

INCH-POUND

MIL-PRF-24763B(SH)

27 August 2009

SUPERSEDING

MIL-E-24763A(SH)

w/INT. AMENDMENT 1

9 August 2006

MIL-E-24763A(SH)

25 August 1993

PERFORMANCE SPECIFICATION

ENAMEL, EMULSION TYPE, FOR SHIPBOARD USE

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 the requirements of (95 percent acrylic) water based emulsion (latex), enamels primarily for use on primed metal surfaces. The enamel is volatile organic content (VOC) compliant and may be supplied in a variety of colors for shipboard use.

1.2 Classification. Enamel covered by this specification is of the following types, classes and grades as specified (see 6.2).

1.2.1 Types. The types of enamel are designated by "Type II" or "Type III" as follows:

Type I – Material no longer used.

Type II – Air-drying, acrylic emulsion type with a VOC not greater than 250 grams per liter (g/L) (2.1 pounds per gallon).

Type III – Air-drying acrylic emulsion type with a VOC less than 100 g/L (0.85 pounds per gallon).

1.2.2 Classes. The classes of the enamel are one of the following:

Class 1 – High gloss, 85 percent minimum.

Class 2 – Semi-gloss, 45 to 60 percent.

Class 3 – Low gloss, 7 to 12 percent

1.2.3 Grades. The grades of enamels are designated as follows:

Grade A – Standard pigmented

Grade B – Low solar absorbent (26173, 26270, 26373 and 26008)

Grade C – Low solar absorbent and anti-stain (26008 and 26270)

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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2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this specification, whether or not they are listed.

2.2 Government documents.

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

FEDERAL SPECIFICATION

TT-P-645 - Primer, Paint, Zinc-Molybdate, Alkyd Type

FEDERAL STANDARDS

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

FED-STD-313 - Material Safety Data, Transportation Data and Disposal Data for Hazardous Materials furnished to Government Activities

FED-STD-595/10080 - Brown, Gloss

FED-STD-595/10324 - Brown, Gloss

FED-STD-595/10371 - Brown, Gloss

FED-STD-595/11105 - Red, Gloss

FED-STD-595/11120 - Red, Gloss

FED-STD-595/11136 - Red, Gloss

FED-STD-595/12197 - Orange, Gloss

FED-STD-595/12199 - Orange, Gloss

FED-STD-595/12246 - Orange, Gloss

FED-STD-595/12300 - Orange, Gloss

FED-STD-595/13538 - Yellow, Gloss

FED-STD-595/13591 - Yellow, Gloss

FED-STD-595/13655 - Yellow, Gloss

FED-STD-595/14062 - Green, Gloss

FED-STD-595/14097 - Green, Gloss

FED-STD-595/14120 - Green, Gloss

FED-STD-595/14449 - Green, Gloss

FED-STD-595/15042 - Blue, Gloss

FED-STD-595/15044 - Blue, Gloss

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FED-STD-595/15048	-	Blue, Gloss
FED-STD-595/15092	-	Blue, Gloss
FED-STD-595/15102	-	Blue, Gloss
FED-STD-595/15182	-	Blue, Gloss
FED-STD-595/15200	-	Blue, Gloss
FED-STD-595/16081	-	Gray, Gloss
FED-STD-595/16099	-	Gray, Gloss
FED-STD-595/16187	-	Gray, Gloss
FED-STD-595/16307	-	Gray, Gloss (Bulkhead/equipment)
FED-STD-595/16376	-	Gray, Gloss
FED-STD-595/16492	-	Gray, Gloss
FED-STD-595/17038	-	Miscellaneous, Gloss (Black)
FED-STD-595/17043	-	Miscellaneous, Gloss (Gold)
FED-STD-595/17100	-	Miscellaneous, Gloss (Dark purple)
FED-STD-595/17142	-	Miscellaneous, Gloss (Purple)
FED-STD-595/17155	-	Purple, Gloss
FED-STD-595/17875	-	Miscellaneous, Gloss (Light blue)
FED-STD-595/17886	-	Miscellaneous, Gloss (Soft white)
FED-STD-595/17925	-	Miscellaneous, Gloss (Bright white)
FED-STD-595/20109	-	Brown, Semigloss
FED-STD-595/20117	-	Brown, Semigloss
FED-STD-595/21136	-	Red, Semigloss
FED-STD-595/23655	-	Yellow, Semigloss
FED-STD-595/23814	-	Yellow, Semigloss
FED-STD-595/24097	-	Green, Semigloss
FED-STD-595/25042	-	Blue, Semigloss
FED-STD-595/25048	-	Blue, Semigloss
FED-STD-595/25102	-	Blue, Semigloss
FED-STD-595/26008	-	Gray, Semigloss (Deck)
FED-STD-595/26118	-	Gray, Semigloss
FED-STD-595/26173	-	Gray, Semigloss (Ocean)
FED-STD-595/26231	-	Gray, Semigloss
FED-STD-595/26270	-	Gray, Semigloss (Haze)

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FED-STD-595/26307	-	Gray, Semigloss (Bulkhead/equipment)
FED-STD-595/26373	-	Gray, Semigloss (Light)
FED-STD-595/26492	-	Gray, Semigloss
FED-STD-595/27038	-	Miscellaneous, Semigloss (Black)
FED-STD-595/27875	-	Miscellaneous, Semigloss (Light blue)
FED-STD-595/27886	-	Miscellaneous, Semigloss (Soft white)
FED-STD-595/30109	-	Brown, Flat or Lusterless
FED-STD-595/30117	-	Brown, Flat or Lusterless
FED-STD-595/31136	-	Red, Flat or Lusterless
FED-STD-595/33655	-	Yellow, Flat or Lusterless
FED-STD-595/34097	-	Green, Flat or Lusterless
FED-STD-595/35042	-	Blue, Flat or Lusterless
FED-STD-595/35048	-	Blue, Flat or Lusterless
FED-STD-595/36118	-	Gray, Flat or Lusterless
FED-STD-595/36173	-	Gray, Flat or Lusterless (Ocean)
FED-STD-595/36231	-	Gray, Flat or Lusterless
FED-STD-595/36270	-	Gray, Flat or Lusterless (Haze)
FED-STD-595/36307	-	Gray, Flat or Lusterless (Bulkhead/equipment)
FED-STD-595/36373	-	Gray, Flat or Lusterless (Light)
FED-STD-595/36492	-	Gray, Flat or Lusterless
FED-STD-595/37038	-	Miscellaneous, Flat or Lusterless (Black)
FED-STD-595/37875	-	Miscellaneous, Flat or Lusterless (Light blue)
FED-STD-595/37886	-	Miscellaneous, Flat or Lusterless (Soft white)

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-23236	-	Coating Systems for Ship Structures
MIL-DTL-24441	-	Paint, Epoxy-Polyamide, General Specification For
MIL-DTL-24441/20	-	Paint, Epoxy-Polyamide, Green Primer, Formula 150, Type III
MIL-DTL-24441/29	-	Paint, Epoxy-Polyamide, Green Primer, Formula 150, Type IV
MIL-PRF-24635	-	Coating Systems, Weather-Resistant, Exterior Use

(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.

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CODE OF FEDERAL REGULATIONS

- 29 CFR 1910.1200, - Hazard Communication
1915.99, 1917.28,
1918.9, and 1926.59
- 29 CFR 1990 - Identification, Classification, and Regulation of Carcinogens
- 40 CFR, Part 60, - Determination of Volatile Matter Content, Water Content, Density,
Appendix A, Volume Solids, and Weight Solids of Surface Coatings
Method 24
- 40 CFR Part 261, - Test method for evaluating solid waste physical/chemical methods, SW
Appendix II 846 (NSN-955-001-00000-1)
- 40 CFR 355 - Emergency Planning and Notification
- 40 CFR 372 - Toxic Chemical Release Reporting: Community Right-to-Know

(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.)

STATE OF CALIFORNIA DEPARTMENT OF HEALTH SERVICES

California Administrative Code Title 22, Division 4, Chapter 30. Minimum standards for Management of Hazardous and Extremely Hazardous Waste. Section 66699 Persistent and Bioaccumulative Toxic Substance and Section 66700 Waste Extraction Test, Pg. 679-681 (Register 90, Nos. 38-41; 10-12-90).

(Application for copies should be addressed to the Hazardous Material Laboratory, State of California, Dept. of Health Services, 2151 Berkeley Way, Berkeley, CA 94704)

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 G154 - Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials
- ASTM D185 - Standard Test Methods for Coarse Particles in Pigments, Pastes, and Paints (DoD adopted)
- ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate (DoD Adopted)
- ASTM D522 - Standard Test Method for Mandrel Bend Test of Attached Organic Coatings (DoD adopted)
- ASTM D523 - Standard Test Method for Specular Gloss (DoD adopted)
- ASTM D562 - Standard Test Method for Consistency of Paints Measuring Krebs Unit (KU) Viscosity Using the Stormer-Type Viscometer (DoD adopted)
- ASTM D609 - Standard Methods for Preparation of Steel Panels for Testing Paint, Varnish, Conversion Coatings, and Related Coating Products (DoD adopted)
- ASTM D660 - Standard Test Method for Evaluating Degree of Checking of Exterior Paints (DoD adopted)
- ASTM D661 - Standard Test Method for Evaluating Degree of Cracking of Exterior Paints (DoD adopted)

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ASTM D714	-	Standard Test Method for Evaluating Degree of Blistering of Paints (DoD adopted)
ASTM F718	-	Standard for Shipbuilders and Marine Paints and Coatings Product/Procedure Data Sheet (DoD adopted)
ASTM D823	-	Standard Practices for Producing Films of Uniform Thickness of Paint, Varnish, and Related Products on Test Panels (DoD adopted)
ASTM D1014	-	Standard Practice for Conducting Exterior Exposure Tests of Paints on Steel (DoD adopted)
ASTM D1210	-	Standard Test Method for Fineness of Dispersion of Pigment-Vehicle Systems (DoD adopted)
ASTM E1347	-	Standard Test Method for Color and Color-Difference Measurement by Tristimulus (Filter) Colorimetry
ASTM D1654	-	Standard Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments (DoD adopted)
ASTM D2243	-	Standard Method for Freeze-Thaw Resistance of Waterborne Coatings (DoD adopted)
ASTM D2244	-	Standard Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates (DoD adopted)
ASTM D2805	-	Standard Test Method for Hiding Power of Paints by Reflectometry (DoD adopted)
ASTM D3168	-	Standard Practice for Qualitative Identification of Polymers in Emulsion Paints (DoD adopted)
ASTM D3273	-	Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber (DoD adopted)
ASTM D3274	-	Standard Test Method of Evaluating Degree of Surface Disfigurement of Paint Films by Microbial (Fungal or Algal) Growth or Soil and Dirt Accumulation (DoD adopted)
ASTM D3278	-	Standard Test Methods for Flash Point of Liquids by Setaflash Closed-Cup Apparatus (DoD adopted)
ASTM D3335	-	Standard Test Method for Low Concentrations of Lead, Cadmium, and Cobalt in Paint by Atomic Absorbance Spectroscopy (DoD adopted)
ASTM D3359	-	Standard Test Method for Measuring Adhesion by Tape Test
ASTM D3891	-	Standard Practice for Preparation of Glass Panels for Testing Paint, Varnish, Lacquer, and Related Products
ASTM D4214	-	Standard Test Methods for Evaluating Degree of Chalking of Exterior Paint Films (DoD adopted)
ASTM D4400	-	Standard Test Method for Sag Resistance of Paints Using a Multinotch Applicator (DoD adopted)

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ASTM D4727/D427M - Standard Specification for Corrugated and Solid Fiberboard heet Rock (Container Grade) and Cut Shapes (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. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein (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 Qualification. The enamels furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified products list (QPL) before contract award (see 4.2, 6.2 and 6.3).

3.2 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.

3.3 Material safety data sheet (MSDS). The contracting activity shall be provided a material safety data sheet at the same time of contract award. The MSDS shall be provided in accordance with the requirements of FED-STD-313. The MSDS shall be included with each shipment of the material covered by this specification (see 6.5).

3.4 Directions for use. The contractor shall provide written directions on each container for the surface preparation, mixing, and applying of the enamel supplied and this direction shall include all information necessary to comply with OSHA Hazard Communication Standard and FED-STD-313. In addition, the contractor shall provide an ASTM F718 data sheet which shall separately detail requirements for small unit (metric and English equivalents of pint, quart, and gallon) and large unit (5-gallon) containers.

3.5 Hazardous material. Manufacturers shall prepare container hazardous chemical warning labels for the paint in accordance with the requirements of 29 CFR Parts 1910.1200, 1915.99, 1917.28, 1918.90 and 1926.59 – OSHA Hazard Communication Standard, Final Rule (see 5.1). In choosing the specific ingredients to manufacture the paint, the manufacturer shall certify in writing to the Naval Sea Systems Command (SEA 05M) that the paint offered for delivery does not contain the following materials in excess of 0.05 percent by weight of either the totals formulated paint or in the dry film formed by the paint: Benzene, Toluene, chlorinated solvents, esters or ethers derived from methylene glycol, hydrolyzable chlorine derivatives, coal tar and coal tar derivatives (see 6.3).

3.5.1 Toxins, carcinogens and reproductive stressors. The materials used in the coating, unless specific material maximum levels are cited herein (see 3.3), shall have no known carcinogenic materials identified by OSHA (29 CFR 1990) as regulated carcinogens, or IARC latest monographs, or the latest NTP report, or ACGIH 0026; and shall have no extremely hazardous substances (EHS) or toxic chemicals identified in 40 CFR 355 and 372, respectively. The coating manufacturer is responsible for maintaining carcinogenic free materials. The manufacturer shall not, unless specific material maximum levels are cited herein, allow the addition of any 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 shall not equal or exceed 0.1 percent by weight. The coating shall have no adverse effect on the health of personnel when used for its intended purpose in accordance with the vendor's instructions. Questions pertinent to this toxicity requirement 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.

3.5.2 Crystalline silica content. When evaluated in accordance with 4.5.20 the coating of shall not contain crystalline silica in excess of 0.1 percent by weight of the dry paint.

3.5.3 Hazardous air pollutants (HAPs). The contents of HAPs solvents in the total enamel shall be not greater than the weight percent (%WT) values listed in Table I when tested as specified in 4.5.14.3.

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3.5.4 Asbestos content. The percent by weight of asbestos in the dry coating film shall be less than 0.5 percent by weight of the dry film of coating when tested in accordance with 4.5.14.

3.5.5 Metal content. The metal content (soluble and total) of the coating shall be less than the values listed in Tables II and III when tested in accordance with 4.5.14.1 and 4.5.14.2. If the test for total metal results in a value less than the soluble metal limit, the soluble metal test need not be conducted. The soluble metal and total metal values shall be reported in Table I results.

TABLE I. Hazardous solvent content.

Hazardous solvent in total enamel	Maximum, %WT
Benzene	0.05
Chlorinated solvent(s), total	0.05
Carbon tetrachloride	
Chloroform (trichloromethane)	
Methylene chloride (dichloromethane)	
Tetrachloroethylene (perchloroethylene)	
1, 1, 1-Trichloroethylene (Methylchloroform)	
Trichloroethylene	
Ethyl benzene	0.05
Methyl, ethyl and butyl mono-ethers of ethylene glycol or the acetates, total (methyl, ethyl and butyl cellosolves and acetates)	0.05
Methyl ethyl ketone (MEK)	0.05
Methyl isobutyl ketone (MIBK)	0.05
Toluene	0.05
Xylene (all forms), total	0.1

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3.6 Composition. The contractor is given his choice in the formulation of the enamel provided the end product conforms to all requirements of this document (see 4.6). However, the contractor shall assure composition conforms to the requirements of 3.5 and that soluble metal content and total metal content of the enamel shall be less than the values listed in Tables II and III when tested in accordance with 4.5.14.1 and 4.5.14.2.

TABLE II. Soluble metals content.

Soluble metal and its compound	Maximum, mg/L
Antimony	15
Arsenic	5
Barium (excluding barite)	100
Beryllium	0.75
Cadmium	1
Chromium (VI) compounds	1
Chromium and its chromium (III) compounds	560
Cobalt	50
Copper	25
Fluoride salts	180
Lead	5
Mercury	0.2
Molybdenum	350
Nickel	20
Selenium	1
Silver	5
Tantalum	100
Thallium	7
Tungsten	100
Vanadium	24
Zinc	250

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TABLE III. Total metals content.

Metal and its compounds	Maximum, %WT
Antimony	0.015
Arsenic	0.005
Barium (excluding barite)	0.10
Beryllium	0.0002
Cadmium	0.0005
Chromium (VI) compounds	0.001
Chromium and its chromium (III) compounds	0.56
Cobalt ^{1/}	0.005
Copper	0.01
Fluoride	0.18
Lead	0.005
Mercury	0.0002
Molybdenum	0.35
Nickel	0.02
Selenium	0.002
Silver	0.001
Tantalum	0.10
Thallium	0.007
Tungsten	0.10
Vanadium	0.01
Zinc	0.25
NOTE: ^{1/} Total cobalt content may exceed 0.005 %WT (up to 0.2 %WT) only if a cobalt drier is used to effect proper drying. Regardless of whether a cobalt drier is used, soluble cobalt content may not exceed Table II requirements.	

3.7 Material requirements. The enamel shall consist of pigments, additives and acrylic emulsion resins so combined to produce a ready-for-use material meeting all the requirements of this document. Infrared analysis as specified in Table VI shall show the resin to be 95 percent unmodified acrylic.

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3.8 Quantitative requirements. The enamel shall conform to the quantitative requirements specified in Table IV and as follows when tested as specified in section 4.

TABLE IV. Quantitative requirements of the enamel.

Characteristics	Requirements	
	Minimum	Maximum
Consistency, Krebs-Stormer, shearing rate, equivalent krebs unit	---	100
Fineness of Grind, Hegman	6	---
Flashpoint, degrees Celcius (°C) (Fahrenheit (°F))	38 (100)	---
VOC, g/L (Lb/gal)		
Type II	---	250 (2.1)
Type III	---	100 (0.84)
Drying time:		
Set-to-touch, hours	---	2
Dry through, hours	---	8
Dry-to-recoat	---	16
Gloss (60-degree specular)		
Class 1	85	---
Class 2	45	60
Class 3	7	12
Coarse particles and skins, percent by weight	---	0.2
Flexibility, 1 mil dry film, 0.25-inch mandrel	Pass	---
Reflectance		
26173, 26270, 26373		
800 nanometers	0.60	
1000 nanometers	0.75	
26008		
800 nanometers	0.35	
1000 nanometers	0.50	
Dry film contrast ratio, percent (All colors)	0.94	—
Sag resistance, anti-sag index	7	---

3.8.1 Color. The color shall be characteristic of the pigments used and shall match the following as specified (see Table V and 4.5.5):

- (a) Colors defined by Tristimulus values shall match the following when measured in accordance with 4.5.5.1.

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Tristimulus values

Colors defined by tristimulus values

	<u>L</u>	<u>a</u>	<u>b</u>
Navy Haze Gray No. 27	+56.0	-1.83	-1.37

(b) All other colors shall match the FED-STD-595 number specified in Table V when measured in accordance with 4.5.5.

TABLE V. FED-STD-595 Color numbers and descriptions.^{1, 2/}

Class			Word description
Gloss	Semi-gloss	Low gloss Lusterless	
10080	---	---	Brown (piping and valve marking)
---	20109	30109	Brown (20109 for replacement of DOD-E-18210 formula 23)
---	20117	30117	Brown
10324	---	---	Tan (piping and valve marking)
10371	---	---	Spar (U.S. Coast Guard)/buff (piping and valve marking)
11105	---	---	Red (piping and valve marking)
11120	---	---	Red (OSHA safety color)
11136	21136	31136	Red (insignia red)
12197	---	---	International orange
12199	---	---	Red (U.S. Coast Guard)
12246	---	---	Orange (piping and valve marking)
12300	---	---	Orange (OSHA safety color)
13538	---	---	Yellow (piping and valve marking)
13655	23655	33655	Yellow
13591	---	---	Yellow (OSHA safety color)
---	23814	---	Chartreuse (piping and valve marking)
14062	---	---	Dark green (piping and valve marking)
14097	24097	34097	Dark green (34092 for replacement of DOD-E-18214 formula 19)
14120	---	---	Green (OSHA safety color)
14449	---	---	Light green (piping and valve marking)
15042	25042	35042	Blue (sea blue)
15044	---	---	Dark blue (piping and valve marking)
15048	25048	35048	Blue (insignia blue)
15092	---	---	Blue (OSHA safety color)

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TABLE V. FED-STD-595 Color numbers and descriptions ^{1/, 2/} - Continued.

15102	25102	---	Blue (light blue)
15182	---	---	Blue (U.S. Coast Guard)
15200	---	---	Light blue (piping and valve marking)
---	26008	---	Gray (26008 for replacement of DOD-E-18214 formula 20)
16081	---	---	Dark gray (piping and valve marking)
16099	---	---	Deck gray (U.S. Coast Guard)
---	26118	36118	Gray # 11 (36118 for replacement of DOD-P-15183 formula 109)
---	26173	36173	Gray #17 (Ocean gray)
16187	---	---	Gray (piping and valve marking)
	26270	36270	Gray #27 (Haze gray)
---	26231	36231	Gray # 23 (36231 for replacement of MIL-DTL-700 formula 20L)
16307	26307	36307	Gray # 30 (Bulkhead gray)
---	26373	36373	Gray #37
16376	---	---	Light gray (piping and valve marking)
16492	26492	36492	Gray # 49 (Gull or Pearl Gray)
17038	27038	37038	Black (27038 for replacement of DOD-E-698 formula 24; 37038 for replacement of DOD-P-15146 formula 104) (piping and valve marking)
17043	---	---	Gold (piping and valve marking)
17100	---	---	Dark purple (piping and valve marking)
17142	---	---	Light purple (piping and valve marking)
17155	---	---	Purple (OSHA safety color)
17875	27875	37875	White (Insignia white - 17875 matches color of MIL-DTL-1115 formula 30)
17886	27886	37886	White (bone white) (piping and valve marking)
17925	---	---	Bright white
Notes:			
^{1/} See FED-STD-595 for color cards.			
^{2/} Table V provides FED-STD-595 color numbers and descriptions for commonly specified colors. To order colors not listed, the contracting officer should provide FED-STD-595 color number or other information necessary to identify the product desired.			

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3.8.1.1 **Color deviation.** The color deviation of the paint shall be obtained as specified in 4.5.5. The measured color deviation terms [Delta (Δ)E, ΔA , ΔB , ΔL] from the appropriate Haze Gray No. 27 [see 3.8.1(a)] or specified FED-STD-595 color card in Commission Internationale de l'Eclairage (CIE; International Commission on Illumination) LAB units shall be not greater than the CIELAB units listed below as either positive or negative (+ or -) values:

Colors defined by tristimulus values	Color deviation values			
	<u>ΔE</u>	<u>ΔA</u>	<u>ΔB</u>	<u>ΔL</u>
Navy Haze Gray No. 27	0.5	0.3	0.3	0.3

FED-STD-595 color no.	Color deviation values			
	<u>ΔE</u>	<u>ΔA</u>	<u>ΔB</u>	<u>ΔL</u>
26173, 26373, 36173, 36270, 36373	0.5	0.3	0.3	0.3
All other colors	1.0	0.5	0.5	0.5

3.8.2 **Accelerated weathering.** When prepared as specified in 4.5.11.1 and tested in accordance with 4.5.13, films of the enamels shall meet the following requirements:

- Be not rated less than 9 (1 percent) for checking (ASTM D660).
- Be not rated less than 9 for cracking (ASTM D661).
- Be not rated less than 10 for blistering (ASTM D714).
- Gloss retention shall be not less than 65 percent of that measured prior to weathering (ASTM D523).
- The CIELAB color difference (delta E), delta L, delta a, and delta b units, shall not be greater than 1.0 CIELAB units from the original color values measured before testing (ASTM D2244).
- The degree of chalking shall not be more than 8 when tested in accordance with ASTM D4214.

3.8.3 **Volatile organic content.** The VOC of the enamel shall not be greater than the quantities allowed in Table IV when determined as specified in 4.5.8 (see 6.3).

3.8.4 **Long term exterior exposure.** When tested in accordance with 4.5.15, films of the enamel shall meet the following requirements:

- 60° Gloss must be not less than 50 percent of that measured prior to testing.
- Chalking shall be rated not less than number 8 of ASTM D4214.
- Checking shall be rated not less than 9 (1 percent).
- Cracking shall be rated not less than 9.
- Blistering shall be rated not less than 10.
- When CIE color values of the exposed test panels are compared to the original CIE color values of the test panel, the ASTM D2244 color difference calculated values shall conform to the following values:
 - Delta E shall not be greater than 1.0 CIELAB units.
 - Delta a shall not be greater than positive or negative ± 1.0 CIELAB unit.
 - Delta b shall not be greater than ± 1.0 CIELAB unit.
 - Delta L shall not be greater than ± 1.0 CIELAB unit.

3.8.5 **Solar absorbance.** When tested in accordance with 4.5.14, low solar absorbance shall meet the reflectance requirements of Table IV. This requirement is applicable only to the low solar absorbent gray paint colors (See 1.2.3).

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3.8.6 Anti-stain properties. Anti-stain properties will be evaluated at a Navy Laboratory with comparison to an established anti-stain paint product. Performance shall be equal or better than the performance of the established paint standard. The established product shall be either a NAVSEA approved or a product qualified to this specification. Test shall be in accordance with 4.5.19.

3.8.7 Low solar absorbance/anti-stain. Products conforming to both 3.8.5 and 3.8.6 and meeting all the requirements of this specification shall be designated Grade C.

3.9 Qualitative requirements (all types). The enamel shall meet the following qualitative requirements specified herein.

3.9.1 Condition in container. When tested in accordance with method 3011.3 of FED-STD-141, the enamel shall be ready mixed and shall show no hard pigment settling, phase separation, evidence of biological growth, livering, skinning, putrefaction, corrosion of the container, pigment float, grit or seed particles, or persistent foam. Any settled or floating pigment shall be easily and completely reincorporated by mechanical shaking within 5 minutes to a smooth and uniform condition, free from persistent foam. When tested in accordance with 4.5.5, the CIELAB color difference of the mixed enamel shall meet the requirements of 3.8.1.1. After a standing period of 2 hours without further mixing, the CIELAB color difference of the enamel shall again be tested in accordance with 4.5.5. The CIELAB color difference measured for 2-hour-old mixed enamel shall be not greater than 0.5 CIELAB units different from the color values measured after stirring, but before the 2-hour standing period. After standing for 2 hours, there shall be no settling or pigment float.

3.9.2 Resistance to biological growth. When tested as specified in 4.5.9, the enamel film shall have a surface disfigurement rating greater than or equal to 8 when evaluated against adjunct no. 12-432740-00 as specified in ASTM D3274.

3.9.3 Freeze-thaw stability. When tested as specified in 4.5.10, the enamel shall be free of livering, curdling, hard-dry caking, pigment settlement or pigment float and tough, gummy sediments. The enamel shall mix readily with a paddle or mechanical mixer within 5 minutes to a smooth, uniform state, free of grits, seeds, tough or gummy sediment, skins, pigment settling and persistent foam. The tested enamel shall show no flocculation and its consistency shall change not greater than ± 8 KU compared to the paint in the original, unopened container in the as-received condition. Additionally, the tested enamel shall meet the requirements of gloss retention and color change required by 3.8.2.

3.9.4 Storage stability.

3.9.4.1 Shelf life. When tested as specified in 4.5.1.1 one year after date of manufacture, unopened full container of enamel shall be free of grits, seeds, tough or gummy sediment, skins, pigment settling and persistent foam. The tested enamel shall mix readily to a smooth, uniform state with a paddle or mechanical mixer within 5 minutes and show no flocculation and its consistency shall change no greater than ± 8 KU as compared to the paint when first delivered. Additionally, the tested paint shall meet the requirements of 3.8.2. When tested in accordance with 4.5.5, the CIELAB color difference of the mixed enamel shall not be greater than 1.0 CIELAB units from the original color values measured prior to the shelf life test. The mixed enamel shall also meet the requirements of 3.8.2. The one year paint shelf life is non-extendable.

3.9.4.2 Partially-full container. After exposure as specified in 4.5.1.2, the enamel shall show no skinning, pigment float, livering, curdling, hard dry caking, or tough or gummy sediment. The enamel shall mix readily to a smooth uniform state within 5 minutes when mixed with a paddle or mechanical mixer to a smooth, uniform state, free of grits, seeds, lumps, and skins. When tested in accordance with 4.5.5, the CIELAB color difference of the mixed enamel shall be not greater than 0.5 CIELAB units from the original color values measured before the shelf life test. The mixed enamel shall also meet the requirements of 3.8.2.

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3.9.4.3 Accelerated storage stability. After storage at 60°C (140°F) for 30 days as specified in 4.5.1.3, the unopened, original container of enamel shall be re-dispersible by mechanical shaking within 5 minutes to a uniform condition and shall meet the requirements specified in 3.9.1, 3.9.5, 3.9.6, and 3.9.7. When tested in accordance with 4.5.5, the CIELAB color difference of the mixed enamel shall not be greater than 1.0 CIELAB units from the original color values measured prior to the shelf life test. The mixed enamel shall also meet the requirements of 3.8.2, when the color difference is calculated using as the original color that was obtained for the 1-year storage test sample.

3.9.5 Spraying properties. When tested as specified in 4.5.2, the enamel shall spray satisfactorily and shall show no running, sagging, or streaking. The dried film shall show no blooming, blushing, bubbling, cratering, dusting, floating, fogging, hazing, mottling, orange peel appearance, pinholing, seeding, or streaking in accordance with method 4331.2 of FED-STD-141.

3.9.6 Brushing properties. When tested as specified in 4.5.3, the enamel shall brush easily and have good flowing and spreading qualities and shall dry to a uniform film. The dried film shall show no running, sagging, or streaking. The dried film shall show no runs, blooming, blushing, bubbling, cratering, dusting, floating, fogging, hazing, mottling, orange peel appearance, pinholing, seeding, or streaking in accordance with method 4321.2 of FED-STD-141.

3.9.7 Rolling properties. When tested as specified in 4.5.4, the enamel shall roll easily and have good flowing and spreading qualities and shall dry to a uniform film. The dried film shall show no running, sagging, blooming, blushing, bubbling, cratering, dusting, floating, fogging, hazing, mottling, orange peel appearance, pinholing, seeding or streaking.

3.9.8 Knife test. When tested as specified in 4.5.7, a film of enamel shall adhere tightly to the primer. It shall be difficult to furrow off with the knife and shall not flake, chip or powder. The enamel shall not show brittle or rubbery characteristics; the knife cut shall show beveled edges.

3.9.9 Primer compatibility.

3.9.9.1 Dry adhesion. When tested as specified in 4.5.11.1, films consisting of primer and enamel shall show no blistering, wrinkling, or any other evidence of separation. The adhesion by tape test shall be rated no less than 4A. The enamel shall adhere tightly to the primer. Using a scalpel, the enamel shall not lift from the primer without leaving some enamel attached to the primer.

3.9.9.2 Wet adhesion. When tested as specified in 4.5.11.2, films consisting of primer and enamel shall show no blistering, wrinkling, or any other evidence of separation. The adhesion by tape test shall be rated no less than 4A. The enamel shall adhere tightly to the primer. Using a scalpel, the enamel shall not lift from the primer without leaving some enamel attached to the primer.

3.9.10 Enamel recoatability. When tested as specified in 4.5.12, films consisting of enamel shall show no blistering, wrinkling, or any other evidence of intercoat separation. Films shall be difficult to separate from one another. Using a scalpel, the enamel shall not lift from the primer without leaving coating on the overcoated film.

3.9.11 Directions for use. The manufacturer must provide written directions for the mixing and applying of the enamel supplied and this direction shall include all information necessary to comply with OSHA Hazard Communication Standard and FED-STD-313. In addition, the manufacturer must prepare an ASTM F718 data sheet with separately details requirements for small unit (pint, quart, and gallon) and large unit (5 gallon) containers.

3.9.12 Compatibility test. When tested in accordance with 4.5.16, the dried enamel film shall not show any visual difference in color and gloss, and no streaks, craters, or pigment flowing.

3.10 Batch specific VOC certification. Manufacturer shall prepare container label instructions for the enamel in accordance with the requirements of 29 CFR 1910, 1915, 1917, 1918, 1926 and 1928 - Hazard Communication (see 6.7). To comply with the Environmental Protection Agency (EPA) National Emission Standards for Hazardous Air Pollution (NESHA) requirements for shipbuilding and ship repair, the following two statements must appear on each paint can label:

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- 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 (VOHAP) per liter of solids.

4. VERIFICATION

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

- a. Qualification inspection (see 4.2).
- b. Conformance inspection (see 4.3).

4.2 First article/Qualification inspection. Qualification inspection (see 6.3) shall be conducted at a commercial or manufacturer's laboratory approved by Naval Sea Systems Command (NAVSEA). Tests shall be monitored by the Defense Contract Management Area Operations (DCMAO). Qualification tests shall consist of all tests and requirements specified in Table VI. If no test paragraph is listed in Table VI, the test shall be conducted in accordance with the method listed and results shall comply with the requirement paragraph listed. A test report detailing the results of the qualification testing performed by the manufacturer, his representatives or at his behest by employed agents shall be provided by the manufacturer to the contracting officer, his agent or the qualifying activity, as appropriate (see 6.3).

4.2.1 Extension of qualification. Approval of qualification for Navy haze gray to match color 26270 of FED-STD-595 shall constitute approval for other colors of the same type and class. Approval of qualification for Type III class enamel shall also constitute approval of qualification of that enamel for Type II of the same class. Enamel substituted for the qualification for a Type III, but passes the VOC requirement for Type II shall be qualified for the same Type II class provided that enamel passes all other requirements for that type and class.

4.3 Conformance inspection. Conformance inspection shall consist of the Table VI tests marked with a 1/ (see table footnote). Test shall be performed on each lot offered for delivery (see 6.3).

4.3.1 Lot. For the purpose of quality conformance inspection and test sampling, a lot is defined as all enamel (in U.S. gallons) of the same type, class and color, from a single uniform batch, produced and offered for delivery at one time. The addition of any substance to a batch constitutes a new lot.

4.3.1.1 Batch. A batch shall consist of an individual finished paint manufactured at the same time from the same units (sacks, cans, barrels, etc) of ingredients.

4.3.2 Sampling for quality conformance inspection. As a minimum, the contractor shall select at random two samples of sufficient size for testing. One sample shall be taken from the first 10 percent of production from the lot. The other sample shall be taken from the last 10 percent of production from the lot. The samples shall be inspected and tested in accordance with Table VI.

4.3.3 Lot rejection. Failure of any sample to pass any inspection or test specified in Table VI of this specification shall be cause for rejection of the entire lot represented by the sample. Rejection of a lot shall require that corrective action be implemented by the contractor.

4.4 Test Conditions. The routine and referee testing conditions shall be in accordance with FED-STD-141. The term referee condition shall mean a temperature of 23 ± 1 °C (73 ± 2 °F) and a relative humidity of 50 ± 4 percent. A dry film thickness of 0.0381 to 0.051 millimeters (0.0015 to 0.002 inches (1.5-2.0 mils)) shall be used whenever film thickness is required in any test unless otherwise specified by the test.

4.4.1 Test panels and surface preparation.

4.4.1.1 Test Panels. Test panels shall consist of two types. The two types are:

- a. Aluminum: Nominal 150-millimeter by 300-millimeter by 6-millimeter (6-inch by 12-inch by 0.25-inch) plate aluminum in accordance with ASTM B209. Aluminum 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 millimeters (0.002 to 0.003 inch) (nominal) on both sides.

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b. **Glass:** Nominal 150-millimeter by 300-millimeter by 6-millimeter (6-inch by 12-inch by 0.25-inch) glass, ground or abrasive blasted with aluminum oxide and solvent cleaned to provide a uniform, clean rough surface on one side.

4.4.1.2 **Test Primers.** Primers shall be applied to the prepared sides(s) of the test panel. Cure for 24 hours at room temperature and then 1 hour at 40 to 50 °C (104 to 122 °F) unless otherwise specified herein. The following primers shall be used:

- a. MIL-DTL-24441/ 20 or MIL-DTL-24441/29.
- b. A Type VI or Type VII epoxy qualified to MIL-PRF-23236.
- c. TT-P-645.

4.5 **Test procedures (all types).** Test procedures shall be listed in Table VI and as otherwise specified herein.

4.5.1 **Storage Stability.**

4.5.1.1 **Shelf Life.** When allowed to remain undisturbed for 1 year under ambient conditions (see 4.4), the enamel shall conform to the requirements in 3.9.4.1.

4.5.1.2 **Partially full container.** Skinning shall be determined after 48 hours in accordance with method 3021.1 of FED-STD-141, except that a $\frac{3}{4}$ -filled, $\frac{1}{2}$ -pint, resin-lines, multiple friction top can shall be used. The can shall be resealed and aged for 30 days at 60 °C (140 °F) and examined for compliance with 3.9.4.2.

TABLE VI. Test procedures.

Characteristic	Requirements	Applicable test method FED-STD-141	ASTM test method	Test
Material requirements	3.7	----	D3168	----
Condition in container	3.9.1	3011.3	----	----
Storage Stability	3.9.4	3022.2	----	4.5.1
Spraying properties	3.9.5	4331.2	----	4.5.2
Brushing properties	3.9.6	4321.3	----	4.5.3
Rolling properties	3.9.7	4335	----	4.5.4
Color/color deviation ^{1/}	3.8.1	----	E1347, D2244	4.5.5
Flexibility	Table IV		D522	4.5.6
Knife Test	3.9.8	6304.2	----	4.5.7
Consistency ^{1/}	Table IV	----	D562	4.5.1.4
Sag resistance ^{1/}	Table IV	----	D4400, Method A	----
Fineness of grind ^{1/}	Table IV	----	D1210	----
Flash point ^{1/}	Table IV	----	D3278	----
VOC ^{4/}	Table IV, 3.8.3	----	----	4.5.8
Drying time ^{1/}	Table IV	4061.3	----	----
Gloss 60-degree specular ^{1/, 2/}	Table IV	----	D523	4.5.17

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TABLE VI. Test procedures - Continued.

Coarse particles	Table IV	----	D185	----
Lead content	Table IV	----	D3335	----
Resistance to biological growth	3.9.2	----	D3274, D3273	4.5.9
Freeze-thaw stability	3.9.3	----	D2243	4.5.10
Primer compatibility	3.9.9		D3359, Method A	4.5.11
Enamel recoatability	3.9.10	----	----	4.5.12
Accelerated weathering	3.8.2	----	----	4.5.13
Contrast ratio ^{1/3/}	Table IV	----	D2805	4.5.5.3
Soluble and total metal content ^{4/}	3.6	----	----	4.5.14
Long term exterior exposure	3.8.4	----	----	4.5.15
Compatibility	3.9.12	----	----	4.5.16
Reflectance (LSA) ^{1/3/}	3.8.5	----	----	4.5.18
Anti stain properties ^{3/}	3.8.6	---	----	4.5.19
Notes:				
^{1/} Required for quality conformance inspection test.				
^{2/} Make a 3 mil wet film thickness drawdown on glass or a standard black and white Leneta chart, dry for 24 hours at ambient laboratory conditions before performing test.				
^{3/} Spreading rate shall be such as to yield a dry film thickness of 3 to 4 mils.				
^{4/} By data certification.				

4.5.1.3 Accelerated storage stability. After exposure to a temperature of 49 °C (120 °F) continually for 7 days, a new unopened full 1-quart can of enamel shall be examined for compliance with 3.9.4.3.

4.5.1.4 Consistency. The consistency of the coating shall be determined in accordance with the procedure in Table VI and reported in Krebs units.

4.5.2 Spraying properties. The enamel shall be sprayed in an “as-received” condition on a ground glass panel (see 4.4.1.1) to a wet film thickness of 0.002 to 0.004 inch (46 to 92 μm). The spray gun distance shall be 6 to 12 inches for conventional spraying and 12 to 15 inches for airless. The panel shall be observed for spraying properties in accordance with method 4331.2 of FED-STD-141 for compliance with 3.9.5.

4.5.3 Brushing properties. The brushing properties of the enamel shall be determined in accordance with method 4321.3 of FED-STD-141 for compliance with 3.9.6.

4.5.4 Rolling properties. The rolling properties of the enamel shall be determined in an “as-received” condition shall be determined in accordance with method 4335 of FED-STD-141 for compliance with 3.9.7.

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4.5.5 Color testing.

4.5.5.1 Instrumental color deviation determination. Test specimens shall be prepared in accordance with ASTM D823 Methods C or E using a nominal 0.006-inch blade film applicator on to a clear plate glass of not less than ¼-inch (nominal) thickness that has been ground to a uniform finish with 1F carborundum. A standard black and white Leneta chart is also acceptable. The color deviation shall be determined in accordance with ASTM D2244 using an instrument having a D_{65} light source (10 degree observer), a 45-degree illumination angle, and a 0-degree viewing angle. The instrument shall be demonstrated to read the color of National Institute for Science and Technology (NIST [formerly National Bureau of Standards; SBS]) traceable standards with the color deviations allowed in 3.8.1.1. After calibration of the instrument, measure the CIE color values of at least two FED-STD-595 color cards of the color being procured which were received from the Government not greater than 1 year prior to the date of this use. Making not less than three readings per card taken at one inch intervals on the long axis, one inch from the edge. Calculate delta E for each color card. Determine the mean values of delta E and the CIE color values for the color cards. If any individual CIE color value differs from the mean color value by more than 0.05, use a different color card and recalculate the mean values. These mean values will be used to calculate the color difference values. Measure the CIE color values of the test enamel using the values of three readings taken at one inch intervals on the long axis, one inch from the edge. Calculate the mean CIE color values of the test enamel. Calculate the color difference terms. If using an instrument that automatically calculates the color differences, enter the color card mean values as the base line for the color difference calculations. The results of the color difference calculations shall be in accordance with the requirements of 3.8.1 or Table V, as applicable.

4.5.5.2 Referee color matching. If the enamel measured in accordance with 4.5.5.1 does not match the color card when visually examined, the discrepancy shall be resolved by an independent laboratory certified to the NIST National Volunteer Laboratory Accreditation Program for paint testing. When tested in accordance with ASTM D823, the test enamel, prepared as in 4.5.5.1, shall visually match the FED-STD-595 color card that most closely corresponds to the mean values calculated in 4.5.5.1.

4.5.5.3 Contrast ratio. The contrast ratio of the fully cured coating shall be determined in accordance with the procedure in Table VI.

4.5.6 Flexibility. The flexibility of the enamel shall be determined in accordance with method ASTM D522. A 2-inch wide film of enamel shall be applied using a film applicator that will give a dry film thickness (DFT) of 0.0009 to 0.0011 inch (23 to 28 μm) on a smooth finished tinsplate steel panel prepared in accordance with method 2011.2 of FED-STD-141 using a mixture of 50:50 aliphatic naphtha and propylene glycol monoethyl ether. The panel shall be prepared from new, cold-rolled, rust-free, carbon steel 0.010 \pm 0.001 inch (25.4 \pm 2.5 μm) thick with a Rockwell 15-T maximum hardness of 82 and finished with a surface roughness of 8 to 12 μm . After application, the panel shall be air dried in a horizontal position for 24 hours at 23 \pm 1.1 $^{\circ}\text{C}$ (73.4 \pm 2 $^{\circ}\text{F}$). The panel shall be conditioned for ½ hour under standard test conditions (see 4.4). The panel shall be bent over a ¼-inch (6.35-millimeter) mandrel. The panel shall be examined for cracks over the area of the bend in a strong light for compliance with Table IV.

4.5.7 Knife test. The knife test shall be conducted in accordance with method 6304.2 of FED-STD-141, using a flat portion of the panel from the flexibility test (see 4.5.6). The test results shall conform to 3.9.8.

4.5.8 Volatile organic content. The VOC in the enamel shall conform to the requirements of Table IV when determined in accordance with EPA 40 CFR CH.1, part 60, Appendix A, method 24.

4.5.9 Resistance to biological growth. The biological growth on the surface of the enamel shall be determined in accordance with ASTM D3274. The extent of surface disfigurement shall be evaluated in accordance with ASTM D3274. Fungal mycelium and spores, slime, and dirt or soil accumulation shall be considered disfiguring agents in the evaluation. The rating shall be as specified in 3.9.2.

4.5.10 Freeze-thaw stability. Enamel shall be tested in accordance with ASTM D2243, except after completion of the exposure and room temperature equilibration, the exposure shall be repeated twice before proceeding to the examination (three exposure cycles to 0 $^{\circ}\text{F}$ and three equilibrations). Consistency shall be determined in accordance with ASTM D562; contrast ratio, gloss, and reflectance shall be determined as specified in Table IV; and characteristics shall comply with the requirements of Table IV (see 3.8.2 and 3.9.3).

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4.5.11 Primer compatibility.

4.5.11.1 Dry adhesion. The 14 test panels shall be aluminum as specified in 4.4.1.1. Six panels shall be primed with two coats of an epoxy-polyamide material in accordance with MIL-DTL-24441 Type III or Type IV. Four panels shall be primed in accordance with TT-P-645. Four panels shall be prepared with a qualified MIL-PRF-23236, Type VI or Type VII epoxy paint in accordance with manufacturer's instructions. Two panels, each prepared with MIL-DTL-24441, shall dry for 6, 24, 168 hours, respectively, at standard test conditions (see 4.4) before the application of two spray coats of enamel conforming to this specification. Film thickness shall be 2 to 4 mils per coat for the MIL-DTL-24441 epoxy and 1.5 to 2 mils of enamel conforming to this specification. The epoxy coated panels dried for 168 hours prior to application of the enamel, shall receive a tack coat of the MIL-DTL-24441, Formula 150 (a wet film application of 1 to 2 mils). Two panels, each to which primer in accordance with TT-P-645 is applied at 2 to 4 mils, shall be dried for 24 and 168 hours, respectively, at standard test conditions (see 4.4) and overcoated with enamel conforming to this specification in like manner as the panels treated with the epoxy-polyamide material. Panels of the MIL-PRF-23236 epoxy shall be dried and overcoated in the same manner as the TT-P645 test panels. All panels overcoated with enamel conforming to this specification shall be dried for 168 hours under standard test conditions (see 4.4). Panels shall be tested as specified in 4.5.13. The tape test shall be performed in accordance with ASTM D3359, method A, except that the tape used shall be commercially available masking tape. Following the tape test, lifting characteristics shall be determined between the enamel and the primer at the scribe and at a distance up to 1 inch perpendicular to the scribe using the aid of a microscope. The test results shall conform to the requirements of 3.9.9.1.

4.5.11.2 Wet adhesion. Application of primers and enamel shall be made to six panels (three aluminum and three glass) as specified in 4.4.1.2 and the systems shall be dried as previously indicated in 4.5.11.1. At the conclusion of the drying cycle, the panels shall be scribed using a tool in accordance with ASTM D1654 and immersed in distilled water at standard test conditions (see 4.4) for 24 hours. While immersed, the panels shall be examined for evidence of blistering, wrinkling, or other evidence of adhesion failure of the test enamel to the primers. Test for wet adhesion shall be in accordance with method 6301.3 of FED-STD-141, except the tape used shall be commercially available masking tape. Following the tape test, lifting characteristics shall be determined between the enamel and the primer at the scribe and at a distance up to 1 inch perpendicular to the scribe using the aid of a microscope. The test results shall conform to the requirements of 3.9.9.2.

4.5.12 Enamel recoatability. Four test panels of aluminum having nominal dimensions of 150 millimeters by 300 millimeters by 3 millimeters (6 inches by 12 inches by $\frac{1}{8}$ inch) shall be prepared. Test panels shall be degreased in accordance with methods B, C or D of ASTM D609. The degreased test panels shall be abrasive blasted with new, clean aluminum oxide to provide a profile pattern of 0.0253 to 0.0506 millimeter (0.001 to 0.002 inch) (average). All test panels shall be painted with 2 coats of MIL-DTL-24441 Type III or IV Formula 150. Each coat of MIL-DTL-24441 shall be applied to 0.051 to 0.101 millimeter (0.002 to 0.004 inch) dry film thickness and allowed to cure 24 hours at ambient laboratory conditions before being overcoated. Two coats of the test enamel shall be spray applied on the MIL-DTL-24441 Formula 150 coated panels to obtain a final dry film thickness of the test topcoat of 101 to 151 millimeters (0.004 to 0.006 inch). Allow not less than 24 hours dry time between applications of the coats of test topcoats at ambient laboratory conditions. The completed painted test panels shall be cured for not less than 7 days at ambient laboratory conditions before proceeding to the mounting on the test rack. Spraying properties shall be in accordance with 3.9.5, as appropriate. Test specimens shall be mounted on a test fence having a 45-degree south facing rack at a distance of not greater than 30 meters (100 feet) of an ocean high tide line. The exposure shall be for a period not less than 1 year (365 days) in accordance with paragraph 6 of ASTM D1014. The fence shall be at the Naval Research Laboratory, Marine Corrosion Laboratory, Key West, Florida, USA. After the exposure period of 1 year (365 days), the panels shall be returned to the laboratory. The panels shall be rinsed with cold tap water at nominal tap pressure for a period of 5 to 10 minutes without rubbing the surface in a manner that would disturb any chalking. The test panels shall then be dried for 24 hours at ambient laboratory conditions. The following overcoats shall be brush applied to $\frac{1}{2}$ of each of two panels and the overcoated panels shall be cured for 48 hours at ambient laboratory conditions:

- a. One coat of enamel, conforming to this specification, at a nominal wet film thickness of 3 to 4 mils (0.003 to 0.004 inch).
- b. One coat of MIL-PRF-24635 Haze Gray no. 27 (FED-STD-595 Color no. 26270) at a nominal wet film thickness of 3 to 4 mils (0.003 to 0.004 inch).

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The adhesion between test coats shall be determined in accordance with 4.5.11.1. The adhesion and appearance shall conform to the requirements of 3.9.10.

4.5.13 Accelerated weathering. The test panels shall consist of six panels prepared in accordance with 4.4.1.1. The priming, drying and coating with enamel conforming to this specification shall be in accordance with 4.5.11.1. Measure the initial color of the test panel in accordance with ASTM E1347 on any suitable instrument. The panels shall then be exposed in an apparatus in conformance with ASTM G154 for a total of 300 hours. The cycle shall be 4 hours ultra-violet exposure using UVA-313 bulbs at 60 °C (140 °F). Remeasure color and gloss of the tested panels. Calculate the change in gloss. Calculate color difference in accordance with ASTM D2244. Results shall comply with the requirements of 3.8.2.

4.5.14 Hazardous material determination. Soluble and total metal content shall be determined on a dried, powdered enamel in accordance with the requirements of 4.5.14.1 and 4.5.14.2. The hazardous solvent shall be determined in accordance with the requirements of 4.5.14.3. Asbestos content shall be determined on a dry film of the coating in accordance with 29 CFR 1915.1001, Appendix K and the results recorded as a percent by weight of the dry coating film as required in 3.5.4.

4.5.14.1 Toxicity characteristic leaching procedure. Soluble and total metal content shall be determined on a dried powdered enamel in accordance with the 40 Code of Federal Regulation (CFR), CH 1, Part 261, Appendix II, Method 1311, toxicity characteristic leaching procedure (TCLP), and the soluble metal content shall not exceed the values which would cause the material to be classified as hazardous waste.

4.5.14.2 Waste extraction test. Soluble and total metal content shall be determined on a dried powdered enamel in accordance with California Administrative Code, Title 22, the waste extraction test, the soluble metal content, and the total metal content shall not exceed the values which would cause the material to be classified as hazardous waste (see Tables I and II).

4.5.14.3 Hazardous air pollutants. Hazardous solvent content shall be determined on the extracted liquid of the enamel in accordance with the 40 Code of Federal Regulation (CFR), CH 1, Part 261, Appendix II, Method 1311, toxicity characteristic leaching procedure (TCLP). The test results for each solvent shall be in accordance with the requirement in 3.5.3.

4.5.15 Long term exterior exposure. . Test panels shall be of aluminum having nominal dimensions of 150 millimeters by 300 millimeters by 3 millimeters (6 inches by 12 inches by $\frac{1}{8}$ inch). Test requires 4 primed test panels. Test panels shall be degreased in accordance with methods B, C or D of ASTM D609. The degreased test panels shall be abrasive blasted with new, clean aluminum oxide to provide a profile pattern of 0.025 to 0.076 millimeters (0.001 to 0.003 inch) (average). All test panels shall be primed with 2 spray applied coats of MIL-DTL-24441, Type III or IV, Formula 150 green primer. Each coat of MIL-DTL-24441, Type III or IV, formula 150 shall be applied to 0.051- to 0.076-millimeter (0.002- to 0.003-inch) dry film thickness. Two coats of the test enamel shall be spray applied on the MIL-DTL-24441, Type III or IV, Formula 150 coated panels to obtain a final dry film thickness of the test topcoat of 0.101 to 0.152 millimeter (0.004 to 0.006 inch). The test panels shall be cured for at least 24 hours dry time between applications of the coats of test topcoats at ambient laboratory conditions. Spraying properties shall be in accordance with 3.9.5 as appropriate. The completed painted test panels shall be cured for at least 7 days prior to mounting on the test rack. Test specimens shall be mounted on a test fence having a 45-degree south facing rack at a distance of not greater than 100 feet of an ocean high tide line. The exposure shall be in accordance with paragraph 6 of ASTM D1014. The fence shall be at the Naval Research Laboratory, Marine Corrosion Laboratory, Key West, Florida, USA. Prior to initiating the test, photograph all of the test panels (include a gray color scale in all photos and develop photographs to the scale). After a test period of 1 year (365 days), the test panels shall be examined for chalking in accordance with ASTM D4214, Fig. 2, after the test panels are rinsed with cold tap water at nominal tap pressure for a period of 5 to 10 minutes without rubbing the surface in a manner that would disturb any chalking. Then wash the panels with a warm soap solution using a soft sponge to remove any chalking or dirt. The test panels shall then be dried for 24 hours at ambient laboratory conditions and examined for film deterioration and color as follows:

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<u>Property</u>		<u>ASTM Test Method</u>
Color	-	E1347
Gloss – 60°	-	D523
Checking	-	D660
Cracking	-	D661
Blistering	-	D714
Color difference	-	D2244

The test results shall conform to the requirements of 3.8.4.

4.5.16 Compatibility test. The thoroughly mixed enamel shall be allowed to stand undisturbed for 5 minutes. On one clear plate-glass panel, prepared in accordance with ASTM D3891, brush a coat of the mixture to approximately 25 µm (0.001 inch) dry film thickness and allow to dry at room temperature in a vertical position for 24 hours. While brushing, observe for streaks and pigment separation. On another panel prepared in the same way, draw down a 51 µm (0.002 inch) wet film thickness on a glass panel. Allow to stand for 5 minutes in a horizontal position. While the paint is still wet, rub-up an area using the index finger in a circular motion for a minimum of 20 revolutions. Exert light pressure of the finger while rubbing so as not to rub off the film. Allow enamel to dry for 24 hours and compare the rubbed-up area against the un-rubbed area. Any visual difference in color or gloss, streaks, craters, or pigment floating of the dried film shall be cause for rejection due to incompatibility. The results of the compatibility tests shall be evaluated for conformance in accordance with the requirements of 3.9.12.

4.5.17 60-degree specular gloss. The thoroughly mixed enamel shall be drawn down on an opaque white glass panels as specified in ASTM D3891. A standard black and white Leneta chart is also acceptable. Use a film applicator that will produce a nominal wet film thickness of 0.075 millimeter (0.003 inch). Dry for a minimum of 24 hours under referee conditions in a dust free environment. Paint specimen shall be dry and hard before gloss test. Use longer cure time if required. When tested as specified in Table VI, gloss shall conform to requirements of Table IV as applicable, for class specified.

4.5.18 Visible and infrared reflectance measurement. A reflectometer capable of measuring reflectance at specific wavelengths shall be used. Measurements shall be made at the wavelengths specified in Table IV. Infrared wavelengths are defined as 800 nm and 1000 nm. Test results shall be in accordance with the requirements of Table IV. A Diano Hardy Match Scan II equipped with a Milton Roy Diano Match Pak II has been found satisfactory for measurements at 800 nm and 1000 nm. Other instruments of equivalent capability may be used. Paint sample shall be applied using a film applicator that will produce a wet film of 0.151 millimeter (0.006 inch) on a standard black and white Leneta chart.

4.5.19 Anti-stain. Four steel test panels shall be prepared similar to the aluminum panels in accordance with 4.4.1.1 with the exception that the panels shall be 4 inches by 6 inches by 0.125 inch cold-rolled steel. The coatings system to be qualified shall be applied to one side of three of the four test panels in accordance with the manufacturer's F718. The fourth panel shall be coated on one side with one of the Grade C products currently listed on the Qualified Products List for this specification (the "control"). All four panels shall be coated on the reverse side and around all edges with one coat of MIL-DTL-24441 Formula 150 green primer to achieve four mils DFT. All panels shall be cured for 7 days at referee conditions.

Three evenly spaced 0.125 (1/8) inch holes shall be drilled through the coating to the steel substrate, but not through the steel plate. These holes shall be located 0.75 inch from one of the 4-inch edges ("the top") of the specimen. One hole shall be centered between the panel edges and the other two holes located one inch to either side of the center hole.

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All four panels shall be exposed in accordance with GM 9540P, Method B, for 100 days. After the 100 day exposure period the panels shall be removed and the vertical length of running rust streaks shall be measured on both the control panel and the three coating panels being qualified to this specification. Evaluate for conformance to 3.8.6.

4.5.20 Toxicological assessment of product. To determine conformance to requirements of 3.5.1 and 3.5.2, the manufacturer of the paint shall disclose the formulation of his product to the Commanding Officer, Navy and Marine Corps Public Health Center, ATTN: Hazardous Materials Department, Industrial Hygiene Directorate, 620 John Paul Jones Circle, Suite 1100, Portsmouth, VA 20378-2103. The disclosure of proprietary information, which shall be held in confidence shall include: the name, formula, CAS number, and approximate percentage by weight and volume of each ingredient in the product (totaling 100 percent); the results of any toxicological testing of the product; identification of its pyrolysis products; and any other information as may be needed to permit an accurate appraisal of any toxicity problem or issues associated with handling, storage, application, use, removal, disposal, or combustion of the material. Where possible, Chemical Abstract Service (CAS) numbers should be provided for all the ingredients in the formulation. A current MSDS and Hazardous Chemical Warning Label, conforming to the provisions of the OSHA Hazard Communication Standard, shall be provided for each product. In addition, the manufacturer shall provide a current MSDS for each ingredient used in the formulation. Within 30 days prior to data submission, the manufacturer shall contact the supplier of each ingredient and confirm each MSDS submission is current. A statement documenting this contact shall be affixed to each ingredient MSDS, and indicate: (1) the date of the contact and (2) the name of the company representative, with telephone number, who confirmed the MSDS was current. The OSHA Form 20 is obsolete, therefore all MSDS information must be submitted on an OSHA Form 174, or an equivalent form containing the identical data elements. Where available, copies of industrial hygiene reports, which address potential health hazards related to working with the material, are also submitted as part of the documentation package. Information pertaining to any adverse health effects experienced by company workers during research/development and manufacture of the product, and industrial experience with the product by major commercial users, is also requested. All data provided must be clearly identified to show it is being provided in connection with qualification under MIL-PRF-24763B.

4.6 Inspection of packaging. Sample Packages and packs, and the inspection of the preservation, packing, and marking for shipment and storage shall be in accordance with the requirements of section 5 and the documents specified therein.

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. This specification covers a high grade, acrylic, water bound, emulsion type (latex) enamel. Type I material is no longer used. Type II is intended for use where the VOC content is less than 250 grams per liter and Type III is intended for use where VOC is less than 100 grams per liter (see 1.2). Paints to this specification are intended for use over primed metal, particularly on smooth, exterior metal, such as ship exterior topside metalwork and equipments. It is intended to be highly weather resistant, and characterized by excellent color and gloss retention, good drying, freedom from after tack, and good flexibility. The enamel may be applied with brush, roller or spray. This enamel is not intended for painting ship interior bulkheads or overheads; it is not fire-retardant.

6.1.1 Additional intended uses. Some additional intended uses of the enamel meeting this specification are for machinery, refinishing trucks and buses, passenger and freight cars, metal drums, metal signs, metal railing and fences, marine use above water, metal trim (exterior), metal sidings, metal doors and bucks, metal structures (exterior), and properly primed wood (exterior).

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6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, and date of the specification.
- b. Color desired (see 3.8.1 and Table V).
- c. Type, class, and grade of enamel required (see 1.2).
- d. QPL number and requirement qualification (see 3.1).
- e. Level of packaging, level of packaging and packaging acquisition options required (see 5.1).
- f. When fire retardant treated lumber and plywood is not required.
- g. Class of fire retardant fiberboard required.
- h. Size of container required.
- i. Required marking.
- j. VOC certification sheets for each batch when requested.

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. 24763 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 or emailed to CommandStandards@navy.mil. An online listing of products qualified to this specification may be found in the Qualified Products Database (QPD) at <http://assist.daps.dla.mil>.

6.3.1 Provisions governing qualifications. Copies of "Provisions Governing Qualification SD-6" may be obtained upon application to Standardization Document Order Desk.

6.4 Material Safety Data Sheets. Contracting officers will 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.

6.5 Occupation reproductive hazards. A copy of OPNAVIST 5100.23C-change 1 to chapter 28, occupational reproductive hazards can be obtained from Office of Chief of Naval Operations, Code N454D, Washington, DC 20350-2000.

6.6 Shelf life. This specification covers items where the assignment of a Federal shelf-life code is a consideration. Specific shelf-life requirements should be specified in the contract or purchase order, and should include, as a minimum, shelf-life code, shelf-life package markings in accordance with MIL-STD-129 or FED-STD-123, preparation of a materiel quality storage standard for Type II (extendible) shelf-life items, and a minimum of 85 percent shelf-life remaining at time of receipt by the Government. These and other requirements, if necessary, are in DoD 4140.27-M, *Shelf-life Management Manual*. The shelf-life codes are in the Federal Logistics Information System Total Item Record. Additive information for shelf-life management may be obtained from DoD 4140.27-M, or the designated shelf-life Points of Contact (POC). The POC should be contacted in the following order: (1) the Inventory Control Points that manage the item and (2) the DoD Service and Agency administrators for the DoD Shelf-Life Program. Appropriate POCs for the DoD Shelf-Life Program can be contacted through the DoD Shelf-Life Management website: <https://www.shelflife.hq.dla.mil/>.

6.7 Volatile content. Although the container marking specifically refers to Federal regulations, the paint may be used any where else a product complying with 1.2 is allowed. This includes other air pollution control districts or similar areas controlling the emission of solvents volume into the atmosphere under volatile organic content (VOC) regulations.

6.8 Suggested packaging requirements. Suggested packaging is contained in Tables VII and VIII.

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TABLE VII. Suggested packing and packaging.

Packaging	Recommended requirements for direct Government acquisitions
Unit of procurement	The paints covered by this specification should be purchased by volume. The unit of procurement should be in multiples of 1 U.S. liquid gallon or 1 L at 15.5 °C (60 °F).
Containers	<p>(a) The paints should be furnished in cans of appropriate volume such as 3.78L (1-gallon) or multiples thereof.</p> <p>(b) 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>(c) Pails should be to PPP-P-704.</p> <p>(d) 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>(e) Coatings with anti-stain properties should be packaged in a lined container to ensure that there will be no chemical or physical interactions between the container and the contents.</p>
Intermediate containers	<p>(a) Paints should be packaged in intermediate containers.</p> <p>(b) 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 ASTM D4727/D4727M. ASTM D4727/D4727M classes should be domestic fire-retardant or weather resistant fire-retardant as specified.</p>
Commercial packaging	<p>(a) Commercial packaging should be to ASTM D3951.</p> <p>(b) 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>(a) Overseas delivery (Level A) packing. Intermediate containers of paint should be packed in close-fitting wood boxes conforming to ASTM D6251, overseas type. 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>(b) 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.</p> <p>(b) Commercial packing. The paint, in the specified unit 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-HDBK-774. Only one size unit or intermediate container should be placed on a pallet.
Packing for Navy acquisitions	<p>Treated lumber and plywood. All lumber and plywood, including laminated veneer materials, used in shipping container and pallet construction, member, blocking, bracing, and reinforcing should 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>
Material safety data sheets (MSDS) and ASTM F718	A copy of the MSDS and ASTM F718 should be attached to the shipping document for each destination (see 6.6).

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TABLE VII. Suggested packing and packaging - Continued.

Packaging	Recommended requirements for direct Government acquisitions
VOC certification sheets	VOC certification sheets for each batch of coating will be provided when requested by the procuring activity.

TABLE VIII. Suggested marking.

Marking type	Recommended marking
Bar codes	Marking should include bar codes
Hazardous warnings	(a) Labels should be in accordance with 29 CFR Parts 1910, 1915, 1917, 1918, 1926 and 1928, as well as PPP-P-1892. (b) All 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." (c) Each component container, shipping container, and palletized load should be marked with the appropriate hazardous symbol in accordance with FED-STD-313.
Volatile organic content (VOC)	"Contains a maximum of 340/250 grams of solvent of volatile organic compounds (VOC) per liter of paint per 40 CFR 60, Appendix A (EPA) Method 24."
OSHA Hazard Communication Act and FED-STD-313.	Markings should include all information necessary to comply with OSHA Hazard Communication Act and FED-STD-313.
Mixing and use instructions	Directions should include mixing, application equipment directions, limitations on thinning, temperature range for use and surface preparation recommendations. Directions should refer user to data sheets, MSDS and ASTM F718 for information.

6.9 Subject term (key word) listing.

Acrylic
 Arsenic
 Flat gloss
 Gloss
 Latex
 Lead
 Low gloss
 Mercury
 Paint
 Semigloss
 Top coat
 VOC

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.

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Preparing Activity:

Navy – SH

(Project 8010-2009-029)

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>.