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MIL-DTL-53039E
16 May 2013
SUPERSEDING
MIL-DTL-53039D
24 January 2011

DETAIL SPECIFICATION

COATING, ALIPHATIC POLYURETHANE, SINGLE COMPONENT, CHEMICAL AGENT RESISTANT

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

1. SCOPE

1.1 Scope. This specification covers single component, polymeric flattened, chemical agent resistant, aliphatic polyurethane coating for use as a finish coat on military tactical equipment, which includes ground, aviation and related support assets. Other than where noted, the materials are free of volatile organic hazardous air pollutants (VOHAP-free), free of inorganic hazardous air pollutants (HAPs) other than cobalt and non-hexavalent chromium. The coating is lead, cadmium, cadmium compounds and hexavalent chromium free.

1.2 Classification. Coating type and color will be as specified below.

1.2.1 Types. The coatings will be furnished in the following types as specified (see 6.2). Whenever one of the following coating types is not cited in a relevant contractual document, select type III, type IV, type V, type VI, or type IX for general painting or type VIII when field touch-up is required. Other than type VIII aerosols, which may contain VOHAPs for application, these coating types are VOHAP-free, contain polymeric flattening agents and have low volatile organic compound (VOC) content.

Type III - A maximum VOC content of 180 grams/liter (g/l) (1.5 pounds/gallon (lbs/gal)) as packaged and VOHAP-free.
Type IV - A maximum VOC content of 120 g/l (1.0 lbs/gal) as packaged and VOHAP-free.
Type V - A maximum VOC content of 60 g/l (0.50 lbs/gal) as packaged and VOHAP-free.
Type VI - A maximum VOC content of 0 g/l (0 lbs/gal) as packaged and VOHAP-free.

Comments, suggestions, or questions on this document should be addressed to: Director, U.S. Army Research Laboratory, Weapons and Materials Research Directorate, Materials Manufacturing Technology Branch, Specifications and Standards Office, ATTN: RDRL-WMM-D, Aberdeen Proving Ground, MD 21005-5069 or emailed to richard.j.squillacioti.civ@mail.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.dla.mil/ .

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Type VIII - Self contained portable kits to include but not limited to, brush, roller, aerosol and cartridge application. A maximum VOC content of 180 g/l (1.5 lbs/gal) as packaged and VOHAP-free, with the exception of aerosols, which shall have a maximum VOC content of 420 g/l (3.5 lbs/gal) as packaged with or without VOHAPs. (Note: Products previously qualified to type VII under previous versions of this specification will be included in the type VIII classification).

Type IX - A maximum VOC content of 420 g/l (3.5 lbs/gal) as packaged and VOHAP-free.

1.2.2 Color. The coating colors will be one of the following FED-STD-595 colors as specified (see 6.2). Where Aircraft Black, 37038, is specified for use, Black, 37030 is authorized to be used in its place.

Aircraft Black, 37038	Brown 383, 30051	IRR Foliage Green 504, 34160
Aircraft Gray, 36300	Dark Green, 34082	Medium Gray, 36375
Aircraft Green, 34031	Dark Sandstone, 33510	Olive Drab, 34088
Aircraft Insignia Blue, 35044	Earth Yellow, 33245	Sand, 33303
Aircraft Red, 31136	Field Drab, 33105	Tan 686A, 33446
Aircraft White, 37875	Green 383, 34094	Tan, 33531
Aircraft Yellow, 33538	Green 808, 34102	Woodland Desert Sage, 34201
Black, 37030	Interior Aircraft Black, 37031	Weapons Safety Red, 38905
Blue Gray, 35237	Interior Aircraft Gray, 36231	

The Army's primary camouflage colors are Aircraft Gray, 36300, Aircraft Green, 34031, Black, 37030, Brown 383, 30051, Green 383, 34094, Green 808, 34102, IRR Foliage Green 504, 34160, Tan 686A, 33446 and Woodland Desert Sage, 34201.

1.3 Part or Identifying Number (PIN). Use the following example to create the PINs to be used for coatings acquired to this specification:

M53039	- XX	- XXX	- XXXXX
Specification Identifier	Coating type designator Type III = 03 Type IV = 04 Type V = 05 Type VI = 06 Type VIII=08 Type IX=09	Container size designator 1 pint = 01P 1 quart = 01Q 1 gallon = 01G 1 Aerosol container = 01A 1 Brush container = 01B 1 Roller container = 01R 1 Cartridge = 01C 1 Touch-up kit = 01T	Color designator FED-STD-595 color chip number

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 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

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specified requirements of documents cited in sections 3, 4, or 5 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks 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.

FEDERAL SPECIFICATIONS

TT-B-1325	-	Beads (Glass Spheres) Retro-Reflective.

FEDERAL STANDARDS

FED-STD-313	-	Material Safety Data, Transportation Data, and Disposal Data for Hazardous Materials Furnished to Government Activities.
FED-STD-595	-	Colors Used in Government Procurement.
FED-STD-595/Color Chip Numbers	-	30051, 31136, 33105, 33245, 33303, 33446, 33510, 33531, 33538, 34031, 34082, 34088, 34094, 34102, 34160, 34201, 35044, 35237, 36231, 36300, 36375, 37030, 37031, 37038, 37875, 38905. All colors are flat or lusterless.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-DTL-12468	-	Decontaminating Agent, STB.
MIL-PRF-23377	-	Primer Coatings: Epoxy, High-Solids.
MIL-DTL-53022	-	Primer, Epoxy Coating, Corrosion Inhibiting Lead And Chromate Free.
MIL-DTL-53030	-	Primer Coating, Epoxy, Water Based, Lead And Chromate Free.
MIL-PRF-85582	-	Primer Coatings: Epoxy, Waterborne.

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

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications 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.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA Method 311 - HAPS in Paints & Coatings.

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(Copies of this document are available online at http://www.epa.gov/ttn/emc/ or from the Environmental Protection Agency, Ariel Rios Building, 1200 Pennsylvania Avenue, N.W., Washington, DC 20460.)

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.

ASTM INTERNATIONAL

ASTM D476		Standard Classification for Dry Pigmentary Titanium Dioxide Products. (DoD adopted)
ASTM D522	-	Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings. (DoD adopted)
ASTM D523	-	Standard Test Method for Specular Gloss. (DoD adopted)
ASTM D562	-	Standard Test Method for Consistency of Paints Measuring Krebs Unit (KU) Viscosity Using a Stormer-Type Viscometer. (DoD adopted)
ASTM D1849	-	Standard Test Method for Package Stability of Paint. (DoD adopted)
ASTM D2371	-	Standard Test Method for Pigment Content of Solvent-Reducible Paints. (DoD adopted)
ASTM D2805	-	Standard Test Method for Hiding Power of Paints by Reflectometry. (DoD adopted)
ASTM D3271	-	Standard Practice for Direct Injection of Solvent Reducible Paints Into a Gas Chromatograph for Solvent Analysis. (DoD adopted)
ASTM D3335	-	Standard Test Method for Low Concentrations of Lead, Cadmium, and Cobalt in Paint by Atomic Absorption Spectroscopy. (DoD adopted)
ASTM D3359	-	Standard Test Methods for Measuring Adhesion by Tape Test.
ASTM D3363	-	Standard Test Method for Film Hardness by Pencil Test. (DoD adopted)
ASTM D3924	-	Standard Specification for Standard Environment for Conditioning and Testing Paint, Varnish, Lacquer, and Related Materials. (DoD adopted)
ASTM D3960	-	Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings. (DoD adopted)
ASTM D4214	-	Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films. (DoD adopted)
ASTM D5895	-	Standard Test Methods for Evaluating Drying or Curing During Film Formation of Organic Coatings Using Mechanical Recorders.
ASTM D7232	-	Standard Test Method for Rapid Determination of the Nonvolatile Content of Coatings by Loss in Weight.
ASTM E308	-	Standard Practice for Computing the Colors of Objects by Using the CIE System. (DoD adopted)
ASTM E1331	-	Standard Test Method for Reflectance Factor and Color by Spectrophotometry Using Hemispherical Geometry.
ASTM G90	-	Standard Practice for Performing Accelerated Outdoor Weathering

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of Nonmetallic Materials Using Concentrated Natural Sunlight.

ASTM G154 - Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials.

(Copies of these documents are available from www.astm.org or ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, 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 coating furnished under this specification shall be a product authorized by the qualifying activity for listing in the Qualified Products Database (QPD) before contract award (see 4.2 and 6.4). Any change in the formulation or processing of a qualified product shall necessitate its requalification. The material supplied under contract shall be identical, within manufacturing tolerances, to the product receiving qualification.

3.2 Materials. The materials used in the coating shall be as specified herein. Materials not specified shall be selected by the contractor and shall be subject to all provisions of this specification.

3.3 Color and reflectance. All camouflage colors listed in table I shall impart to the substrate the required spectral reflectance properties in the visible (400-700 nanometers) and near infrared (700-900 nanometers) spectrums. Some camouflage colors shall have numerical requirements and some shall have visual matches for chromaticity as listed in table I. Interior Aircraft Black, 37031, Aircraft Gray, 36300, Dark Sandstone, 33510 and Tan 33531 shall visually match the appropriate chips from FED-STD-595. Aircraft Green, 34031 and Green 808, 34102 shall visually match color chips furnished by U.S. Army Research Laboratory (ARL), ATTN: RDRL-WMM-C, Organic Coatings Team, Building 4600, Deer Creek Loop, Aberdeen Proving Ground (APG), MD 21005-5066. All other colors listed in 1.2.2 shall visually match the appropriate chip from FED-STD-595. The colors listed in table I shall meet the infrared reflectance requirements of table I when tested as outlined in 4.6.2 and 4.6.13. The color Dark Green, 34082 and Green 383, 34094 shall meet the spectral reflectance limits specified in table III. The color IRR Foliage Green 504, 34160 shall meet the spectral reflectance limits specified in table IV. The color Green 808, 34102 shall meet the spectral reflectance limits in table V. Colors not listed in table I are only visual matches (VM) to the required color chip, as specified in FED-STD-595.

TABLE I. Color and reflectance requirements using tristimulus color coordinates.

Color	Brightness (Y)	Chromaticity x	Chromaticity y	Average Near Infrared [1/] Min.	Average Near Infrared [1/] Max.	Allowable Ratio [2/] (Min.)
Dark Green, 34082	0.071 – 0.091	0.339	0.390	-	60.0	5.2

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TABLE I. Color and reflectance requirements using tristimulus color coordinates - Continued.

Color	Brightness (Y)	Chromaticity x	Chromaticity y	Average Near Infrared [1/] Min.	Average Near Infrared [1/] Max.	Allowable Ratio [2/] (Min.)
Green 383, 34094	0.063 – 0.083	0.328	0.365	-	60.0	5.2
Green 808, 34102	33.10 [3/]	-4.70 [3/]	8.70 [3/]	-	60.0	4.9
IRR Foliage Green 504, 34160	0.125 – 0.153	0.315	0.331	23.0	33.0	-
Field Drab, 33105	0.093 – 0.117	0.390	0.383	25.0	35.0	-
Earth Yellow, 33245	0.228 – 0.263	0.420	0.395	30.0	40.0	-
Sand, 33303	0.284 – 0.323	0.360	0.366	55.0	65.0	-
Brown 383, 30051	0.060 – 0.080	0.357	0.342	8.0	20.0	-
Black, 37030	0.030 – 0.041	0.310	0.315	0.0	15.0	-
Tan 686A, 33446	0.360 – 0.400	0.368	0.364	62.0	72.0	-
Tan, 33531	VM [4/]	VM [4/]		62.0	72.0	-
Woodland Desert Sage,34201	0.187 – 0.220	0.347	0.360	15.0	25.0	-
Aircraft Green, 34031	VM [4/]	VM [4/]		-	7.0	-
Interior Aircraft Black, 37031	VM [4/]	VM [4/]		-	7.0	-
Aircraft Gray, 36300	VM [4/]	VM [4/]		-	15.0	-
Dark Sandstone, 33510	VM [4/]	VM [4/]		-	45.0	-

1/ See table II or 4.6.2 or 4.6.13.
2/ Allowable ratio is calculated by dividing the average infrared value by the average red value determined by using the selected wavelengths in table II. This is only applicable for Dark Green, 34082, Green 383, 34094 and Green 808, 34102.
3/ For Green 808, 34102, CIELAB units (L*, a*, b*) shall be used in lieu of the tristimulus values (Y, x, y). The color difference (L*, a*, b*) +/- with a Delta (Δ) E no greater than 1.5 CIELAB units of value listed in table 1 for Green 808, 34102. Obtain L*, a*, b* values using the standard illuminant D65 and the 10-degree standard observer angle.
4/ Visual Match(es) (VM) as stated in 3.3 are to be used for Aircraft Green, 34031, Interior Aircraft Black, 37031, Aircraft Gray, 36300, and Dark Sandstone, 33510.

3.3.1 Camouflage system colors. The colors of the camouflage system shall fall within 2.0 National Bureau of Standards (NBS) units of the values listed in table I using tristimulus color coordinates. Obtain brightness (Y) and chromaticity (x, y) values under standard illuminant C, and the 2-degree standard observer angle in accordance with paragraph 4.6.2.

3.4 Composition. The material shall be furnished as a single package, and shall consist of an aliphatic polyisocyanate prepolymer combined with volatile solvents, pigments, extenders and additives.

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TABLE II. Selected wavelengths for determining red and infrared values from reflectance data.

Red Region 1/ (Nanometers)	Infrared Region 2/ (Nanometers)
620.0	720.0
630.0	740.0
640.0	760.0
640.0	770.0
650.0	780.0
650.0	800.0
650.0	810.0
660.0	830.0
660.0	840.0
660.0	860.0

1/ The red value is the average reflectance for the ten wavelengths listed.
2/ The infrared value is the average reflectance for the ten wavelengths listed.

TABLE III. Spectral reflectance limits for Dark Green, 34082 and Green 383, 34094.

Wavelength Nanometers	% Reflectance Max.	Min.	Wavelength Nanometers	% Reflectance Max.	Min.
600	10.2	-	760	59.5	40.0
610	9.8	-	770	61.5	42.0
620	9.8	-	780	-	42.0
630	9.8	-	790	-	42.0
640	9.5	-	800	-	42.0
650	9.5	-	810	-	42.0
660	10.0	-	820	-	42.0
670	10.5	4.0	830	-	42.0
680	13.0	5.8	840	-	42.0
690	21.5	8.5	850	-	42.0
700	28.0	11.0	860	-	42.0
710	35.8	15.0	870	-	42.0
720	41.0	19.0	880	-	42.0
730	48.5	25.0	890	-	42.0
740	51.8	30.0	900	-	42.0
750	56.0	36.3			

TABLE IV. Spectral reflectance limits for IRR Foliage Green 504, 34160.

Wavelength Nanometers	% Reflectance Max.	Min.
600	18	8

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TABLE IV. Spectral reflectance limits for IRR Foliage Green 504, 34160 - Continued.

Wavelength Nanometers	% Reflectance Max.	Min.
620	18	8
640	20	8
660	26	10
680	26	10
700	28	12
720	30	16
740	30	16
760	32	18
780	34	18
800	36	20
820	38	22
840	40	24
860	42	26

TABLE V. Spectral reflectance limits for Green 808, 34102.

Wavelength Nanometers	% Reflectance Max.	Min.	Wavelength Nanometers	% Reflectance Max.	Min.
600	11.0	-	800	-	47.0
610	11.0	-	810	-	48.0
620	11.0	-	820	-	49.0
630	11.0	-	830	-	50.0
640	12.0	-	840	-	51.0
650	13.0	-	850	-	52.0
660	14.0	-	860	-	52.5
670	15.5	6.0	870	-	53.0
680	17.5	7.0	880	-	53.5
690	20.0	9.0	890	-	54.0
700	23.0	11.0	900-1000	-	54.0
710	27.0	13.0	1000-1100	-	54.0
720	33.0	15.0	1100-1200	-	54.0
730	39.0	18.0	1200-1300	-	54.0
740	45.0	22.0	1300-1400	-	54.0
750	51.0	27.0	1400-1500	-	54.0
760	57.0	33.0			
770	61.0	39.0			
780	-	43.0			
790	-	45.0			

3.4.1 Pigment. The pigments listed in table VI, or any combination thereof, shall make up the primary hiding pigmentation for the colors specified. Iron oxides used as hiding pigments shall

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be of synthetic origin and not naturally occurring. The titanium dioxide shall be a rutile, chalk resistant type conforming to ASTM D476, type III or IV. If other tinting pigments are used to match the spectral characteristics, these additional pigments shall have good color stability. When tested in accordance with 4.6, no component of the coating shall contain lead, cadmium, cadmium compounds, and hexavalent chromium. Compounds of antimony, arsenic, beryllium, cyanide, manganese, mercury, nickel and selenium shall be absent. The flattening pigment materials shall be of polymeric based polyurethane or urea formaldehyde condensation type polymers or other polymeric composition. The amount shall not exceed the limits of table VIII. Glass beads for Interior Aircraft Black, 37031 shall conform to TT-B-1325, type I, grade B and shall conform to the amount specified in table VIII.

3.4.1.1 Lead content. The lead content shall not exceed 0.05 percent by weight of total nonvolatile content upon analysis as specified in 4.6.6.

3.4.2 Nonvolatile vehicle. The nonvolatile vehicle shall be a hydroxyl terminated prepolymer reacted with an aliphatic polyisocyanate. The IR spectrum of the partially cured resin shall show the presence of aliphatic polyisocyanates and shall contain no aromatic polyisocyanates when determined as stated in 4.6.7.

3.4.3 VOC content. The VOC content for the types of coatings shall be as specified in 1.2.1 and tested in accordance with 4.6.8.

3.4.4 VOHAP content. All types of coatings, except for type VIII aerosols, shall be VOHAP-free when tested in accordance with 4.6.8.1.

TABLE VI. Pigmentation.

Color	Pigment
Dark Green, 34082 Green 383, 34094 IRR Foliage Green 504, 34160	Acid insoluble green pigment predominately composed of cobalt, zinc and chromium oxides with other oxides permitted; carbazole dioxazine violet, iron oxides, light stable organic yellow and orange, zinc/magnesium ferrite or other mixed metal oxides.
Green 808, 34102	Complex inorganic acid insoluble green pigment (Non-Cobalt), chromium oxide, titanium dioxide, light stable organic yellow or orange, carbazole dioxazine violet, iron oxides, zinc/magnesium ferrite or other mixed oxides.
Field Drab, 33105 Brown 383, 30051 Earth Yellow, 33245 Sand, 33303 Tan 686A, 33446 Tan, 33531 Woodland Desert Sage, 34201 Dark Sandstone, 33510	Chromium oxide, titanium dioxide, carbon black, carbazole dioxazine violet, iron oxides, zinc/magnesium ferrite or other mixed metal oxides.

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TABLE VI. Pigmentation - Continued.

Color	Pigment
Aircraft Green, 34031 Olive Drab, 34088	Iron oxides, carbon black, zinc/magnesium ferrites, titanium dioxide, chromium oxide or other mixed metal oxides.
Black, 37030 Aircraft Black, 37038 Interior Aircraft Black, 37031	Carbon black, iron oxides.
Aircraft White, 37875	Titanium dioxide.
Aircraft Red, 31136 Weapons Safety Red, 38905	Titanium dioxide, light stable organic red.
Aircraft Gray, 36300 Interior Aircraft Gray, 36231 Blue Gray, 35237 Medium Gray, 36375	Titanium dioxide, carbon black, iron oxides.
Aircraft Insignia Blue, 35044	Copper phthalocyanine blue, carbon or lampblack, black iron oxide, titanium dioxide.
Aircraft Yellow, 33538	Light stable organic yellow and orange, titanium dioxide, mixed metal oxides

Note: Chromium oxides exclude the use of hexavalent chromium. Copper phthalocyanine blue does not contain cyanide compounds.

3.5 Quantitative requirements. The coating shall conform to the quantitative requirements of table VII when tested as specified in 4.6.

3.5.1 Specific quantitative requirements. Each color shall conform to its specific requirement in table VIII when tested as specified in 4.6.1.1. Total solids, pigment solids and vehicle solids are calculated as percent by weight. Extender pigment is the percent by weight of total pigment.

TABLE VII. Coating requirements.

Characteristic	Min.	Max.
Pigment, hexavalent chromium, cadmium, cadmium compounds	Absent	
Inorganic HAP compounds, other than cobalt and chromium	Absent	
VOHAP compounds, except for type VIII aerosols	Absent	
Lead content, percent of total solids		.05
Viscosity (Krebs-Stormer, K.U.)	55	80
Hiding power (contrast ratio)		
Aircraft Red, 31136	.94	-
Weapons Safety Red, 38905	.94	-
Aircraft White, 37875	.92	-
Other colors	.98	-
Drying time		
Set to touch, minutes	5	30
Dry hard, hours	-	3
Dry through, hours	-	4

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TABLE VII. Coating requirements - Continued.

Characteristic	Min.	Max.
Specular gloss for Dark Sandstone, 33510 and Sand, 33303, Earth Yellow, 33245, Tan 686A, 33446 and Tan, 33531		
60 degree	-	1.6
85 degree	-	4.0
Specular gloss for primary camouflage colors, including IRR Foliage Green, 34160 and Aircraft Black, 37038, unless otherwise cited		
60 degree	-	1.0
85 degree	-	3.5
Specular gloss for Woodland Desert Sage, 34201		
60 degree	-	1.8
85 degree	-	4.0
Specular gloss for Aircraft Green, 34031 and Interior Aircraft Black, 37031		
60 degree	-	0.6
85 degree	-	1.2
Specular gloss for other colors		
60 degree	-	3.0
85 degree	-	8.0

3.6 Qualitative requirements.

3.6.1 Condition in container. When tested as specified in 4.6.14, the coating shall be free from grit, seeds, skins, abnormal thickening or livering in a freshly opened container and shall show no more pigment settling or caking than can be easily and completely reincorporated to a smooth homogeneous state.

3.6.2 Storage stability.

3.6.2.1 Accelerated storage stability. After testing as in 4.6.15.1, the coating shall meet all the requirements of the specification and have a maximum viscosity of 90 KU. There shall be no curdling or hard dry caking and any sedimentation shall easily mix back into a smooth homogeneous state.

3.6.2.2 Full container storage stability. The liquid coating, stored in the full quart can or submitted touch up kit, shall show no skinning, livering, curdling, hard dry caking nor tough gummy sediment when tested as specified in 4.6.15.2. It shall remix readily to a smooth homogeneous state, shall have a maximum viscosity of 90 KU, and shall meet all other requirements of this specification.

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TABLE VIII. Specific quantitative requirements.

Color	Percent Total Weight Solids (Min.)	Percent Vehicle Solids of Paint (Min.)	Percent Total Pigment of Paint (Min.)	Percent Flattening Agents of Total Pigment (Max.)
Dark Green, 34082	55	17	28	60
Green 383, 34094	55	17	28	60
Green 808, 34102	55	17	28	60
IRR Foliage Green 504, 34160	55	17	28	60
Brown 383, 30051	55	17	25	70
Tan 686A, 33446	55	17	26	70
Woodland Desert Sage, 34201	55	17	26	70
Black, 37030	48	17	20	75
Aircraft Green, 34031	55	17	28	70
Sand, 33303	55	17	26	70
Field Drab, 33105	55	17	28	70
Olive Drab, 34088	55	17	28	70
Dark Sandstone, 33510	55	17	28	70
Aircraft White, 37875	55	17	28	70
Aircraft Red, 31136	55	17	28	70
Weapons Safety Red, 38905	55	17	28	70
Aircraft Black, 37038	48	17	20	85
Aircraft Gray, 36300	55	17	28	70
Aircraft Insignia Blue, 35044	55	17	28	70
Interior Aircraft Gray, 36231	55	17	28	70
Interior Aircraft Black, 37031	55	17	28	70 1/
Earth Yellow, 33245	55	17	29	67

1/ 19-20 percent of total pigment are glass beads.

3.6.3 Spraying properties. When tested as specified in 4.6.16, the coating shall spray satisfactorily in all respects and shall show no running, sagging, or streaking. The coating shall not spray dry and the dried film shall show no dusting, mottling or color separation. Furthermore, the dry film shall present a smooth lusterless flat finish, free from voids, seediness or pinholes or any film defects that may undermine the performance of the Chemical Agent Resistant Coating (CARC) system. Texturing or surface roughness is permitted for Aircraft Green, 34031 provided all performance requirements of the specification are met.

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3.6.4 Brushing properties. When tested as specified in 4.6.17, the coating shall brush satisfactorily and shall dry to a smooth, uniform film, free from seeds, runs, sags, or streaks. The dried film shall show no discernible brush marks.

3.6.5 Flexibility. A film of the coating tested as specified in 4.6.18 shall withstand bending without cracking or flaking.

3.6.6 Recoatability. When tested as specified in 4.6.19, recoating of a dried film shall produce no lifting, softening, or other film irregularity.

3.6.7 Adhesion. The assessment of the adhesion of the coating film shall be determined by its ability to not peel from the substrate when tested in accordance with ASTM D3359 as specified in 4.6.20. The resultant test rating shall be classified as scale 4B or better.

3.6.8 Elevated temperature adhesion. The assessment of the adhesion of the coating film shall be determined by its ability to not peel from the previous coating film when tested in accordance with ASTM D3359, as specified in 4.6.21. The resultant test rating shall be classified as scale 4B or better. After the initial 24 hour air dry, recoating of a dried film shall produce no lifting, softening, or other film irregularity. The force dry panels shall show similar results to the baseline air dry panel for recoating and adhesion.

3.6.9 Water resistance. When tested as specified in 4.6.22, a film of the coating shall show no blistering or wrinkling and no more than a slight whitening or softening immediately upon removal from the water. Film softening shall not exceed a 2 pencil hardness difference (see ASTM D3363) from an unexposed film with identical cure history prior to water exposure. After 2 hours air drying the portion of the panel, that was immersed, shall be almost indistinguishable with regard to adhesion, hardness, color, and gloss from an unexposed film with identical cure history prior to water exposure.

3.6.10 Hydrocarbon resistance. When tested as specified in 4.6.23, a film of the coating shall show no blistering or wrinkling when examined immediately after removal from the hydrocarbon test fluid. When examined 2 hours after removal, there shall be no excessive softening, whitening, or dulling. Film softening shall not exceed a 2 pencil hardness difference (see ASTM D3363) from an unexposed film with identical cure history prior to hydrocarbon exposure. After 24 hours drying the portion of the panel which was immersed shall be almost indistinguishable with regard to hardness, adhesion, and general appearance from a panel prepared at the same time but not immersed and shall have no more than a 0.5 gloss unit increase over the original 60 and 85 degree gloss values.

3.6.11 Acid resistance. When tested as specified in 4.6.24, a film of Green 383, 34094, Green 808, 34102, Dark Green 34082, Woodland Desert Sage, 34201 and IRR Foliage Green 504, 34106 shall have no blistering and show no change from the original color.

3.6.12 Accelerated weathering. Samples of aircraft colors and Olive Drab, 34088 tested as specified in 4.6.25 for 800 hours shall show no cracking, chalking, or loss of adhesion, and shall meet the color, infrared reflectance, 60 and 85 degree gloss requirements of the specification. Camouflage colors tested as specified in 4.6.24 for 800 hours shall show no cracking, chalking, loss of adhesion, or increase in the 60 and 85 degree glosses to exceed maximum values in table VII.

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Color change shall be less than 2.5 NBS units when compared to an unexposed sample of the same batch using tristimulus color coordinates. In addition, after accelerated weathering the color change shall remain within 2.5 NBS units of the value specified in table I (difference from nominal values or center of color ellipse). The infrared reflectance and allowable ratio shall remain within those limits originally specified.

3.6.13 Super Tropical Bleach (STB) resistance. When tested as specified in 4.6.26, a film of the coating shall show no blistering, wrinkling, or film softening when examined immediately after washing with water. Film softening shall not exceed a 2 pencil hardness difference (see ASTM D3363) from an unexposed film with identical cure history prior to STB exposure. After drying, there shall be a maximum color change of 2.5 NBS units when comparing a portion of the untested panel to that of the tested area using tristimulus color coordinates. The STB composition shall be in accordance with MIL-DTL-12468.

3.6.14 Chemical agent resistance. A film of the coating tested as specified in 4.6.27 shall desorb a maximum of 180 micrograms of agent HD, a vesicant agent, and a maximum of 40 micrograms of agent GD, a toxic nerve agent.

3.6.15 Weather resistance. Films of the coating tested as specified in 4.6.28 shall show no checking, cracking, or appreciable film deterioration. There shall be no more than light chalking (see ASTM D4214). The color shall not exceed 2.5 NBS units at 560 MJ/m^2 of total UV irradiance when compared to an unexposed sample of the same batch using tristimulus color coordinates. The approximate equivalence of two years of total UV irradiance in Arizona is 620 MJ/m^2.

3.7 User instruction marking and precaution sheet. All containers shall include the VOC content and VOHAP content in g/l or lbs/gal of coating, and a printed precaution sheet with the following information:
CAUTION: The Surgeon General requires airline respirators to be used unless air sampling shows exposure to be below standards. Then, either chemical cartridge respirators or airline respirators are required. Avoid contact with skin and eyes. Use with adequate ventilation. For other safety recommendations, refer to the Material Safety Data Sheets (MSDS). Keep containers closed.

3.8 Toxicity clearance. All new chemicals and materials being added to the Army supply system shall have a toxicity clearance. A toxicity clearance involves a toxicological evaluation of materials prior to introduction into the Army supply system. The Army program manager shall be responsible for identifying technically feasible materials and requesting a toxicity clearance for use of that material within their program (see 6.4.4).

3.9 MSDS. The manufacturer shall comply with the requirements set forth by the Hazardous Communication Standard, 29 CFR 1910.1200. A MSDS shall be prepared for the coating in accordance with FED-STD-313 and forwarded to the qualifying activity (see 6.4.2). The MSDS for the material covered by this specification shall be included with each shipment, and submitted to pertinent Government agencies as stated in FED-STD-313.

3.9.1 Safety Data Sheets (SDSs). A Safety Data Sheets (SDSs) shall be phased into the system by the following deadline of June 1, 2015 and after June 1, 2016 the Material Safety Data Sheets

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(MSDSs) becomes extinct and you must ensure that each hazardous chemical in your workplace has an SDS and only a SDS as specified in the OSHA Brief http://www.osha.gov/dsg/hazcom/osha-brief.html and as specified in Appendix D of 29 CFR 1910.1200 (see: http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10103).

4. VERIFICATION

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

a. Qualification inspection (see 4.2).
b. Extension of qualification inspection (see 4.3).
c. Conformance inspection (see 4.4)

4.2 Qualification inspection. Qualification shall be conducted by the qualifying activity (see 6.4). The qualification test sample shall consist of four quarts of the paint. The samples shall be legibly identified (see 6.4.3). Qualification inspection shall consist of tests for all requirements in section 3 and table X. Qualification inspection shall examine for user instruction marking (see 3.7). The results of each test shall be compared with the applicable requirement in section 3. Failure to conform to any requirement shall be counted as a defect, and paint represented by the sample test shall not be approved for inclusion in the QPD under this specification.

4.3 Extension of qualification inspection. Qualification inspection (see 4.2) shall be performed on the colors listed in the left column of table IX. These ten (10) primary colors shall require full qualification testing. These colors shall be approved first for inclusion in the QPD under this specification in order to qualify their respective colors listed in the right column to an extension test program. The extension test program shall test for color, infrared reflectance, accelerated weathering (only for Aircraft Yellow, 33538 and Aircraft Red, 31136), 60 and 85 degree gloss, STB resistance, acid resistance, accelerated storage stability, chemical agent resistance, and viscosity. The extension test program can include limited extension testing. Limited extension testing for only color, gloss, and STB resistance shall be determined on a case by case basis and formalized prior to testing through test service agreements. Colors in the right column shall be listed in the QPD if they satisfy the requirements of the extension test program. The qualification test sample shall consist of a one quart sample of the paint. The sample and the necessary paperwork (see 6.4.3) shall be sent to the qualifying activity (see 6.4).

TABLE IX. Qualification and extension colors.

Full QPD testing/color qualified	QPD extension test program/additional colors to which approval is extended
Green 383, 34094	Dark Green, 34082; Olive Drab, 34088; Field Drab, 33105
Green 808, 34102	-
IRR Foliage Green 504, 34160	-
Tan 686A, 33446	Earth Yellow, 33245; Dark Sandstone, 33510; Sand, 33303; Tan, 33531
Woodland Desert Sage, 34201	-
Brown 383, 30051	-

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TABLE IX. Qualification and extension colors –Continued.

Black, 37030	Aircraft Black, 37038; Interior Aircraft Black, 37031
Aircraft Green, 34031	-
Aircraft White, 37875	Aircraft Red, 31136; Aircraft Yellow, 33538; Aircraft Insignia Blue, 35044, Weapons Safety Red, 38905
Aircraft Gray, 36300	Interior Aircraft Gray, 36231; Blue Gray, 35237; Medium Gray, 36375

4.4 Conformance inspection. The contracting officer shall require that an appropriate sprayed sample from each production lot (see 4.4.1) be forwarded to ARL, ATTN: RDRL-WMM-C, Organic Coatings Team, Building 4600, Deer Creek Loop, APG, MD 21005-5066. Conformance inspection shall consist of testing spectral reflectance characteristics to include color, STB resistance, and gloss at 60 and 85 degrees. There shall be no failures (see 6.5).

4.4.1 Lot and batch formation. For purposes of conformance inspection, a lot shall consist of all coatings of the same type, composition and color, from a single uniform batch, produced and offered for delivery at one time (see 6.4.1). A batch shall consist of all coating material (in U.S. gallons) manufactured during one continuous operation and forming part of one contract or order for delivery (see 6.4.1). When required, the manufacturer shall furnish with each lot and/or batch a certified test report showing that the material has passed the conformance inspection, and that there has been no formulation or process change from that which resulted in the production of the qualification inspection sample. The addition of any substance to a batch shall constitute a new lot.

4.5 Inspection conditions. Unless otherwise specified, all inspections shall be performed in accordance with ASTM D3924. Also, unless otherwise stated in the test method or paragraph, room temperature shall be 73 ± 4 °F (23 ± 2 °C) and a 40 - 70 percent relative humidity.

4.6 Test methods.

4.6.1 Testing. Except as otherwise specified herein, the routine testing and referee testing shall be conducted in accordance with ASTM D3924. A dry film thickness of 2 ± 0.2 mils (50 ± 5 microns) shall be used whenever film thickness is requested in any test, unless otherwise required by the test. Failure of any test result to fall within the ranges specified in section 3 shall constitute failure of the applicable test.

4.6.1.1 Test procedures. Tests shall be conducted in accordance with table X. The right is reserved to make any additional tests deemed necessary to determine that the coating meets the requirements of this specification.

4.6.1.2 Test panels. Unless otherwise specified, metal panels used for test purposes shall be of the following types:

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a. Steel, cold rolled, pretreated with zinc phosphate coating B-952 with P60 chrome rinse, 0.032 inches (0.8128 mm) thick, for all tests except flexibility.
b. For aviation system application, aluminum test panels shall be aluminum alloy 2024-T3 treated with MIL-DTL-5541, type II (see 4.6.1.3).
c. Steel, tinplated, 0.010 inches (0.254 mm) thick, for flexibility only.

4.6.1.3 Epoxy primer. Test panels shall be solvent wiped and cleaned prior to applying epoxy primer. Apply epoxy primer conforming to MIL-DTL-53022 or MIL-DTL-53030 to a dry film thickness of 1.5 ± 0.2 mils (37.5 ± 5 microns). For aviation system application evaluation, MIL-PRF-23377 or MIL-PRF-85582 epoxy primers shall be used and applied to a dry film thickness of 0.6 - 0.9 mils (15 - 22.5 microns).

4.6.2 Color and reflectance. Prepare two sprayed samples of the coating on a black and white hiding chart to a dry film thickness of 2 ± 0.2 mils (50 ± 5 microns). Dry for a minimum of 48 hours according to the test conditions in 4.6.1. Determine the color and infrared reflectance from the spectral curves using the recording spectrophotometer method in accordance with ASTM E308 and ASTM E1331. Measurements shall be made over the black portion of the hiding chart (see 4.6.13). For aircraft colors and Dark Sandstone, 33510, compare the color as specified in 3.3 and 3.3.1. Visually match the other colors listed in 1.2.2 to the appropriate color chip from FED-STD-595 for compliance with 3.3 and table I. Spectral reflectance limits are outlined in tables III, IV and V. Noncompliance to 3.3 and 3.3.1 shall constitute failure of this test.

4.6.3 Total and vehicle solids. Determine the total solids (nonvolatile matter) of the coating in accordance with ASTM D7232. Check for compliance with table VIII.

TABLE X. Index.

Item	ASTM Method	Test Paragraph	Requirement Paragraph or Table
Color and reflectance	E308 and E1331	4.6.2	3.3 and 3.3.1
Total and vehicle solids	D7232	4.6.3	Table VIII
Pigment analysis	D2371	4.6.4	3.4.1, Table VI and VIII
Titanium dioxide	D476, type III or IV	-	3.4.1
Hexavalent chromium	-	4.6.5	Table VII
Lead content	D3335	4.6.6	Table VII
Cadmium content	D3335	-	Table VII
Nonvolatile vehicle	-	4.6.7	3.4.2
VOC content	D3960	4.6.8	3.4.3
VOHAP content 1/	D3271	4.6.8.1	3.4.4

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TABLE X. Index - Continued.

Hiding-power (contrast ratio)	D2805	4.6.9	Table VII
Viscosity, Krebs-Stormer	D562	4.6.10	Table VII
Drying time	D5895	4.6.11	Table VII
Specular gloss	D523	4.6.12	Table VII
Infrared reflectance Camouflage colors 2/ Other colors Aircraft colors 3/ Dark Sandstone, 33510	E308 and E1331	4.6.2 and 4.6.13	3.3 and 3.3.1, Table I and II
Spectral reflectance limits Dark Green, 34082 Green 383, 34094 IRR Foliage Green 504, 34160 Green 808, 34102	E308 and E1331	-	Table III, IV and V
Condition in container	-	4.6.14	3.6.1
Accelerated storage stability	-	4.6.15.1	3.6.2.1
Full container storage stability	D1849	4.6.15.2	3.6.2.2
Spraying properties	-	4.6.16	3.6.3
Brushing properties	-	4.6.17	3.6.4
Flexibility	D522	4.6.18	3.6.5
Recoatability	-	4.6.19	3.6.6
Adhesion	D3359	4.6.20	3.6.7
Elevated temperature adhesion	D3359	4.6.21	3.6.8
Water resistance	-	4.6.22	3.6.9
Hydrocarbon resistance	-	4.6.23	3.6.10
Acid resistance	-	4.6.24	3.6.11
Accelerated weathering	G154	4.6.25	3.6.12
STB resistance	-	4.6.26	3.6.13
Chemical agent resistance	-	4.6.27	3.6.14
Weather resistance	G90	4.6.28	3.6.15

1/ EPA Method 311.
2/ Exclude from this category Aircraft Green, 34031 and Aircraft Gray, 36300.
3/ Include the camouflage colors Aircraft Green, 34031 and Aircraft Gray, 36300 in this category.

4.6.4 Pigment analysis. Determine the pigment content of the coating in accordance with ASTM D2371. The pigment generated by this method shall be used for the screening tests of the coating's heavy metal content as listed below. Check for compliance with tables VI and VIII and 3.4.1.

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4.6.5 Hexavalent chromium. Determine the presence or absence of hexavalent chromium by either of the following chemical reagent screening techniques.

(a) Weigh approximately 250 mg of pigment into a small glass test tube. Add 5 ml of 25 percent aqueous KOH and shake vigorously for 1-2 minutes. Decant a one ml aliquot into a plastic micro-centrifuge tube and centrifuge for five (5) minutes at 17000 rpm, balancing the centrifuge with a tube containing one ml of the KOH solution. The resulting supernatant liquid shall be nearly colorless. Use the tube containing the KOH solution as a reference. A distinct yellow color indicates the presence of hexavalent chromium and therefore shall constitute failure of the test requirement.

(b) Weigh approximately 50 mg of pigment into a small glass test tube. Add 5ml of 10 percent aqueous H_2SO_4 and shake vigorously for 1-2 minutes. Decant a one ml aliquot into a plastic micro-centrifuge tube and centrifuge for five (5) minutes at 17,000 rpm, balancing the centrifuge with a second tube containing one ml of the H_2SO_4 solution. The solution in the second tube shall act as the test "blank". Immerse a chromate ion (CrO_4^{2-}) test strip into the supernatant from each tube. Shake off the excess liquid and after approximately one minute compare the color change in the reaction zone of the strips to the color scale (concentration levels) provided by the manufacturer. The appearance of a purple/violet color from the "sample" strip is indicative of hexavalent chrome and therefore shall constitute failure of the test requirement. If a color change is apparent from the "blank" strip rerun the test using fresh, chromium-free reagents. The appearance of a pronounced color change is indicative of hexavalent chrome and therefore shall constitute failure of the test requirement.

4.6.6 Lead content. Determine the presence or absence of lead by weighing 50 mg of pigment into a small glass test tube. Add 5 ml of dilute HNO_3 and shake vigorously for 1-2 minutes. Decant a one ml aliquot into a plastic micro centrifuge tube and centrifuge for five (5) minutes at 17,000 rpm, balancing the centrifuge with a second tube containing one ml of the dilute HNO_3 solution. The solution in the second tube shall act as the test "blank". Immerse a lead ion test strip into the supernatant from each tube. Shake off the excess liquid and after approximately one minute compare the color change in the reaction zone of the strips to the color scale (concentration levels) provided by the manufacturer. If a color change is apparent from the "blank" strip rerun the test using fresh, lead-free reagents. Confirmation of the exact lead concentration in the coating's solids shall be quantified using ASTM D3335. Nonconformance to the table VII requirements shall constitute failure of this test.

4.6.6.1 Antimony, arsenic, beryllium, cadmium, cyanide, manganese, mercury, nickel and selenium. Manufacturers need to review applicable environmental and safety regulations and comply with material shipment requirements (see 6.2). The SDS needs to include a notarized statement that verifies that the composition of the material (coating formulation) is free of the antimony, arsenic, beryllium, cadmium, cyanide, manganese, mercury, nickel, selenium and their compounds.

4.6.7 Nonvolatile vehicle. Centrifuge a 1:1 mixture of methyl isobutyl ketone and paint at 12,000 rpm for 10 minutes. Evaporate a film of the vehicle on a sodium chloride plate at 105 °C (221 °F) for 5 minutes. Scan the infrared spectrum from 2.5 to 15 micrometers. Check for compliance with 3.4.2.

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4.6.8 Solvent analysis for VOC content determination. Determine the VOC content in accordance with ASTM D3960. Check for compliance with 3.4.3.

4.6.8.1 VOHAP content of coatings. Hazardous solvent content of each individual coating shall be determined in accordance with ASTM D3271 or EPA Method 311, as applicable. Check for compliance with 3.4.4.

4.6.9 Hiding power (contrast ratio). Using a sprayed sample from the color determination (see 4.6.2), determine the reflectance using the daylight reflectance factor of ASTM D2805 over the black and white portion of the card and record the values as R_B/R_W and check for compliance with table VII.

4.6.10 Viscosity, Krebs-Stormer. Determine viscosity in accordance with ASTM D562. Check for compliance with table VII.

4.6.11 Drying time. Spray the mixed coating to a dry film thickness of 2 ± 0.2 mils (50 ± 5 microns) and determine the drying under ambient conditions in accordance with ASTM D5895. Check for compliance with table VII.

4.6.12 Specular gloss. Spray the mixed coating to a dry film thickness of 2 ± 0.2 mils (50 ± 5 microns). Test for 60 degree gloss and 85 degree gloss (sheen) in accordance with ASTM D523. Check for compliance with table VII.

4.6.13 Infrared reflectance (for Aircraft Green, 34031, Aircraft Gray, 36300, Interior Aircraft Black, 37031, and Dark Sandstone, 33510). Determine the infrared reflectance on the black portion of the sprayed sample in 4.6.2. For Aircraft Green, 34031 and Interior Aircraft Black, 37031 determine the infrared reflectance value at 870 nanometers. Determine the infrared reflectance for Aircraft Gray, 36300 and Dark Sandstone, 33510 at 1500 nanometers. In all evaluations, use a spectrophotometer which is capable of measuring the total diffuse reflectance in accordance with ASTM E308 and ASTM E1331. Nonconformance with table I shall constitute failure of this test.

4.6.14 Condition in container. Upon opening a full previously unopened container the condition of the contents shall be examined for compliance with 3.6.1. Reseal, then agitate the container for 3 minutes on a paint shaker and examine for compliance with 3.6.1. On reexamination of the contents, the disclosure of any gel bodies or undispersed pigment indicates unsatisfactory settling properties.

4.6.15 Storage stability.

4.6.15.1 Accelerated storage stability. Fill an epoxy lined pint container with the coating and determine the viscosity in accordance with ASTM D562. Tightly seal the container and place sample in a preheated oven for 7 days at 60 ± 1 °C (140 ± 1.8 °F). Allow to cool to room temperature and examine the contents. Check for compliance with 3.6.2.1.

4.6.15.2 Full container storage stability. Allow 2 quarts of liquid coating to stand undisturbed for 6 and 12 months respectively in accordance with ASTM D1849. Examine the contents for skinning. Reseal and agitate the can for 5 minutes on a paint shaker. Reexamine and evaluate

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for pigment settling as specified in 4.6.14. Determine viscosity and other applicable tests for compliance with 3.6.2.2.

4.6.16 Spraying properties. If reduction is necessary for spray application, reduce with a VOHAP-free thinner recommended by the manufacturer, not to exceed VOC limits where applicable. Spray the coating on a solvent cleaned test panel (see 4.6.1.2 and 4.6.1.3) to a dry film thickness between 2 ± 0.2 mils (50 ± 5 microns). Observe the spraying properties for compliance with 3.6.3.

4.6.17 Brushing properties. Apply the coating using a 2-1/2 inch brush to a test panel pretreated and primed (see 4.6.1.2 and 4.6.1.3). The packaged coating shall be reduced as in 4.6.16 without exceeding the VOC limit if needed. Check for compliance with 3.6.4.

4.6.18 Flexibility. Determine flexibility in accordance with ASTM D522, method B using a ¼ inch mandrel. Spray the coating on a steel panel, tinplated 0.010 inches (0.254 mm) thick. Air dry for 168 hours. Bend the coated panels according to ASTM D522, method B. Examine the coating for cracks over the area of the bend for compliance with 3.6.5.

4.6.19 Recoatability. Prepare two test panels pretreated (see 4.6.1.2) and primed (see 4.6.1.3). Air dry the two test panels according to the requirements of the primer in use for this test. Mix the coating by agitating the paint can for 5 minutes on a paint shaker. Spray the coating to a dry film thickness of 2 ± 0.2 mils (50 ± 5 microns). Apply a second coat of paint to one of the above panels after 2 hours (air dry) and a second coat to the other after air drying for 24 hours. Air dry both panels 24 hours. Examine for lifting, softening, and evidence of other film irregularity for compliance with 3.6.6.

4.6.20 Adhesion. Prepare a test panel pretreated (see 4.6.1.2) and primed (see 4.6.1.3). Mix the coating as specified in 4.6.16. Spray the coating to a dry film thickness of 2 ± 0.2 mils (50 ± 5 microns) and air dry for 168 hours. Perform adhesion testing as specified in ASTM D3359, method B, and examine for compliance with 3.6.7.

4.6.21 Elevated temperature adhesion. Prepare three test panels pretreated (see 4.6.1.2) and primed (see 4.6.1.3). Mix the coating as specified in 4.6.19. On the test panels, spray the coating to a dry film thickness of 2 ± 0.2 mils (50 ± 5 microns). The first panel is to be dried at room temperature. The second panel is to be dried at room temperature for 30 minutes followed by hour oven exposure at 180 °F. The third panel is to be dried at room temperature for 30 minutes followed by hour oven exposure at 240 °F. All three panels are to be recoated to a dry film thickness of 2 ± 0.2 mils (50 ± 5 microns) within 24 hours after the initial topcoating. These panels are to cure at room temperature after the recoat. Twenty four (24) hours after the recoat, the panels are to be examined for lifting, softening and evidence of other film irregularity for compliance with 3.6.8. After 168 hours of air drying, perform adhesion testing as specified in ASTM D3359, method B, and examine for compliance with 3.6.8.

4.6.22 Water resistance. Prepare a test panel pretreated (see 4.6.1.2) and primed (see 4.6.1.3). Mix the coating by agitating the paint can for 5 minutes on a paint shaker. Spray the coating to a dry film thickness of 2 ± 0.2 mils (50 ± 5 microns) and air dry for 168 hours. Coat all exposed unpainted metal surfaces with wax or suitable protective coating and immerse in deionized water at 25 ± 1 °C (77 ± 2 °F) for 168 hours. Panels shall be immersed at a minimum depth of 50%. At the end of the test period, remove and examine for compliance with 3.6.9.

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4.6.23 Hydrocarbon resistance. Spray the coating on a test panel (see 4.6.1.2 and 4.6.1.3) to a dry film thickness of 2 ± 0.2 mils (50 ± 5 microns). Air dry the specimen for 168 hours and then immerse for 168 hours in a hydrocarbon fluid conforming to JP8 at 25 ± 1 °C (77 ± 2 °F). Panels shall be immersed at a minimum depth of 50%. At the end of the test period, remove and examine for compliance with 3.6.10.

4.6.24 Acid resistance (only for Green 383, 34094, Dark Green 34082, Green 808, 34102, Woodland Desert Sage, 34201 and IRR Foliage Green 504, 34160). Using the film prepared and air dried for 168 hours, place a 3 to 5 ml spot of a 10 percent by volume acetic acid solution on the surface of the coating. Cover the film with an appropriate size watch glass and allow to stand for 1 hour. Rinse with water thoroughly, allow to dry, and examine the film for blistering and color change for compliance with 3.6.11.

4.6.25 Accelerated weathering. Spray the coating on four test panels (see 4.6.1.2 and 4.6.1.3) to a dry film thickness of 2 ± 0.2 mils (50 ± 5 microns) and air dry for 168 hours. Three panels are to be tested and one retained as a control. Determine the color and infrared reflectance as in 4.6.2 and measure the 60 and 85 degree gloss. Expose three panels for 800 hours to accelerated weathering in accordance with ASTM G154 using a UV 340A light source. Measure the 60 and 85 degree gloss and determine the color and infrared reflectance of the exposed film. Examine the panel for chalking by rubbing with a piece of velvet or cheese cloth. Check for compliance with 3.6.12.

4.6.26 Super Tropical Bleach (STB) resistance. Spray one 4 by 12 inch test panel (see 4.6.1.2 and 4.6.1.3) to a dry film thickness of 2 ± 0.2 mils (50 ± 5 microns). Air dry the panel a minimum of 168 hours. Scribe a 1 inch diameter wax ring using a china marker on the painted surface of the panel. Place approximately 1 ml of STB agent on the panel surface. Do not cover. Allow to stand 30 minutes then thoroughly wash with water. A STB slurry mix of 40 parts STB and 60 parts water by weight shall be used. Examine for compliance with 3.6.13.

4.6.27 Chemical agent resistance.

4.6.27.1 Panel preparation. Spray eight test panels pretreated and primed as specified in 4.6.1.2 and 4.6.1.3. Coupons shall be circular discs with a 2.42 inch (61.5 mm) diameter for the chemical agent testing. Air dry the test panels for 2 hours. Mix the topcoat paint as specified in 4.6.14 and then spray on the topcoat paint to a dry film thickness of 2 ± 0.2 mils (50 ± 5 microns). Air dry the panels for 7 days.

4.6.27.2 Test conditions. Because the desorption rate of agents from paint is temperature dependent, all agent tests shall be conducted at 25 °C (77 °F). Extremely toxic materials are used in this testing. Agent HD, a vesicant agent, is also a known carcinogen. Agent GD is a toxic nerve agent, exposure to which is difficult to treat. Consequently, all work shall be performed in an approved fume hood, and appropriate measures to protect individuals at risk of exposure shall be taken.

4.6.27.3 Test apparatus. The test apparatus used for both HD and GD testing consist of a temperature controlled Plexiglas box (approximately 0.5 m x 0.5 m x 1 m) containing five separate test cells. Four of these cells are used to test sample CARC panels. The fifth is used to

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test a control panel. All five tests shall be run simultaneously. The test cells are machined from aluminum and consist of two parts that are clamped together to hold the test panels in place. Maintain a gastight seal. Agent desorbed from the test panels is entrained by dry nitrogen that passes through a temperature-humidity-flow controller, with final temperature controlled by a proportional temperature controller. The nitrogen passes through an external chamber fitted with a bleed valve before entering the test cells. Determine the agent recovered in micrograms for compliance with 3.6.14.

4.6.27.4 Test procedure. Place a 5 cm^2 circular template on the area of the test panel to be contaminated with agent. Use a grease pencil to mark a circle around the template; the grease mark serves to keep the agent from spreading out of the designated area. Place 50 microliters of agent HD or GD on the test area. Place a glass cover slip (microscope slide) over the test area to minimize evaporation of the agent. After 30 minutes remove the cover slip, rinse the agent from the panel with isopropanol and allow to air dry for approximately 45 seconds. Place the panel in the test cell, which has been maintained at 25 °C (77 °F), with the coated area positioned such that the nitrogen stream shall pass across the contaminated area. Nitrogen is used instead of air to eliminate the possibility of reaction of the desorbed agent over the time of the test, which is 22 hours. Pass the nitrogen through an impinger containing the appropriate solvent, n-decane for HD and iso-octane (2, 2, 4-trimethylpentane) for GD. The flow of nitrogen shall be maintained at 0.252 grams/min across each sample. Terminate the test at the end of 22 hours.

4.6.27.5 Analysis. Transfer the contents of each impinger to a 25 ml volumetric flask. Rinse the impinger twice with the same solvent and add the rinse to the flask. Bring the volume up to the mark with solvent and mix well. Transfer a 1 ml portion to a GC vial for analysis. Perform the analysis on a Finnigan-MAT GQC ion-trap mass spectrometer equipped with a 25 m MS-5 capillary column, using helium as the carrier gas. Standardize the mass spectrometer by serial dilutions of an agent solution in the appropriate solvent, analyzed in the same conditions. The instrument conditions are as follows: introduce the samples from an AST 2000 autosampler, volume of 1 microliter, onto the GC column in splitless mode; injector temperature of 280 °C (536 °F). Temperature program the column from an initial temperature of 50 °C to 120 °C (122 °F to 248 °F) at a rate of 10°/min; followed by an increase of 25 °C/min (77 °F/min) to a final temperature of 200 °C (392 °F). Acquire mass spectra in electron impact mode over the mass range of 50-150 for HD and 50-200 for GD. Under these conditions, HD has a retention time of 8.15 minutes. Integrate the peak areas of the relevant portion of the reconstructed ion chromatograms for the ion at m/z 109. Under the cited conditions GD elutes as a pair of completely resolved diastereomeric enantiomers with retention times of 9.56 and 10.04 minutes. Integrate the peak areas of the relevant portion of the reconstructed ion chromatograms for the ion at m/z 99. Construct the standard response curve for HD and GD using the integrated area on the y axis and concentration (µg/ml) on the x axis. Use the linear regression analysis function of an Excel spreadsheet, which shall calculate the slope, intercept, and correlation coefficient of the standard response curve. The slope and intercept of the standard response curve are used to calculate concentration of agent HD or GD in the impinger solutions. Calculate the total amount of agent (in micrograms) that outgassed from the CARC panel by multiplying the concentration of agent in the impinger solution (micrograms/milliliter read from the standard curve) by the volume of the impinger solution (25 ml).

4.6.28 Weather resistance. Prepare five 3 by 6 inch test panels (see 4.6.1.2 and 4.6.1.3). Spray on the topcoat paint to a dry film thickness of 2 ± 0.2 mils (50 ± 5 microns). Air dry the panels a

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minimum of 7 days. The chemical agent resistant coating shall be placed outdoors, for the equivalent of 560 MJ/m^2 of total UV irradiance, in an accelerated outdoor exposure according to ASTM G90. At 70 MJ/m^2 intervals, examine the panels for compliance with 3.6.15. Determine chalking in accordance with ASTM D4214. Wash the panels with a warm soap solution using a soft sponge or cloth, rinse, dry and examine for color change at each interval. The exposure racks shall be weathered at latitude 33° 23' North and 112° 35' West.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When 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 command. 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.

5.2 Markings. Containers of paint shall be marked with a label that identifies the specification number, type, color and material designation so that traceability to the QPD can be verified.

6. NOTES

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

6.1 Intended use. This single component polyurethane coating is intended to provide surfaces that are easily and effectively decontaminated after exposure to liquid chemical agents. It may be used in areas where VOCs and VOHAPs are regulated. It is applied over epoxy primers (MIL-PRF-23377, MIL-DTL-53022, MIL-DTL-53030, MIL-PRF-85582, MIL-PRF-32348, type I or electrodeposition primer MIL-DTL-53084) depending on the application and substrate. For adequate camouflage properties, it is necessary to apply the coatings to a minimum dry film thickness of 2 ± 0.2 mils (50 ± 5 microns).

6.1.1 Marking. Use CARC marking paint on CARC coatings.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of this specification.
b. Type and color of coating (see 1.2.1 and 1.2.2).
c. Part or identifying number (PIN) (see 1.3).
d. If a toxicity clearance is required (see 3.8).
e. Whether a SDS is required with each shipment (see 3.9 and 4.6.6.1).
f. If qualification samples are required and where to send them (see 4.2 and 6.4).
g. If extension of qualification samples are required and where to send them (see 4.3 and 6.4).
h. If conformance samples are required and where to send them (see 4.4).
i. Packaging requirements (see 5.1).

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6.3 Basis of purchase. The coating covered by this specification should be purchased by volume, the unit being one U.S. liquid gallon of 231 cubic inches at 68 °F (20 °C).

6.4 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 the QPD, MIL-DTL-53039E. The attention of contractors is called to this requirement and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or purchase orders for the products covered by this specification. Samples for QPD testing (see 4.2) and for the extension testing program (see 4.3) should be submitted to ARL, ATTN: RDRL-WMM-C, Organic Coatings Team, Building 4600, Deer Creek Loop, APG, MD 21005-5066.

6.4.1 Conformity to qualified sample. All lots of coatings supplied under this specification must be manufactured using the same formulation, raw materials and supplier(s) of raw materials, methods of manufacture, equipment, and geographic location as the qualification sample, unless changes have been approved by the qualifying activity.

6.4.2 MSDS. Contracting officers will identify those activities requiring copies of a completed MSDS prepared in accordance with FED-STD-313. The pertinent Government mailing addresses for submission of data are listed in FED-STD-313.

6.4.3 Sample identification for qualification inspection. Samples for QPD testing and for the extension testing program are to be identified in a cover letter with the following information:

Manufacturer's name and product number.
Submitted by (name and date).
Specify the number of samples.
Specify the reason for submitting the samples.
Specification MIL-DTL-53039E; Type _____, Color _____,
"Coating, Aliphatic Polyurethane, Single Component, Chemical Agent Resistant".
Provide a copy of the SDS.
Provide a copy of the notarized statement of composition.
Provide a copy of the technical data sheet.
Provide a copy of the test report.

6.4.4 Toxicity clearance request. Department of the Army Regulation (AR) 40-5, Preventive Medicine, (AR) 70-1, Acquisition Policy, and Department of the Army Pamphlet 70-3, Acquisition Procedures, require a toxicity clearance. Army toxicity questions and/or a toxicity clearance request should be addressed to: US Army Public Health Command (USAPHC), ATTN: MCHB-IP-TTE, 5158 Blackhawk Road, APG-EA, MD 21010-5403 or emailed to usaphctepinfo@amedd.army.mil

6.4.5 Retention of qualification. To retain qualification of products approved for listing in the QPD, the manufacturer will be requested to verify by certification to the qualifying activity 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.

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6.5 Conformance rejection and retest. Failure in any conformance inspection will result in the rejection of the batch from which it was obtained. Rejected material cannot be resubmitted for acceptance without written approval from the qualification activity (see 4.4). The application for resubmission will contain all details concerning previous rejections and measures taken to correct these deficiencies.

6.6 Detail specification. MIL-DTL-53072, Chemical Agent Resistant Coating (CARC) System Application Procedures and Quality Control Inspection, is available for application procedures and quality control inspection of this coating.

6.7 Subject term (key word) listing.

Aircraft
Beads
CARC
Colors
Equipment
Pigment
Total solids
Vehicle solids

6.8 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

CONCLUDING MATERIAL

Custodians:
Army - MR
Navy - AS
Air Force - 99

Review activities:
Army - MD1, MI
Navy - CG, SH
Air Force - 11, 84

Civil agency:
GSA/FAS

Preparing activity:
Army - MR

Project 8010-2012-005

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 https://assist.dla.mil/.