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MILITARY SPECIFICATION

PLASTIC PLASTISOL (FOR COATING METALLIC OBJECTS)

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

1. SCOPE.

1.1 Scope. This specification covers plastisols with primer, suitable for coating metallic objects to provide protection from corrosion and abrasion, and to impart a comfortable feel.

1.2 Classification. The plastisols covered by this specification shall be of the following types and classes, as specified (see 6.2).

- Type I - General purpose dip coating compound
- Type II - General purpose spray coating compound
- Type III - General purpose roller coating compound

Classes under each type shall be as follows:

- Class 1 - General use
- Class 2 - Fungus resistant

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Director, US Army Laboratory Command, Materials Technology Laboratory, ATTN: SLCMT-MEE, Watertown, MA 02172-0001 by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

FSC 8030/

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2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation.

SPECIFICATIONS

FEDERAL

- PPP-C-96 - Cans, Metal, 28 Gauge and Lighter
- PPP-D-705 - Drum, Shipping and Storage: Steel, 16 and 30 Gallon Capacity
- PPP-D-729 - Drums, Shipping and Storage, Steel, 55 Gallon (208 Liters)
- PPP-P-704 - Pails, Metal: Shipping, Steel, (1 Through 12 Gallons)

STANDARDS

FEDERAL

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

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- MIL-STD-129 - Marking for Shipment and Storage
- MIL-STD-147 - Palletized Unit Loads
- MIL-STD-1190 - Minimum Guidelines for Level C Preservation, Packing, and Marking

(Copies of specifications, standards, handbooks, drawings, publications, and other Government documents required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

2.2 Other publications. The following document(s) form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted shall be those listed in the issue of the DODISS specified in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS shall be the issue of the non-Government documents which is current on the date of the solicitation.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- ASTM B117 - Salt Spray (Fog) Testing
- ASTM D149 - Dielectric Breakdown Voltage and Dielectric Strength of Electrical Insulating Materials at Commercial Power Frequencies
- ASTM D439 - Automotive Gasoline

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- ASTM D543 - Resistance of Plastics to Chemical Reagents
- ASTM D609 - Preparation of Steel Panels for Testing Paint, Varnish, Laquer, and Related Products
- ASTM D618 - Conditioning Plastics and Electrical Insulating Materials for Testing
- ASTM D746 - Brittleness Temperature of Plastics and Elastomers by Impact
- ASTM D817 - Cellulose Acetate Propionate and Cellulose Acetate Butyrate
- ASTM D882 - Tensile Properties of Thin Plastic Sheet
- ASTM D1823 - Apparent Viscosity of Plastics and Organosols at High Shear Rates by Extrusion Viscometer
- ASTM D1824 - Apparent Viscosity of Plastics and Organosols at Low Shear Rates by Brookfield Viscometer
- ASTM D1898 - Sampling of Plastics
- ASTM D2115 - Oven Heat Stability of Poly (Vinyl Chloride) Compositions
- ASTM D2240 - Rubber Property Durometer Hardness
- ASTM G21 - Determining Resistance of Synthetic Polymeric Materials to Fungi

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

NATIONAL MOTOR FREIGHT TRAFFIC ASSOCIATION, INC., AGENT:
National Motor Freight Classification

(Application for copies should be addressed to the American Trucking Associations, Inc., Tariff Order Section, 1616 P Street, N.W., Washington, DC 20036)

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

AMS 2825 - Material Safety Data Sheets

(Applications for copies of Aerospace Material Specifications (AMS) should be addressed to SAE, 400 Commonwealth Drive, Warrendale, PA 15096.)

UNIFORM CLASSIFICATION COMMITTEE, AGENT:
Uniform Freight Classification

(Application for copies should be addressed to the Uniform Classification Committee, Room 1106, 222 South Riverside Plaza, Chicago, IL 60606.)

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein (except for associated detail specifications, specification sheets or MS standards), the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 First article. When specified in the contract or purchase order, a sample shall be subjected to first article inspection (see 4.2.1 and 6.2)

3.2 Material. The coating system shall consist of a two part primer plastisol system. The plastisol shall consist of a dispersion of polyvinyl chloride in a suitable plasticizer or mixture of plasticizers, and other ingredients such as pigments and chemicals that provide protection against

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deterioration from heat and light. The primer shall be suitable for use with the plastisol.

3.3 Property values.

3.3.1 Dispersed plastisol. The dispersed plastisol shall conform to the property values specified in table I when tested as specified in the applicable procedure of 4.4.3.

3.3.2 Cast fused plastisol. Specimens prepared in accordance with 4.4.1.1 by coating unprimed steel with plastisol, followed by fusing the plastisol, shall conform to the property values specified in table II when tested as specified in the applicable procedure of 4.4.4.

3.3.3 Bonded fused plastisol. Specimens prepared in accordance with 4.4.1.2 by use of the primer plastisol system shall conform to the properties specified in table III when tested as specified in the applicable procedure of 4.4.5.

3.4 Color. Unless otherwise specified by the acquisition activity (see 6.2) color of the dispersed plastisol shall be black. If a color other than black is required for either the dispersed or the bonded fused plastisol, the color and method of inspection shall be as specified by the acquisition activity.

3.5 Shelf life.

3.5.1 Dispersed plastisol. The dispersed plastisol shall not settle, segregate, or change in such a way that it cannot easily be redispersed, after 6 months in the original container at $25^{\circ} + 10^{\circ}\text{C}$ ($77^{\circ} + 18^{\circ}\text{F}$). After redispersion, if required, there shall be no change in material properties that would exceed the original requirements.

3.5.2 Primer. The primer shall not settle, segregate, or change in such a way that it cannot easily be redispersed, after 6 months in the original container at $25^{\circ} + 10^{\circ}\text{C}$ ($77^{\circ} + 18^{\circ}\text{F}$). After redispersion, if required, there shall be no change in material properties that would exceed the original requirements.

3.6 Dipability, sprayability, and roller coating of plastisol.

3.6.1 Dipability. The plastisol coating shall be smooth, have a thickness of $40 + 10$ mils ($1.0 + 0.25$ mm), and a variation in thickness from top to bottom not exceeding 5 mils (0.125 mm) when tested as specified in 4.4.6.

3.6.2 Sprayability. The plastisol coating shall be $20 + 10$ ($0.5 + 0.25$ mm) mils thick, and free from runs and sags when tested as specified in 4.4.7.

3.6.3 Roller coating. The plastisol coating shall be smooth, have a thickness of $40 + 5$ mils ($1.0 + 0.125$ mm), and a variation in thickness not exceeding 3 mils (0.075 mm) when tested as specified in 4.4.8.

3.7 Application and adhesion of primer. The primer shall be capable of being applied easily by dipping, brushing, or spraying, as specified by the

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acquisition activity (see 6.2). The primer shall be capable of bonding coatings of the plastisol to the metal panels and conform to the requirements of table III.

3.8 Instruction sheet. Each shipment of the primer plastisol system shall include one or more copies, as specified (see 6.2), of an instruction sheet. In addition to any information considered pertinent by the supplier, the instruction sheet shall contain the following:

- (a) Designation of the primer required to be used with the plastisol to obtain the adhesion required.
- (b) Recommended method of application and curing of the primer.
- (c) Types of metallic surfaces and methods of preparing the surfaces for the adhesion required.
- (d) Recommended method of application of the plastisol including fusing temperature and time.
- (e) Changes in normal fusing temperature and time as required by effects of plastisol coating thickness, and size and shape of objects to be coated.
- (f) Approximate range of plastisol coating thickness obtainable with single and multiple casts.
- (g) Recommended dipping, spraying, and roller coating techniques, as applicable.
- (h) Recommended method for repairing damaged coatings (see 6.5).
- (i) Coverage of the primer, in square feet per gallon and square meters per liter.
- (j) Recommended method of primer application.
- (k) Curing or drying procedure for primer.
- (l) Temperature limitations for the primer.
- (m) Precautions in handling primer, if necessary.
- (n) Rates of primer to plastisol.

3.9 Workmanship. The dispersed plastisol and primer each shall be uniform in color and consistency, and shall be clean and free from visually identifiable foreign material. The applied and fused plastisol and primer shall appear as a smooth and uniform coating except runs and sags shall be allowed on production parts provided they do not exceed .005 in. (0.125 mm) difference in thickness when measured against surrounding areas, do not exceed 1.0 inch (25 mm) in any direction and are not as a result of poor bonding with the part surface.

3.10 Safety data. A material safety data sheet conforming to AMS 2825 shall be furnished to the acquisition activity by the supplier prior to, or concurrent with, the initial shipment of material. If the material formulation is subsequently changed within the constraints permitted by this specification, a revised data sheet shall be supplied prior to, or concurrent with, the first shipment of material with the revised formulation. Material safety data sheets shall be identified with this specification number.

4. QUALITY ASSURANCE PROVISIONS

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

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specified in the contract or purchase order, 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.

4.1.1 Responsibility for compliance. All items must meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of assuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling in quality conformance does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to acceptance of defective material.

4.1.2 Certificate of compliance (COC). Unless otherwise specified in the contract or purchase order, the supplier shall furnish with each shipment, a certificate of compliance (in triplicate) signed by a duly authorized representative of the supplier, stating compliance with the requirements specified herein and listing the specific results of all the acceptance tests. The certificate of compliance shall also include this specification number, the purchase order number, and the batch number.

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

- a. First article (i.e., preproduction) inspection (see 4.2.1)
- b. Quality conformance (i.e., lot acceptance) inspection (see 4.2.2)
- c. Process control (see 4.2.3)

4.2.1 First article inspection. First article inspection shall consist of all the tests contained in this specification (tables I, II and III.)

4.2.2 Quality conformance inspection. Quality conformance inspection shall consist of the tests specified in table IV.

4.2.3 Process control inspection. The equipment, procedures and operations employed by a supplier shall be capable of producing high quality plastic plastisol parts. Test specimens for process control of parts being plastisol shall be prepared and examined in accordance with table V.

4.3 Sampling for inspection. Sampling for inspection shall be performed in accordance with the provisions set forth in ASTM D1898 or as otherwise specified.

4.4 Test methods. Testing of dispersed, cast fused, and bonded fused plastisol for compliance with the requirements of this specification shall be performed in accordance with the applicable test methods described in this specification to the maximum extent practicable or as otherwise specified by the acquisition activity.

4.4.1 Specimen preparation.

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4.4.1.1 Cast fused plastisol.

4.4.1.1.1 Test panels. The test panels shall be prepared in accordance with method A of ASTM D609. Panel length and width shall be 12 inches by 4 inches (30 x 10 cm). If difficulty is experienced in stripping the fused coating from the panel, a suitable release agent, proved to have no deleterious effect on the coating, may be used.

4.4.1.1.2 Application and fusing of coating. The plastisol shall be applied to the panel with a draw down bar. Either one or both sides of the panel may be used. All coatings shall be 0.040 ± 0.005 inches (1.0 ± 0.1 mm) thick after fusing, except those for fungus resistance and flexibility testing. Specimens for fungus resistance shall be 0.020 to 0.025 inches (0.5 to 0.6 mm) thick after fusing, and those for flexibility testing shall be 0.075 ± 0.010 inches (2 ± 0.25 mm) thick. The plastisol shall be fused in accordance with the supplier's instruction sheet.

4.4.1.1.3 Cutting of cast fused specimens. The cast fused plastisol coating shall be stripped from the panel and cut into specimens. Specimens for tension testing shall be die cut to the dimensions specified in the applicable test method. Specimens for volume change testing shall be cut with a knife or scissors. Measurements for Durometer hardness shall be made on the portions of the blanks remaining after the other specimens have been removed. For testing to determine resistance to immersion, oven aging, and fungi, the specimens to be used as controls and those to be subjected to the environmental changes shall be selected from the various blanks at the same time so that initial differences between blanks or between different areas of the same blank will not affect the averaged results.

4.4.1.2 Bonded fused plastisol.

4.4.1.2.1 Test panels. Test panels shall be prepared in accordance with 4.4.1.1.1 except that dimensions shall be as specified in the applicable test method. For the adhesion test, a portion of the panel shall be left unprimed (see 4.4.1.2.2).

4.4.1.2.2 Application and fusing of coating. The primer shall be applied and cured in accordance with the supplier's instruction sheet. The plastisol shall be applied and fused in accordance with 4.4.1.1.2. For the adhesion test, a portion of the panel, of convenient size, shall be left unprimed so that a sufficient length of the coating can be stripped to provide an end to be grasped in the pulling device.

4.4.2 Conditioning and testing. Unless otherwise specified in the applicable test method, all specimens and other test samples (dispersed plastisol) shall be conditioned in accordance with procedure A of ASTM D618, and tested at $23^{\circ} \pm 2^{\circ}\text{C}$ ($73^{\circ} \pm 4^{\circ}\text{F}$) and 50 ± 5 percent relative humidity.

4.4.3 Dispersed plastisol testing.

4.4.3.1 Volatile matter. One determination for percent volatile matter of the plastisol shall be made by heating 5 ± 0.1 grams in an approximately 2

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inch (5 cm) diameter aluminum cup for 16 ± 1.0 hours at $600 \pm 20^\circ\text{C}$ ($1400 \pm 40^\circ\text{F}$). Heating shall be in an oven with mechanical air recirculation and exhaust. Percent loss in weight after 16 ± 1.0 hours shall indicate the amount of volatile matter.

4.4.3.2 Ash. One determination of ash content shall be made. The ash content shall be determined in accordance with ASTM D817.

4.4.3.3 Viscosity and viscosity ratio, Brookfield. Determination of viscosity shall be the average of three readings using a Brookfield model RVF viscometer with a number 6 spindle at 20 RPM. The as received plastisol shall be allowed to temperature stabilize for a minimum of 24 hours at $23^\circ \pm 2^\circ\text{C}$ ($73^\circ \pm 4^\circ\text{F}$). After temperature stabilization, the container shall be opened and any solid films or skins over the top surface of the dispersed plastisol shall be carefully removed and discarded. The contents shall be hand stirred for 15 minutes with a wide blade spatula with caution taken to avoid disturbing any partially cured plastisol adhering to the sides of the container and also avoid introducing air into material. For large containers such as 5 gallon (19 liter) drums, an additional 15 minutes of slow power driven stirring may be needed to assure complete mixing of the plastisol. Samples and viscosity measurements shall be in accordance with ASTM D1824-66. For viscosity ratios, three viscosity determinations shall be made using a number 6 spindle at 2 RPM. The viscosity ratio shall be calculated as the ratio of the average viscosity of 2 RPM to that at 20 RPM.

4.4.3.4 Viscosity, Castor-Severs. Three determinations for viscosity, by Castor-Severs viscometer, shall be made in accordance with ASTM D1823. Three determinations for type of flow shall be made in accordance with ASTM D1823, at shear rates between 900 sec^{-1} to 1500 sec^{-1} .

4.4.4 Cast fused plastisol testing. Specimens shall be prepared in accordance with 4.4.1.1.

4.4.4.1 Hardness. Three specimens of any convenient size shall be tested in accordance with ASTM D2240, using type A durometer.

4.4.4.2 Tensile strength and elongation. Three specimens shall be tested in accordance with ASTM D882, using method A. The length and width of specimens shall be as specified in ASTM D882.

4.4.4.3 Flexibility. Three specimens shall be tested in accordance with ASTM D746, except that the specimens shall be immersed for a minimum of one hour at the test temperature prior to testing. Testing temperature shall be $-40^\circ \pm 2^\circ\text{C}$ ($-40^\circ \pm 4^\circ\text{F}$). The length and width of specimens shall be as specified in ASTM D746.

4.4.4.4 Resistance to immersion. Three specimens shall be tested in accordance with ASTM D543, using the reagents specified in table II and a minimum immersion period of 2 days at $23^\circ \pm 2^\circ\text{C}$ ($73^\circ \pm 4^\circ\text{F}$). Tensile strength and elongation values after the immersion period shall be determined as specified in 4.4.4.2. The length and width of specimens shall be as specified in 4.4.4.2.

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4.4.4.5 Resistance to oven aging. Three specimens shall be tested in accordance with ASTM D2115, using a minimum aging period of 7 days at $70^{\circ} + 2^{\circ}\text{C}$ ($158^{\circ} + 4^{\circ}\text{F}$). Tensile strength and elongation values after the oven aging period shall be determined as specified in 4.4.4.2. The length and width of specimens shall be as specified in 4.4.4.2.

4.4.4.6 Dielectric strength. Three specimens shall be tested in accordance with ASTM D149, using the electrodes specified in this test method for tapes and films. Specimen dimensions shall be only of sufficient area to prevent flashover under the conditions of test.

4.4.4.7 Resistance to attack by fungi. Three specimens shall be tested in accordance with ASTM G21. The specimens shall be incubated in accordance with ASTM G21 for a minimum of 21 days. Tensile strength and elongation values after the incubation period shall be determined as specified in 4.4.4.2. The length and width of specimens shall be as recommended in ASTM G21 for film forming materials.

4.4.5 Bonded fused plastisol testing. Specimens shall be prepared in accordance with 4.4.1.2.

4.4.5.1 Adhesion. Three panels, of any convenient size for testing, shall be immersed in water at $23^{\circ} + 2^{\circ}\text{C}$ ($73^{\circ} + 4^{\circ}\text{F}$) for a minimum period of 7 days. The immersion period shall be followed by conditioning in accordance with 4.4.2. After conditioning, two parallel cuts, between 1/4 and 1/2 inch (6-12 mm) apart, shall be made along the long axis of the panel to the base metal. The plastisol and primer shall be separated from the surface of the panel, along the cut strip, for a distance sufficient to permit attachment of a suitable clamping device. It may be necessary to use repeated cuts with a sharp knife point to cause separation. The loose end of the strip shall be pulled slowly and steadily at approximately 90° to the surface of the panel. A specimen shall be considered to have passed the test if the strip breaks at a distance from the clamp before it has peeled from the panel an additional distance of 1/4 inch (6 mm). Each of the three specimens must pass. If necessary, the gripped portion of the strip shall be made wider than the remainder of the strip to prevent breaking in the grips. For the purposes of quality conformance and process control, the 7 day immersion in water prior to testing shall be deleted, and the specimens may be immediately tested for adhesion.

4.4.5.2 Impact flexibility. Three panels shall be tested in accordance with method 6226 of FED-STD-141. Panel dimensions shall be as specified in method 6226 of FED-STD-141.

4.4.5.3 Corrosion resistance. Three panels, of any convenient size for testing shall be tested in accordance with ASTM B117. After being subjected to testing in accordance with ASTM B117, the primer plastisol system shall be stripped off the metal panels. The panels shall be observed for visual evidence of corrosion where the primer plastisol system was removed.

4.4.6 Dipability of plastisol (applicable to type I material only). A primed panel shall be dipped in plastisol in accordance with the supplier's instruction sheet, and inspected for conformance with 3.6.1. The primed panel

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shall be prepared in accordance with supplier's instruction sheet. Panel dimensions shall be in accordance with 4.4.1.1.1, and depth of panel immersion shall be $10 \pm 1/2$ inch (25 ± 1.25 cm).

4.4.7 Sprayability of plastisol (applicable to type II material only). A primed panel shall be sprayed in accordance with the supplier's instruction sheet, and inspected for conformance with 3.6.2. The primed panel shall be prepared in accordance with supplier's instruction sheet.

4.4.8 Roller coating of plastisol (applicable to type III material only). A primed panel shall be roller coated in accordance with the supplier's instruction sheet, and inspected for conformance with 3.6.3. The primed panel shall be prepared in accordance with supplier's instruction sheet.

5. PACKAGING

• 5.1 Packaging. Packaging shall be level A or C, as specified (6.2).

5.1.1 Level A. The plastisol and primer shall be packaged, as specified (see 6.2), in 1 gallon (3.8 liters) or smaller cans conforming to type V, class 2, round of PPP-C-96, 5 gallon (19 liters) pails conforming to type II, class 3 of PPP-P-704, 16 gallon (60 liters) drums conforming to type III of PPP-D-705 or 55 gallon (220 liters) drums conforming to type III or IV of PPP-D-729. Cans conforming to PPP-C-96 shall be rust resistant coated on the exterior in accordance with plan B and the side seam shall be striped with a suitable corrosion resistant coating.

5.1.2 Level C. The cans, pails or drums shall be packaged to provide a sufficient level of protection to prevent deterioration during shipment, and to ensure safe delivery at destination.

5.2 Packing. Packing shall be level A, B, or C, as specified (see 6.2).

5.2.1 Level A. Plastisol and primer packaged in containers conforming to PPP-C-96 shall be packed in accordance with the overseas requirements of the appendix thereto. Plastisol and primer packaged in containers conforming to PPP-P-704, PPP-D-705, or PPP-D-729 require no overpacking. When specified (see 6.2), 5 gallon (19 liters) pails and 16 gallon (60 liters) drums shall be palletized in accordance with MIL-STD-147.

5.2.2 Level B. Plastisol and primer packaged in containers conforming to PPP-C-96 shall be packed in accordance with the domestic requirements of the appendix thereto. Plastisol and primer packaged in containers conforming to PPP-P-704, PPP-D-705, or PPP-D-729 require no overpacking. When specified (see 6.2), 5 gallon pails and 16 gallon drums shall be palletized in accordance with MIL-STD-147.

5.2.3 Level C. Packing shall be in accordance with MIL-STD-1190 practice adequate to ensure acceptance and delivery by the carrier for the mode of transportation employed. Containers shall comply with the requirements of the Uniform Freight Classification Rules or National Motor Freight Classification Rules, as applicable to the mode of transportation.

5.3 Marking. In addition to any special marking required by the contract or order (see 6.2), interior packages, exterior shipping containers, and palletized unit loads shall be marked in accordance with MIL-STD-129.

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6. NOTES

6.1 Intended use. Plastisols conforming to this specification are intended to be used to form protective coatings on metallic objects. These coatings usually are in the thickness range of 1.5 to 3 millimeters (1/16 to 1/8 inch), have a good resistance to abrasion and to immersion in moderate concentrations of acids and alkalis at temperatures below approximately 60°C (140°F), and can withstand dry storage at somewhat higher temperatures. Although they will withstand occasional cleaning and splashing with detergent solutions, organic solvents, and petroleum based fuels and lubricants, they are not recommended for continuous immersion in these liquids. Although not the best electrical insulators, coatings of sufficient thickness to provide a comfortable feel will provide protection from low voltage electrical shocks.

6.1.1 Type I. The type I plastisols are expected to produce coatings which are of higher quality in regard to their resistance to abrasion and to chemicals and solvents than are many of those made with filled plastisols which are commonly applied to domestic civilian items. They are intended to be used for coating on triggers, levers, handwheels and handtools to provide a comfortable feel and to enable the articles to be handled at low temperatures. Type I plastisols are applied by dip coating.

6.1.2 Types II, and III. The types II, and III plastisols are intended for use as coatings for chemical tanks, fume hoods and ducts, battery supports and plating racks where the base metal is relatively heavy and the coating is required to have maximum resistance to abrasion and chemicals. Type II materials are applied by spray coating methods, and type III materials are applied by the roller coating process.

6.1.3 Classes 1 and 2. Class 1 materials of types I, II, and III are intended for general purpose use. Class 2 materials of types I, II, and III are intended for applications where fungus resistance is required.

6.2 Ordering data. Acquisition documents should specify the following:

- a. Title, number, and date of this specification
- b. Type and class required (see 1.2 and 6.1)
- c. Color of plastisol required, and method of determination (if other than black), (see 3.4)
- d. Method of primer application (see 3.7), and color or primer, if required
- e. Number of instruction sheets (see 3.8)
- f. Whether commercial packaging is required (see 5.4)
- g. Quality conformance inspection if other than 4.2.2
- h. Quantity of plastisol and primer and size of containers)
- i. Level of packaging and packing required (see 5.1 and 5.2)
- j. Whether palletizing is required (see 5.2.1 and 5.2.2)
- k. Any special marking required (see 5.3)
- l. Whether first article inspection is required (see 3.1)

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6.3 Adhesion. The amount of adhesion required depends on the shape of the object to be coated and on the service to which the coated object will be subjected. When the coating completely surrounds a part, adhesion may not be required. Although a reasonable amount of adhesion usually can be obtained by applying the primer-plastisol system to clean metal, the best adhesion and resistance to the spread of corrosion under the coating from breaks or edges is obtained by the use of a phosphate treatment. The primer which provides the best adhesion of a particular plastisol to phosphated steel may be expected to provide the best adhesion of that plastisol to other surfaces. However, the adhesion of the system to different bases may be different. For example, it is difficult to obtain good adhesion to stainless steel, chrome platings and hot dip galvanized surfaces. A primer which works well with one plastisol may not be suitable for use with another. Therefore, the supplier of the plastisol is required to supply and to be responsible for the behavior of the primer to be used under it. The quantity of plastisol required to coat a given number of objects depends on the volume of the coating, which is the area multiplied by the thickness. However, the quantity of primer required depends only on the area to be coated. Therefore, different proportions of primer to plastisol are required, and should be ordered, to produce coatings of different thicknesses.

6.4 Application. The usual procedure for applying plastisol coatings to metallic objects is to clean and sometimes to roughen or chemically treat the metallic base, depending on the nature of the base and the adhesion and durability of coating required, to apply and cure (usually by baking) the primer, to heat the primed object to a suitable temperature and to immerse the heated object in the plastisol (or to apply the plastisol by spraying or roller coating). A jell coating of the plastisol will adhere to the surface. The thickness of this coating can be controlled by varying the temperature of the part before immersion, the immersion time, the rate of withdrawal from the bath, and the number of dips. These factors may have to be changed as the properties of the dispersion in the dip tank change with age. The thickness of coating applicable by one dip will vary with the composition, shape, and size of the object being coated. Liberal thickness tolerances should be specified for coatings on object which have thin and thick sections. This coating must then be fused by heating the coated object for the proper time at the recommended fusing temperature usually 177° to 205°C (350° to 400°F). When multiple dipping (or spraying) is performed, the usual practice is to bake the first and intermediate coats at a temperature lower than that used for the final coat in order to avoid overbaking the undercoats. Since some primers can be injured by heating to too high a temperature before they have been protected with a coating of plastisol, the directions of the manufacturer should be followed in preheating primed parts before dipping. The use of an oven having adequate air circulation is essential for the proper fusing of thick plastisol coatings. The following requirements should be considered as minima:

Exhaust - 2 internal oven volumes per minute.

Recirculation - 10 oven volumes per minute.

Heat input - 1000 Btu/cu. ft./hr. (9547 kcal/m³/hr.)

6.5 Repairing. Damaged coatings can be repaired by adding plastisol to the defective area and fusing it at the temperature required, in accordance with supplier's instructions.

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6.6 Optimum fusing time. The optimum fusing time at the recommended temperature should be determined on the particular object by trial. The optimum fusing time is that time at the recommended temperature at which the coating is completely fused but not injured by overheating. One method of determining this time is by dipping unprimed units of the article to be coated, heating them at the recommended temperature for various lengths of time, stripping the coatings, subjecting them to tensile tests, and plotting their elongations. The optimum fusing time is the time at which the slope of the percent elongation vs. time curve becomes horizontal or nearly so. The tensile tests may be made shortly after the specimens have cooled to room temperature, provided that all the specimens are tested after the same aging procedure, since only comparative results are needed. If the optimum fusing temperature is not known, the above experiment may be repeated at different baking temperatures and a temperature should be chosen which produces specimens having satisfactory tensile strengths and elongations after a reasonable heating time. It is expected that the manufacturer's recommended fusing temperature and time for the standard specimen will have been based on similar tests. In some instances it may be advisable to make thick coatings at lower temperatures and for longer times than those found suitable for thin coatings. If the size and shape of the object is such that a tensile specimen cannot be obtained from it, another object of different shape but of equivalent mass and thickness may be substituted for it in this test.

6.7 Fungicides and plating baths. Some fungicides are capable of poisoning certain plating baths, particularly chrome plating baths. Therefore, when a plastisol conforming to this specification is to be used as a coating which will be in contact with a plating solution, it is recommended that it be specified that only plastisols approved by the manufacturer of the plating solution be used.

6.8 Subject term (key word) listing.

Plastisols	Corrosion protection
Dip coating	Spray coating
Roller coating	

Custodians
 Army - MR
 Navy - SH
 Air Force - 84

Preparing activity:
 Army - MR

Project 8030-0601

Review interest:
 Army - MI, AR, EA
 Navy - SH
 Air Force - 84

User interest:
 Army - AT, ME
 Navy - YD, AS, EC

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TABLE I. Property values of dispersed plastisol.

Property	Type I	Classes 1 and 2	
		Type II	Type III
Volatile matter, percent, max.	5	10	10
Ash content, percent, max.	10	10	5
Viscosity, Brookfield RVF, No. 6 spindle, 20 rpm, 10^3 centipoises	8 ± 2	15 ± 10	5 ± 0.5
Viscosity ratio, Brookfield RVF, 2/20 rpm, No. 6 spindle, min.	NA <u>1/</u>	3	NA
Viscosity, Castor-Severs, 1/8 inch orifice, poise at sec ⁻¹	NA	150	150
type of flow (at 900 sec ⁻¹ to 1500 sec ⁻¹ shear rate)	NA	non dilatent	non dilatent

1/NA - Not applicable.

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TABLE II. Property values of cast fused plastisol.

Property	Classes 1 and 2 ^{1/}		
	Type I	Type II	Type III
Hardness, Durometer A	65 ± 5	65 ± 5	65 ± 5
Tensile strength, psi, (MPa), min.	1500(10.3)	1500(10.3)	1500(10.3)
Elongation, percent, min.	250	250	250
Flexibility at -40° ± 2°C (-40° ± 4°F)	pass _{2/}	pass _{2/}	pass _{2/}
Resistance to immersion for 2 days at 23° ± 2°C (73° ± 4°F), percent change in property, max.			
<u>Property</u>			
% tensile strength change,	+ 20	+ 20	+ 20
% elongation change,	+ 10	+ 10	+ 20
% volume change, Reagent: 20% sulfuric acid	+ 5	+ 5	+ 5
% tensile strength change,	+ 15	+ 20	+ 20
% elongation change,	+ 15	+ 15	+ 15
% volume change, Reagent: 20% sodium hydroxide	+ 5	+ 5	+ 5
% tensile strength change, Reagent: ASTM D439 Class A unleaded gasoline	+ 20	+ 20	+ 20
Resistance to oven aging for 7 days at 70° ± 2°C (158° ± 4°F)			
% tensile strength change, max.	+ 20	+ 20	+ 20
% Change in elongation, max.	+ 10	+ 10	+ 10
Dielectric strength, volts per mil, min.	300	300	300
Resistance to attack by fungi ^{1/} , ^{3/} Appearance of inoculated and incubated specimens	No visible growth	No visible growth	No visible growth
% Change in tensile strength, max.	+ 20	+ 20	+ 20
% Change in elongation, max.	+ 20	+ 20	+ 20

^{1/}Resistance to attack by fungi applicable to class 2 material only.

^{2/}The plastisol shall not crack.

^{3/}The plastisol shall not contain any organo-mercury compounds (see 4.2.1)

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TABLE III. Properties of bonded fused plastisol.

Property	Type I	Classes 1 and 2	
		Type II	Type III
Adhesion after 7 days immersion in water at $23^{\circ} \pm 2^{\circ}\text{C}$ ($73^{\circ} \pm 4^{\circ}\text{F}$)	pass ₁ /	pass ₁ /	pass ₁ /
Impact flexibility	pass ₂ /	pass ₂ /	pass ₂ /
Corrosion resistance	pass ₃ /	pass ₃ /	pass ₃ /

1/The plastisol shall show no visible evidence of separation from the metal. The plastisol shall show good adhesion to the metal when cut with a knife and lifted from the cut. A recovery period of 30 to 35 minutes at $23^{\circ} \pm 2^{\circ}\text{C}$ ($73^{\circ} \pm 4^{\circ}\text{F}$) is allowable before testing adhesion.

2/The plastisol shall show no visible evidence of shattering, cracking, or chipping.

3/There shall be no visible evidence of corrosion of the metal panel.

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TABLE IV. Quality conformance tests.

Test	Class 1 and 2			Method Para.
	Type I	Type II	Type III	
For dispersed plastisol				
Volatile matter	X	X	X	4.4.3.1
Ash content	X	X	X	4.4.3.2
Viscosity, Brookfield	X	X	X	4.4.3.3
Viscosity Ratio, Brookfield	N/A	X	N/A	4.4.3.4
Viscosity, Castor-Severs	N/A	X	X	4.4.3.5
For cast fused plastisol				
Hardness, Durometer A	X	X	X	4.4.4.1
Tensile strength	X	X	X	4.4.4.2
Elongation	X	X	X	4.4.4.2
For bonded fused plastisol				
Dipability	X	N/A	N/A	4.4.6
Sprayability	N/A	X	N/A	4.4.7
Roller coating	N/A	N/A	X	4.4.8
Adhesion	X	X	X	4.4.5.1

TABLE V. Process control tests.

Test	Specimen	Method Criteria	Frequency
Adhesion	4.4.1.2.2	4.4.5.1	1 per week minimum
Dipability 1/	4.4.6	4.4.6, 3.6.1	1 per week minimum
Sprayability 2/	4.4.7	4.4.7, 3.6.2	1 per week minimum
Roller Coat 3/	4.4.8	4.4.8, 3.6.3	1 per week minimum

1/ Type I

2/ Type II

3/ Type III

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

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1. DOCUMENT NUMBER MIL-P-20689D	2. DOCUMENT TITLE Plastic Plastisol (FOR COATING METALLIC OBJECTS)
3a. NAME OF SUBMITTING ORGANIZATION b. ADDRESS (Street, City, State, ZIP Code) 	4. TYPE OF ORGANIZATION (Mark one) <input type="checkbox"/> VENDOR <input type="checkbox"/> USER <input type="checkbox"/> MANUFACTURER <input type="checkbox"/> OTHER (Specify): _____
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