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DETAIL SPECIFICATION

# CAMOUFLAGE COATING, WATER DISPERSIBLE ALIPHATIC POLYURETHANE, 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 water-dispersible, chemical agent resistant, aliphatic polyurethane camouflage coatings for use as a finish coat on all military tactical equipment, which includes ground, aviation and related support assets. The materials are free of volatile organic hazardous air pollutants (VOHAP-free), free of inorganic HAPs other than cobalt and non-hexavalent chromium, and have a maximum volatile organic compound (VOC) content of 220 grams/liter (g/l) (1.8 pounds/gallon (lbs/gal)) as packaged.

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

1.2.1 Type. The coating 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 II for general painting or Type III when field touch-up is required.

Type I - Siliceous flattening agents.
Type II - Polymeric flattening agents.
Type III - Self contained portable kits. The kits contain the Type II Chemical Agent Resistant Coating (CARC) in a touch-up system.

Comments, suggestions, or questions on this document should be addressed to: Director, U.S. Army Research Laboratory, Weapons and Materials Research Directorate, Coatings, Corrosion, & Engineered Polymers Branch, ATTN: RDRL-WMM-C, Aberdeen Proving Ground, MD 21005-5069 or emailed to bernard.hart@us.army.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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1.2.2 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 | Blue Gray, 35237 | Interior Aircraft Black, 37031 |
| Aircraft Gray, 36300 | Brown 383, 30051 | Interior Aircraft Gray, 36231 |
| Aircraft Green, 34031 | Dark Green, 34082 | Medium Gray, 36375 |
| Aircraft Insignia Blue, 35044 | Dark Sandstone, 33510 | Olive Drab, 34088 |
| Aircraft Red, 31136 | Earth Yellow, 33245 | Sand, 33303 |
| Aircraft White, 37875 | Field Drab, 33105 | Tan 686A, 33446 |
| Aircraft Yellow, 33538 | IRR Foliage Green 504, 34160 | Tan, 33531 |
| Black, 37030 | Green 383, 34094 | Woodland Desert Sage, 34201 |

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

## 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 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 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.

Color Chips 30051, 31136, 33105, 33245, 33303, 33446, 33510, 33531, 33538, 34031, 34082, 34088, 34094, 34160, 34201, 35044, 35237, 36231, 36300, 36375, 37030, 37031, 37038, 37875. All colors are flat or lusterless.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-DTL-12468 - Decontaminating Agent, STB.

MIL-P-53022 - Primer, Epoxy Coating, Corrosion Inhibiting, Lead and Chromate Free.

MIL-P-53030 - Primer Coating, Epoxy, Water Reducible, Lead and Chromate Free.

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(Copies of these documents are available online at http://assist.daps.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.

(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 D2805 - Standard Test Method for Hiding Power of Paints by Reflectometry. (DoD adopted)
ASTM D3335 - Standard Test Method for Low Concentration 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 D3723 - Standard Test Method for Pigment Content of Water-Emulsion Paints by Low-Temperature Ashing.
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.

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| | | |
|---|---|---|
| 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 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, Tan, 33531, and Dark Sandstone, 33510 shall visually match the appropriate chips from FED-STD-595. Aircraft Green, 34031 shall visually match color chips furnished by U.S. Army Research Laboratory, ATTN: RDRL-WMM-C, Camouflage, Coating and Corrosion Team, Building 4600, Deer Creek Loop, Aberdeen Proving Ground, MD 21005-5069. 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 in 4.4.2 and 4.4.11. 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.

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 4.4.2.

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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 |
| Green 383, 34094 | 0.063 – 0.083 | 0.328 | 0.365 | - | 60.0 | 5.2 |
| 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 3/ | VM 3/ | | 62.0 | 72.0 | - |
| Woodland Desert Sage,34201 | 0.187 – 0.220 | 0.347 | 0.360 | 15.0 | 25.0 | - |
| Aircraft Green, 34031 | VM 3/ | VM 3/ | | - | 7.0 | - |
| Interior Aircraft Black, 37031 | VM 3/ | VM 3/ | | - | 7.0 | - |
| Aircraft Gray, 36300 | VM 3/ | VM 3/ | | - | 15.0 | - |
| Dark Sandstone, 33510 | VM 3/ | VM 3/ | | - | 45.0 | - |

1/ See table II or 4.4.2 or 4.4.11.
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 and Green 383, 34094.
3/ Visual Match(es) (VM) as stated in 3.3 are to be used for Aircraft Green, 34031, Interior Aircraft Black, 37031, Aircraft Gray, 36300, Dark Sandstone, 33510, and Tan, 33531.

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.

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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 |
| 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 |

3.4 Composition. The material shall be furnished in two components. Component A shall consist of a hydroxyl functional polyurethane dispersion that may be combined with prime and extender pigments, additives and solvents. Component B shall consist of an aliphatic isocyanate prepolymer type that is dispersible in water that may be combined with volatile solvents. The mixing ratio shall be two parts of component A to one part of component B.

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3.4.1 Pigment. The pigments listed in table V, or any combination thereof, shall make up the primary hiding pigmentation for the colors specified. Iron oxides used as hiding pigments shall 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 4.4.4.1 and 4.4.4.2, no component of the coating shall contain lead, or hexavalent chromium. Compounds of antimony, arsenic, beryllium, cadmium, cyanide, manganese, mercury, nickel and selenium shall be absent. Extender pigments (flattening agents) shall be composed of siliceous matter such as diatomaceous silica, and talc for type I. For type II, materials shall be polymeric based on polyurethane or urea formaldehyde condensation type polymers or other polymeric composition. The amount shall not exceed the limits of table IX.

TABLE V. Pigmentation.

| | |
|---|---|
| Dark Green, 34082<br>Green 383, 34094<br>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. |
| Field Drab, 33105<br>Brown 383, 30051<br>Earth Yellow, 33245<br>Sand, 33303<br>Tan 686A, 33446<br>Tan, 33531<br>Woodland Desert Sage, 34201<br>Dark Sandstone, 33510 | Chromium oxide, titanium dioxide, carbon black, carbazole dioxazine violet, iron oxides, zinc/magnesium ferrite or other mixed metal oxides. |
| Aircraft Green, 34031<br>Olive Drab, 34088 | Iron oxides, carbon black, zinc/magnesium ferrites, titanium dioxide, chromium oxide or other mixed metal oxides. |
| Black, 37030<br>Aircraft Black, 37038<br>Interior Aircraft Black, 37031 | Carbon black, iron oxides. |
| Aircraft White, 37875 | Titanium dioxide. |
| Aircraft Red, 31136 | Titanium dioxide, light stable organic red. |
| Aircraft Gray, 36300<br>Interior Aircraft Gray, 36231 | Titanium dioxide, carbon black, iron oxides. |
| Aircraft Insignia Blue, 35044 | Copper phthalocyanine blue, carbon or lampblack, black iron oxide, titanium dioxide. |

Note: Chromium oxides exclude the use of hexavalent chromium.

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 4.4.4.1.

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3.4.2 Nonvolatile vehicle.

3.4.2.1 Component A.

3.4.2.1.1 Hydroxyl functional polyurethane dispersion. When evaluated as specified in 4.4.5, the hydroxyl functional polyurethane dispersion shall contain sufficient reactivity/hydroxyl functionality to meet the specification performance requirements using a two to one mixing ratio of component A to component B.

3.4.2.2 Component B. When tested as specified in 4.4.6, the nonvolatile vehicle in component B shall be an aliphatic isocyanate prepolymer. It shall contain no toluene diisocyanate.

3.4.3 Volatile content for type I and II. The volatile content of components A and B admixed shall consist of a nonphotochemically reactive solvent blend. The admixed portion shall not contain any hazardous air pollutants (HAPs) in the volatile portions when tested as specified in 4.4.7.1.

3.4.4 Volatile organic compound content for types I and II. The volatile organic compound content shall not exceed 220 g/l (1.8 lb/gal) when tested as specified in 4.4.7.1.

3.5 Quantitative requirements.

3.5.1 Component A (polyol). Component A shall conform to the quantitative requirements of table VI when tested as specified in 4.4.5.

3.5.2 Component B (isocyanate). Component B shall conform to the quantitative requirements of table VII when tested as specified in 4.4.6.

TABLE VI. Component A requirements.

| Characteristic | Minimum | Maximum |
|---|---|---|
| Viscosity, Krebs Units (K.U.) | 55 | 100 |

TABLE VII. Component B requirements.

| Characteristic | Minimum |
|---|---|
| Nonvolatile (total solids) content, percent by weight of component B | 60 |

3.5.3 Mixed coating. When mixed 2 parts component A to 1 part component B by volume, the coating shall conform to the quantitative requirements of table VIII when tested as specified in 4.4.1.1.

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TABLE VIII. Mixed coating requirements.

| Characteristic | Minimum | Maximum | |
|---|---|---|---|
| Hiding power (contrast ratio) | | | |
| Aircraft Red, 31136 | .94 | - | |
| Aircraft White, 37875 | .92 | - | |
| Other colors | .98 | - | |
| 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 other camouflage colors including Aircraft Black, 37038 | | | |
| 60 degree | - | 1.0 | |
| 85 degree | - | 3.5 | |
| Specular gloss for IRR Foliage Green 504, 34160 | | | |
| 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 | |
| Drying time | | Type I | Type II |
| Set to touch, minutes | - | 50 | 60 |
| Dry hard, hours | - | 4 | 6 |
| Dry through, hours | - | 5 | 8 |

3.5.4 Specific quantitative requirements.

3.5.4.1 Specific quantitative requirements. Each color shall conform to its specific requirements in table IX when tested as specified in 4.4.1.1. Total solids, pigment solids, and vehicle solids are percent by weight of component A. Extender pigment is percent by weight of pigment.

3.6 Qualitative requirements.

3.6.1 Condition in container.

3.6.1.1 Component A. When tested as specified in 4.4.12.1, a freshly opened container of component A shall be free from grit, seeds, skins, abnormal thickening, or livering and shall show no more pigment settling or caking than can be easily and completely reincorporated to a smooth homogeneous state.

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TABLE IX. Specific quantitative requirements.

| Color | Total Solids (minimum) Type I | Total Solids (minimum) Type II | Pigment Solids (minimum) Type I | Pigment Solids (minimum) Type II | Vehicle Solids (minimum) Type I | Vehicle Solids (minimum) Type II | Extender pigment (maximum) Type I | Extender pigment (maximum) Type II |
|---|---|---|---|---|---|---|---|---|
| Green 383, 34094 | 55 | 47 | 40 | 29 | 15 | 14 | 60 | 42 |
| IRR Foliage Green 504, 34160 | 47 | 45 | 28 | 25 | 18 | 13 | 65 | 45 |
| Brown 383, 30051 | 52 | 43 | 30 | 22 | 15 | 15 | 70 | 48 |
| Tan 686A, 33446 | 52 | 47 | 34 | 28 | 16 | 15 | 57 | 43 |
| Tan, 33531 | 52 | 43 | 34 | 22 | 16 | 15 | 57 | 52 |
| Woodland Desert Sage, 34201 | 52 | 43 | 34 | 22 | 16 | 15 | 57 | 52 |
| Black, 37030 | 48 | 37 | 30 | 16 | 15 | 13 | 83 | 67 |
| Aircraft Green, 34031 | 47 | 45 | 29 | 26 | 18 | 13 | 65 | 45 |
| Aircraft Gray, 36300 | 45 | 40 | 28 | 26 | 15 | 13 | 60 | 50 |

3.6.1.2 Component B. When tested as specified in 4.4.12.2, component B shall be clear and free from sediment and suspended matter when examined by transmitted light. A freshly opened, full container shall show no livering, curdling, gelling, or skinning.

3.6.2 Storage stability.

3.6.2.1 Component A. When tested as specified in 4.4.13.1, a full quart can of component A shall show no skinning, livering, curdling, hard dry caking, or tough gummy sediment. It shall remix readily to a smooth homogeneous state, shall have a maximum viscosity of 110 Krebs Units (K.U.) for type I and II, and shall meet all other requirements of this specification.

3.6.2.2 Component B. When tested as specified in 4.4.13.2, a full can of the component B shall be clear and free from sediment and suspended matter when examined by transmitted light. A freshly opened container shall show no livering, curdling, gelling, or skinning, and shall meet all other requirements of this specification.

3.6.3 Mixing properties. When tested as specified in 4.4.14, a smooth, homogeneous mixture shall result. The coating shall be free from grit, seeds, skins, or lumps. After aging as specified in 4.4.14, the coating shall show no signs of gelation.

3.6.4 Spraying properties. When tested as specified in 4.4.15, 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 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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3.6.5 Brushing properties. When tested as specified in 4.4.16, 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.

3.6.6 Flexibility. When tested as specified in 4.4.17, a film of the coating shall withstand bending without cracking or flaking.

3.6.7 Recoatability. When tested as specified in 4.4.18, recoating of a dried film shall produce no lifting, softening, or other film irregularity.

3.6.8 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 4.4.19. The resultant test rating shall be classified as scale 4B or better.

3.6.8.1 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 4.4.19.1. 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 4.4.20, 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 immersed portion of the panel 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 4.4.21, 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 immersed portion of the panel 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 4.4.22, a film of Green 383, 34094, Dark Green, 34082, Woodland Desert Sage, 34201, and IRR Foliage Green 504, 34160 shall have no blistering and show no change from the original color.

3.6.12 Accelerated weathering. When tested as specified in 4.4.23, samples of aircraft colors and Olive Drab, 34088 shall show no cracking, chalking, or loss of adhesion and shall meet the color, infrared reflectance, 60 and 85 degree gloss requirements of this specification. When tested as specified in 4.4.23, camouflage colors shall show no cracking, chalking, loss of adhesion, or increase in the 60 and 85 degree glosses to exceed maximum values in table VIII.

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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 4.4.24, 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. When tested as specified in 4.4.25, a film of the coating shall desorb a maximum of 40 micrograms of agent GD, a toxic nerve agent, and a maximum of 180 micrograms of agent HD, a vesicant agent.

3.6.15 Weather resistance. When tested as specified in 4.4.26, films of the coating shall show no checking, cracking, or appreciable film deterioration. There shall be no more than light chalking (see ASTM D4214). The color shall show no excessive change in value and chroma and no change in hue. After removal of any chalking that has occurred the original color shall be substantially restored and the washed area shall show no more than slight fading or darkening. The color shall not exceed 2.5 NBS units at 280 $MJ/m^2$ of total UV irradiance for siliceous flattened coatings when compared to an unexposed sample of the same batch using tristimulus color coordinates. The color shall not exceed 2.5 NBS units at 560 $MJ/m^2$ of total UV irradiance for polymeric flattened coatings when compared to an unexposed sample of the same batch using tristimulus color coordinates. The approximate equivalence of one year of total UV irradiance in southern Florida is 280 $MJ/m^2$.

3.6.16 Freeze-Thaw resistance (component A). After being tested as in 4.4.27, the coating shall mix readily to a smooth, homogeneous state and there shall be no apparent change in the appearance of the dried film, when compared to one prepared from an untested sample. The viscosity change shall not exceed 10%, and the hiding power, gloss, and color shall meet the requirements of the specification.

3.6.17 Exclusion of toxic solvents. The product shall contain no benzol (benzene), chlorinated compounds, hydrolyzable chlorine derivatives, or ethylene based glycol ethers and their acetates.

3.7 User instruction marking. In addition to the markings specified herein, all containers shall include the VOC content and VOHAP content in grams per liter or pounds per gallon of coating. All containers shall be legibly marked or labeled with precautionary information as follows:

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 and use with adequate ventilation. Keep containers tightly closed. Component B is very water sensitive and caution shall be taken to ensure that water or high humidity do not come in contact with component B at any time

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during reduction, application, or drying. For other safety recommendations, refer to the Material Safety Data Sheet (MSDS).

3.7.1 Instructions for use. Mix component A well, then add 1 part by volume of component B to 2 parts by volume of component A and mix well with a mechanical mixer. Reduce with deionized water or as specified by manufacturer's instructions for spray application. Material shall be used within 4 hours after mixing.

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 6.5).

3.9 Material safety data sheet (MSDS). 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 shall be included with each shipment of the material covered by this specification and submitted to pertinent Government agencies as stated in FED-STD-313.

## 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 4.2.1).
c. Conformance inspection (see 4.3).

4.2 Qualification inspection. Qualification shall be conducted by the qualifying activity (see 6.4). The qualification test sample shall consist of three quart kits of each material. The samples shall be legibly identified (see 6.4.3). Qualification inspection shall consist of tests for all requirements specified in section 3 and table XI. 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.

4.2.1 Extension of qualification inspection. Qualification inspection (see 4.2) shall be performed on the colors listed in the left column of table X. These nine 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

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test sample shall consist of a one quart kit of each material. The sample and the necessary paperwork (see 6.4.3) shall be sent to the qualifying activity (see 6.4).

4.3 Conformance inspection.

4.3.1 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.

TABLE X. 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 |
| 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 | - |
| 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 |
| Aircraft Gray, 36300 | Interior Aircraft Gray, 36231<br>Blue Gray, 35237<br>Medium Gray, 36375 |

4.3.2 Conformance tests. When approved by the cognizant activity, acceptance of lots for use as a component on an end item shall be based on conformance with specified requirements for color and spectral reflectance, 60° and 85° specular gloss, acid resistance, hydrocarbon fluid resistance, and water resistance.

4.3.3 Acceptance tests. Acceptance testing of individual lots shall consist of condition in container, hiding power, total solids, infrared reflectance, viscosity, specular gloss, drying time, color and spectral reflectance, spraying properties, and mixing properties as specified in sections 3 and 4.

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

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4.3.5 Validation. The contracting officer shall require that an appropriate sprayed sample from each production lot (see 4.3.1) be forwarded to the U.S. Army Research Laboratory, ATTN: RDRL-WMM-C, Camouflage, Coating and Corrosion Team, Building 4600, Deer Creek Loop, Aberdeen Proving Ground, MD 21005-5069, for validation of spectral reflectance characteristics to include color, STB resistance and gloss at 60 and 85 degrees. There shall be no failures (see 6.4.5).

4.4 Test methods.

4.4.1 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.

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

TABLE XI. Index.

| Item | EPA Method | ASTM Method | Test Paragraph | Requirement Paragraph or Table |
|---|---|---|---|---|
| Color and reflectance | - | E308 and E1331 | 4.4.2 | 3.3 and 3.3.1 |
| Total solids | - | - | 4.4.3 | Table VII and IX |
| Pigment analysis | - | D3723 | 4.4.4 | 3.4.1, Table V and IX |
| Lead content | - | D3335 | 4.4.4.1 | 3.4.1.1 |
| Hexavalent chromium | - | - | 4.4.4.2 | 3.4.1 |
| Antimony, arsenic, beryllium, cadmium, cyanide, manganese, mercury, nickel and selenium | - | - | 4.4.4.3 | 3.4.1 |
| Solvent analysis | 311 | - | 4.4.7 | 3.4.3 |
| Volatile organic compounds | 311 | D3960 | 4.4.7.1 | 3.4.4 |
| Viscosity, Krebs-Stormer | - | D562 | - | Table VI |
| Hiding-power (contrast ratio) | - | D2805 | 4.4.8 | Table VIII |
| Drying time | - | D5895 | 4.4.9 | Table VIII |
| Specular gloss | - | D523 | 4.4.10 | Table VIII |

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TABLE XI. Index - Continued.

| Item | EPA Method | ASTM Method | Test Paragraph | Requirement Paragraph or Table |
|---|---|---|---|---|
| Infrared reflectance<br>Camouflage colors 1/<br>Other colors<br>Aircraft colors 2/<br>Dark Sandstone, 33510 | - | E308 and E1331 | 4.4.2 and 4.4.11 | 3.3 and 3.3.1, Table I and II |
| Spectral reflectance limits<br>Dark Green, 34082<br>Green 383, 34094<br>IRR Foliage Green 504, 34160 | - | E308 and E1331 | - | Table III and IV |
| Condition in container<br>Component A<br>Component B | - | - | <br>4.4.12.1<br>4.4.12.2 | <br>3.6.1.1<br>3.6.1.2 |
| Storage stability<br>Component A<br>Component B | - | <br>D1849<br>- | <br>4.4.13.1<br>4.4.13.2 | <br>3.6.2.1<br>3.6.2.2 |
| Mixing properties | - | - | 4.4.14 | 3.6.3 |
| Spraying properties | - | - | 4.4.15 | 3.6.4 |
| Brushing properties | - | - | 4.4.16 | 3.6.5 |
| Flexibility | - | D522 | 4.4.17 | 3.6.6 |
| Recoatability | - | - | 4.4.18 | 3.6.7 |
| Adhesion | - | D3359 | 4.4.19 | 3.6.8 |
| Elevated temperature adhesion | - | D3359 | 4.4.19.1 | 3.6.8.1 |
| Water resistance | - | - | 4.4.20 | 3.6.9 |
| Hydrocarbon resistance | - | - | 4.4.21 | 3.6.10 |
| Acid resistance | - | - | 4.4.22 | 3.6.11 |
| Accelerated weathering | - | G154 | 4.4.23 | 3.6.12 |
| STB resistance | - | - | 4.4.24 | 3.6.13 |
| Chemical agent resistance | - | - | 4.4.25 | 3.6.14 |
| Weather resistance | - | D4214 and G90 | 4.4.26 | 3.6.15 |
| Freeze-Thaw resistance | - | - | 4.4.27 | 3.6.16 |
| Toxic solvents | - | - | - | 3.6.17 |

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

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4.4.1.2 Test panels. Unless otherwise specified, metal panels used for test purposes shall be of two types:

a. Steel, cold rolled, pretreated with zinc phosphate coating B-952 with P60 chrome rinse or equivalent, 0.032 inches (0.8128 mm) thick, for all tests except flexibility.
b. Steel, tinplated, 0.010 inches (0.254 mm) thick, for flexibility only.

4.4.1.3 Epoxy primer. Test panels shall be solvent wiped and cleaned prior to applying epoxy primer. Apply epoxy primer conforming to the latest revision of MIL-P-53022 or MIL-P-53030.

4.4.2 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 4.4.1. 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. 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 table III and table IV. Nonconformance to 3.3 and 3.3.1 shall constitute failure of this test.

4.4.3 Total solids, pigment and vehicle solids. Prepare a Computrac Max 5000 test instrument or equivalent for testing. Balance the weight of the aluminum flat bottom test pan that holds the sample. Follow proper instructions for two component mix ratio. The test shall be completed with the sample mixed. The test parameters are a 2 ± 0.5 g sample size, 302 °F (150 °C) temperature, and evaporation rate less than 0.1000 %/min. Transfer paint with a dropper into the instrument. Start loading paint onto the center of a filter sheet in the test pan and work out into a spiral. When the sample size falls in the range of 1.5 - 2.5 g, the instrument beeps. The instrument weighs the sample and the test begins. Within the first 5 seconds, open the instrument lid and use tweezers to flip over the filter paper so the paint is directly touching the test pan. The test instrument displays total solids as a percent of total system by weight. An ash test starts automatically five minutes after the total solids test has concluded. The test parameters are a 2 ± 0.5 g sample size, 842 °F (450 °C) temperature, and evaporation rate less than 0.2500 %/min. The test instrument displays ash (pigment solids in the sample) as a percent of total system by weight.

Calculations:

Symbols: TS = Total solids as % of total mass by weight
VS = Vehicle solids as % of total mass by weight
A = Ash as % of total mass by weight
NVV = % nonvolatile in vehicle

a. Vehicle solids = VS = TS – A
b. Nonvolatile in vehicle = NVV = 100 – VS

4.4.4 Pigment analysis. Determine the pigment content of the coating in accordance with ASTM D3723. The pigment generated by this method shall be used for the screening tests of the coating's heavy metal content as listed below.

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4.4.4.1 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 17000 rpm - balancing the centrifuge with a tube containing one ml. of the dilute $HNO_3$ solution. This tube shall also act as the test "blank". Immerse a lead 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 any color change is apparent from the "blank" strip rerun the test using fresh, lead-free reagents. For the "Sample" strip, the appearance of a bright red color is indicative of lead at a concentration level above the specification limit, while no color change or a faint pink color change is indicative of lead concentrations below the specification limit. Confirmation of the exact lead concentration in the coating's solids can be determined using any authoritative quantitative method, such as ASTM D3335.

4.4.4.2 Chrome (VI). Determine the presence or absence of hexavalent chrome 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 chrome 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 $H_2S0_4$ 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 17000 rpm - balancing the centrifuge with a tube containing one ml of the $H_2S0_4$ solution. This tube shall also act as the test "blank". Immerse a chromate 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 chromate-free reagents.

4.4.4.3 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 Material Safety Data Sheet (MSDS) 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.

4.4.5 Analysis of component A. Determine total solids, pigment and vehicle solids content for component A according to the method in 4.4.3. Check for compliance with table IX (see 3.5.4.1).

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4.4.6 Analysis of component B. Determine total solids content for component B according to the method in 4.4.3. Check for compliance with table VII (see 3.5.2).

4.4.7 Solvent analysis.

4.4.7.1 Volatile content. The volatile content of the admixture (see 3.4.3) determined by EPA Method 311 and the volatile organic compound (VOC) analysis (see 3.4.4) determined in accordance with ASTM D3960 shall comply with 3.4.4. Nonconformance to the VOC limit in 3.4.4 shall constitute failure of this test.

4.4.8 Hiding power (contrast ratio). Using a sprayed sample from the color determination (see 4.4.2), determine the reflectance using the daylight reflectance factor of ASTM D2805 over the black and white portion of the card. Record the values as $R_B/R_W$ and check for compliance with table VIII.

4.4.9 Drying time. Spray the mixed coating on a test panel (see 4.4.1.2) 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 VIII.

4.4.10 Specular gloss. Spray the mixed coating on a test panel (see 4.4.1.2) to a dry film thickness of 2 ± 0.2 mils (50 ± 5 microns). Test for 60-degree gloss and 85-degree gloss (sheen) as specified in table XI and check for compliance with table VIII.

4.4.11 Infrared reflectance. Determine the infrared reflectance on the black portion of the sprayed sample made in 4.4.2. 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.

4.4.12 Condition in container.

4.4.12.1 Component A. Upon opening a full previously unopened container the condition of the contents shall be examined for compliance with 3.6.1.1. Reseal, then agitate the container for 3 minutes on a paint shaker and examine for compliance with 3.6.1.1. On reexamination of the contents, the disclosure of any gel bodies or undispersed pigment indicates unsatisfactory settling properties.

4.4.12.2 Component B. Upon opening a full previously unopened container the condition of the contents shall be examined for compliance with 3.6.1.2.

4.4.13 Storage stability.

4.4.13.1 Component A. Allow a full quart can of component A to stand undisturbed for 1 year in accordance with ASTM D1849 and then examine the contents. Evaluate the pigment settling as specified in 4.4.12.1 except agitate the can for 5 minutes on a paint shaker prior to reexamination. Determine viscosity and other applicable tests for compliance with 3.6.2.1.

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4.4.13.2 Component B. Allow a full 8-ounce can of component B to stand undisturbed for 1 year under standard laboratory conditions. At the end of this period examine the contents for compliance with 3.6.2.2.

4.4.14 Mixing properties. Using high-shear mechanical equipment, thoroughly mix 2 parts by volume of component A with 1 part by volume of component B, reduce as specified in 4.4.15, and examine for compliance with 3.6.3. Place 3 ounces of the material in a 4-ounce glass jar (lid not tightened to allow $CO_2$ to escape) and do not agitate or disturb for 4 hours. At the end of this period examine for compliance with 3.6.3.

4.4.15 Spraying properties. Reduce admix coating to sprayable viscosity with water (3 parts by volume of the admix coating material with up to 1 part by volume of water) or follow manufacture's recommendations for proper thinning. Use the admix coating within 6 hours. Material shall be sprayed on a solvent cleaned test panel (see 4.4.1.2 and 4.4.1.3) to a dry film thickness of 2 ± 0.2 mils (50 ± 5 microns). The coating properties of the dry sprayed surface shall be observed for compliance with 3.6.4.

4.4.16 Brushing properties. Apply the coating after mixing 2 parts by volume of component A with 1 part by volume of component B to steel test panels (see 4.4.1.2 a). Thin as specified in 4.4.15 if necessary. Use a 1 1/2 inch brush appropriate for use with polyurethane coatings. Check for compliance with 3.6.5.

4.4.17 Flexibility. Determine flexibility in accordance with ASTM D522, method B. Spray the coating on a solvent cleaned test panel (see 4.4.1.2 and 4.4.1.3) to a dry film thickness of 2 ± 0.2 mils (50 ± 5 microns). Air dry for 168 hours. Bend the coated panels over a ¼ inch mandrel. Examine the coating for cracks over the area of the bend for compliance with 3.6.6.

4.4.18 Recoatability. Pretreat two test panels (see 4.4.1.2). Apply epoxy primer (see 4.4.1.3) to a dry film thickness of 1 ± 0.1 mil (25 ± 2.5 microns). Air dry the two test panels for two hours. Mix the topcoat paint as specified in 4.4.14. Spray on the topcoat paint 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 air drying for 2 hours and a second coat to the other panel 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 3.6.7.

4.4.19 Adhesion. Prepare a test panel pretreated (see 4.4.1.2) and primed (see 4.4.1.3). Air dry the test panel for two hours. Mix the topcoat paint as specified in 4.4.14. Spray on the topcoat paint 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 3.6.8.

4.4.19.1 Elevated temperature adhesion. Prepare three test panels pretreated (see 4.4.1.2) and primed (see 4.4.1.3). Mix the coating as specified in 4.4.18. 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 a one hour oven exposure at 180 °F (82 °C). The third panel is to be dried at room temperature for 30 minutes followed by a one hour oven exposure at 240 °F (116 °C). All three panels are to be recoated to a dry film thickness of 2 ± 0.2 mils (50 ± 5 microns) within 24 hours

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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 3.6.8.1. After 168 hours of air drying, perform adhesion testing as specified in ASTM D3359, method B, and examine for compliance with 3.6.8.1.

4.4.20 Water resistance. Prepare a test panel pretreated (see 4.4.1.2) and primed (see 4.4.1.3). Air dry the test panel for two hours. Mix the topcoat paint as specified in 4.4.14. Spray on the topcoat paint 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 77 ± 2 °F (25 ± 1 °C) for 168 hours. At the end of the test period, remove and examine for compliance with 3.6.9.

4.4.21 Hydrocarbon resistance. Prepare a film of the coating as specified in 4.4.20. Air dry the test panel for 168 hours after spraying on the topcoat paint. Then immerse for 168 hours in a hydrocarbon fluid conforming to JP8 at 77 ± 2 °F (25 ± 1 °C). At the end of the test period, remove and examine for compliance with 3.6.10.

4.4.22 Acid resistance (only for Green 383, 34094, Dark Green, 34082), Woodland Desert Sage, 34201, and IRR Foliage Green 504, 34160). Prepare a film of the coating as specified in 4.4.20. After air drying the topcoat paint 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 standing for 1 hour. Rinse thoroughly with water, allow drying and then examine the film for blistering and color change for compliance with 3.6.11.

4.4.23 Accelerated weathering. Prepare four test panels as specified in 4.4.20. Air dry the test panels for 168 hours after spraying on the topcoat paint. Three panels shall be tested and one retained as control. Determine the color and infrared reflectance as specified in 4.4.2 and measure the 60 and 85 degree gloss. Expose three panels for 1000 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.

4.4.24 Super tropical bleach (STB) resistance. Prepare one 4 by 12 inch test panel as specified in 4.4.20. Air dry the panel a minimum of 168 hours after spraying on the topcoat paint. 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. An STB slurry mix of 40 parts STB and 60 parts water by weight shall be used. Examine for compliance with 3.6.13.

4.4.25 Chemical agent resistance.

4.4.25.1 Panel preparation. Spray eight test panels pretreated (see 4.4.1.2) and primed (see 4.4.1.3) to a dry film thickness of 1 ± 0.1 mil (25 ± 2.5 microns). 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 4.4.14 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.

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4.4.25.2 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.

4.4.25.3 Test apparatus. The test apparatus used for both HD and GD testing consists 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 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. A gastight seal is maintained by means of O-rings. Agent desorbed from the test panels is entrained by dry nitrogen that passes through a Miller-Nelson HCS4OI temperature-humidity-flow controller, with final temperature controlled by a YSI Model 72 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 3.6.13.

4.4.25.4 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 using a microliter syringe. 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 77 °F (25 °C), 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 across each sample shall be 200 ml/min, maintained by mass flow controllers. Terminate the test at the end of 22 hours.

4.4.25.5 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 1ml 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-S 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 536 °F (280 °C). Temperature program the column from an initial temperature of 122 °F to 248 °F (50 °C to 120 °C) at a rate of 10°/min, followed by an increase of 77 °F/min (25 °C/min) to a final temperature of 392 °F (200 °C). 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

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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 per milliliter read from the standard curve) by the volume of the impinger solution (25 ml).

4.4.26 Weather resistance. Spray five 3 by 6 inch test panels pretreated (see 4.4.1.2) and primed (see 4.4.1.3) to a dry film thickness of 1 ± 0.1 mil (25 ± 2.5 microns). Air dry the test panels for 2 hours. Mix the topcoat paint as specified in 4.4.14 and then spray on the topcoat paint to a dry film thickness of 2 ± 0.2 mils (50 ± 5 microns). Air dry the panels a minimum of 7 days. The chemical agent resistant coating that is flattened with polymeric materials 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. The chemical agent resistant coating that is flattened with siliceous materials shall be placed outdoors for the equivalent of 280 $MJ/m^2$ 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.

4.4.27 Freeze-Thaw resistance (component A). Prepare samples for testing by filling 1 pint (500 ml) resin-lined cans, two thirds full. Ensure that the bulk sample from which the cans are filled is well stirred and uniform, that the containers used are clean, and that the lids are applied promptly to the cans to prevent evaporation losses. Two such samples are required for each test.

4.4.27.1 Test conditions. Store one can at room temperature and identify this as the control sample. Place the can with the test coating in the chamber maintained at 0 °F (-18 °C) in such a manner that it does not touch the walls or bottom of the chamber, so free circulation of air around the can is permitted. Maintain a minimum of 1 inch (25 mm) of air space between adjacent cans and between cans and the chamber walls. Keep the test sample in the chamber for 17 hours and then remove and allow it to stand for 7 hours undisturbed at room temperature, adjacent to the control sample. This shall complete one freeze-thaw cycle of 24 hours. Repeat for three additional freeze-thaw cycles.

4.4.27.2 Examination and recording test results. After completion of the four cycles and before stirring, examine both samples for condition in the can, observing any evidence of settling, gelation, coagulation, or lumpiness. Then stir the samples and determine their viscosity. Immediately following the viscosity determinations, apply both specimens of paint to steel test panels pretreated and primed as in 4.4.18. Allow the coatings to dry at least 24 hours and then compare the test specimen to the control. Note any changes in hiding power, gloss, agglomeration, coagulation, or color and check for compliance with 3.6.15.

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## 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.

## 6. NOTES

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

6.1 Intended use. Use of this camouflage coating is intended to provide surfaces that are easily and effectively decontaminated after exposure to liquid chemical agents. This coating may be used in areas where air pollution regulations are in force. It is applied over epoxy primers MIL-PRF-23377, MIL-PRF-85582, MIL-P-53022, MIL-P-53030 or electrodeposited primer MIL-P-53084 depending on the substrate or regulatory requirements. For adequate camouflage properties, it is necessary to apply the coatings to a minimum dry film thickness of 1.8 mils (45 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. If a toxicity clearance is required (see 3.8).
d. Whether material safety data sheets (MSDS) are required with each shipment (see 3.9).
e. If qualification samples are required and where to send them (see 4.2 and 6.4).
f. If extension of qualification samples are required and where to send them (see 4.2.1 and 6.4).
g. If conformance samples are required and where to send them (see 4.3.5).
h. Packaging requirements (see 5.1).
i. Part or identifying number (PIN) (see 6.6).

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. 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 4.2.1) should be submitted to the U.S. Army Research Laboratory, ATTN: RDRL-

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WMM-C, Camouflage, Coating and Corrosion Team, Building 4600, Deer Creek Loop, Aberdeen Proving Ground, MD 21005-5069.

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 Material safety data sheets (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-64159A; Type _____, Color _____
"Camouflage Coating, Water Dispersible Aliphatic Polyurethane, Chemical Agent Resistant"
Provide a copy of the material safety data sheet (MSDS)
Provide a copy of the statement of composition
Provide a copy of the technical data sheet
Provide a copy of the test report

6.4.4 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.

6.4.5 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 4.3.5). The application for resubmission will contain all details concerning previous rejections and measures taken to correct these deficiencies.

6.5 Toxicity 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: Commander, US Army Center For Health Promotion And Preventive Medicine (MCHB-TS-T), 5158 Blackhawk Road, Aberdeen Proving Ground, MD 21010-5403.

6.6 Part or Identifying Number (PIN). Use the following example to create the PIN for coating products:

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| M64159 | - | XX | - | XXX | - | XXXXX |
|---|---|---|---|---|---|---|
| Specification Identifier | | Coating type designator<br>Type I = 01<br>Type II = 02<br>Type III = 03 | | Container size designator<br>X pint (X liter) = 0XP<br>X quart (X liter) = 0XQ<br>X gallon (X liter) = 0XG<br>50 gallon (XX liter) = 50G<br>X case (Aerosol) = 0XA<br>X case (Brush) = 0XB<br>X case (Roller) = 0XR | | Color designator<br>FED-STD-595<br>color chip number |

6.7 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.

6.8 Subject term (key word) listing.

Aircraft
CARC
Colors
Polymeric agents
Pigment
Siliceous agents
Tactical equipment
Total solids
Vehicle solids

6.9 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 - SH
Air Force - 11

Review activities:
Army – MD1, MI
Navy – AS, CG
Air Force - 84, 99

Civil agency:
GSA/FAS

Preparing activity:
Army - MR

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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/.