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METRIC

MIL-DTL-24441D(SH)
27 August 2009

SUPERSEDING
MIL-DTL-24441C(SH)
19 May 1999

DETAIL SPECIFICATION

PAINT, EPOXY-POLYAMIDE, GENERAL SPECIFICATION FOR

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 a series of two component epoxy-polyamide paints designed to protect surfaces from environmental attack (see 6.1).

1.2 Classification. Paints covered by this specification will be of the following types, as specified (see 6.2):

Type III – Three-coat system for use where air pollution regulations restrict volatile organic compound (VOC) content to less than 340 grams per liter (2.8 pounds per gallon) of paint.

Type IV – Two-coat system for use where air pollution regulations restrict VOC content to less than 340 grams per liter (2.8 pounds per gallon) of paint.

Type V – Two coat system for use where air pollution regulations restrict VOC content to less than 250 grams solvent per liter (2.08 pounds per gallon) of paint.

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.

Comments, suggestions, or questions on this document should be addressed to: Commander, Naval Sea Systems Command, ATTN: SEA 05M2, 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.

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FEDERAL SPECIFICATIONS

QQ-S-698	-	Steel Sheet and Strip, Low Carbon

FEDERAL STANDARDS

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

DEPARTMENT OF DEFENSE SPECIFICATIONS

(See Supplement 1 for list of specification sheets.)

(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.

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1910	-	Occupational Safety and Health Standards
29 CFR 1910.1000 - Subpart Z	-	Toxic and Hazardous Substances
29 CFR 1910.1200	-	Hazard Communication
29 CFR 1990	-	Identification, Classification, and Regulation of Potential Occupational Carcinogens
40 CFR 60, Ch. 1, Appendix A, Method 24	-	Determination of Volatile Matter Content, Water Content, Density, Volume Solids, and Weight Solids of Surface Coatings
40 CFR Part 63, Appendix A, Method 311		HAPS in Paints and Coatings
40 CFR 82	-	Protection of Stratospheric Ozone
40 CFR 261, Appendix 11, Method 1311	-	Toxicity Characteristic Leaching Procedure (TCLP)
40 CFR 355, Appendixes A and B	-	The List of Extremely Hazardous Substances and Their Threshold Planning Quantities
40 CFR 372.65	-	Specific Toxic Chemical Listings
49 CFR 171-178	-	Hazardous Materials Regulations

(Copies of these documents are available from the Superintendent of Documents, U.S. Government Printing Office, Washington DC 20401 or online at www.gpoaccess.gov/index.html.)

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA SW-846 - Test Methods for Evaluating Solid Waste –Physical/Chemical Methods

EPA 600/4-020 - Methods for Chemical Analysis of Water and Waste

(Copies of these documents are available from the Environmental Protection Agency, Ariel Rios Building, 1200 Pennsylvania Avenue, N.W., Washington DC 20460 or online at www.epa.gov.)

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 D185 - Standard Test Methods for Coarse Particles in Pigments, Pastes, and Paint

ASTM D522 - Standard Test Method for Mandrel Bend Test of Attached Organic Coatings

ASTM D523 - Standard Test Method for Specular Gloss

ASTM D562 - Standard Test Method for Consistency of Paints Using the Stormer-Type Viscometer

ASTM D714 - Standard Test Method for Evaluating Degree of Blistering of Paints

ASTM D1141 - Standard Specification for Substitute Ocean Water

ASTM D1210 - Standard Test Method for Fineness of Dispersion of Pigment-Vehicle Systems by Hegman-Type Gage

ASTM D1296 - Standard Test Method for Odor of Volatile Solvents and Diluents

ASTM D1308 - Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes

ASTM D1364 - Standard Test Method for Water in Volatile Solvents (Karl Fischer Reagent Titration Method)

ASTM D1394 - Standard Test Methods for Chemical Analysis of White Titanium Pigments

ASTM D1475 - Standard Test Method for Density of Liquid Coatings, Inks, and Related Products

ASTM D1640 - Standard Test Methods for Drying, Curing, or Film Formation of Organic Coatings at Room Temperature

ASTM D1652 - Standard Test Methods for Epoxy Content of Epoxy Resins

ASTM D1729 - Standard Practice for Visual Appraisal of Color Differences of Diffusely-Illuminated Opaque Materials

ASTM D2244 - Standard Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates

ASTM D2369 - Standard Test Method for Volatile Content of Coatings

ASTM D2698 - Standard Test Method for Determination of the Pigment Content of Solvent-Reducible Paints by High-Speed Centrifuging

ASTM D2805 - Standard Test Method for Hiding Power of Paints by Reflectometry

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ASTM D3278 - Standard Test Methods for Flash Point of Liquids by Small Scale Closed-Cup Apparatus

ASTM D3960 - Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings

ASTM D4400 - Standard Test Method for Sag Resistance of Paints Using a Multinotch Applicator

ASTM D4417 - Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel

ASTM D4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers

ASTM E260 - Standard Practice for Packed Column Gas Chromatography

ASTM E1252 - Standard Practice for General Techniques for Qualitative Infrared Analysis

(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.)

INTERNATIONAL AGENCY FOR RESEARCH ON CANCER (IARC)

International Agency for Research on Cancer (IARC) Monographs

(Copies of this document are available from WHO Press, World Health Organization, CH-1211 Geneva 27, Switzerland or online at www.who.int/bookorders.)

NATIONAL TOXICOLOGY PROGRAM (NTP)

Latest Annual Report on Carcinogens, Summary, National Toxicology Program

(Copies of this document are available from NIEHS, Public Information Office, MD B2-04, Research Triangle Park, NC 27709 or online at http://library.niehs.nih.gov.)

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

3. REQUIREMENTS

3.1 Specification sheets. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheet. In the event of any conflict between the requirements of this specification and the specification sheet, the latter shall govern.

3.2 Qualification. The paints furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified products list before contract award (see 4.2 and 6.3).

3.3 Manufacturer. The paint shall be manufactured (see 6.5) and supplied as a two-component system formulated in accordance with the applicable specification sheet to produce a uniform, high quality product capable of meeting all requirements.

3.4 Composition. The components shall be manufactured using the material specified in the specification sheet and in the proportions as specified in the individual specification sheets. The components shall be completely compatible so, when components A and B are mixed as specified by volume, the paint shall be suitable for spray applications above 4.4 degrees Celsius (°C) (40 degrees Fahrenheit (°F)), and shall meet all other specified requirements. To achieve specified colors, pigments dispersed in polyamide may be used for tinting provided all requirements of the specification are met. Added pigment shall not exceed 120 grams for 100 liters (1 pound for 100 gallons).

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3.4.1 Use of alternate ("or equal") ingredients. Specification sheets allow manufacturers to use alternate ("or equal") ingredients for named ingredients. When ingredients not listed on the individual specification sheets are proposed for use, manufactures shall conduct complete qualification tests.

3.4.2 Hazardous solvents. When tested as specified in 4.5.20, the content of hazardous air pollutant solvents (HAPs) in the each individual liquid coating shall not exceed the percent by weight (wt%) values specified in table I. Within these limitations and the requirement that the finished coating meet all requirements of this specification, coating system solvent selection shall be in accordance with the individual specification sheets.

TABLE I. HAP solvent content limits of coatings using alternate solvents.

Hazardous solvent in each individual total paint	Maximum, wt%
Benzene	0.05
Chlorine or fluorine containing solvents, total	0.05
Class I or Class II ozone-depleting chemicals as defined in 40 CFR 82.	0.01
Ethyl benzene	0.05
Methyl, ethyl, and butyl mono-ethers of ethylene glycol or the acetates thereof, total (methyl, ethyl, and butyl cellosolves, and methyl, ethyl, and butyl cellosolve acetates)	0.05
Methyl ethyl ketone (MEK)	0.05
Methyl isobutyl ketone (MIBK)	0.05
Toluene	0.05
Xylene (all forms), total	0.1

3.4.3 Hazardous pigments and additives. When tested as specified in 4.5.21, the content of each soluble metal and the total content of each metal in the coating shall be less than the values specified in table II. In addition, asbestos and asbestos form pigments shall not exceed 0.5 weight per cent of the dry paint film (see 4.5.21). Crystalline silica shall not exceed 100 milligrams per liter (mg/L).

TABLE II. Metals content for coatings using alternate pigments.

Soluble metal and its compound in each individual dry paint	Soluble content, maximum, mg/L	Total content, maximum, wt%
Antimony	15	0.015
Arsenic	5	0.005
Barium (excluding barite)	100	0.10
Beryllium	0.75	0.0002
Cadmium	1	0.0005
Chromium (VI)	1	0.001
Chromium and chromium (III)	560	0.56
Cobalt	50	0.005

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TABLE II. Metals content for coatings using alternate pigments – Continued.

Soluble metal and its compound in each individual dry paint	Soluble content, maximum, mg/L	Total content, maximum, wt%
Copper	25	0.01
Fluoride salts	180	0.18
Lead	5	0.005
Mercury	0.2	0.0002
Molybdenum	350	0.35
Nickel	20	0.02
Selenium	1	0.002
Silver	5	0.001
Tantalum	100	0.100
Thallium	7	0.007
Tungsten	100	0.100
Vanadium	24	0.01
Zinc	250	0.25

3.4.4 Toxicity. The materials used in the coating compound, unless specific material maximum levels are cited herein (see 3.4.2 and 3.4.3), shall have no known carcinogenic or potentially carcinogenic materials identified by OSHA (29 CFR 1990) as regulated carcinogens, or IARC latest monographs, or the latest annual report of the NTP; and shall have no extremely hazardous substances (EHS) or toxic chemicals identified in 29 CFR 1910.1000, 40 CFR 355, and 40 CFR 372, respectively. The manufacturer is responsible for maintaining carcinogenic free, extremely hazardous substance free, and toxic chemical free materials. The manufacturer shall not, unless specific material maximum levels are cited herein, allow the addition of any of these prohibited materials to the formulation; and when any of these prohibited materials are/may be present, as a result of being present as a trace or impurity in another ingredient(s), the concentration of the prohibited material shall not equal or exceed 0.1 percent by weight of the coating compound. Questions pertinent to this toxic effect shall be referred by the 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.

3.4.5 Recycled, recovered, or environmentally preferable materials. Recycled, recovered, or environmentally preferable materials should be used to the maximum extent possible provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs.

3.5 Conformance requirements. The paint shall conform to all conformance requirements specified in table III.

3.5.1 Qualification requirements. The paint shall conform to all qualification requirements specified in 3.6 and the applicable specification sheets as identified in table III (see 4.2).

3.6 Qualitative requirements. Qualitative requirements shall be as specified in 3.6.1 through 3.6.10:

3.6.1 Brushing properties. When prepared for application as specified in 4.5.1 and tested as specified in 4.5 and 4.5.8, the paint shall be capable of being brushed out and laid off without excess drag on the brush. When dry, the brushed surface shall be free from sags or runs, and shall show a minimum of brush marks.

3.6.2 Spraying properties. When prepared for application as specified in 4.5.1 and tested as specified in 4.5 and 4.5.9, the paint shall spray satisfactorily in all respects, and shall show no running, sagging, or streaking. The film shall show no dusting, mottling, or color separation and shall be smooth and uniform.

3.6.3 Flexibility. When prepared as specified in 4.5.1 and tested as specified in 4.5.10, a film of paint shall withstand bending without visible cracking or flaking.

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3.6.4 Stability in partially full container. When tested as specified in 4.5.12, a three-quarter filled, closed 0.25 -liter (8-ounce) glass jar of part A and part B shall show no skinning, livering, curdling, seeding, hard caking, loss of thixotropy, or gummy sediment. After this aging, each component shall remix readily to a smooth uniform mixture with a consistency not greater than 625 grams to produce a 200 revolutions per minute (r/min) Krebs-Stormer shear rate (121 Krebs units (KU)).

3.6.5 Dilution stability. When thinned as specified in 4.5.13 and mixed as specified in 4.5.1, paint shall remain stable and uniform showing no precipitation, separation, or curdling.

3.6.6 Odor. The odor shall be characteristic of the volatiles permitted.

3.6.7 Condition in container.

3.6.7.1 Components. When tested as specified in 4.5.14, each component shall be readily broken up with a paddle to a smooth, uniform consistency and shall not liver, gel, or show any other objectionable properties for at least 1 year after date of acceptance.

3.6.7.2 Paint. When tested as specified in 4.5.14, components which have been stored for at least 1 year in their original containers, when mixed as specified in 4.5.1, shall produce a paint which meets all requirements of this specification and the applicable specification sheet, except that the consistency of the mixed paint reported in grams shall be not greater than 625 grams (121 KU).

3.6.7.3 Accelerated storage stability. When tested as specified in 4.5.14.1, components shall meet the requirements of this specification and the applicable specification sheet for consistency, fineness of grind, and condition in container. Mixed paints from these components shall have a consistency of not more than 625 grams when tested in accordance with ASTM D562, and, when tested as specified in table III, shall meet the requirements of the applicable specification sheet for dust-free time, dry-hard time, fineness of grind, pot life, sag, gloss, sprayability, and condition in container.

3.6.8 Immersion tests. When tested as specified in 4.5.15, qualification paint test panels shall perform at least as well as the reference panels for blistering resistance and the average adhesion, both to the substrate and the original paint in the recoated area, shall be not less than 95 percent of average adhesion values measured for the reference panels in the same areas.

3.6.9 Solvent resistance. When prepared and tested as specified in 4.5.11, paint films shall show no wrinkling, softening, tackiness, swelling, blistering, loss of adhesion, or other sign of solvent attack when examined.

3.6.10 Cathodic protection (formula 159 only). When formula 159 is tested as specified in 4.5.19, the coating shall prevent corrosion in the bare metal area for not less than 48 hours. No corrosion of bare circle or any other surface shall occur.

3.6.11 Batch specific VOC certification. Manufacturers shall prepare label instructions in accordance with 29 CFR 1910. Each container shall 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 two following statements shall appear on each paint can label:

a. Certification that the paint in the container meets the NESHAP requirements for shipbuilding and ship repair.

b. Statement of the ratio of volatile content to solids expressed as grams of volatile organic hazardous pollutants (VOHAPS) per liter of solids.

4. VERIFICATION

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

a. Qualification inspection (see 3.5.1 and 4.2).

b. Conformance inspection (see 3.5 and 4.3).

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4.2 Qualification inspection. Qualification inspection for paint ingredients and for finished paints shall be conducted at a laboratory satisfactory to the Naval Sea Systems Command (NAVSEA). Qualification inspection for paint ingredients shall consist of the appropriate ingredient specification tests and performance testing of paints made using the candidate ingredients. These performance tests shall be run comparing paints made with the candidate raw material to paints made exclusively from reference materials. Qualification inspections for paints made with candidate raw materials, and qualification inspections for a manufacturer's paint, shall consist of all tests specified in 4.5.

4.2.1 Qualification application. The contractor shall apply at least three coatings comprising at least one of the coating systems listed (see 4.5.15.1) for qualification inspection.

4.2.2 Toxicological product formulations. The contractor shall have the toxicological product formulations and associated information, including the material safety data sheet (MSDS), available for review by the contracting activity to evaluate the safety of the material for the proposed use.

4.3 Conformance inspection.

4.3.1 Lot. For purposes of conformance inspection, a lot shall consist of all epoxy-polyamide paint of the same formula number from a single uniform batch or single uniform blend of batches (for each component) offered for delivery at one time. Two representative samples of components A and B from each lot of paint (total of four samples per lot) shall be forwarded to a designated Government laboratory for verification tests. The four samples per lot shall be packaged in separate containers. Minimum size for each sample shall be 1 liter (1 quart).

4.3.2 Conformance tests. Conformance tests for acceptance of individual lots shall be performed at the contractor's site and shall consist of all tests identified by footnote 1/ in table III. As a minimum, the contractor shall select representative samples from the first and last containers from each lot of each component, and subject the samples to all conformance tests. Results shall meet the applicable requirements in section 3 (see 3.5 and 6.7).

4.4 Inspection conditions. Unless otherwise specified herein, all inspections shall be performed in accordance with the test conditions specified in section 4.

4.5 Test methods. The paint shall be tested in accordance with the applicable methods specified in table III and other methods as described herein.

TABLE III. Verification requirements.

Item	Applicable method in FED-STD-141	Applicable ASTM test method	Test	Requirement
Pigment content	----	D2698	----	2/
Volatile percent	----	D2369	4.5.2	2/
Nonvolatile vehicle content	4053.2	----	----	2/
Water	----	D1364	----	2/
Coarse particles	----	D185	----	2/
Consistency1/	----	D562	----	2/
Weight per liter (kilograms/liter (kg/L)) (pounds/gallon (lb/gal))1/	----	D1475	----	2/
Dust-free drying time1/	----	D1640	4.5.3	2/
Dry-hard time	----	D1640	4.5.3	2/
Fineness of grind1/	----	D1210	----	2/
Flash point1/	----	D3278	----	2/
Adhesion	----	D4541	4.5.15.4	2/
Titanium dioxide	----	D1394	----	2/

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TABLE III. Verification requirements – Continued.

Item	Applicable method in FED-STD-141	Applicable ASTM test method	Test	Requirement
Pot life	----	----	4.5.4	2/
Gloss 1/	----	D523	4.5.5	2/
Contrast ratio	----	D2805	----	2/
Sag 1/3/	----	D4400	4.5.6	2/
Epoxy equivalent weight	----	D1652	4.5.17	2/
Color (wetted film) 1/	----	D2244	4.5.7.1	2/
Accelerated storage stability	----	----	4.5.14.1	3.6.7.3
Color (dry film) 1/	----	D1729	4.5.7.2	2/
Brushing properties	4321.3	----	4.5.8	3.6.1
Spraying properties	4331.2	----	4.5.9	3.6.2
Flexibility	----	D522	4.5.10	3.6.3
Stability in partially full container	----	----	4.5.12	3.6.4
Dilution stability	4203.2	----	4.5.13	3.6.5
Odor	----	D1296	4.5.16	3.6.6
Condition in container	3011.3	----	4.5.14	3.6.7
Immersion tests	----	----	4.5.15	3.6.8
Solvent resistance	----	D1308	4.5.11	3.6.9
Volatile organic content	----	D3960	4.5.18	2/
Cathodic protection	----	----	4.5.19	3.6.10

NOTES:

1/ See 4.3.2.

2/ See applicable specification sheet.

3/ In accordance with FED-STD-141.

4.5.1 Preparation of paint for testing.

4.5.1.1 Conditioning of paint. Each component, prior to testing, shall be mixed on a paint shaker. One-liter (1-quart) samples shall be shaken for not less than 5 minutes, and 4-liter (1-gallon) containers shall be shaken for not less than 10 minutes until all ingredients are uniformly distributed.

4.5.1.2 Storage. Components shall be maintained at ambient laboratory conditions (nominal 23 °C (73 °F)) and any other further mixing shall be by spatula or paddle.

4.5.1.3 Mixed paints. Prepare 844 milliliters (13.5 ounces) of paint. Thoroughly mix by hand, stirring with a spatula or paint paddle. Allow the thoroughly mixed paint to condition for 1 hour in a bath maintained at 23±1 °C (73±2 °F) prior to testing.

4.5.1.4 Reference paints. When reference paints are referred to in this document, paints of any type having the equivalent formula number from a vendor qualified to this specification shall be used. Reference paints constituting the equivalent system to that being qualified shall be from the same qualified source. Preparation of panels using the reference paints shall be in accordance with this specification.

4.5.2 Volatile percent. Determine volatiles in accordance with ASTM D2369. Test results shall be in accordance with the requirements of the appropriate specification sheet.

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4.5.3 Dust-free and dry-hard times. Prepare duplicate test panels by drawing down material prepared as specified in 4.5.1 to a 75-micrometer (µm) (3-mil) wet film thickness on a ground glass panel. Cure one panel in a dust-free location at 4.4±1 °C (40±2 °F). Determine the dry-hard time on each panel in accordance with ASTM D1640. Dust-free and dry-hard time shall be in accordance with the requirements of the appropriate specification sheet.

4.5.4 Pot life. Mix 1 liter of paint (1 quart) as specified in 4.5.1.3 from materials conditioned to 23+1 °C (73+2 °F). Remove mixed paint from the water bath at the following intervals from initial mixing and determine consistency: 1 hour before the specified pot life and every half-hour for the remaining hour. Test may be terminated whenever the consistency exceeds 625 grams or at the end of the specified pot life, whichever comes first. Pot life shall be in accordance with the requirements of the appropriate specification sheet.

4.5.5 Gloss. Prepare a test panel by spraying out a 100-µm (4-mil) (nominal) wet film thickness of material prepared as specified in 4.5.1, except allow a maximum of 2 hours conditioning prior to spray out on plain opaque white glass or other suitable substrate using a suitable spray apparatus. Dry the film in a dust-free area for 24 hours at 23 °C (73 °F) (nominal) and determine gloss in accordance with ASTM D523. Gloss shall be in accordance with the requirements of the appropriate specification sheet.

4.5.6 Sag test. Test the paint mixed, as specified in 4.5.1, in accordance with ASTM D4400. Determine the greatest value at which sag does not occur. Sag shall be in accordance with the requirements of the appropriate specification sheet.

4.5.7 Color. Determine color in accordance with one of the following, depending on whether wet film or dry film is specified.

4.5.7.1 Camouflage coatings. Wetted film for camouflage coatings (camouflage coatings are identified as formulas 153, 154, and 155). Prepare the test panel by spraying on smooth steel a 100-µm (4-mil) (nominal) wet film thickness of material prepared as specified in 4.5.1. Dry the panel for 16 hours at ambient laboratory conditions, then 15 minutes at 52 ±3 °C (125±5 °F). The color shall be measured using ASTM D2244. Color shall be in accordance with the requirements of the appropriate specification sheet.

4.5.7.1.1 Reflectometer. The reflectometer shall have a geometry with an illumination angle of 45 degrees from the perpendicular, and a viewing angle of 0 degrees from the perpendicular. The reflectometer shall measure green reflectance in the range of 0.80±0.01 to 4.00±0.01 percent. Any instrument with the required precision and accuracy is suitable for use (see 4.5.7.1.4).

4.5.7.1.2 Wetting solution. Distilled water containing approximately 0.1 percent of a clear wetting agent (detergent) shall be used for wetting the specimens. Solution shall wet the paint film in a sheet without foam.

4.5.7.1.3 Procedure. Cover the specimen to be tested with a thin film of the wetting solution mixture (see 4.5.7.1.2) and immediately obtain a green reflectance reading. Check specimen after obtaining reading for intact water film. If water film is not intact, repeat procedure until a satisfactory reading is obtained on a fully wetted test area.

4.5.7.1.4 Alternative color measuring equipment. Manufacturers can qualify alternative color measuring equipment to NAVSEA or the General Services Administration (GSA) by demonstrating that the particular instrumentation to be used measures the green color parameter with the accuracy specified in 4.5.7.1.1. The manufacturer shall demonstrate that the alternate instrumentation can provide green color parameters that result in the colors defined in the appropriate specification sheet.

4.5.7.2 Color of dry film of non-camouflage paints. Prepare a panel for test by spraying or drawing down upon smooth steel or other suitable substrate a 100-µm (4-mil) (nominal) wet film thickness of material prepared as specified in 4.5.1. Dry for 16 hours at ambient laboratory conditions, then 15 minutes at 52±3 °C (125±5 °F). Compare the test panel with the standard color chip in accordance with ASTM D1729. If doubt exists as to whether the match is satisfactory, determine the color difference by instrument as specified in ASTM D2244. An acceptable color match shall be as specified in the individual specification sheets.

4.5.8 Brushing properties. Prepare the paint as specified in 4.5.1. Without further reduction, apply the paint in accordance with Method 4321.3 of FED-STD-141. Brushing properties shall be as specified in 3.6.1.

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4.5.9 Spraying properties. Prepare the paint as specified in 4.5.1. Without further reduction, spray on a sandblasted steel panel to a 150-µm (6-mil) (nominal) wet film thickness. Observe for spraying properties in accordance with Method 4331.2 of FED-STD-141. Spraying properties shall be as specified in 3.6.2. For referee test, use automatic application of Method 2131.2 of FED-STD-141.

4.5.10 Flexibility. Determine flexibility in accordance with ASTM D522 (Method A) and as follows:

4.5.10.1 Panel preparation. To a flat cold rolled steel strip (22-gage) panel, apply a 50-millimeter (2-inch) (nominal) wide film of mixed paint (see 4.5.1) with a suitable film applicator that will give a dry film thickness of 38±8 µms (1.5±0.3 mils). Air-dry paint in a horizontal position for 24 hours at ambient laboratory conditions.

4.5.10.2 Procedure. Bend the panel 180 degrees over the graduated mandrel, and in the 3-millimeter area examine the coating for cracks over the area of the bend in a strong light at a 2-diameter magnification. Flexibility shall be as specified in 3.6.3.

4.5.11 Solvent resistance. Determine solvent resistance by immersion in xylene, methyl isobutyl ketone (MIBK), and a 1:1 by volume mixture of methyl isobutyl ketone and xylene.

4.5.11.1 Panel preparation. Prepare three tin panels by cleaning with a 50:50 mixture of petroleum naphtha and 2-ethoxy ethanol. Draw down a film of mixed paint (see 4.5.1) to give a dry film thickness of 38±8 µms (1.5±0.3 mils). Air-dry the film at 23±3 °C (73±5 °F) for 24 hours.

4.5.11.2 Procedure. Immerse a panel in each solvent system listed in 4.5.11 at 23±3 °C (73±5 °F) for 18 hours in accordance with ASTM D1308. Examine for wrinkling, softening, tackiness, swelling, blistering, loss of adhesion, or other signs of solvent attack at removal, 2 hours and at 24 hours after removal from the solvent. Solvent resistance shall be as specified in 3.6.9.

4.5.12 Stability in partially full container. Determine stability and consistency of a three-quarter filled, closed 0.25-liter (8-ounce) glass jar of each component after aging for 7 days at 60 °C (140 °F). Results shall be as specified in 3.6.4.

4.5.13 Dilution stability. Prepare thinner by mixing 1 volume of thinner prepared from the solvents specified by the formula being tested in the amounts specified. Reduce 1 part by volume of mixed component from 4.5.1 with 1 part by volume thinner. Then test in accordance with Method 4203.2 of FED-STD-141. Results shall be as specified in 3.6.5.

4.5.14 Condition in container. When tested in accordance with Method 3011.3 of FED-STD-141, the individual components shall be readily broken up with a paddle to a smooth, uniform consistency. When tested as specified in table III, paint, mixed from the components aged for 1 year at ambient laboratory conditions, shall be as specified in 3.6.7.2. When tested in accordance with ASTM D562, the consistency of the paint, mixed from the aged components, shall be as specified in 3.6.7.2.

4.5.14.1 Accelerated storage stability. After exposure of components A and B to a temperature of 60 °C (140 °F) for a period of 14 days, previously unopened containers of components A and B shall be prepared for testing in accordance with 4.5.1 and tested for compliance with the requirements of 3.6.7.3.

4.5.15 Hot distilled water test. Determine resistance to hot distilled water. Six qualification paint and six reference test panels (see 4.5.1.4) are required from each system. Three qualification paint and three reference panels are used as test controls for the 82 °C (180 °F) immersion test and the remaining three panels of each paint system are used as test controls from the 93 °C (200 °F) immersion test. Examine for compliance with 3.6.8.

4.5.15.1 Preparation of panels. Panels shall be mild steel in accordance with QQ-S-698, cold rolled, 90 by 150 by 3.0 millimeters (6 by 10 by 0.125 inches) (nominal) blasted using aluminum abrasive blasting media to a uniform white appearance with a minimum surface profile of 25 µms (1 mil) (nominal), but not greater than 75 µms (3 mils) (nominal) peak to valley when measured in accordance with ASTM D4417. Panels shall be vapor degreased before blasting and care shall be taken to prevent recontamination (especially by fingerprints) before painting. Panels shall be cleaned after blasting using clean, dry compressed air or vacuum.

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a. Type III paints. Prepare six test panels for each of the following systems:

	System A	System B	System C	System D
Coat number 1	F.150[1/]	F.150	F.150	F. 162
Coat number 2	F.151	F.151	F.151	F.161
Coat number 3	F.152	F.156	F.153, 154, 155	F.160
NOTE: [1/] F. indicates formula number.				

b. Type IV paints. Prepare six test panels for each of the following systems:

	System A	System B	System C	System D	System E
Coat number 1	F.150[1/]	F.150	F.150	F.150	F. 162
Coat number 2	F.151	F.152	F.156	F.153, 154, 155	F. 156
NOTE: [1/] F. indicates formula number.					

The total dry film thickness, 200 to 250 µms (8 to 10 mils) (nominal) for Type III and Type IV paints, shall be applied to both sides of panel. Apply paint using standard spray equipment, allowing 16 to 24 hours drying time between coats at ambient laboratory conditions (nominal 23 °C (73 °F)). Condition coated panels for 1 week after application of final coat at ambient laboratory conditions (nominal 23 °C (73 °F)). Measure and report the dry film thickness for each side of each panel.

4.5.15.2 Testing of panels. Immerse three panels in 82 °C (180 °F) distilled water and three panels in 93 °C (200 °F) distilled water. Remove the panels from the 93 °C (200 °F) tank at the end of 2 weeks, wash, dry, and sand one side of each panel to a dull finish with a number 100 emery cloth. Wash, dry, and recoat the sanded side with an additional 50- to 75-µm (2- to 3-mil) (nominal) coat of coat number 3 for Type III paints or coat number 2 of Type IV paints. Cure for 1 week and reimmerse in 93 °C (200 °F) distilled water for 2 weeks. Remove the panels and examine for appearance, blistering, and adhesion. Repeat the preceding for the panels immersed in 82 °C (180 °F) distilled water after 10 weeks immersion. That is, remove, prepare, recoat and the reimmerse for 2 weeks.

4.5.15.3 Blistering. Determine degree of blistering in accordance with ASTM D714. Blisters appearing within 6 millimeters (0.25 inch) (nominal) from the edge of the panel that are less than 1.6 millimeters (0.0625 inch) in diameter shall be disregarded. Qualification test panels shall perform at least as well as the reference panels for blistering both the substrate and to the original paint in the recoated area.

4.5.15.4 Adhesion. Determine adhesion of both sides of each panel using a tensile adhesion tester in accordance with ASTM D4541 to determine any loss of adhesion. Adhesion shall be as specified in 3.6.8.

4.5.16 Odor. Test in accordance with ASTM D1296. Odor shall be as specified in 3.6.6.

4.5.17 Epoxy equivalent. Determine the epoxy equivalent weight of the nonvolatile from Component B. Separate the pigments from Component B in accordance with ASTM D2698. Remove solvents from the resinous portion by evaporating on a steam bath. Determine epoxy equivalent weight of the nonvolatile vehicle in accordance with ASTM D1652. Epoxy equivalent weight shall be as specified in the appropriate specification sheet.

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4.5.18 Volatile organic content (VOC) determination. VOC shall be determined in accordance with EPA Method 24 (40 CFR 60, Ch. 1, Appendix A, Method 24) as follows:

a. The paint test sample shall be drawn from material prepared as specified in 4.5.1.3.

b. Nonvolatile matter content shall be determined in accordance with EPA Method 24 and ASTM D2369. Between steps 7.2 and 7.3 of ASTM D2369, in the EPA Method 24, the aluminum foil dish containing the solvent-paint test sample mixture shall be held in a desiccator for up to 24 hours to cure resin fractions not volatile under use conditions, but volatile at 105 °C (221 °F). After cure, proceed to step 7.3 of ASTM D2369 and complete all testing required by ASTM D3960. (Note: Since neither ASTM D2369 nor EPA Method 24 contain a time interval requirement between steps 7.2 and 7.3, this modification does not violate the test procedure.)

4.5.19 Cathodic protection.

4.5.19.1 Panel preparation. Test panels shall be prepared from cold rolled sheet steel in accordance with QQ-S-698, shall be 150 by 300 by 3 millimeters (6 by 8 by 0.125 inches) (nominal), and blasted using aluminum oxide abrasive blasting media to a uniform white appearance (no more than 0.01 percent remaining rust) with a minimum surface profile of 75 µms (3 mils) (nominal) peak to valley when measured in accordance with ASTM D4417. Panels shall be vapor degreased before blasting, and care shall be taken to prevent recontamination (especially by fingerprints) before painting. Panels shall be cleaned after blasting with clean, dry compressed air or vacuum. After blasting, mask off a 60-millimeter (2.5-inches) (nominal) circle in the center of the panel with a non residue tape or other non residue impervious mask. Apply by spraying 75 to 125 µms (3 to 5 mils) of formula 159 to all exposed metal surfaces. Cure 24 hours at ambient laboratory conditions.

4.5.19.2 Immersion. After removing circle mask, wash bare metal with appropriate solvent to remove all tape residue and allow to dry. Fully immerse panel in a container of substitute ocean water in accordance with ASTM D1141 for 48 hours at ambient laboratory conditions. Cathodic protection results shall be as specified in 3.6.10.

4.5.20 HAP content of coatings. Hazardous solvent content of each individual coating shall be determined in accordance with ASTM E260, or EPA Test Method 311, as applicable. Solvent fractions shall be identified in accordance with ASTM E1252. Accuracy of the analysis shall be 0.25 percent by weight absolute and the reproducibility shall be 0.25 percent by weight over a minimum of three runs. Test results shall be reported as percent by weight of the total paint. The test results for each solvent shall be as specified in 3.4.2.

4.5.21 Hazardous pigments and additives. Soluble and total metal content, except tantalum and tungsten, shall be determined on a dry paint film of the coatings in accordance with 40 CFR 261, Appendix 11, Method 1311 and the appropriate test specified in tables IV and V. Asbestos shall be determined on a dry paint film of each individual coating of the coating system in accordance with OSHA Validated Analytical Method ID-191 reported as percent per weight of the dry paint film. Soluble metal content shall be reported as milligrams per liter. Total metal content shall be reported as percent by weight of the dry paint film. The test results shall be as specified in 3.4.3. Tantalum and tungsten soluble metal content and total metal content shall be analyzed as specified in 4.5.21.1.

TABLE IV. EPA SW-846 - test methods for evaluating solid waste - physical/chemical methods.

Metal/material	Digestion test method
All metals, except chromium (VI)	3050
Chromium (VI)	3060

Metal/material	Analysis test method
Antimony	7040 or 7041
Arsenic	7060 or 7061
Barium	7080 or 7081
Cadmium	7131

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TABLE IV. EPA SW-846 - test methods for evaluating solid waste - physical/chemical methods – Continued.

Metal/material	Analysis test method
Total chromium	7190
Chromium (VI)	7195, 7196, or 7197
Lead	7421
Mercury	7470 or 7471
Nickel	7520 or 7521
Selenium	7740 or 7741
Silver	7760 or 7761

TABLE V. EPA 600/4-020 - methods for chemical analysis of water and waste (USEPA 1979).

Metal/material	Test method
Beryllium	10.1 or 210.2
Cobalt	219.1 or 219.2
Copper	220.1 or 220.2
Fluoride	340.1, 340.2, or 340.3
Molybdenum	246.1 or 246.2
Thallium	279.1 of 279.2
Vanadium	286.1 or 286.2
Zinc	289.1 or 289.2

4.5.21.1 Tantalum and tungsten content. Determine the tantalum and tungsten content of the paint using any appropriate spectroscopy test method. Conduct the tests in accordance with the instrument manufacturer's directions for the use of the instrument. Manufacturer is responsible for establishing data supporting the test method choice and analytical accuracy. The test results for tantalum or tungsten shall be as specified in 3.4.3.

5. PACKAGING

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

6. NOTES

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

6.1 Intended use. Paints covered by this specification are intended for use on sandblasted steel, aluminum, or fiberglass where a hard, durable, chemically resistant, non-porous coating is desired. Formulations suitable for priming, interior, or exterior coats are provided. For painting particular areas aboard ship, such as bilges, tanks, and exterior underwater hull, coating system and instructions are covered in applicable Navy directives or technical manuals. All types are for use in applicable air quality management and air pollution control districts where volatile organic content (VOC) regulations apply.

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6.1.1 The paints covered by this specification are specified in reactor plant paint schedules and are exempt from conversion to performance or non-government documents.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of the specification.

b. Type of material required and applicable specification sheet (see 1.2 and 3.1).

c. If required, the specific issue of individual documents referenced (see 2.2.1 and 2.3).

d. Packaging requirements (see 5.1 and 6.8).

e. Whether an MSDS and ASTM F718 are required (see 6.4).

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Products List QPL No. 24441, whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from Commander, Naval Sea Systems Command, ATTN: SEA 05M2, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160.

6.4 Material Safety Data Sheets and product use data sheets (ASTM F718). Contracting officers will identify those activities requiring copies of completed Material Safety Data Sheets prepared in accordance with FED-STD-313 and product use data sheets (ASTM F718). The pertinent Government mailing addresses for submission of data are listed in FED-STD-313.

6.5 Manufacturing note. Manufacturing procedure determines the thixotropy of the components. Manufacturers should follow instructions issued by the manufacturer of the thixotroping agent to ensure development of proper consistency and sag resistance (see 3.3).

6.6 Material disposal. Disposal of the material components or the reacted compound should conform to applicable Federal, state, and local regulations.

6.7 Lot acceptance and rejection criteria. Acceptance of individual lots is based on compliance of paint with conformance tests specified in 4.3.2. Detection of one or more defective characteristics in any combined sample (Component A plus Component B) is cause for rejection of the lot. The contractor has the option of screening 100 percent of the rejected lot and correcting all defective characteristics, or providing a new lot. In the event of a rejected lot, the corrected lot or new lot being offered to the Government should be tested in accordance with all requirements specified herein.

6.8 Packaging. Recommended packaging requirements are provided in table VI.

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TABLE VI. Packaging.

Packaging	Recommended requirements for direct Government acquisitions
Containers	1. The components should be furnished in cans appropriate to kit requirements capable of holding 0.47 liters (L) (1 pint (pt)), 0.945L (1 quart (qt)), 3.78L (1 gallon (gal)), and 18.9L (5 gals). Kits should consist of two containers. 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 3.78L (1-gal) container. Closure of the properly filled and sealed cans should be as specified in the appendix thereto. 3. 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). 4. Unit of procurement: The paints covered by this specification should be purchased by volume. The unit of procurement should be in multiples of 1 L or 1 U.S. liquid gallon at 15.5 °C (60 °F).
Commercial packaging	1. Commercial packaging should be in accordance with ASTM D3951. 2. 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).
Packing	Packing should be specified as follows: 1. Overseas delivery (level A) packing. Intermediate containers of like size kits of paint should be packed in close-fitting wood boxes in accordance with 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. 2. Domestic delivery (level B) packing. 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. 3. Commercial packing. 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.
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.
Unit kits	The paints covered by this specification should be packed and packaged as kits.
MSDS and product/ procedure data sheets	A copy of the MSDS and company product data/procedure sheets (ASTM F718) should be attached to the shipping document for each destination.
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 be in accordance with PPP-F-320. PPP-F-320 classes should be domestic fire-retardant or weather resistant fire-retardant.

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TABLE VI. Packaging – Continued.

Packaging	Recommended requirements for direct Government acquisitions
Packing for acquisitions involving direct delivery to Navy ships or installations	Treated lumber and plywood. 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: 1. General use, weather resistant: MIL-L-19140, Type 11, Category I. 2. General use, non-weather resistant: MIL-L-19140, Type I, Category I.
Marking type	Recommend marking.
Bar codes	Marking should include bar codes.
Hazardous warnings	1. Labels should be in accordance with 29 CFR 1910, 1915, 1917, 1918, 1926 and 1928, as well as PPP-P-1892. 2. Individual containers should have the following marking: "CAUTION: 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." 3. Each component container, shipping container, and palletized load should be marked with the appropriate hazardous symbol in accordance with 29 CFR 1910, 1915, 1917, 1918, 1926, and 1928 (Hazard Communication Act). 4. Unit containers should be marked: "This product is Asbestos, Lead, Chromium, Cadmium free." Type III containers should also be marked: "This product is free of volatile organic hazardous air pollutants (VOHAPs/HAPs)."
Volatile organic content (VOC)	Either contains 340 g/L or 250 g/L of VOC per 40 CFR 60, Ch. 1, Appendix A, Method 24.
VOC certification sheets	VOC certification sheets will be provided by the manufacturer for each batch of combined Parts A and B when requested by the procuring activity.
Shelf life	Each unit container, intermediate container where applicable, and shipping container should be marked as follows: "Date of first re-inspection (insert date 4 years after date of manufacture)."

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6.9 Subject term (key word) listing.

Asbestos free

Cargo tank coating

Chromate free

Coating

HAP

Hazardous air pollutant free

Lead free

Protective coating

VOC

VOC compliant

6.10 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.

Preparing activity:
Navy – SH
(Project 8010-2009-002)

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.