

NOT MEASUREMENT SENSITIVE

MIL-PRF-85285D
w/AMENDMENT 3
2 February 2009
SUPERSEDING
MIL-PRF-85285D
w/AMENDMENT 2
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PERFORMANCE SPECIFICATION

COATING: POLYURETHANE, AIRCRAFT AND SUPPORT EQUIPMENT

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

1. SCOPE

1.1 Scope. This specification covers the requirements for polyurethane coating with a maximum volatile organic compound (VOC). The coating is furnished in kit form.

1.2 Classification. The coating covered by this specification is divided into the following types and classes (see 6.2):

1.2.1 Type. The types of coatings are as follows:

Type I - Aircraft application (420 grams/liter g/l maximum VOC content)

Type II - Support equipment application (340 g/l maximum VOC content)

Type III - Aircraft and support equipment application (50 g/l maximum VOC content)

Type IV - Aircraft application with extended weatherability (420 grams/liter g/l maximum VOC content)

1.2.2 Class. The classes of coatings are as follows:

Class H – High-solids formulation

Class W – Water-borne formulation

Comments, suggestions, or questions on this document should be addressed to: Commander, Naval Air Warfare Center Aircraft Division, Code 4L8000B120-3, Highway 547, Lakehurst, NJ 08733-5100 or emailed to michael.sikora@navy.mil . Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at http://assist.daps.dla.mil .

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1.3 Part or Identifying Number (PIN). The PINs to be used for polyurethane coatings acquired to this specification are created as follows:

M85285	-	X	-	X	-	XXXXX	-	XXXX
Specification identifier		Type designator		Class designator		FED-STD-595 Color Designation (see 6.7)		Kit size designator (see 1.3.1)
		1 = Type I		(H or W)				
		2 = Type II						
		3 = Type III						
		4 = Type IV						

1.3.1 Kit size. The coatings covered by this specification should be purchased by volume, the unit being a kit containing two components. The kit component sizes need not be of the same size. When this part numbering system is used, the kit size is to be identified as:

Kit Size <u>1/</u>	Kit Size Designator
Less than one pint	<u>2/</u>
4-pint (0.47-liter)	004P
4-quart (0.95-liter)	004Q
4-gallon (3.79-liter)	004G
20-gallon (75.7-liter)	020G

1/ The kit size and its designator may be modified for ease of procurement and is not limited.

2/ Designators for less than pint size kits (small touch-up kits) should be expressed in cubic centimeters (cc) and should be designated by "C." Example: A type I, class H, 50 cc kit, gloss red should be designated M85285-1-H-11136-050C.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications and standards. The following specifications and standards form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

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SPECIFICATIONS

FEDERAL

TT-R-2918 - Remover, Paint, No Hazardous Air Pollutants (HAPs).

DEPARTMENT OF DEFENSE

MIL-DTL-5541 - Chemical Conversion Coatings on Aluminum and Aluminum Alloys.
 MIL-DTL-5624 - Turbine Fuel, Aviation, Grades JP-4, JP-5, and JP-5/JP-8ST.
 MIL-A-8625 - Anodic Coatings for Aluminum and Aluminum Alloys.
 MIL-PRF-23377 - Primer Coatings: Epoxy, High-Solids.
 MIL-PRF-23699 - Lubricating oil, Aircraft Turbine Engine, Synthetic Base, NATO Code Number O-156
 MIL-R-81294 - Remover, Paint, Epoxy, Polysulfide, and Polyurethane Systems
 MIL-T-81772 - Thinner, Aircraft Coating.
 MIL-PRF-83282 - Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon Base, Metric, NATO Code Number H-537.
 MIL-PRF-85570 - Cleaning Compound, Aircraft, Exterior.
 MIL-PRF-85582 - Primer Coatings: Epoxy, Waterborne.

STANDARDS

FEDERAL

FED-STD-141 - Paint, Varnish, Lacquer and Related Materials; Methods of Inspection, Sampling and Testing.
 FED-STD-595 - Colors Used in Government Procurement
 Color numbers 34095, 13538, 17925, 36375.

(Copies of these documents are available online at <http://assist.daps.dla.mil/quicksearch/> or <http://assist.daps.dla.mil> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) INTERNATIONAL

ASTM-D185 - Pigments, Pastes, and Paints, Coarse Particles in. (DoD Adopted)
 ASTM-D522 - Mandrel Bend Test of Attached Organic Coatings. (DoD Adopted)

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ASTM-D523	-	Gloss Specular. (DoD Adopted)
ASTM-D823	-	Producing Films of Uniform Thickness of Paint, Varnish, and Related Product on Test Panels. (DoD Adopted)
ASTM-D1193	-	Reagent Water. (DoD Adopted)
ASTM-D1200	-	Cup, Viscosity by Ford Viscosity. (DoD Adopted)
ASTM-D1210	-	Fineness of Dispersion of Pigment-Vehicle Systems, by Hegman-Type Gage. (DoD Adopted)
ASTM-D1296	-	Volatile Solvents and Dilutents, Odor of. (DoD Adopted)
ASTM-D1364	-	Water in Volatile Solvents (Karl Fischer Reagent Titration Method). (DoD Adopted)
ASTM-D1640	-	Organic Coatings, Drying, Curing, or Film Formation of, at Room Temperature. (DoD Adopted)
ASTM-D2243	-	Water-Borne Coatings, Freeze-Thaw Resistance of. (DoD Adopted)
ASTM-D2244	-	Calculation of Color Differences From Instrumentally Measured Color Coordinates,. (DoD Adopted)
ASTM-D2247	-	Water Resistance Testing of Coatings in 100 Percent Relative Humidity. (DoD Adopted)
ASTM-D3335	-	Lead, Cadmium, and Cobalt in Paint by Atomic Absorption Spectroscopy, Test For Low Concentrations of. (DoD Adopted)
ASTM-D3359	-	Measuring Adhesion by Tape Test, Standard Test Method
ASTM-D3432	-	Solutions by Gas Chromatography, Unreacted Toluene Diisocyanates in Urethane Prepolymers and Coating. (DoD Adopted)
ASTM-D3718	-	Paint, Chromium in, by Atomic Absorption Spectroscopy, Low Concentrations of. (DoD Adopted)
ASTM-D3924	-	Paint, Varnish, Lacquer, and Related Materials, Conditioning and Testing, Standard Environment For. (DoD Adopted)
ASTM-D3960	-	Paints and Related Coatings, Determining Volatile Organic Content (VOC) of. (DoD Adopted)
ASTM-G155	-	Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials.

(Copies of these documents are available from www.astm.org or ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.)

AMERICAN SOCIETY FOR QUALITY (ASQ)

ASQ-Z1.4	-	Procedures, Sampling and Tables for Inspection by Attributes. (DoD Adopted)
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(Copies of this document are available from www.asq.org or the American Society for Quality, 600 Plankinton Avenue, Milwaukee, WI 53203.)

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SOCIETY OF AUTOMOTIVE ENGINEERS (SAE) INTERNATIONAL

SAE-AMS-QQ-A-250/4 - Aluminum Alloy 2024, Plate and Sheet. (DoD Adopted)

(Copies of this document are available from <http://www.sae.org> or from the Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096-0001.)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Qualification. The coatings furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified products list (QPL) before contract award (see 4.3 and 6.5).

3.2 Materials. Materials used to manufacture these coatings are not limited, provided that the resulting coatings meet the requirements of this specification.

3.3 Toxicity. The coatings shall have no adverse effect on the health of personnel when used for its intended purpose and with the precautions listed in 3.10.1 - 3.10.3, when evaluated in accordance with 4.6.15 (see 6.3).

3.4 Composition. The polyurethane coating furnished under this specification shall be in the form of a kit consisting of component A, containing the pigmented polyester resins and solvents, component B, containing the clear, aliphatic isocyanate resins (see 6.3) and solvents, and optional component C containing either organic solvents for class H, or deionized water for class W. Component B shall act as the hardener or curing agent for component A. The volume mixing ratio shall be as specified by the manufacturer. The coating kit shall be supplied such that the admixed coating consists of the minimum volume specified by the procuring activity (see 6.2). When tested in accordance with 4.6, the total free isocyanate in the admixed coating shall not exceed 1.0 percent by weight, no component of the coating shall contain cadmium, cadmium compounds, or more than 0.05 percent by weight of lead metal or lead compounds, and the coating shall not contain hexavalent chromium.

3.4.1 Solvent content. All solvents necessary for thinning purposes shall be supplied as part of either the base or the activator component of the coating kit. The resistivity of the solvents shall permit application of class H coatings by electrostatic spray methods. When tested in accordance with 4.6, the maximum VOC content shall be 420 grams per liter (g/l) for types I and IV coatings, 340 g/l for type II coatings, and 50 g/l for type III coatings. Solvents used for class H shall be urethane grade and contain a minimum of water and alcohol (see 6.4). Class H coatings shall be compatible with thinner conforming to MIL-T-81772, type I. Brominated and

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chlorinated solvents, except for para-chlorotrifluoromethylbenzene or equal, shall be prohibited in the formulation of this product.

3.5 Component properties.

3.5.1 Condition in container.

3.5.1.1 Component A. When tested in accordance with 4.6.1, component A shall be smooth, homogeneous, and pourable. The coating shall be free of grit, skin, seeds, lumps, foreign contaminants, and abnormal thickening or livering, and shall not exhibit pigment floatation nor excessive settling that cannot be reincorporated into a smooth, homogeneous state by mixing with a hand paddle.

3.5.1.2 Component B. Component B shall be homogeneous, clear, and free from gelation or detectable particulate matter, either suspended in solution or settled on the inner surface of the container. Component B shall not cause its container to deform (see 4.6.1).

3.5.1.3 Component C (class W only). Component C shall be water clear, free from particles, have a pH between 5 and 8, and an electrical resistivity greater than or equal to 0.2 Mohm/cm (see 4.6).

3.5.2 Storage stability. The unopened coating components, as packaged by the manufacturer, shall meet all requirements of this specification after storage for a period of one year. The conditions for the storage shall be a daily ambient air temperature that is maintained at 1.7 to 46 °C (35 to 115 °F) (see 4.6 and 6.5.2).

3.5.3 Accelerated storage stability. After storage for 14 days (see 4.6.2), the coating components as packaged by the manufacturer, when admixed shall meet all requirements of this specification. The container shall not become deformed or the lid shall not become unsealed during the storage period.

3.5.4 Freeze-thaw stability (class W only). The coating components, as packaged by the manufacturer, shall meet all the requirements of this specification after being subjected to five cycles of freezing and thawing as specified in 4.6.

3.5.5 Moisture content (class H only). Component A shall contain no more than 2.0 percent by weight of water when tested as specified in 4.6.

3.6 Liquid properties.

3.6.1 Fineness of grind. The fineness of grind (measured on the Hegman scale) of the admixed coating shall be a minimum of 7 for gloss colors and a minimum of 5 for camouflage (flat or lusterless) colors when tested as specified in 4.6.

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3.6.2 Coarse particles. Coarse particles retained on a No. 325 sieve shall be no more than 0.5 percent by weight of the admixed coating when tested as specified in 4.6.

3.6.3 Odor. The odor of the coating, as packaged components, as an admixed coating, and as a film after application, shall be characteristic of the thinners used when tested as specified in 4.6. The air-dried coating shall retain no residual odor 48 hours after application.

3.6.4 Viscosity and pot life. The viscosity of the admixed coating when maintained under continuous mixing (no vortex) in a closed container, and tested as specified in 4.6 through a No. 4 Ford cup, shall be as specified in table I:

TABLE I. Viscosity.

Time from mix (minimum)	Maximum time through a No. 4 Ford cup
Initially	30 seconds
4 hours	60 seconds
5 hours	no gelation

3.7 Cured coating properties.

3.7.1 Drying time. When applied by spray techniques and tested as specified in 4.6, the coating shall be set-to-touch within six hours and dry-hard within twelve hours.

3.7.2 Surface appearance. The coating shall dry to a uniform, smooth surface, free from runs, sags, bubbles, streaks, hazing, seeding, dusting, floating, mottling, or other defects (see 4.6.3). No orange peel (wavy appearance) shall be evident when viewed from at least six feet away.

3.7.3 Color. The admixed coating, when tested as specified in 4.6, using CIELAB color coordinates, shall have a color difference (ΔE) of less than 1 when compared to the specified color chip in FED-STD-595.

3.7.4 Infrared reflectance (FED-STD-595, color number 34095 only). The total infrared reflectance (specular and diffuse) of the coating (FED-STD-595, color number 34095), relative to barium sulfate shall be not greater than 8 throughout the range of 700 to 2,600 nanometers (nm) (see 4.6.4).

3.7.5 Gloss. The specular gloss of the coating, when tested as specified in 4.6, shall be as shown in Table II at a 60° angle of incidence.

TABLE II. Specular gloss.

Color type	Minimum	Maximum
Gloss	90	---
Semi-gloss	15	45
Camouflage (flat or lusterless)	---	5

A maximum of 10 for camouflage colors at an 85° angle of incidence.

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3.7.6 Opacity (hiding power). The coating shall have a contrast ratio of no less than 0.95 for all colors except yellow (FED-STD-595, Color 13538), which shall have a contrast ratio of not less than 0.90, when cast to a dry film thickness of 1.9 to 2.1 mils [48 to 53 micrometer (μm)] on a black and white chart and tested in accordance with 4.6.5.

3.7.7 Adhesion. The coating shall have a rating of no less than 4A when examined in accordance with ASTM-D3359 (see 4.6.6).

3.7.8 Flexibility.

3.7.8.1 Impact flexibility. The coating shall meet the following minimum requirements for ambient temperature impact flexibility: types I, III and IV, 40 percent; and type II, 5 percent; when tested in accordance with 4.6.7.1.

3.7.8.2 Low-temperature flexibility (Type I, Type III and Type IV only). The type I, type III, and type IV coatings, at a temperature of -51 ± 3 °C (-60 ± 5 °F), shall exhibit no cracking when bent, coated side away, over a 1.0 inch (in.) [25.4 millimeter (mm)] mandrel for gloss and semi-gloss colors, and over a 2.0 in. (50.8 mm) mandrel for camouflage colors, when tested in accordance with 4.6.7.2

3.8 Resistance properties.

3.8.1 Fluid resistance. When immersed in lubricating oil conforming to MIL-L-23699, hydraulic fluid conforming to MIL-PRF-83282, and JP-5 fuel conforming to MIL-DTL-5624, the coating shall not exhibit any blistering, softening, or other coating defects. Slight staining of the coating is acceptable (see 4.6.8).

3.8.2. Weather resistance. For types I, II, and III, after exposure in Xenon-arc weatherometer for 500 hours as specified in 4.6.9: (a) 60° specular gloss of the coating shall be a minimum of 80 Gloss Units (G.U.) for gloss colors; a minimum of 15 G.U. for semi-gloss colors; a maximum of 5 G.U. for camouflage colors, and (b) the coating color difference (DE) shall have a value of less than 1.0 when compared to an unexposed sample of the same batch using CIELAB color coordinates.

For type IV, after exposure in Xenon-arc weatherometer for 3000 hours as specified in 4.6.9: (a) The 60° specular gloss of gloss colors shall have a change in Gloss Units (G.U.) of less than 20 from the unexposed initial value. (b) The semi-gloss colors shall have a minimum of 15 G.U. at 60°. (c) The camouflage colors shall have a change in G.U. of less than 3 at 60° and 85° from the unexposed initial values, and (d) the coating color difference (ΔE) shall have a value of less than 1.0 when compared to an unexposed sample of the same batch using CIELAB color coordinates.

3.8.3. Humidity resistance. The coating shall withstand exposure for no less than 30 days in a humidity cabinet maintained at 49 ± 2 °C (120 ± 3 °F) and 100 percent relative humidity (RH) without blistering, softening, exhibiting any loss of adhesion, nor other film defects when tested as specified in 4.6.

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3.8.4. Heat resistance (color change). The coating after exposure to 121 ± 3 °C (250 ± 5 °F) in accordance with 4.6.10 for 60 minutes, shall have a color difference (ΔE) less than or equal to 1.0 when compared to an unexposed sample of the same batch and tested as specified in 4.6.10 using CIELAB color coordinates.

3.8.5 Solvent resistance (cure). The coating shall withstand 25 double rubs with a cotton terrycloth rag soaked in methyl ethyl ketone (MEK) solvent (see 6.10) when tested in accordance with 4.6.11. Rubbing through to bare metal indicates failure of the coating due to improper cure.

3.8.6 Tape resistance. The coating shall not exhibit permanent marring caused by masking tape applied to the coated test panels, when tested in accordance with 4.6.12.

3.9 Working properties.

3.9.1 Mixing. When following the manufacturer's instructions all components of the coating shall mix readily to a homogenous product using a hand-held paddle.

3.9.2 Application. The coating shall be applied by conventional, airless, HVLP, or electrostatic (class H only) spray application. When spray is applied at 15.6 to 32.2 °C (60 to 90 °F) and a relative humidity of 20 to 80 percent, the coating material shall yield a smooth, uniform film at a dry-film thickness of 1.7 to 2.3 mil. No orange peel (wavy appearance) shall be evident when viewed from at least six feet away. When reducing the coating, caution shall be taken not to exceed the maximum VOC content of 420 g/l for types I and IV, 340 g/l for type II, and 50 g/l for type III.

3.9.3 Cleanability. The coating shall maintain a cleaning efficiency of not less than 75 percent, when cleaned in accordance with 4.6.13 through 4.6.13.5.

3.9.4 Strippability. Coatings shall be tested in accordance with Methods A and B of 4.6.14, and a minimum of 90 percent of the coating shall be stripped by one of the methods.

3.10 Identification of material. Individual containers greater than 1 pint and cases of containers 1 pint or less, shall bear permanent labels showing the following:

Specification MIL-PRF-85285D, "Coating: Polyurethane, Aircraft and Support Equipment"

Component A, B, or C (as applicable)

Type and class

Color (name and FED-STD-595 color number)

Manufacturer's name, product number, and batch number

Date of manufacture by month and year

VOC content in grams/liter

Net contents

Mixing and thinning instructions

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3.10.1 Component containers. All containers of toxic and hazardous chemicals and materials shall be labeled in accordance with the applicable federal, state, and municipal laws, statutes, regulations, and ordinances. In addition to the labeling, the following shall appear on each component container in every kit, on each exterior shipping container, and on the case of containers less than 1 pint.

CAUTION
THIS COATING MATERIAL IS TOXIC AND FLAMMABLE
DO NOT USE IN CONFINED AREAS
DO NOT USE WHERE THERE ARE OPEN FLAMES, ARCING EQUIPMENT,
HOT SURFACES, NOR WHERE SMOKING IS PERMITTED.
USE ONLY WITH ADEQUATE VENTILATION.
AVOID BREATHING OF VAPOR.
DO NOT GET IN EYES, ON SKIN, ON CLOTHING.
IN CASE OF CONTACT, IMMEDIATELY FLUSH EYES OR SKIN WITH PLENTY OF
WATER. FOR EYES, GET MEDICAL ATTENTION.

3.10.2 Lid (component B only). Each lid of component B material shall have a red printed label with the following information:

"USE CAUTION.
OPEN SLOWLY."

3.10.3 Precautions. Each kit shall include a sheet listing the following precautions:

- a. The surface to be coated must be clean (free of oil, dust, etc.)
- b. Spray equipment must be adequately grounded. Clean equipment immediately after use. For class W only, use water followed by thinner. For all other classes use thinner only. In all cases thinner conforming to MIL-T-81772, type I, shall be used.
- c. Mix only the amount of coating to be used within four hours.
- d. Never mix coating or individual component from one vendor with that of another vendor. Components from different kits are not interchangeable. For example, do not use Component A in white with component B in gray.
- e. Apply to pretreated metal or appropriately prepared organic matrix composite surfaces.
- f. Dispose of, without opening, any container that is bulged or deformed.
- g. Open component B carefully. If the contained material is not clear, dispose of it.
- h. Perform production type operations only in specifically designated areas with local exhaust ventilation and other environmental control measures, as may be recommended on the basis of an on-site industrial hygiene survey.
- i. Perform touch-up type operations only in areas with good ventilation (such as a hangar deck or in a hangar with the doors open). Do not expose unprotected personnel in adjacent areas to mist, spray, or vapor. Application shall be restricted to brush, roller, or self-pressurized spray kit. No one person shall apply more than one quart of polyurethane coating by self-pressurized spray in any 24-hour period

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4. VERIFICATION

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

- a. Qualification inspection (see 4.3).
- b. Conformance inspection (see 4.4).

4.2 Inspection conditions. Unless otherwise specified, all inspections shall be performed in accordance with the conditions specified in ASTM-D3924, and in duplicate. Unless otherwise stated in the test method or paragraph herein, room temperature shall be $21^{\circ} \pm 5^{\circ}\text{C}$ ($70^{\circ} \pm 10^{\circ}\text{F}$) and relative humidity as 50 ± 10 percent.

4.3 Qualification inspection. The qualification inspection shall consist of all tests specified in 4.6 and table III.

4.4 Conformance inspection.

4.4.1 Tests. The conformance inspection shall consist of all the tests specified in table III, except toxicity (3.3), composition (3.4), storage stability (3.5.2), freeze-thaw stability (3.5.4), infrared reflectance (3.7.4), weather resistance (3.8.2), humidity resistance (3.8.3), cleanability (3.9.3), and strippability (3.9.4) (see 6.9).

4.4.1.1 Visual inspection of filled containers. Samples shall be selected at random from each lot (see 6.8) in accordance with ASQ-Z1.4, inspection level S-2. The lot size for this examination shall be the number of kits fully prepared for delivery. The samples shall be examined for container fill, weight, and marking.

4.5 Test panels. All test panels shall be prepared under laboratory conditions (see 4.6). The dimensions for all test panels shall be approximately 0.020 by 3.0 by 6.0 in. (0.5 by 76.2 by 152.4 mm). With the exception of the panels used for flexibility testing, test panels shall be aluminum alloy 2024 (T3 temper) conforming to SAE-AMS-QQ-A-250/4. See 4.6.3 for test panels to be used for flexibility testing.

4.5.1 Panel preparation. With the exception of the panels used for flexibility testing (see 4.6.3), the panels shall be treated with conversion coating to produce coatings conforming to MIL-DTL-5541, class 1A.

4.5.2 Application of coatings.

4.5.2.1 Primer coating. Spray apply one cross-coat of primer coating to a dry-film thickness of 0.6 to 0.9 mil (15 to 23 μm) in accordance with ASTM-D823 that conforms to MIL-PRF-23377 or MIL-PRF-85582 and air dry for at least five hours or at least two hours respectively.

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4.5.2.2 Topcoat. In accordance with the manufacturer's instructions the admixed topcoat may be reduced with deionized or distilled water for class W, or thinner conforming to MIL-T-81772, type I, for class H. If reducing with thinner, do not exceed the maximum allowable VOC content (see 3.4.1). Allow the topcoat to stand no less than 30 minutes before using. Spray apply the topcoat in accordance with ASTM-D823 to a dry-film thickness of 1.7 to 2.3 mil (43 to 58 μm). Prior to testing, the applied coating shall be air-dried for no less than 14 days at room temperature, or air-dried for no less than 24 hours followed by 24 hours at 150 °F (see 4.6).

4.6 Test methods. The tests of this specification shall be conducted in accordance with the methods specified in table III, and 4.6.1 through 4.6.14.

TABLE III. Test methods.

Requirement Paragraph	Test Title	Test Method Paragraph	FED-STD-141 Method Number	ASTM Method
3.3	Toxicity	4.6.15	---	---
3.4	Free isocyanate content	---	---	D3432
3.4	Lead and cadmium content	---	---	D3335
3.4	Chromium content	---	---	D3718
3.4.1	VOC content	---	---	D3960
3.5.1.1	Condition in container (component A)	4.6.1	---	---
3.5.1.2	Condition in container (component B)	4.6.1	---	---
3.5.1.3	Condition in container (component C)	---	---	D1193
3.5.2	Storage stability	4.6 – 4.6.14	---	---
3.5.3	Accelerated storage stability (component B only)	4.6.2	---	---
3.5.4	Freeze-thaw stability (class W only)	---	---	1/ D2243
3.5.5	Moisture content (class H only)	---	---	D1364
3.6.1	Fineness of grind	---	---	D1210
3.6.2	Coarse particles	---	---	D185
3.6.3	Odor	---	---	D1296
3.6.4	Viscosity and pot life	---	---	D1200
3.7.1	Drying time	---	---	D1640
3.7.2	Surface appearance	4.6.3	---	---
3.7.3	Color <u>2/</u>	---	---	D2244
3.7.4	Infrared reflectance (color number 34095, only)	4.6.4	---	---
3.7.5	Gloss <u>2/</u>	---	---	D523
3.7.6	Opacity (hiding power)	4.6.5	---	D2244

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TABLE III. Test methods. – Continued.

Requirement Paragraph	Test Title	Test Method Paragraph	FED-STD-141 Method Number	ASTM Method
3.7.7	Adhesion, tape test	4.6.6	---	D3359
3.7.8.1	Impact flexibility	4.6.7.1	---	---
3.7.8.2	Low-temperature flexibility (types I, III and IV)	4.6.7.2	---	D522
3.8.1	Fluid resistance	4.6.8	---	---
3.8.2	Weather resistance	4.6.9	---	G155
3.8.3	Humidity resistance <u>2/</u>	---	---	D2247
3.8.4	Heat resistance (color change)	4.6.10	6051	---
3.8.5	Solvent resistance (cure)	4.6.11	---	---
3.8.6	Tape resistance	4.6.12	---	---
3.9.3	Cleanability	4.6.13	---	---
3.9.4	Strippability	4.6.14	---	---

1/ One freeze-thaw cycle shall be 16 hours at -9 ± 3 °C (15 ± 5 °F) followed by 8 hours at a room temperature of 18 to 29.5 °C (65 to 85 °F).

2/ The coating tested shall be applied to test panels in accordance with 4.5 through 4.5.2.

4.6.1 Condition in container. Allow component A to stand without agitation for no less than 14 days in a closed container. Mix by hand with a paddle and within 5 minutes examine its condition for conformance to 3.5.1.1. Examine the condition of component B for conformance to 3.5.1.2.

4.6.2 Accelerated storage stability. Not less than one full, unopened, sealed container of each component shall be stored undisturbed for not less than 14 consecutive days in a location maintained at 60 ± 3 °C (140 ± 5 °F). At the end of 14 days, the container(s) shall be allowed to cool 24 hours to room temperature (see 4.2). During the storage period, it is advised that the unopened containers be placed in larger, vented containers to confine any splash that may occur if the lid of the unopened container is blown off by gassing. If, upon removal, the unopened container is deformed, do not open. If the container is not deformed, open carefully and examine its contents for conformance to 3.5.3.

4.6.3 Surface appearance. Within four hours after mixing, the coating shall be applied to test panels in accordance with 4.5 through 4.5.2 and air dried for no less than 24 hours. Examine both coatings for conformance to 3.7.2.

4.6.4 Infrared reflectance (FED-STD-595 color number 34095 only). The admixed coating shall be applied to test panels in accordance with 4.5 through 4.5.2, and the total reflectance (specular and diffuse) of the coating relative to barium sulfate shall be measured using a Perkin-Elmer LAMBDA 9, or equivalent spectrophotometer over a range of 700 to 2,600 nm. Examine for conformance to 3.7.4.

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4.6.5 Opacity (hiding power). Cast the admixed coating to a thickness of 1.9 to 2.1 mil [48 to 53 micrometer (μm)] on a black and white chart (Lenata Form 3B, or equivalent). The contrast ratio shall be determined by measuring the “L” reflectance value of coating over the black and white side of the chart, respectively. Determine the “L” value of the coating covering the white and black part of the chart, L_W and L_B respectively, in accordance with ASTM-D2244. The contrast ratio is calculated as follows: $C = L_B \div L_W$.

4.6.6 Adhesion. The coating shall be applied to the test panels in accordance with 4.5 through 4.5.2. The test panels shall be immersed in distilled water for no less than 24 hours at room temperature (see 4.2). Remove the test panels from the water and wipe dry with a soft cloth. Within 3 minutes after removal from the water make two parallel scribes with a stylus through the coating to the substrate. The scribes shall be $\frac{3}{4}$ of an inch apart and 2-inches long. The panels shall then be scribed to the substrate from opposing ends of the parallel scribes to form an “X”. Immediately apply a 1-inch wide strip of masking tape with the adhesive side down across the scribes. Press the tape against the surface of the coating by passing a roller across the tape eight times. The masking tape and roller shall be as specified in FED-STD-141, method 6301.3. Remove the tape with one quick motion and examine for coating damage. Examine the coating for conformance to 3.7.7.

4.6.7 Flexibility. Test panels shall be aluminum alloy 2024 (0 temper) conforming to SAE-AMS-QQ-A-250/4 and shall be anodized in accordance with MIL-A-8625, type I. Test panel dimensions shall be 0.020 by 3.0 by 6.0 in. (0.5 by 76.2 by 152.4 mm). Apply the topcoat, without a primer, in accordance with 4.5.2.2, and allow the test panels to air-dry for no less than 14 days before testing.

4.6.7.1 Impact flexibility. Two test panels, prepared in accordance with 4.6.7, shall be tested with a GE Impact-Flexibility Tester, or equivalent, at $21 \pm 5^\circ\text{C}$ ($70 \pm 10^\circ\text{F}$) and 50 ± 10 percent RH. Place the coated panel, film downward, on the rubber pad at the bottom of the impactor guide. Drop the impactor on the panel so that the impression of the entire rim of the impactor is made in the panel. Reverse the impactor ends; drop the impactor on the panel adjacent to the first area of impact. After testing, examine the coating using ten-power magnification, to determine surface cracking. Measure the percent elongation corresponding to the largest spherical impression at which no cracking occurs. Examine the coating for conformance to 3.7.8.1.

4.6.7.2 Low-temperature flexibility (Type I, Type III and Type IV only). Two test panels, prepared as specified in 4.6.7, shall be tested in accordance with ASTM-D522, method B. The test shall be performed at a temperature of $-51 \pm 3^\circ\text{C}$ ($-60 \pm 5^\circ\text{F}$) using a 1.0 in. mandrel for gloss and semi-gloss colors and a 2.0 in. mandrel for camouflage colors. After testing, examine the coating using the unaided eye, for conformance to 3.7.8.2.

4.6.8 Fluid resistance. The coating applied to test panels in accordance with 4.5 through 4.5.2 shall be immersed in the fluids, at the temperature, and for the minimum time specified in table IV. The film shall be examined one hour after removal from the fluid and examined for conformance to 3.8.1.

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Table IV. Immersion time.

Fluid	Fluid temperature	Time of immersion (minimum)
Lubricating oil (conforming to MIL-L-23699)	121 \pm 3 °C (250 \pm 5 °F)	24 hours
Hydraulic fluid (conforming to MIL-PRF-83282)	66 \pm 3 °C (150 \pm 5 °F)	24 hours
JP-5 fuel (conforming to MIL-DTL-5624)	Room temperature	7 days

4.6.9 Weather resistance. For types I, II, and III, the coating shall be applied to test panels in accordance with 4.5 through 4.5.2, and tested in accordance with ASTM-G155 using a Xenon-arc weatherometer (Atlas Electric Devices Company or equivalent) that is cycling between 102 minutes of light only and 18 minutes of light and water spray for not less than 500 hours.

For type IV, the coating shall be applied to test panels in accordance with 4.5 through 4.5.2, and tested in accordance with ASTM-G155 using a Xenon-arc weatherometer (Atlas Electric Devices Company or equivalent) that is cycling between 102 minutes of light only and 18 minutes of light and water spray for not less than 3000 hours.

The following conditions shall apply when tested in accordance with ASTM-G155:

Cabinet temperature:	42 \pm 3 °C (108 \pm 5 °F)
Black body temperature in cabinet:	63 \pm 3 °C (145 \pm 5 °F)
Relative humidity in cabinet:	50 \pm 5 percent
Intensity (spectral irradiance):	0.35 to 0.5 watt/meter ² at a wavelength of 340 nm

After removal from the weatherometer, the 60° specular gloss of the coating shall be tested in accordance with ASTM-D523; in addition, the Type IV camouflage colors shall be tested for 85° specular gloss to determine conformance to 3.8.2 (a). The coating color shall then be tested in accordance with ASTM-D2244 to determine conformance to 3.8.2(b).

4.6.10 Heat resistance. Prepare two test panels in accordance with 4.5 through 4.5.2. One test panel shall act as control, the other as the test specimen. Expose the test specimen to 121 \pm 3 °C (250 \pm 5 °F) for no less than 60 minutes, in accordance with FED-STD-141, method 6051. After exposure, the coating shall be tested in accordance with ASTM-D2244 to determine the color difference (ΔE) value and examined for conformance to 3.8.4.

4.6.11 Solvent resistance (cure). Test panels shall be prepared in accordance with 4.5 through 4.5.2. A cotton, terrycloth rag shall be soaked in MEK solvent and rubbed back and forth 25 times (50 passes) over the coating with firm finger pressure. The coating shall be examined for conformance to 3.8.5.

4.6.12 Tape resistance. Test panels, prepared as specified in 4.5 through 4.5.2, shall be air-dried for no less than twelve hours. A strip of masking tape (3M Company #250 or equivalent), no less than 1.0 in. (25.4 mm) wide, shall be applied to each panel, adhesive side down, and pressed down with one pass of a roller weighing no less than 4.5 pounds (2.04 kilograms (kg)). The tape shall remain in contact with the test panel for no less than one hour and then shall be carefully removed. Examine the coating conformance to 3.8.6.

4.6.13 Cleanability. The cleanability test method shall be performed in accordance with 4.6.13.1 through 4.6.13.5 to determine conformance to 3.9.3.

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4.6.13.1 Preparation of artificial soil. Place 50.0 ±0.5g of carbon black and 500.0 ±1.0g of hydraulic fluid conforming to MIL-PRF-83282, in a container, such as a one quart jar. Homogenize the soil using a high shear (such as a Cowles dispersator, or equivalent) mixer for 15 ±1 minutes. Prior to application of the soil, stir or shake the mixture by hand.

4.6.13.2 Preparation of test panels. Prepare two test panels in accordance with 4.5 through 4.5.2. Using a clean, hog bristle brush, lightly scrub the coating of each panel with a 1.0 percent (by weight) solution of Alconox detergent, or equivalent, in reagent water. Rinse each panel thoroughly three times with reagent water. Dry for no less than 18 hours at 49 ±2 °C (120 ±4 °F). Using ASTM-D2244, determine the L value of the coating. This will be value "A" (see 4.6.13.5).

4.6.13.3 Soiling of test panels. Using a soft-bristle brush, coat the painted surfaces of test panels with the prepared soil. Remove excess soil by covering the test panel surface with folded absorbent tissue and exerting pressure by rolling the tissue with a 5 lb. rubber roller. Repeat this blotting procedure twice. Brush the soiled surface parallel to the long dimension of the test panel, using 10 brush strokes in each direction. Bake the test panel at 105 ±2 °C (221 ±4 °F) for 60 ±1 minutes. Determine the L value of the coating in accordance with ASTM-D2244. This will be value "B" (see 4.6.13.5).

4.6.13.4 Procedure. Within 4 hours of soiling the test panels, conduct the cleanability test as specified in MIL-PRF-85570, using the type II control formulation.

4.6.13.5 Calculation. Calculate the cleaning efficiency achieved on each test panel as follows (value "A" from 4.6.13.2, value "B" from 4.6.13.3, and value "C" from 4.6.13.4) and examine for conformance to 3.9.3:

$$\text{Cleaning efficiency (\%)} = [(C - B) \div (A - B)] \times 100$$

4.6.14 Strippability. Method A: Prepare two test panels as specified in 4.5 through 4.5.2.2 and weather for no less than 500 hours as specified in 4.6.9. Using a stylus the panels shall be scribed to the substrate with an "X" 1-inch in length in the middle of the panel on the coated surface side. Seal the edges of the prepared test panels with beeswax by dipping in melted wax to a depth not to exceed 6 mm (0.25 in.) from all edges. The test panels shall then be placed on a rack at 60° to the horizontal, coated side up. Enough coating remover conforming to the control formulation of TT-R-2918, type I, shall be poured along the upper edge of the test panels to completely cover the coating surface. After no less than 4 hours of exposure, the panel shall then be scraped with a rubber scraper to remove loosened coating; apply additional remover conforming to the control formulation of TT-R-2918, type I, to cover any remaining coating and allow it to dwell for an additional 4 hours. Immediately after this second 4 hour exposure, the test panels shall be scraped with a rubber scraper to remove the bulk of the loosened coatings and remover residue. The test panels shall then be rinsed with cool tap water and brushed with a soft, nylon bristle brush. Paint removal shall be determined for each test panel by estimating the percentage of the substrate revealed by the stripping process. The result shall be the average of the two panels tested. The result shall conform to 3.9.4.

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Method B: Two test panels, prepared as specified in 4.5 through 4.5.2.2 and weathered for no less than 500 hours as directed in 4.6.9 shall be placed on a rack at a 60° angle with the horizontal. Enough paint remover conforming to MIL-R-81294, type I or II, shall be poured along the upper edge of each test panel to completely cover the coating surface. After no less than 60 minutes of exposure, the loosened coating shall be brushed off, and the test panels shall be rinsed while brushing under a stream of cool water. The result shall be the average of the two panels tested. The result shall conform to 3.9.4.

4.6.15 Toxicity. The product shall be evaluated by the Navy Environmental Health Center (NAVENVIRHLTHCEN) using the administrative Health Hazard Assessment (HHA) (see 6.3).

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the military service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature which may be helpful, but is not mandatory.)

6.1 Intended use. The combination of all properties of MIL-PRF-85285; component; liquid; cured coating; resistance; mixing; application; cleanability; strippability; along with the composition and solvent content provide the necessary requirements for a polyurethane coating used in the extremes of the naval aviation environment. There are no commercial equivalents that meet the combination of all properties of MIL-PRF-85285. Type I of this polyurethane coating is intended for use on aircraft weapons systems and other applications. Type II is intended for use on support equipment. Type III is intended for use on aircraft and support equipment. Type IV is intended for use on aircraft weapons systems where extended weatherability is necessary. Type IV is a direct replacement for Type I on aircraft weapons systems. No additives other than the appropriate thinner for class H or deionized or distilled water for class W to obtain the proper spray viscosity need to be added.

6.2 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number, and date of this specification.
- b. Type and class (see 1.2).
- c. Quantity and size of containers.
- d. If a retention sample is required and where to send it (see 4.4.2).

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- e. Any formulation modifications (see 6.5.3.1).
- f. Color number and name (see 6.7).
- g. Packaging requirements (see 5.1).

6.3 Toxicity evaluation. A flowchart for the HHA process can be found as enclosure (1) of BUMEDINST 6270.8. The HHA is a review of the product based on information submitted by the manufacturer, to assess health hazards associated with the handling, application, use and removal of the product. Sufficient data to permit a HHA of the product should be provided by the manufacturer/distributor to the NAVENVIRHLTHCEN. To obtain current technical information requirements specified by the NAVENVIRHLTHCEN or any questions concerning toxicity, information required to conduct a HHA, and requests for a HHA should be addressed to the Commanding Officer, Navy Environmental Health Center, ATTN: Hazardous Materials Department, Industrial Hygiene Directorate, 620 John Paul Jones Circle, Suite 1100, Portsmouth, VA 20378-2103. Upon receipt of the HHA, a copy should be provided to Commander, Naval Sea Systems Command, ATTN: SEA 05M1, 1333 Isaac Hull Ave., SE, Stop 5133 Washington Navy Yard, DC 20376-5133.

6.3.1 Toxicity. Some free isocyanate is released during mixing and application of multi-component polyurethane coatings. Released free isocyanates can produce significant irritation to the skin, eyes, and respiratory tract. Personnel exposed to free isocyanates may develop an allergic pulmonary sensitization, particularly if there is any inhalation of the vapor and mist produced during spray application. This sensitization may cause an asthmatic reaction with wheezing, dyspnea, and cough. Once sensitized, further exposure cannot be tolerated. For this reason, there is a restriction on the issuance and use of this material. Personnel exposed to free isocyanates on a regular basis should receive a periodic medical exam that includes a chest roentgenograph (X-ray), pulmonary function tests, and an evaluation of any respiratory disease or history of allergy. Periodic testing of pulmonary functions may aid in detecting the onset of pulmonary sensitization. Questions pertinent to the effect(s) of these coatings on the health of personnel using them should be referred by the procuring activity to the appropriate medical service, who will act as an advisor.

6.3.2 Personnel protective methods. Eye protection and appropriate clothing to prevent repeated or prolonged skin contact should be worn while applying material that contains free isocyanates. Additional information pertaining to protective equipment and other necessary precautions should be available from the coating application facility's Occupational Safety and Health Office.

6.4 Moisture (class H only). Polyurethane materials should be kept dry. The presence of moisture degrades the quality of the coating. Packaging of the materials should be done in a dry atmosphere. Solvents and resins should be examined for evidence of contamination before they are incorporated, even if they are "urethane grade," as solvents and thinners may become contaminated with water in tank cars or storage tanks. The purchase of "urethane grade" solvents and thinners is no guarantee that excessive moisture is not present. It is recommended that all users check for moisture contamination prior to use.

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6.4.1 Method to detect water in solvent used for polyurethane coatings. The following is a suggested method that may be used to determine the presence of water in the solvents used for polyurethane coatings: Add one drop of aluminum secondary butoxide to 100 ml of the solvent in a stoppered flask and shake well. An appreciable amount of turbidity indicates the presence of water.

6.5 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Products List QPL-85285, whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, 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. Information pertaining to qualification of products may be obtained from the Commander, Naval Air Warfare Center Aircraft Division, Code 4.9.7.2, Building 2188, Patuxent River, MD 20670-1908.

6.5.1 Qualification inspection samples. The test samples should consist of a minimum of one two-quart kit consisting of the following FED-STD-595 colors: 17925 and 36375. The material should be furnished in the type of containers to be used in filling contract orders. Samples should be identified as follows and forwarded to the laboratory designated in the letter of authorization (see 6.5).

Qualification inspection samples

Specification MIL-PRF-85285D; Type _____, Class _____, Color _____

“Coating: Polyurethane, Aircraft and Support Equipment”

Manufacturer's name and product number

Submitted by (name and date) for qualification testing in accordance with authorization (reference authorizing letter)

6.5.2 Storage stability, inspection, and other information. In addition to the qualification test samples, the qualifying activity will request the manufacturer to submit to the qualification activity: (a) certification that the manufacturer's material meets the storage stability requirements (see 3.5.2); (b) one copy of the MSDS (see 6.6); (c) a certified test report showing that the material conforms to the requirements of this specification; and (d) certification that the following chemicals were not used in the formulation of this coating: methylene chloride, trichloroethane and trichlorotrifluoroethane.

6.5.3 Retention of qualification. To retain qualification of products approved for listing on the Qualified Products List (QPL), one of the items that the manufacturer will be requested to verify by certification to the qualifying activity is that its product(s) comply with the requirements of this specification. Unless otherwise specified by the qualifying activity, the time of periodic verification by certification will be in two-year intervals from the date of original qualification and will be initiated by the qualifying activity.

6.5.3.1 Retention of qualification for formulation modifications. Manufacturers must request formulation modifications in writing. The request is reviewed and approval is determined

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by the preparing activity. The approval process may include limited testing of the modified material, complete qualification testing, and/or laboratory data and certification of the performance properties by the manufacturer.

6.6 Material Safety Data Sheet (MSDS). 29 CFR 1910.1200 requires that the MSDS for each hazardous chemical used in an operation must be readily available to personnel using the material. Contracting officers should identify the activities requiring copies of the MSDS.

6.7 Color designation codes: The five digit color designator is the FED-STD-595 color number. The following is a list of colors frequently used by the Department of Defense, but is not a list of all of the colors authorized, used, or available:

Color type:	FED-STD-595 color number	Color name
Gloss:	11136	Red
	13538	Orange-yellow
	14187	Green
	15044	Insignia blue
	15180	Blue
	16440	Light gray
	17038	Black
	17925	Untinted white
Semi-gloss:	25200	Blue
	26231	Gray
Camouflage (low gloss)	34095	Field green
	34097	Green
	35237	Blue gray
	36081	Flat gray
	36231	Lusterless gray
	36320	Dark gray
	36375	Medium gray
	36440	Light gray
	36495	Aircraft gray
	37038	Black

6.8 Batch and lot formation. A batch consists of all coating material manufactured during one continuous operation and forming part of one contract or order for delivery. A lot consists of all coatings of the same color, manufactured at one time from one batch, forming part of one contract, and submitted for acceptance.

6.9 Rejection and retest. Failure in any conformance test should result in rejection of that batch and should constitute justification for removal from the qualified products list. Rejected material should not be resubmitted for acceptance without written approval from the qualification activity (see 6.5). The application for resubmission should contain full particulars concerning previous rejections and measures taken to correct these deficiencies. Samples for retest should be randomly selected as in 4.4.2 and forwarded to the testing activity.

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6.10 Safely handling MEK solvent. To minimize exposure to MEK solvent, it is recommended that personnel conducting the solvent resistance (cure) test, as a minimum, wear either butyl rubber or Teflon gloves and a National Institute of Occupational Safety and Health (NIOSH) approved half-face respirator equipped with organic vapor cartridges and goggles or a full-face respirator equipped with organic vapor cartridges.

6.11 Special application solutions. Procuring activities may request minor solvent and additive modifications to qualified products to solve unique application problems, such as faster drying time and shorter pot-life coatings encountered for plural-component spray equipment. Only application conditions are permitted to be modified. The cured coating (dry film) properties of the coating are not permitted to be changed. Any modified coatings must be clearly identified as such on its container and may only be furnished to the requesting activity. The specific modifications and labeling instructions should be detailed in any procurement request for the modified material.

6.12 Subject term (key word) listing.

Exterior use
Flammable
Isocyanate
Methyl ethyl ketone

6.13 Amendment notations. The margins of this specification are marked with vertical lines to indicate modifications generated by this amendment. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations.

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CONCLUDING MATERIAL

Custodians:

Army - MR
Navy - AS
Air Force - 99

Preparing activity:

Navy - AS

(Project 8010-2009-0026)

Review activities:

Army - AR
Navy - CG, MC, SH
Air Force - 11, 84
Other – DS

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at <http://assist.daps.dla.mil>.