

METRIC

MIL-DTL-24631A(SH)
w/INT. AMENDMENT 1
9 August 2006

USED IN LIEU OF
MIL-DTL-24631A(SH)
6 June 1997

DETAIL SPECIFICATION

PAINT, CAMOUFLAGE FOR SUBMARINES,
GENERAL SPECIFICATION FOR (METRIC)

This specification is approved for use by the Naval Sea Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers requirements for two colors of camouflage paint and a flexible white marking paint.

1.2 Classification. Camouflage paints, which are based on two different resins (epoxy and polyurethane), are detailed on specification sheets of this specification and are classified in types as follows (see 6.2):

Type I - Epoxy paints:

Navy Formula 184, Black, R₀ 1.8
Navy Formula 185, Dark Gray, R₀ 3.6
Navy Formula 186, White

Type II - Polyester urethane paints:

Navy Formula 187, Black, R₀ 1.8

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.

Comments, suggestions, or questions on this document should be addressed to Commander, Naval Sea Systems Command, ATTN: SEA 05Q, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or emailed to CommandStandards@navy.mil, with the subject line "Document Comment". 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>.

MIL-DTL-24631A(SH)
w/INT. AMENDMENT 1

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.

SPECIFICATIONS

DEPARTMENT OF DEFENSE

- MIL-P-24441 - Paint, Epoxy-Polyamide, General Specification for.
- MIL-P-24441/20 - Paint, Epoxy-Polyamide, Green Primer, Formula 150, Type 111.
- MIL-P-24441/29 - Paint, Epoxy-Polyamide, Green, Primer, Formula 150, Type IV.
- MIL-DTL-24631/1 - Paint, Epoxy, Black R01.8, Navy Formula 184, Type I. (Metric)
- MIL-DTL-24631/2 - Paint, Epoxy, Dark Gray R, 3.6, Navy Formula 185, Type I. (Metric)
- MIL-DTL-24631/3 - Paint, Epoxy, White, Navy Formula 186, Type I. (Metric)
- MIL-DTL-24631/4 - Paint, Polyester Urethane, Black R₀ 1.8, Navy Formula 187, Type 11. (Metric)
- MIL-DTL-24631/7 - Paint, Polyester Urethane, Black, Navy Formula 187, Type 11. (Metric)

STANDARDS

FEDERAL

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

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available 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 are those cited in the solicitation.

PUBLICATIONS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (USEPA)

- 40 Code of Federal Regulations (CFR) ch.1, part 60, appendix A, method 24 - Determination of Volatile Matter Content, Water Content, Density, Volume Solids and Weight Solids of Surface Coatings.
- 40 CFR Part 261, Appendix II - Toxicity Characteristic Leaching Procedure (TCLP).

MIL-DTL-24631A(SH)
w/INT. AMENDMENT 1

DEPARTMENT OF LABOR
OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA)
29 CFR Parts 1910, 1915, 1917, 1918, 1926 and 1928 Occupational Safety and Health Standards
July 1, 1996.
29 CFR 1915 Ch. XVII, Appendix K to 1915.1001 – Polarized Light Microscopy of Asbestos,
Method ID-191.

(The Code of Federal Regulations (CFR) are for sale on a subscription basis by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. When indicated, reprints of certain regulations may be obtained from the Federal agency responsible for issuance thereof.)

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

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)
Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents in the Work
Environment and Biological Exposure Indices.

(Application for copies should be addressed to the American Conference of Governmental Hygienists, 6500 Glenway Avenue, Bldg D7, Cincinnati, Ohio 45211).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- ASTM D 56 - Standard Test Method for Flash Point by Tag Closed Tester.
- ASTM D 344 - Standard Test Method for Relative Hiding Power of Paints by the Visual Examination of Brushouts.
- ASTM D 476 - Standard Specification for Titanium Dioxide Pigments. (DoD adopted)
- ASTM D 523 - Standard Test Method for Specular Gloss. (DoD adopted)
- ASTM D 562 - Standard Test Method for Consistency of Paints Using the Stormer Viscometer. (DoD adopted)
- ASTM D 605 - Standard Specification for Magnesium Silicate Pigment (Talc).
- ASTM D 822 - Standard Practice for Operating Light- and Water-Exposure Apparatus (Carbon-Arc Type) for Testing Paint, Varnish, Lacquer, and Related Products. (DoD adopted)
- ASTM D 823 - Standard Test Methods for Producing Films of Uniform Thickness of Paint, Varnish, and Related Products on Test Panels.
- ASTM D 1210 - Standard Test Method for Fineness of Dispersion of Pigment-Vehicle Systems. (DoD adopted)
- ASTM D 1296 - Standard Test Method for Odor of Volatile Solvents and Diluents.
- ASTM D 1475 - Standard Test Method for Density of Paint, Varnish, Lacquer, and Related Products. (DoD adopted)
- ASTM D 1640 - Standard Test Method for Drying, Curing, or Film Formation of Organic Coatings at Room Temperature. (DoD adopted)
- ASTM D 1729 - Standard Practice for Visual Evaluation of Color Differences of Opaque Materials. (DoD adopted)
- ASTM D 2000 - Classification System for Rubber Products in Automotive Applications.
- ASTM D 2244 - Standard Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates. (DoD adopted)
- ASTM D 2369 - Standard Test Method for Volatile Content of Coatings. (DoD adopted)
- ASTM D 2698 - Standard Method for Determination of the Pigment Content of Solvent-Reducible Paints by High-Speed Centrifuging. (DoD adopted)
- ASTM D 2805 - Standard Test Method for Hiding Power of Paints by Reflectometry.
- ASTM D 3278 - Standard Test Method for Flash Point of Liquids by Setaflash Closed-Cup Apparatus. (DoD adopted)
- ASTM D 4400 - Standard Test Method for Sag Resistance of Paints Using a Multinotched Applicator.

MIL-DTL-24631A(SH)
w/INT. AMENDMENT 1

- ASTM D 4615 - Standard Specification for n-Butyl Acetate (All Grades).
 ASTM E 1252 - Standard Practice for General Techniques for Qualitative Infrared Analysis.
 ASTM G 53 - Standard Practice for Operating Light- and Water-Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials. (DoD adopted)

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

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related specification sheets), 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 Specification sheets. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheet (see 2.2.1). In the event of any conflict between the requirements of this specification and the specification sheet, the latter shall govern.

3.2 First article. When specified (see 6.2), a sample shall be subjected to first article inspection in accordance with 4.2.

3.3 Composition. The paint supplied shall consist of ingredients in the proportions shown in the appropriate specification sheets (see 6.2), except that minor variation of the ratio of titanium dioxide pigment to carbon black pigment, as applicable, is permitted to meet the color requirements, provided all other specification requirements are met (see 4.4.4).

3.4 Quantitative requirements.

3.4.1 Specification sheet requirements. When tested in accordance with table II and any applicable paragraphs of 4.5, the paint properties listed shall be in accordance with the quantitative requirements of this specification and the applicable specification sheet (see 6.2):

- (a) Pigment Content, percent (%) by weight (wt)
- (b) Volatile content, %wt
- (c) Nonvolatile vehicle, %wt
- (d) Consistency, Kneb units
- (e) Sag resistance, mils
- (f) Fineness of grind, Hegman units
- (g) Set-to-touch, hours (hr)
- (h) Dry hard, hr
- (i) Gloss 60°, %
- (j) Contrast ratio
- (k) Coarse particles
- (l) Flash point, degrees Celsius (°C) (degrees Fahrenheit [°F])
- (m) Mass per unit volume, grams/liter (g/L) (pounds/gallon [lb/gal])
- (n) Color, % (wet reflectance [R_w], or FED-STD-595)
- (o) Color fastness
- (p) Pot life, hr

3.4.2 Volatile organic content (VOC). When tested in accordance with 4.5.4, the volatile organic content (VOC) of the paints shall be in accordance with the requirements of the individual specification sheets (see 6.2).

MIL-DTL-24631A(SH)
w/INT. AMENDMENT 1

3.4.3 Color fastness. When tested in accordance with 4.5.5, the after test R_W of formulas 184, 185 and 187 paints shall be 85 to 115 percent (%) of the R_W measured before testing (delta [Δ] R_W of $\pm 15\%$). After testing, ΔE of the dry color of formula 187 shall be not more than 4 Commission Internationale de l'Eclairage (CIE; International Commission on Illumination) LAB units (CIELAB). After testing, ΔE of the dry colors of each of the formulas 184, 185 and 186 paints shall be not more than 3 CIELAB units.

3.5 Qualitative requirements. The paints shall be in accordance with the qualitative requirements of 3.5.1 through 3.5.7.

3.5.1 Brushing properties. When tested in accordance with 4.5.9, the paint shall not exhibit excessive drag during brushing or when being laid off. When dry, the paint shall be free of: (a) obvious lap marks or brush marks, (b) gloss and color variations or mottling and (c) pigment streaking or separation.

3.5.2 Spraying properties. When tested in accordance with 4.5.10, the liquid paint shall not exhibit running, sagging or fogging. When dry, the paint shall not exhibit dusting, floating, mottling, bubbling, wrinkling, streaming, pinholing, cratering, orange peel, blushing, blooming or silking.

3.5.3 Adhesion. When tested in accordance with 4.5.11, there shall be no loss of paint.

3.5.4 Water immersion. When tested in accordance with 4.5.12, the paint shall not whiten, change color, crack or be easily furrowed off the rubber, flake, chip or powder.

3.5.5 Storage stability.

3.5.5.1 Partially-full containers - formulas 184, 185 and 186. When tested in accordance with 4.5.13, the individual components shall have no skinning, livering, curdling, hard settling (caking) or gummy sediment. Each individual component shall be capable of being readily mixed to a smooth uniform state within 5 minutes with no surface float (separated pigments or other ingredients on the surface of the liquid) when mixed with a paddle or mechanical mixer and shall have a consistency not greater than 5 units from the original Krebs unit consistency before testing. Paint mixed from the individual partially full containers shall meet all other requirements of this specification and the applicable individual specification sheet.

3.5.5.2 Full containers - all types. When tested in accordance with 4.5.14, the individual components shall show no skinning, livering, curdling, hard settling (caking) or gummy sediment. The paint shall be capable of being mixed to a smooth uniform state with no surface float (separated pigments or other ingredients on the surface of the liquid) and shall have a consistency not greater than 5 units from the original Krebs unit consistency before testing. Paint mixed from the individual components shall meet all other requirements of this specification and the applicable individual specification sheet, except when tested in accordance with 4.5.5, the CIELAB color difference of the mixed paint shall be not greater than 0.5 CIELAB units from the original color values measured prior to the shelf life test and consistency shall be no more than 525 grams to produce a 200 revolution per minute (r/min) Krebs-Stormer shear rate (115 Krebs Units).

3.5.5.3 Accelerated storage stability. When tested in accordance with 4.5.15, previously unopened, original containers of individual components shall have no gelling, skinning, livering, curdling, hard settling (caking) or gummy sediment. The individual components shall be re-dispersible within 5 minutes with a paddle or mechanical mixer to a uniform condition. When tested in accordance with 4.5.5, the CIELAB color difference of the mixed paint shall be not greater than 0.5 CIELAB units from the original color values measured prior to the shelf life test and consistency shall be no more than 525 grams to produce a 200 revolution per minute (r/min) Krebs-Stormer shear rate (115 Krebs Units).

3.5.6 Odor. When tested in accordance with 4.5.16, the odor shall be characteristic of the volatiles permitted.

3.5.7 Infrared spectrum. When tested in accordance with 4.5.17, the nonvolatile vehicle of:

- (a) Component A (aliphatic amine) of formulas 184, 185 and 186 shall conform qualitatively to the infrared spectrum on figure 1.

MIL-DTL-24631A(SH)
w/INT. AMENDMENT 1

- (b) Component B (epoxy) of formulas 184, 185 and 186 shall conform qualitatively to the infrared spectrum on figure 2.
- (c) Component A (polyester) of formula 187 shall conform qualitatively to the infrared spectrum on figure 3.
- (d) Component B (polyisocyanate-HDI) of formula 187 shall conform qualitatively to the infrared spectrum on figure 4.

3.6 Toxicity. The paint shall not contain the following materials in excess of 0.06% by weight of the dry paint: asbestos or asbestos-form pigments, hydrolyzable chlorine derivatives, coal tar or coal tar derivatives, any ACGIH carcinogenic or ACGIH suspected carcinogenic compounds. Lead or its compounds and chromium or its compounds shall not exceed 0.0050% by weight of the dry paint film. (See 6.2 and 6.7).

3.7 Batch specific VOC certification. Manufacturer shall prepare label instructions in accordance with 29 CFR 1910. Each container must be affixed with a hazardous chemical warning label in accordance with 29 CFR 1910.1200. To comply with the Environmental Protection Agency (EPA) National Emission Standards for Hazardous Air Pollutants (NESHAP) requirements for shipbuilding and ship repair, the following two statements must appear on each paint can label:

- a. A certification that the paint in the container meets the NESHAP requirements for shipbuilding and ship repair.
- b. A statement of the ratio of volatile content to solids expressed as grams of volatile organic hazardous air pollutants (VOHAPS) per liter of solids.

3.8 Hazardous air pollutants (HAPS). When tested in accordance with 4.5.19, the content of HAPS solvents in the total paint shall not be greater than the weight percent (%WT) values listed in table I.

TABLE I. Hazardous solvent content.

Hazardous solvent in total paint	Maximum, %WT
Benzene	0.05
Chlorinated solvent(s), total	0.05
Carbon tetrachloride	
Chloroform (Trichloromethane)	
Methylene chloride (Dichloromethane)	
Tetrachloroethylene (Perchloroethylene)	
1,1,1-Trichloroethylene (Methyl chloroform)	
Trichloroethylene	
Ethyl benzene	0.05
Total of the following:	0.05
Ethylene glycol monomethyl ether	
Ethylene glycol monoethyl ether	
Ethylene glycol monobutyl ether	
Ethylene glycol monomethyl ether acetates	
Ethylene glycol monoethyl ether acetates	
Ethylene glycol monobutyl ether acetates	
(Also known as Methyl, Ethyl and Butyl Cellosolves and Methyl, Ethyl and Butyl Cellosolve acetates)	
Methyl ethyl ketone (MEK)	0.05
Methyl isobutyl ketone (MIBK)	0.05
Toluene	0.05
Xylene (all forms), total	0.01

MIL-DTL-24631A(SH)
w/INT. AMENDMENT 1

4. VERIFICATION.
 - 4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:
 - (a) First article inspection (see 4.2).
 - (b) Conformance inspection (see 4.3).
 - 4.2 First article inspection. First article inspection shall consist of all tests specified in table II.
 - 4.3 Conformance inspection. Conformance inspection shall consist of all tests specified in table II with a footnote 1/ (see 6.8).

MIL-DTL-24631A(SH)
w/INT. AMENDMENT 1

TABLE II. Quality assurance tests and examinations.

Test or examination title	Requirement	FED-STD-141 test method	ASTM test method	Test procedure
Composition <u>1/</u>	3.3	----	----	4.5.1
Pigment content, %wt <u>1/</u>	3.4.1	----	D 2698	<u>2/</u> 4.5.2
Volatile content, %wt <u>1/</u>	3.4.1	----	D 2363	<u>2/</u> 4.5.2
Nonvolatile vehicle content, %wt <u>1/</u>	3.4.1	4053.1	----	<u>2/</u> 4.5.2
Consistency, Kneb units <u>1/</u> <u>3/</u>	3.4.1	----	D 562	<u>2/</u> 4.5.2
Sag resistance, mils <u>1/</u> <u>3/</u>	3.4.1	----	D 4400	<u>2/</u> 4.5.2
Fineness of grind, Hegman units <u>1/</u>	3.4.1	----	D 1210	<u>2/</u> 4.5.2
Set-to-touch, hr <u>1/</u> <u>3/</u>	3.4.1	----	D 1640	<u>2/</u> 4.5.2
Dry hard time, hr <u>1/</u> <u>3/</u>	3.4.1	----	D 1640	<u>2/</u> 4.5.2
Gloss 60°, % <u>1/</u>	3.4.1	----	D 523 D 823	<u>2/</u> 4.5.2
Contrast ratio	3.4.1	----	D 2805 D 823	<u>2/</u> 4.5.2, 4.5.6
Coarse particles <u>1/</u>	3.4.1	4092.1	----	<u>2/</u> 4.5.2, 4.5.7
Flash point, °C (°F) <u>1/</u>	3.4.1	----	D 3278	<u>2/</u> 4.5.2
Mass per unit volume, g/L (lb/gal) <u>1/</u>	3.4.1	----	D 1475	<u>2/</u> 4.5.2
Pot life, hr	3.4.1	----	D 562	<u>2/</u> 4.5.8
Color (wet reflectance R _w , % or FED-STD-595) <u>1/</u>	3.4.1	----	D 823 D 1729	<u>2/</u> 4.5.3
Volatile content and VOC <u>1/</u>	3.4.2	7356; 7360	E 1252	<u>2/</u> 4.5.4
Color fastness	3.4.3	----	D 822 D 2244 G 53	4.5.5
Brushing properties <u>1/</u>	3.5.1	4321.2	----	4.5.9
Spraying properties <u>1/</u> <u>3/</u>	3.5.2	4331.1; 2131	----	4.5.10
Adhesion	3.5.3	----	----	4.5.11
Water immersion	3.5.4	----	----	4.5.12
Storage stability – partially-full container	3.5.5.1	3021.1 3022.1	----	4.5.13
Storage stability – full container	3.5.5.2	3022.1	----	4.5.14
Accelerated storage stability	3.5.5.3	3022.1	----	4.5.15
Odor <u>1/</u>	3.5.6	----	D 1296	4.5.16
Infrared spectrum <u>1/</u>	3.5.7	----	E 1252	4.5.17
Toxicity <u>1/</u>	3.6	----	----	4.5.18
Hazardous solvent content <u>1/</u>	3.7	7356; 7360	E 1252	4.5.19

1/ Conformance inspection test (see 4.3).

2/ See applicable specifications sheet and applicable 4.5 test requirement.

3/ Recommended shelf life reinspection tests.

MIL-DTL-24631A(SH)
w/INT. AMENDMENT 1

4.3.1 Definition of a lot. For the purposes of conformance inspection and test sampling, a lot is defined as all the paint of the same type, formula and color from a single uniform batch, produced and offered for delivery at one time. The addition of any substance to a batch shall constitute a new lot.

4.3.2 Sampling for conformance testing. As a minimum, the contractor shall select two samples of sufficient size to permit the performance of all the inspections and tests as specified in table II (see 6.8).

4.4 General test requirements.

4.4.1 Test conditions. Unless otherwise specified, all testing conditions shall be in accordance with Section 9 of FED-STD-141. The term referee condition shall mean a temperature of $23 \pm 1^\circ\text{C}$ ($73 \pm 2^\circ\text{F}$) and a relative humidity of $50 \pm 4\%$.

4.4.2 Metal test panels. Unless otherwise specified, test panels shall be:

- (a) 150 x 300 x 3 millimeter (mm) (6 x 12 x 0.125 inch [in]) (nominal) plate mild steel.
- (b) Steel test plates shall be abrasive blasted with aluminum oxide and solvent cleaned to provide a uniform, clean rough surface with a profile of 0.050 to 0.076 mm (0.002 to 0.003 in) (nominal) on both sides. Care shall be taken to coat edges and to cover the blast profile.
- (c) Paint test film shall be spray or brush applied to the primed steel panel and the dry film thickness of the test film shall be 7.6 to 12.7 micrometers (Δm) (0.003 to 0.005 inches [in]).
- (d) Paint test specimens shall be cured not less than 7 days at ambient laboratory conditions before testing.

4.4.3 Neoprene rubber test panels. Unless otherwise specified, neoprene test panel shall conform to ASTM D-2000-75e, Type BC.

- (a) Neoprene rubber in accordance with 4.4.3 shall be lightly sanded with no. 240 sandpaper and shall be wiped with mineral spirits to remove manufacturing and sanding residue and any oils that may be present.
- (b) Paint test film shall be spray applied and the wet film thickness shall be 13 to 21 Δm (0.006 to 0.008 inches).
- (c) Paint test specimens shall be cured not less than 7 days at ambient laboratory conditions before testing.

4.4.4 Preparation of mixed coating. The paint shall be prepared for mixed paint tests by thoroughly mixing components A and B in accordance with the ratio specified in the applicable specification sheet. The thoroughly mixed paint shall be allowed to condition at ambient laboratory conditions for $\frac{1}{2}$ hour prior to testing.

4.5 Examinations and tests.

4.5.1 Composition. Manufacturer records (material orders, receipts for material delivery, batch tickets showing material used, etc.) shall be reviewed. Reviewed results shall be in accordance with the requirements of 3.3.

4.5.2 Standard quantitative tests. The paint shall be tested for the quantitative requirements of table II as specified in 3.4.1 as follows (see table II):

MIL-DTL-24631A(SH)
w/INT. AMENDMENT 1

TABLE III. Standard quantitative tests.

Characteristic	ASTM/FED-STD-141 method
Pigment content	D 2698 (see 6.5)
Volatile content	D 2369
Nonvolatile vehicle content	4053.1
Consistency	D 562
Sag resistance	D 4400
Fineness of grind	D 1210
Set-to-touch	D 1640
Dry hard	D 1640
Gloss	D 523 and Method C or E of D 823
Contrast ratio	D 2805 and Method C or E of D 823
Course particles	D 1210
Flash point	D 3278, except where D 56 is specified (Formula 187).
Mass per unit volume	D 1475

The measured characteristic values shall be in accordance with the requirements of 3.4.1 and the appropriate specification sheet.

4.5.3 Color (wet reflectance [R_w] and FED-STD-595). Test panels shall be prepared in accordance with ASTM D 823 Test Methods C or E using a nominal 0.006 in blade film applicator on to a clear plate glass panel of not less than 1/4 in (nominal) thickness which has been ground to a uniform finish with 1F carborundum. Paint shall be thoroughly cured and hard (not less than 16 hours) at ambient laboratory conditions before proceeding to measuring color. Panels prepared for color may also be used for color fastness (see 4.5.5) tests.

4.5.3.1 Apparatus. Reflectance shall be determined using a reflectometer instrument having a D_{65} light source (10 degree observer) or C light source (2 degree observer), a 45 degree illumination angle and a 0 degree viewing angle. The reflectometer shall measure green reflectance in the range of 0.8% to 2.1% with an error of no more than ± 0.05 of the value being measured. The instrument shall be calibrated in accordance with manufacturer instructions and shall be demonstrated to read the color of National Institute for Science and Technology (NIST) traceable standards with color values not greater than 3 units different than the color to be measured. Note: Calibration standard is measured dry.

4.5.3.2 Formulas 184, 185, and 187. Immediately before making an R_w green reflectance, moisten the area of the panel to be measured with a solution of distilled water with up to 1% clear surfactant (detergent) to a uniform water covering. Quickly measure the green reflectance. Immediately remove the panel and inspect the measurement area for complete wetness. If area is not covered with a uniform layer of water, remoisten and remeasure. Repeat this process until the removed panel has a uniform film of water at both the start and completion of the reflectance measurement. Record the measured reflectance. The wetted green reflectance (R_w) shall be in accordance with the requirements of 3.4.1 and the appropriate specification sheet.

4.5.3.3 Formula 186. The whiteness difference of the dry test paint from color 17886 of FED-STD-595 shall be determined in accordance with ASTM D 1729. Color deviation shall be in accordance with the requirements of 3.4.1 and the appropriate specification sheet.

4.5.3.4 Alternative color measuring equipment. Manufacturers can qualify alternative color measuring equipment to Naval Sea Systems Command (NAVSEA) or the General Services Administration (GSA) by demonstrating that the particular instrumentation to be used measures the green color parameter with the accuracy required in 4.5.3.1. The manufacturer shall demonstrate that the alternate instrumentation can provide green color parameters that result in the colors defined in 3.4.

4.5.4 Volatile solvent constituent content.

MIL-DTL-24631A(SH)
w/INT. AMENDMENT 1

4.5.4.1 Solvent constituent content. Solvent constituent content shall be determined in accordance with Methods 7356 and 7360 of FED-STD-141. Solvent fractions shall be identified in accordance with ASTM E 1252. Test results shall be reported as % by weight of the total solvent content. The test results for each solvent shall be in accordance with the requirement in 3.4.2 and the appropriate specification sheet (see 6.5).

4.5.4.2 VOC. VOC tests shall be conducted on mixed paint prepared for application in accordance with 4.5.4. The VOC test shall be conducted in accordance with 40 CFR CH.1, part 60, appendix A, (EPA) method 24 and test results shall be in accordance with the requirements of 3.4.2 and the appropriate specification sheet (see 6.5).

4.5.5 Color fastness.

4.5.5.1 Formulas 184, 185 and 186. Color fastness shall be determined in a xenon or equivalent weathering device operated in accordance with D 822. Three test panels of appropriate size for equipment shall be prepared as specified in 4.5.3. Dry color measurements shall be performed in the normal way. Wetted green reflectance (R_w) of the test panels shall be measured in accordance with 4.5.3 before testing. Record dry and wetted green reflectances. After 500 hours exposure in the weather device, remeasure dry and wetted green (R_w) reflectance in accordance with 4.5.3. Determine change in dry and wetted green (R_w) reflectance for each test panel. Average both the dry and wetted green (R_w) reflectance reflectances. The average change in reflectances shall be in accordance with the requirements of 3.4.3

4.5.5.2 Formula 187. Color fastness shall be determined in accordance with 4.5.5.1, except that an ASTM G 53 ultraviolet weather device shall be used. The ASTM G 53 device shall be operated as follows:

- (a) Set device parameter controls to provide alternating periods of 6 hours darkness at 100% humidity and 6 hours of UV_b radiation.
- (b) Device UV bulbs shall have an average wavelength of 313 nanometers (nm).
- (c) Temperature controls shall be capable of maintaining the device a nominal 23°C (73°F) during the dark portion of a cycle and a nominal 52°C (125°F) during the UV lighted portion of a cycle.
- (d) Dry tristimulus reflectance values and wetted green reflectance of the test panels shall be measured in accordance with 4.5.3 before testing. Record the dry tristimulus reflectance and wetted green reflectances. After 500 hours exposure in the weather device, remeasure dry tristimulus reflectance values and wetted green reflectance in accordance with 4.5.3. Calculate color parameters, L, a and b, and the color change terms Delta (Δ)E, ΔA , ΔB , ΔL in accordance with ASTM D 2244. Determine change in wetted green reflectance for each test panel. Average ΔE values. Average wetted green reflectances. The average ΔE change and ΔR_w , shall be in accordance with the requirements of 3.4.3.

4.5.6 Contrast ratio. In accordance with ASTM D 344 paragraphs 6 and 7 using a ratio of 7 milliliters (mL) of paint per 930 square centimeters (cm²) prepare a smooth surfaced paper chart test having adjacent black and white color areas and coated with a lacquer or varnish to render the surface impermeable to the liquid paint. Measure test specimen and calculate contrast ratio (C) in accordance with ASTM D 2805. Contrast ratio shall be in accordance with the requirements of 3.4 and the appropriate specification sheet.

4.5.7 Course articles and skins. Course particles and skins shall be determined in accordance with method 4092.1 of FED-STD-141 on each individual component, except that butyl acetate conforming to ASTM D 4615 shall be used for solvent. Test results shall be in accordance with the requirements of 3.4 and the appropriate specification sheet.

4.5.8 Pot life. One liter (1 quart) of paint shall be prepared in accordance with 4.4.4, except testing shall begin as soon as mixed. The consistency shall be determined in accordance with ASTM D 562 at the following intervals from completion of initial mixing: Once during the first four hours and every hour for the next four hours. The test shall be terminated when the consistency exceeds 115 Krieb units, or at the end of eight hours. Pot life shall be in accordance with the requirements of 3.4.1 and the appropriate specification sheet.

MIL-DTL-24631A(SH)
w/INT. AMENDMENT 1

4.5.9 Brushing properties. The paint shall be prepared as specified in 4.4.4. Without further reduction, the paint shall be applied and laid off in accordance with method 4321.2 of FED-STD-141 and 4.5 using a natural bristle brush. After drying for a minimum of 16 hours at ambient laboratory conditions, the dry paint film shall be observed for: (a) obvious lap marks or brush marks, (b) gloss and color variations or mottling and (c) pigment streaking or separation. Test results shall be in accordance with the requirements of 3.5.1.

4.5.10 Spraying properties. The paint shall be prepared as specified in 4.4.4. Without further reduction, the paint shall be sprayed on a sandblasted steel panel to a 4 mil wet film thickness. The steel panel shall be observed for dusting, floating, mottling, bubbling, wrinkling, streaming, pinholing, cratering, orange peel, blushing, blooming or silking in accordance with method 4331.1 of FED-STD-141. The wet and dry sprayed paint films shall be in accordance with the requirements of 3.5.2. For referee test, use automatic application in accordance with method 2131 of FED-STD-141.

4.5.11 Adhesion. Prepare neoprene test panel (see 4.4.3) in accordance with 4.4.3(c) with a spray applied film of the test paint. After curing the sprayed film for a minimum of 16 hours at ambient laboratory conditions, immerse the coated neoprene panel in deionized or distilled water for a 24 hour period. After 24 hours in the water, remove the test panel and quickly pat the surface dry with a paper towel. Within one minute after removal of the test panel from the water, make two parallel cuts through the coating surface to or into the neoprene rubber with a sharp knife. The cuts shall be approximately 2.54 cm (1 inch) apart, and at least 2.54 cm (1 inch) in length. A piece of commercial masking tape shall be pressed firmly across the cuts. The tape shall be pulled off rapidly, and the panel shall be examined for any adhesion loss. Adhesion loss shall be in accordance with the requirements of 3.5.3.

4.5.12 Water immersion test. Prepare painted neoprene test panel in accordance with 4.4.3. One-half of the coated neoprene panel shall be immersed in distilled or deionized water in a container with closure for 21 days. The other 1/2 shall remain exposed to the high humidity over the enclosed area. The adhesion on both halves of the test panel shall be evaluated in accordance with 4.5.11. There shall be no whiteness or color change of the film when the coated neoprene is removed from the water. The panel shall be bent double over a 1-inch mandrel and examined without magnification for cracks. Test results shall be in accordance with the requirements 3.5.4.

4.5.13 Storage stability - partially-full containers - Formulas 184, 185 and 186. Components shall be tested separately. Condition in container shall be determined in accordance with method 3021.1 and method 3022.1 of FED-STD-141 and skinning shall be determined after 48 hours in accordance with method 3021.1 of FED-STD-141. The partially full containers shall be resealed and aged for 30 days at 60°C (140°F). After aging examine for individual components for skinning, surface float (separated pigments or other ingredients on the surface of the liquid), livering, curdling, hard settling (caking), gummy sediment. After mixing to a smooth uniform state with a paddle or mechanical mixer (mechanical stirrer or paint shaker) for 5 minutes, inspect for surface float (separated pigments or other ingredients on the surface of the liquid) measure consistency. After aging, examine mixed paint for curing. Test results shall be in accordance with the requirements of 3.5.5.1.

4.5.14 Storage stability - full container. A full container of each individual component shall be allowed to stand undisturbed for 12 months at ambient laboratory conditions and then the contents tested. The cans contents shall be evaluated for condition in container for skinning, livering, curdling, hard settling (caking) or gummy sediment. After mixing to a smooth uniform state with a paddle or mechanical mixer (mechanical stirrer or paint shaker) for 5 minutes, inspect for surface float (separated pigments or other ingredients on the surface of the liquid) measure consistency and color shall be determined and other applicable tests (see table 11) made for compliance with 3.4 and the applicable specification sheet. All test results shall be in accordance with the requirements of 3.5.5.2.

4.5.15 Storage stability - accelerated storage stability. Previously unopened, original containers of each individual component shall be exposed at a nominal temperature of 60°C (140°F) for a period of 30 days. After completion of thermal test, container shall be equilibrated at ambient laboratory conditions for 24 hours. Each container of paint component shall be examined in accordance with 4.5.14 for compliance with all the requirements of 3.5.5.3. Test results shall be in accordance with the requirements of 3.5.5.3.

4.5.16 Odor. Odor shall be determined in accordance with ASTM D 1296. Test results shall be in accordance with the requirements of 3.5.6.

MIL-DTL-24631A(SH)
w/INT. AMENDMENT 1

4.5.17 Infrared spectrum. The infra-red spectrum of nonvolatile vehicle shall be established on a recording infra-red spectrophotometer from approximately 600 to 4000 wave numbers in accordance with ASTM E 1252. Test results shall be in accordance with the requirements of 3.5.7.

4.5.18 Toxicological product formulations. The contractor shall have the toxicological product formulations and associated information available for review by the contracting activity to evaluate the safety of the material for the proposed use. Manufacturer testing for product conformance and any Government quality conformance testing shall be in accordance with the following:

- (a) Metals shall be determined in accordance with 40 CFR Part 261, Appendix 11, Toxicity Characteristic Leaching Procedure (TCLP).
- (b) Asbestos shall be determined in accordance with 29 CFR Ch XVII, Part 1915.1001, Appendix K, Method ID-191, "Polarized Light Microscopy of Asbestos", July 1, 1996.
- (c) Solvents shall be identified in accordance with Methods 7356 and 7360 of FED-STD-141. Solvent fractions shall be determined in accordance with ASTM E 1252.

The information shall be in accordance with the requirements of 3.6.

4.5.19 Hazardous solvent content. Hazardous solvent content shall be determined in accordance with Methods 7356 and 7360 of FED-STD-141. Solvent fractions shall be identified in accordance with ASTM E 1252. Test results shall be reported as % by weight of the total paint. The test results for each solvent shall be in accordance with the requirement in 3.7 and table I.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department'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 which may be helpful, but is not mandatory.)

6.1 Intended use. This camouflage paint is intended for areas above the waterline when retention of color is essential. This paint was developed principally for rubber substrates. Paints are to be used at rubber and steel interfaces to maintain continuous camouflage with paints compatible with the substrates.

6.2 Acquisition requirements. Acquisition documents must specify the following:

- (a) Title, number, and date of this specification.
- (b) Title, number, and date of specification sheets.
- (c) Type, Formula number, and applicable specification sheet (see 1.2, 2.2.1, 3.3, 3.4.1, and 3.4.2).
- (d) Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.2.1 and 2.3).
- (e) Whether first article is required (see 3.2 and 6.3).
- (g) Whether certification data, including VOC and volatile constituent content, hazardous air pollutants and toxicological requirements have been met.
- (h) Packaging requirements (see 5.1 and 6.9).
- (i) Whether MSDS and ASTM F 718 is required (see 6.6).

MIL-DTL-24631A(SH)
w/INT. AMENDMENT 1

6.3 First article inspection. When first article inspection is required, the contracting officer should provide specific guidance to offerors whether the item(s) should be a preproduction sample, a first article sample, a first article production item, a sample selected from the first production items, a standard production item from the contractor's current inventory (see 3.11, and the number of items to be tested as specified in 4.2. The contracting officer should include specific instructions in acquisition documents regarding arrangements for examinations, approval of first article test results, and disposition of first articles. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspections to those bidders offering a product which has been previously acquired or tested by the government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract. Bidders should not submit alternate bids unless specifically requested to do so in the solicitation.

6.4 Pigment separation. ASTM D 2698 should be followed. Since carbon black may be difficult to separate, a volume of suitable solvent may be mixed with the paint to be centrifuged. If quantitative work is to be done on the paint, the mass of the paint sample and the added solvent must be known.

6.5 Volatile content. Although the container marking specifically refer to the Federal regulations, the paints may be used anywhere else a product complying with 3.4.1 is allowed. This includes other air pollution control districts or similar areas controlling the emission of solvents into the atmosphere.

6.6 Material Safety Data Sheets and ASTM F 718. Contracting officers should identify those activities requiring copies of completed Material Safety Data Sheets prepared in accordance with FED-STD-313. The pertinent Government mailing addresses for submission of data are listed in FED-STD-313. The ASTM F 718 should be included with each shipment of the material covered by this specification. In order to obtain the MSDS, federal acquisition regulation (FAR) clause 52.223-3 must be in the contract.

6.7 Toxicity. Questions pertinent to this requirement should be referred by contracting activity to the qualifying activity. The qualifying activity will act as advisor to the contracting activity. The qualifying activity will arrange for review of questions by the appropriate departmental medical service.

6.8 Lot acceptance and rejection criteria. For conformance testing, if any defects are found in any sample, the entire lot represented by the sample should be rejected. If a lot is rejected, the contractor has the option of providing a new lot which is to be inspected and tested in accordance with the procedures in section 4.

6.9 Recommended packaging requirements. Recommended packaging requirements are contained in tables IV and V.

MIL-DTL-24631A(SH)
w/INT. AMENDMENT 1

TABLE IV. Recommended packaging.

Packaging	Recommended requirements for direct Government acquisitions
Containers	<p>(1) The components should be furnished in cans appropriate to kit requirements capable of holding 0.47 liters (L) (1- pint), 0.945L (1-quart) or 3.78L (1-gallon).</p> <p>(2) Multiple friction plug containers should be in accordance with PPP-C-96, type V, class 2. Interior coatings should be as specified therein. Exterior coatings, including side seam stripping, should be as specified therein for plan B. Wire handles as specified therein, should be provided for the 1-gallon container. Closure of the properly filled and sealed cans should be as specified in the appendix thereto.</p> <p>(3) All containers should comply with the requirements of the Uniform Freight Classifications (UFC), the National Motor Freight Classification (NMFC), and the applicable requirements of the Code of Federal Regulations 49 CFR, Department of Transportation (DOT).</p> <p>(4) Container lining: Solvent-resistant baked phenolic lining materials have been successfully used in containers for paints covered by this specification. The paint, as specified herein, may gel if stored in contact with metal. In properly lined containers, however, the coating is stable for over 2 years.</p> <p>(5) Unit of procurement: The paints covered by this specification should be purchased by volume. The unit of procurement shall be in multiples of 1 L or 1 U.S. liquid gallon at 15.5°C (60°F).</p>
Commercial packaging	<p>(1) Commercial packaging should be to ASTM D 3951.</p> <p>(2) All containers should comply with the requirements of the Uniform Freight Classifications (UFC), the National Motor Freight Classification (NMFC), and the applicable requirements of the Code of Federal Regulations 49 CFR, Department of Transportation (DOT).</p>
Packing	<p>Packing should be specified as follows:</p> <p>(1) <u>Overseas delivery (Level A) packing.</u> Intermediate containers of like size kit intermediate containers of paint should be packed in close-fitting wood boxes conforming to PPP-B-601, overseas type, or PPP-B-621, class 2. Box closure and strapping should be as specified in the applicable box specification or the appendix thereto except that strapping should be flat and the finish B.</p> <p>(2) <u>Domestic delivery (Level B) packing.</u> Level B packing should be as for level A, except that boxes should be domestic type or class and the strapping should be finish A or B.</p> <p>(3) <u>Commercial packing.</u> The paint, in the unit kit and intermediate containers should, as applicable, be packed in multiples of like sizes in accordance with UFC, NMFC and 49 CFR requirements.</p>
Palletization	Intermediate containers should be palletized in accordance with MIL-STD-147. Only one size unit or intermediate container should be placed on a pallet.
Intermediate containers	Paints should be packaged in intermediate containers as kits. Intermediate containers should be close-fitting corrugated fiberboard boxes in accordance with UFC, NMFC and 49 CFR requirements. Fiberboard used in the construction of interior (unit and intermediate) and exterior containers, including interior packaging forms, should conform to the PPP-F-320. PPP-F-320 classes should be domestic fire-retardant or weather resistant fire retardant (see 6.2).

MIL-DTL-24631A(SH)
w/INT. AMENDMENT 1

TABLE IV. Recommended packaging - Continued.

Packaging	Recommended requirements for direct Government acquisitions
Packing for acquisitions involving direct delivery to Navy ships or installations	<p><u>Treated lumber and plywood.</u> All lumber and plywood, including laminated veneer materials, used in shipping container and pallet construction, member, blocking, bracing, and reinforcing must be fire-retardant treated material in accordance with MIL-L-19140 as follows:</p> <p>(a) General use, weather resistant: MIL-L-19140, type II, Category I.</p> <p>(b) General use, non-weather resistant: MIL-L-19140, type I, Category I.</p>
Unit kits	<p>The paints covered by this specification should be packed and packaged as kits. The kits should be as follows:</p> <p>(a) Formulas 184, 185 and 186 should be kits having two containers of equal volume.</p> <p>(b) Formula 187 should be a kit having two containers having relative volumes of 5 (containing 4 volumes of component A) to 1 (containing 1 volume of component B) to allow for mixing. (Example: a kit might consist of 4 gallons of component A in a 5 gallon container with a 1 gallon container of component B.)</p>
Material safety data sheets (MSDS)/ASTM F718	A copy of the MSDS and ASTM F 718 should be attached to the shipping document for each destination (see 6.3).

TABLE IV. Recommended marking.

Marking type	Recommended marking
Bar codes	Marking should include bar codes
Hazardous warnings	<p>(a) Labels should be in accordance with 29 CFR Parts 1910, 1915, 1917, 1918, 1926 and 1928, as well as PPP-P-1892.</p> <p>(b) All individual containers should have the following marking: “NOTICE: This paint contains volatile solvents, with probable hazardous vapors. Use with adequate ventilation. Avoid prolonged breathing of vapors or spray mists. The solvents are highly flammable, avoid open flame and smoking.”</p> <p>(c) Each component container, shipping container, and palletized load should be marked with the appropriate hazardous symbol in accordance with FED-STD-313.</p>
Volatile organic content (VOC)	“Contains 340 grams per liter of volatile organic content per 40 CFR CH.1, part 60, Appendix A (EPA) Method 24.”
VOC certification sheets	VOC certification sheets will be provided by the manufacturer for each batch of combined Parts A & B for each coat of the coating system when requested by the procuring activity.
Shelf life	<p>Each unit container, intermediate container where applicable, and shipping container should be marked as follows:</p> <p>“Date of first reinspection (insert here date 1 year after date of manufacture). For recommended reinspection tests, see MIL-DTL-24631, Table 2, Footnote 4.”</p>

MIL-DTL-24631A(SH)
w/INT. AMENDMENT 1

TABLE IV. Recommended marking - Continued.

Marking type	Recommended marking
Mixing and use instructions	<p>Each component container should be marked with mixing and use instructions as follows:</p> <p>(a) <u>Type I, Type II and Type III (Epoxy paints)</u></p> <p>[1] <u>Component A:</u></p> <p style="text-align: center;">“NOTICE</p> <p style="text-align: center;">This is one component of a two component system which WILL NOT HARDEN OR CURE unless both components are mixed together.</p> <p style="text-align: center;"><u>INSTRUCTIONS FOR USE</u></p> <p style="text-align: center;">Mix component A and Component B thoroughly. Stir component A and Component B together 1:1 by volume. Mix amount for no more than 8 hours work. Allow mixed paint to stand for 1/2 hour before application. DO NOT THIN”</p> <p>The following solvent mixture can be used to clean equipment:</p> <p>(1) N-butyl alcohol (ASTM D 304) - 1 part by volume. (2) N-butyl acetate (TT-B-838) - 1 part by volume.”</p> <p>[2] <u>Component B:</u></p> <p style="text-align: center;">“NOTICE</p> <p style="text-align: center;">This is one component of a two component system which WILL NOT HARDEN OR CURE unless both components are mixed together.</p> <p style="text-align: center;"><u>INSTRUCTIONS FOR USE</u></p> <p style="text-align: center;">Mix Component A and Component B thoroughly. Stir Component A and Component B together 1:1 by volume. Mix amount for no more than 8 hours work. Allow mixed paint to stand for 1/2 hour before application. DO NOT THIN”</p> <p>The following solvent mixture can be used to clean equipment:</p> <p>(1) N-Butyl alcohol (ASTM D 304) - 1 part by volume. (2) N-Butyl acetate (TT-B-838) - 1 part by volume.”</p> <p>(b) <u>Type II (Black polyurethane paint)</u></p> <p>[1] <u>Component A:</u></p> <p style="text-align: center;">“NOTICE</p> <p style="text-align: center;">This is one component of a two component system which WILL NOT HARDEN OR CURE unless both components are mixed together.</p> <p style="text-align: center;"><u>INSTRUCTIONS FOR USE</u></p> <p style="text-align: center;">Mix Component A and Component B thoroughly. Stir Component A and Component B together 4:1 by volume (4 parts Component A and 1 part Component B). Mix amount for no more than 1 hour work. ROLL APPLY WITH SHORT NAP ROLLER.</p> <p style="text-align: center;">THIN ONLY FOR SPRAY APPLICATION. THIN ONLY WITH DI-ISOBUTYL KETONE OR BUTYL ACETATE (TT-B-838) AND ONLY IF ALLOWED BY LOCAL AIR QUALITY OR AIR POLLUTION CONTROL DISTRICT REGULATIONS. DO NOT apply at temperatures below 7°C (45°F). DO NOT apply if relative humidity is above 80%.”</p> <p>[2] <u>Component B:</u></p>

MIL-DTL-24631A(SH)
w/INT. AMENDMENT 1

TABLE IV. Recommended marking - Continued.

Marking type	Recommended marking
	<p>“NOTICE</p> <p>This is one component of a two component system which WILL NOT HARDEN OR CURE unless both components are mixed together.</p> <p>INSTRUCTIONS FOR USE</p> <p>Mix Component A and Component B thoroughly. Stir Component A and Component B together 4:1 by volume (4 parts Component A and 1 part Component B). Mix amount for no more than 1 hour work.</p> <p>ROLL APPLY WITH SHORT NAP ROLLER.</p> <p>THIN ONLY FOR SPRAY APPLICATION. THIN ONLY WITH DI-ISOBUTYL KETONE OR BUTYL ACETATE (TT-B-838) AND ONLY IF ALLOWED BY LOCAL AIR QUALITY OR AIR POLLUTION CONTROL DISTRICT REGULATIONS.</p> <p>DO NOT apply at temperatures below 7°C (45°F).</p> <p>DO NOT apply if relative humidity is above 80%.”</p>

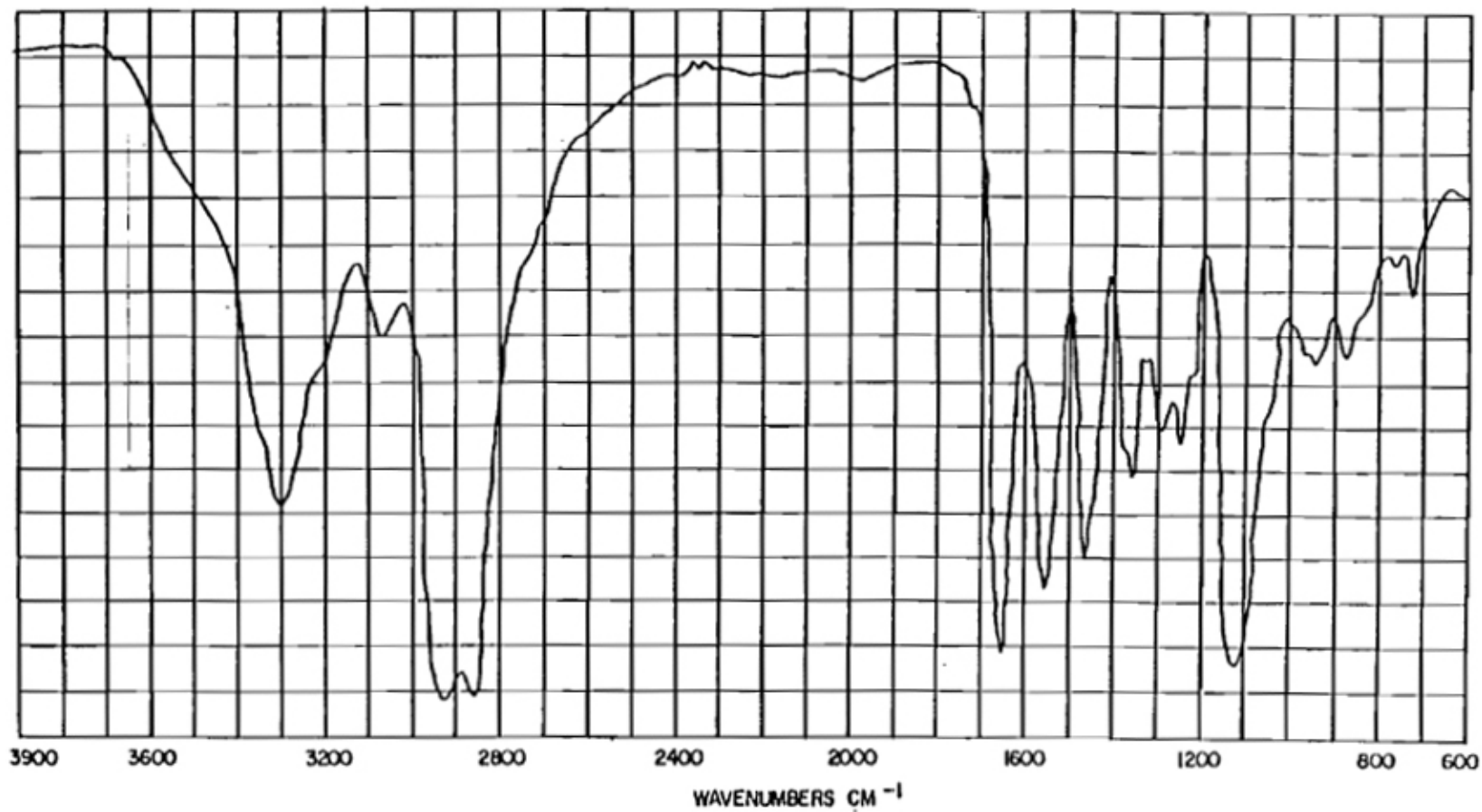


FIGURE 1. Infrared spectrogram of Scotch Weld 2216A (aliphatic amine).

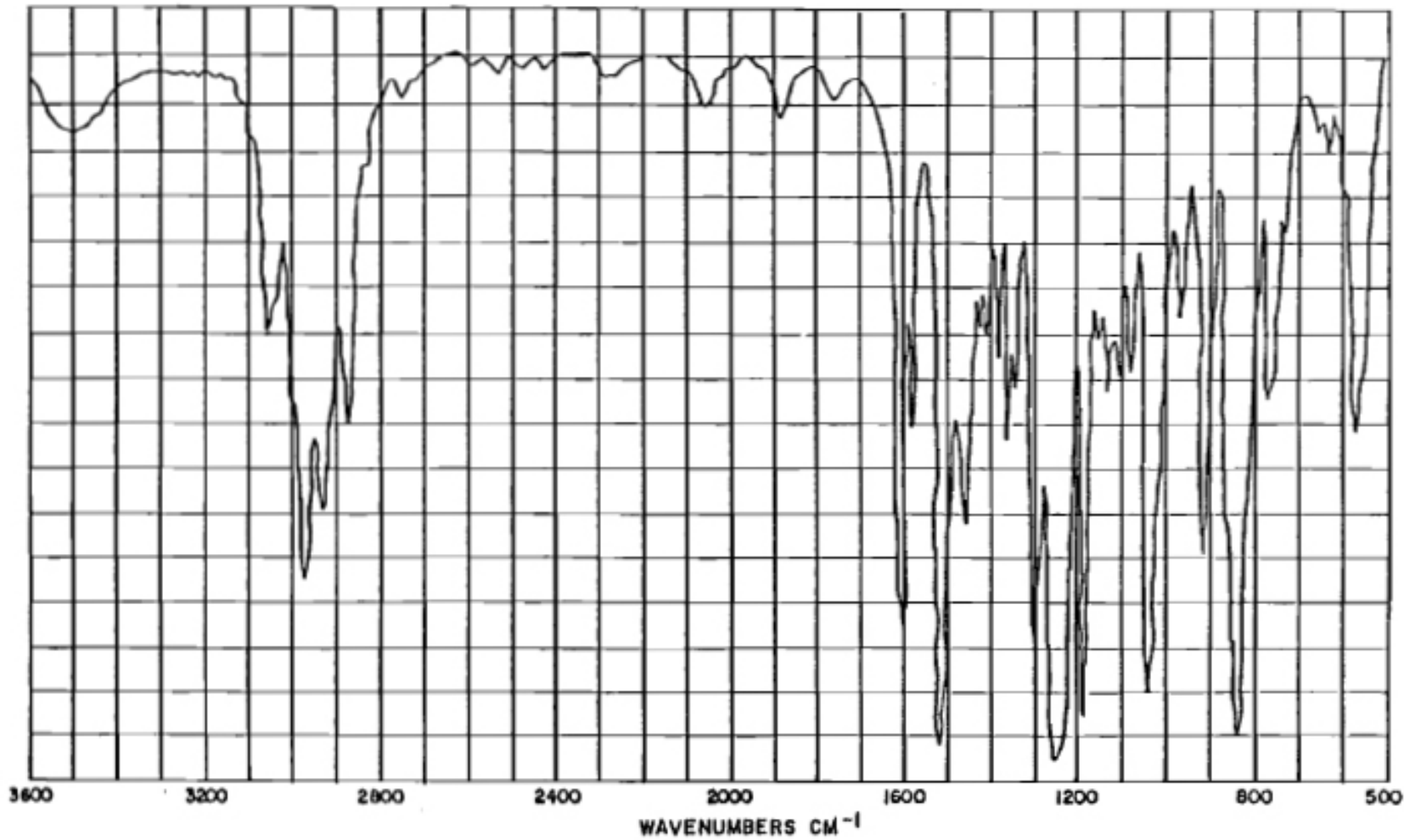


FIGURE 2. Infrared spectrogram of Scotch Weld 2216B (epoxy resin).

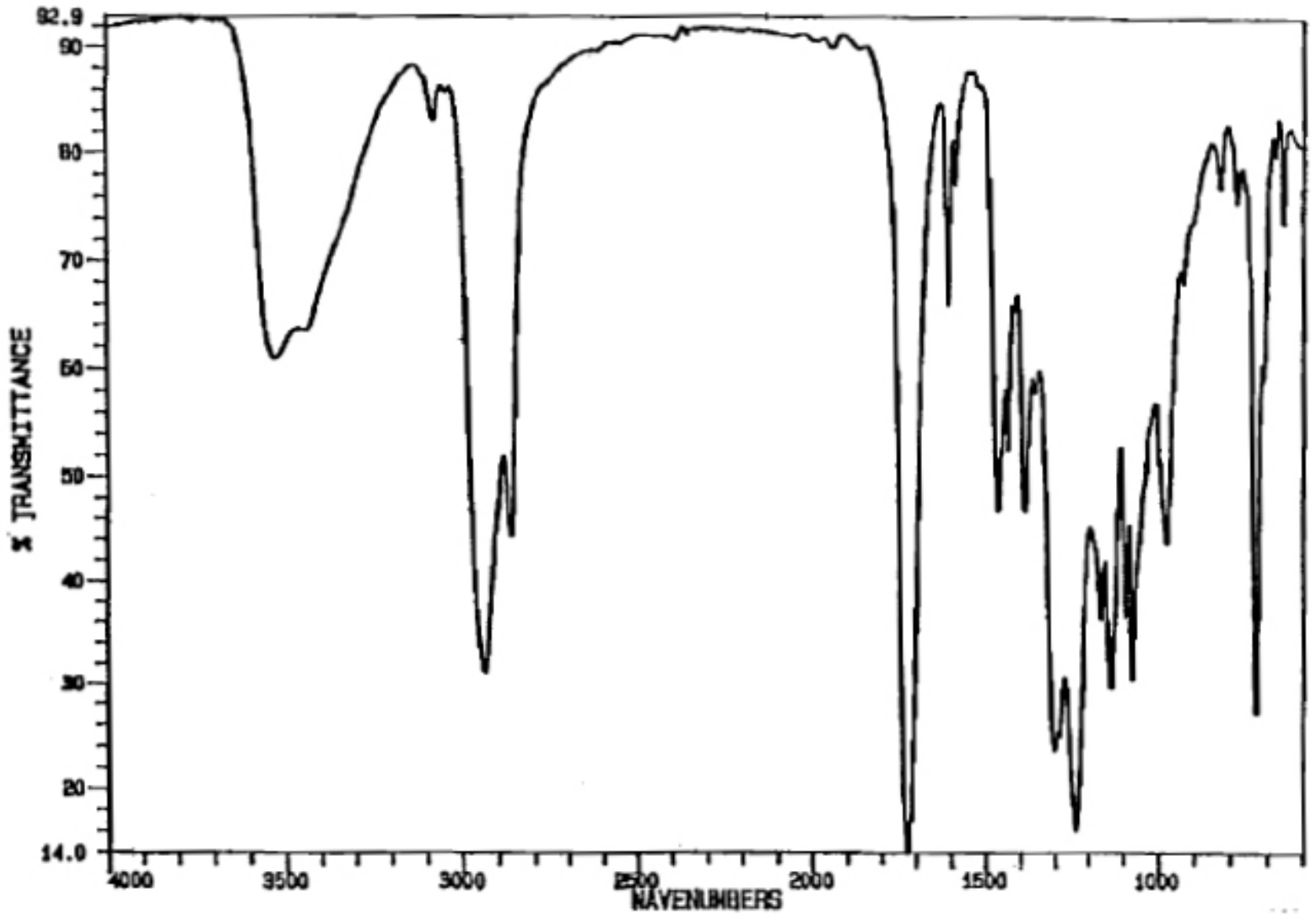


FIGURE 3. Infrared spectrogram of Desmophen 670A-80 (polyester resin).

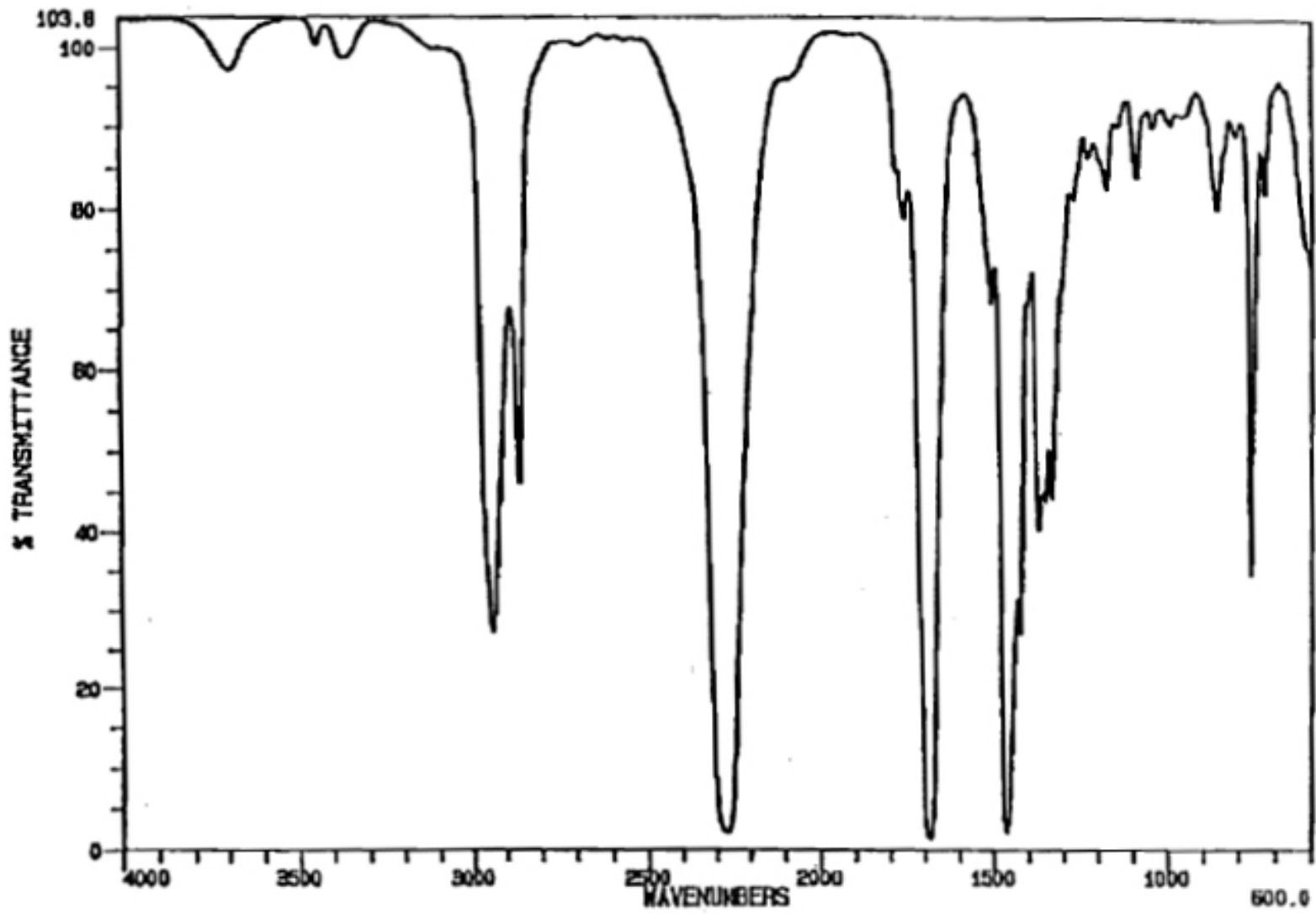


FIGURE 4. Infrared spectrogram of Desmodur N-3300 (polyisocyanate (HDI) reactor).

MIL-DTL-24631A(SH)
w/INT. AMENDMENT 1

6.10 Subject term (key word) listing.

Camouflage
Epoxy
Flexible
Polyurethane
Rubber
Two-component

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

Preparing activity:
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