specimens from the water at the conditions specified in 4.4. The procedure for using the Q-meter shall be as follows:

- (a) Resonate, without any test panel, the Q-meter specified in ASTM D 150 resonance-rise method, and record voltmeter reading Q_1 and capacitance reading C_1 .
- (b) With test panel connected in parallel to Q circuit, resonate the Q-meter and record voltmeter reading Q_2 and capacitance reading C_2 . It should be noted what measurement leads should be of equal length and as short as practicable to reduce lead inductance when performing these measurements.
- (c) Calculate the Q of the coated and uncoated test panel as follows:

$$Q_x = \frac{Q_1 Q_2 (C_2 - C_1)}{(Q_1 - Q_2) C_1}$$

4.8.9 Thermal shock (see 3.12). The coating materials shall be tested in accordance with method 107 of MIL-STD-202. The following details shall apply:

- (a) Test condition letter - B-2 (C-2 for type SR only).
- (b) Examinations after test - After conditioning at 25° ± 2° C and 50 ± 5 percent relative humidity for 24 hours, appearance and dielectric withstanding voltage shall be tested as specified in 4.8.2 and 4.8.7, respectively.

4.8.10 Moisture resistance (see 3.13). The coating materials shall be tested in accordance with method 106 of MIL-STD-202. The following exception and detail shall apply:

- (a) The low temperature and vibration shall be omitted.
- (b) Measurement during test - Insulation resistance measurements shall be made during step 5 of the first, fourth, seventh, and tenth cycles (when conditions are 65° C and 90 to 95 percent relative humidity) of the moisture resistance test cycle.
- (c) Examinations after test - Following step 6 of the final cycle of the moisture resistance test, the panels shall be maintained at a temperature of 25° ± 2° C and a relative humidity 50 ± 5 percent, for a period of 24 hours, after which appearance, insulation resistance, and dielectric withstanding voltage shall be tested as specified in 4.8.2, 4.8.6, and 4.8.7, respectively.

4.8.11 Flexibility (see 3.14). The panels shall be tested in accordance with method 6221 of FED-STD-141. The mandrel diameter used in the test shall be 1/8-inch.

4.8.12 Hydrolytic stability (see 3.15). One panel shall be maintained as a control at 25° C and 50 percent relative humidity. Three panels shall be subjected to 120 days at 85° ± 1° C and 95 ± 4 percent relative humidity. Examination of the three panels shall be made as follows:

- (a) After 28, 56, and 84 days, the panels shall be returned to 25° C and 50 percent relative humidity, held for 2 hours and examined for degradation.
- (b) After the 120 days aging, the panels shall be held at 25° C and 50 percent relative humidity for an additional seven days prior to examination and for tackiness in accordance with method 4061 (Dry-through for varnish, lacquers and enamels) of FED-STD-141.

4.8.13 Flame resistance (see 3.16). The flame resistance shall be determined in accordance with method 2021 of FED-STD-141. CAUTION: This test shall be performed under a ventilated hood, since some materials may generate toxic fumes or gases.

5. PREPARATION FOR DELIVERY

5.1 Preparation for delivery shall be in accordance with PPP-C-300. Level A unit containers shall be limited to pint, quart or gallon cans conforming to type V, class 2 of PPP-C-96; 5-gallon pails conforming to PPP-P-704, type II or 55-gallon drums conforming to PPP-D-729, type III as specified (see 6.2). Cans conforming to PPP-C-96 shall be exteriorly coated in accordance with plan P with the side seams stripped with a suitable corrosion resistant coating. The 1-gallon cans and 5-gallon pails for level A unit packaging shall be provided with galvanized or protectively coated wire handles. When the coating material consists of two components, each component shall be individually furnished in sufficient quantities to prepare the total amount of the coating specified in the contract or purchase order (see 6.2).

5.2 Marking. In addition to any special marking required by the contract or purchase order (see 6.2), each unit and shipping container shall be marked in accordance with MIL-STD-129 and the requirements of the Interstate Commerce Commission. Marking shall also include the following:

- (a) Specification number.
- (b) Manufacturer's part number.
- (c) Manufacturer's lot or batch number.
- (d) Name of manufacturer.
- (e) Name of contractor (if other than the manufacturer).
- (f) Date of manufacture (month and year).
- (g) Precautionary handling as follows:

CAUTION: AVOID INHALATION OF FUMES OR EXCESSIVE SKIN CONTACT.
KEEP AWAY FROM FACE AND EYES.
WORK IN A WELL-VENTILATED AREA.
CLEANSE SKIN REGULARLY WITH SOAP AND WATER AFTER CONTACT.

6. NOTES

6.1 Intended use.

6.1.1 Type AR. Acrylic resin coating is intended for use where excellent electrical properties are required for a general purpose coating. This type of coating is intended to be used as a brush, spray, or dip-coat application on glass or paper epoxy laminates.

6.1.2 Type ER. Epoxy resin coating is intended for use where the best electrical properties are required for a general purpose coating. This type of coating is intended to be used as a brush, spray, or dip-coat application on glass or paper epoxy laminates.

6.1.3 Type SR. Silicone resin coating is intended where excellent dielectric and high arc resistance properties are required.

6.1.4 Type UR. Polyurethane resin coating is intended for use where good resistance to moisture and abrasion is required.

6.1.5 Type XY. Paraxylylene coatings are vacuum deposited polymers controlled by a proprietary patent (see 1.2). They may be applied in extremely thin films on printed circuit boards having closely packed units.

6.1.6 Operating temperature. These coatings are normally useful at temperatures up to 125° C (200° C for type SR), but the useful life of the deposited coating can be extended by reducing the operating temperature. The effect of a humid environment is to reduce the useful life.

6.1.7 Selection. The selection of coating should be such that the curing process shall have no harmful effects on the parts or materials coated. Coatings covered by this specification are not suitable for use on boards fabricated from types GP, GR, GT, or GX (polytetrafluoroethylene resin) laminates in accordance with MIL-P-13949 or from FEP-Fluorocarbon material of MIL-P-27538.

6.1.8 Q (resonance) information. The typical Q for uncoated type GF laminate at frequencies of 1, 50, and 100 megahertz (MHz) are 60, 80, and 85, respectively. It should be noted that when boards are coated more than 0.0020-inch thickness, the Q factor begins to drop rapidly; coating thickness in range of 0.001- to 0.002-inch range gives maximum protection of the electrical qualities of the circuit.

6.2 Ordering data. Procurement documents should specify the following:

- (a) Title, number, and date of this specification.
- (b) Type of coating required (see 1.2).
- (c) Compatibility required (see 3.3).
- (d) Curing time and temperature (see 3.4).
- (e) Special marking, if required (see 5.2).
- (f) Size of unit containers (see 5.1).
- (g) Quantity of material required (see 5.1).

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 qualified products list, whether or not such products have actually been so listed by that date. The attention of the suppliers 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 Electronics Command; however, information pertaining to qualification of products may be obtained from the Defense Electronics Supply Center (DESC-E), Dayton, Ohio 45444.

6.3.1 Copies of SD-6, "Provisions Governing Qualification" may be obtained upon application to Commanding Officer, Naval Publication and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.

6.4 Caution note. When the printed wiring assembly utilizes components made of brittle materials (glass or ceramic), such components should be protected, prior to coating, against breakage by the conformal coating type covering the component with transparent, clean, thin, pliant buffer material securely fitted, such as with heat shrinkable sleeving, polyethylene terephthalate covered by MIL-I-23053/7. The buffer material should cover the entire component and should not extend over the component by more than 0.062 inch and should be compatible with the conformal coating material. Also, these components should have stress relieving bends in their leads and should be so shaped that the leads remain straight for at least 0.060 inch from the part extremity (including seal and weld) and the inside bend radius should be equal to or exceed the lead diameter. Buffer material may not be needed when types SR or XY are used.

6.5 Ventilation. Coatings may contain toxic solvents and should be used with caution and in well ventilated areas. Suppliers shall include a "Warning" on the label of containers of material which may have a toxic effect on using personnel.

6.6 Changes from previous issue. Asterisks are not used in this revision to identify changes with respect to the previous issue, due to the extensiveness of the changes.

Custodians:

Army - EL
Navy - EC
Air Force - 80

Review activities:

Army - EL, MU, SL
Navy - AS
Air Force - 17
DSA - GS
NSA - S2

User activities:

Army - AV, WC
Navy - MC, OS, SH
Air Force -

Preparing activity:

Army - EL

Agent:

DSA - ES

(Project 5970-0372)

