

INCH-POUND

MIL-PRF-24635D

15 November 2006

SUPERSEDING

MIL-PRF-24635C

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PERFORMANCE SPECIFICATION

COATING SYSTEMS, WEATHER-RESISTANT, EXTERIOR USE

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

1. SCOPE

1.1 Scope. This specification establishes the performance requirements for weather-resistant coating systems for use on primed, smooth metal, glass reinforced plastic (GRP), wood and plastic/composite exterior surfaces on naval vessels.

1.2 Classification. Coatings are of the following Types, Classes, and Grades, as specified (see 6.1 and 6.2).

1.2.1 Types.

Type II - Standard durability coatings with VOC not greater than 340 grams per liter (g/L) [2.8 pounds per gallon (lb/gal)]

Type III - Standard durability coatings with VOC not greater than 250 g/L (2.08 lb/gal)

Type IV - Standard durability coatings with VOC not greater than 100 g/L (0.83 lb/gal)

Type V - High durability coatings with VOC not greater than 250 g/L (2.08 lb/gal)

Type VI - High durability coatings with VOC not greater than 100 g/L (0.83 lb/gal)

1.2.2 Class.

Class 1 - High gloss, ≥ 85

Class 2 - Semi-gloss, 45 to 60

Class 3 - Low gloss, 7-12

1.2.3 Grade.

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 05Q, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or emailed to CommandStandards@navy.mil, with the subject line "Document Comment". Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <http://assist.daps.dla.mil>.

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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 SPECIFICATIONS

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-595 - Colors Used in Government Procurement
color chips 10371, 16081, 16099, 16307, 17038, 26008, 26118, 26173, 26231, 26270, 26307, 26373, 27038, 36118, 36173, 36231, 36270, 36307, 36373, and 37038

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-24647 - Paint System, Anticorrosive and Antifouling, Ship Hull

(Copies of these documents are available online at <http://assist.daps.dla.mil/quicksearch/> or <http://assist.daps.dla.mil> 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 Air Contaminants

29 CFR 1915 - Occupational Safety and Health Standards for Shipyard Employment

29 CFR 1915.1001, - Polarized Light Microscopy of Asbestos
Appendix K Method
ID-191

29 CFR 1917 - Marine Terminals

29 CFR 1918 - Safety and Health Regulations for Longshoring

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29 CFR 1926	-	Safety and Health Regulations for Construction
29 CFR 1928	-	Occupational Safety and Health Standards for Agriculture
29 CFR 1990	-	Identification, Classification, and Regulation of Potential Occupational Carcinogens
40 CFR 60, Ch.1, Appendix A-7, Method 24	-	Determination of Volatile Matter Content, Water Content, Density, Volume Solids, and Weight Solids of Surface Coatings
40 CFR 63	-	National Emission Standards for Hazardous Air Pollutants for Source Categories
40 CFR 63.782	-	National Emission Standards for Shipbuilding and Ship Repair (Surface Coating) Definitions
40 CFR 82	-	Protection of Stratospheric Ozone
40 CFR 261	-	Identification and Listing of Hazardous Waste
40 CFR 261, Appendix II, Method 1311	-	Toxicity Characteristic Leaching Procedure (TCLP)
40 CFR 302	-	Designation, Reportable Quantities, and Notification
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.)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA SW-846	-	Test Methods for Evaluating Solid Waste, Physical/Chemical Methods
EPA 600/4-79-020	-	Methods for Chemical Analysis of Water and Wastes

(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 Paints (DoD adapted)
ASTM D522	-	Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings (DoD adopted)
ASTM D523	-	Standard Test Method for Specular Gloss (DoD adopted)
ASTM D562	-	Standard Test Method for Consistency of Paints Measuring Krebs Unit (KU) Viscosity Using a Stormer-Type Viscometer (DoD adopted)

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ASTM D609	-	Standard Practice for Preparation of Cold-Rolled 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)
ASTM D714	-	Standard Test Method for Evaluating Degree of Blistering of Paints (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 and Coatings on Metal Substrates (DoD adopted)
ASTM D1210	-	Standard Test Method for Fineness of Dispersion of Pigment-Vehicle Systems By Hegman-Type Gage (DoD adopted)
ASTM D1308	-	Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes (DoD adopted)
ASTM D1364	-	Standard Test Method for Water in Volatile Solvents (Karl Fischer Reagent Titration Method) (DoD adopted)
ASTM D1849	-	Standard Test Method for Package Stability of Paint (DoD adopted)
ASTM D2244	-	Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates (DoD adopted)
ASTM D2369	-	Standard Test Method for Volatile Content of Coatings (DoD adopted)
ASTM D2805	-	Standard Test Method for Hiding Power of Paints by Reflectometry (DoD adopted)
ASTM D3278	-	Standard Test Methods for Flash Point of Liquids by Small Scale Closed-Cup Apparatus (DoD adopted)
ASTM D3359	-	Standard Test Methods for Measuring Adhesion by Tape Test
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)
ASTM D5895	-	Standard Test Methods for Evaluating Drying or Curing During Film Formation of Organic Coatings Using Mechanical Recorders
ASTM E1347	-	Standard Test Method for Color and Color-Difference Measurement by Tristimulus (Filter) Colorimetry
ASTM F718	-	Standard for Shipbuilders and Marine Paints and Coatings Product/Procedure Data Sheet (DoD adopted)
ASTM G154	-	Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials

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(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.)

GENERAL MOTORS ENGINEERING STANDARDS

GM 9540P - Method B, Materials and Process – Procedures, Accelerated Corrosion Test

(Copies of these documents are available from General Motors International, General Motors Technical Center, Warren, MI 48092.)

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC-SP11 - Power Tool Cleaning to Bare Metal (DoD adopted)

(Copies of this document are available from SSPC Publication Sales, 40 24th Street, 6th Floor, Pittsburgh, PA 15222-4656 or online at www.sspc.org.)

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 Qualification. The coating systems furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualification data set (QDS) before contract award (see 4.2 and 6.3).

3.2 Composition. The manufacturer is given his choice of ingredients used in the formation of the coatings described in this document. For two component systems, the allowed proportions for the ratio of resin component to hardener shall be limited to 4:1, 3:1, 2:1, or 1:1 by volume. When mixed and applied in accordance with the manufacturer's instructions, the final coating system shall be in accordance with all requirements of this specification.

3.3 Ozone-depleting substances (ODS). The use of any ODS in the composition of the coating under this specification, directly or referenced in any test method, is prohibited. Class I or Class II ozone-depleting chemicals are defined by 40 CFR 82.

3.4 Application. The coatings under this specification shall be able to be applied either directly to bare steel or aluminum surfaces prepared to SSPC-SP-11 or better, or shall be able to be applied over substrates that have previously been coated with the same product, or primers of systems conforming to MIL-PRF-23236, MIL-DTL-24441, MIL-PRF-24647, or TT-P-645.

3.5 Performance requirements.

3.5.1 Toxicity. The coating shall have no adverse effect on the health of personnel when used for its intended purpose. The material used in the coating 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 302, 355, and 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 other ingredient(s), the concentration of the prohibited material shall not equal or exceed 0.1 percent by weight of the coating. The material shall be evaluated at the Navy Environmental Health Center (NEHC) (see 6.5).

3.5.1.1 Asbestos content. The percent by weight of asbestos in the dry coating film shall be below the detectable threshold.

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3.5.1.2 Metal content. The metal content (soluble and total) of the coating shall be less than the values listed in Table I when tested in accordance with 4.5.1. 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.

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TABLE I. Metals content of coatings.

Metal and its compound in each coating dry film	Soluble metal, maximum (mg/L)	Total content, maximum (%weight)
Antimony	15.0	0.015
Arsenic	5.0	0.005
Barium (excluding barite)	100.0	0.10
Beryllium	0.75	0.0002
Cadmium	1.0	0.0005
Chromium VI compounds	1.0	0.001
Chromium and chromium III compounds	560.0	0.56
Cobalt*	50.0	0.005
Copper	25.0	0.01
Fluoride Salts	180.0	0.18
Lead	5.0	0.005
Mercury	0.2	0.0002
Molybdenum	350.0	0.035
Nickel	20.0	0.02
Selenium	1.0	0.002
Silver	5.0	0.001
Tantalum	100.0	0.100
Thallium	7.0	0.007
Tungsten	100.0	0.100
Vanadium	24.0	0.01
Zinc	250.0	0.25

* Total cobalt content may exceed 0.005 %wt (up to 0.2 %wt) only if a cobalt drier is used to effect proper drying; however, soluble cobalt content may not exceed Table I requirements.

3.5.1.3 Hazardous air pollutants (HAPS). The content of the HAPs solvents in the mixed coating or its components shall not exceed the weight percent (%wt) values listed in Table II. Within these limitations and the requirement that the finished coating meet all requirements of this specification, solvent selection is the responsibility of the manufacturer. HAP materials are defined by 40 CFR 63.

TABLE II. Hazardous air pollutant solvent content limits.

Hazardous solvent in mixed coating or its components	Maximum, %wt
Benzene	0.05
Chlorinated solvent (s), total	0.05
Solvents containing fluorine as defined by 40 CFR 82	0.01
Ethyl benzene	0.05
Methyl, Ethyl, and Butyl mono-ethers of ethylene glycol or the acetates thereof, total (also known as methyl, ethyl, and butyl cello solves and methyl, ethyl, and butyl cello solve acetates)	0.05
Methyl ethyl ketone (MEK)	0.05
Methyl isobutyl keytone (MIBK)	0.05
Toluene	0.05
Xylene (all forms), total	0.1

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3.5.1.4 Volatile organic content (VOC).

3.5.1.4.1 Type II. The VOC shall not exceed 340 grams per liter (2.8 lb/gal).

3.5.1.4.2 Types III and V. The VOC shall not exceed 250 g/L (2.08 lb/gal).

3.5.1.4.3 Types IV and VI. The VOC shall not exceed 100 g/L (0.83 lb/gal).

3.5.1.5 Paint thinners. Thinning of VOC compliant paint is not allowed. The paint must be able to meet the viscosity requirements and to be applied without the addition of thinning agents.

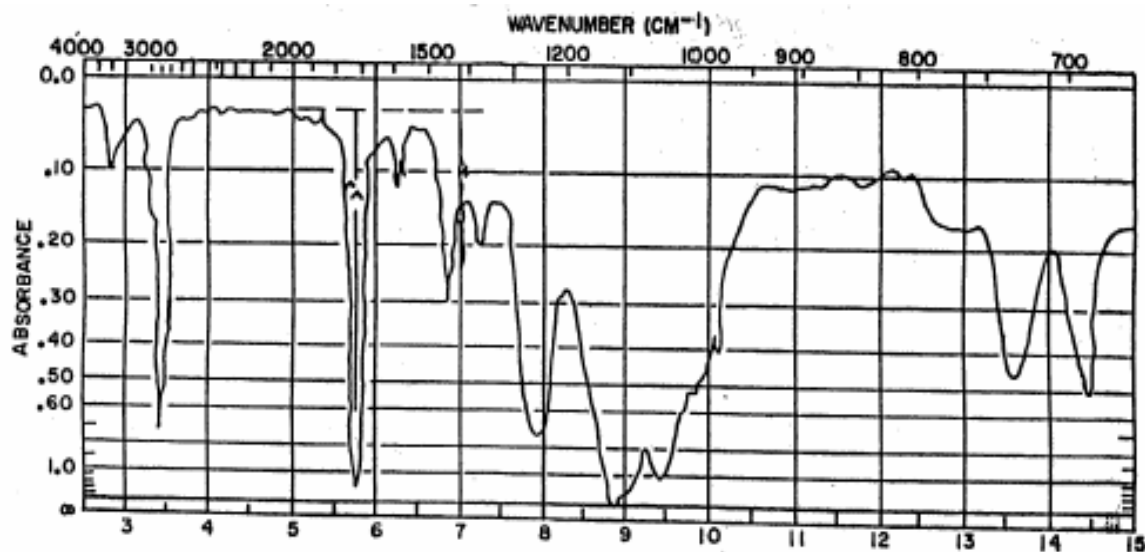
3.5.2 Vehicle resin (types II, III and IV only). The vehicle shall consist of a copolymerized, air-drying silicone modified long oil soya alkyd conforming to the requirements of Table III.

TABLE III. Characteristics of vehicle.

Characteristics	Requirements	
	Min	Max
Silica (SiO ₂) percent by weight of nonvolatile vehicle	14.7	--
Phthalic anhydride, percent by weight of nonvolatile vehicle	Positive (By certification)	
Drying oil acids, percent by weight of nonvolatile vehicle	Positive (By certification)	
Soya oil	Positive (By certification)	
Rosin	Negative (By certification)	
Phenolic resin	Negative (By certification)	

3.5.2.1 Identification spectra. The copolymer shall give two similar spectra, both of which shall have the significant bands of both the alkyd and silicone resins as shown on Figure 1 below. Both spectra shall not have an absorption band in the 13.9 to 14.0 micrometer (μm) region and both shall show a sharp narrow absorption band at 7.0 μm.

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FIGURE 1. Wavelength (micrometers).

3.5.3 Flash point. The flash point of the coating or any component shall not be less than 38 °C (100 °F).

3.5.4 Condition in container. The coating system or components shall be free of grit, seeds, skins, lumps or livering, and shall show no more surface float (separated pigments or other ingredients on the surface of the liquid) or pigment settling or caking than can be readily re-incorporated to a smooth uniform state.

3.5.5 Storage stability.

3.5.5.1 Partially-full container (types II, III and IV only). The coating components shall show no skinning. After aging, the coating components shall show no surface float (separated pigments or other ingredients on the surface of the liquid), livering, curdling, hard caking or gummy sediment. The components shall mix readily to a smooth uniform state within 5 minutes when mixed with a paddle or mechanical mixer and shall have a consistency not greater than 5 units from the original Krebs unit consistency before testing (see 3.5.8). At the end of the 7 day period specified in 4.5.5.1, the mixed coating shall continue to meet the requirements of 3.5.10, 3.5.11, 3.5.12, 3.5.14, and 3.5.17. The CIELAB color difference of the mixed coating shall be not greater than 0.5 CIELAB units from the original color values measured prior to the required storage period.

3.5.5.2 Full container. The coating components shall show no skinning, livering, curdling, hard caking, or gummy sediment. The components shall mix to a smooth uniform state with no surface float (separated pigments or other ingredients on the surface of the liquid) within 5 minutes when mixed with a paddle or mechanical mixer and shall have a consistency not greater than 5 units from the original Krebs unit consistency before testing (see 3.5.8). After the shelf life duration, the mixed coating shall continue to meet the requirements of 3.5.10, 3.5.11, 3.5.12, 3.5.14, and 3.5.17. The CIELAB color difference of the mixed coating shall be not greater than 0.5 CIELAB units from the original color values measured prior to the required storage period.

3.5.5.3 Accelerated storage stability. A previously unopened, original container of each coating component shall be re-dispersible within 5 minutes with a paddle or mechanical mixer to a uniform condition free of grit, seeds, skins, lumps, livering, pigment settling or surface float. The mixed coating shall continue to meet the requirements of 3.5.8, 3.5.10, 3.5.11, 3.5.12, 3.5.14, and 3.5.17. The CIELAB color difference of the mixed coating shall not be greater than 0.5 CIELAB units from the original color values measured prior to the required storage period.

3.5.6 Water content (non water-based systems only). The water content of the mixed coating shall not be greater than 0.5 percent by weight.

3.5.7 Coarse particles. The coarse particles (and skins for Types II, III, and IV coatings) shall not be greater than 0.5 percent by weight of the mixed coating.

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3.5.8 Consistency (types II, III, and V only). The consistency of the mixed coating shall not exceed 120 Krebs units.

3.5.9 Fineness of grind. The fineness of grind of the mixed coating shall receive a minimum ASTM D1210 rating of 6.

3.5.10 Brushing properties. The coating shall brush satisfactorily and shall dry to a uniform film, free from seeds, runs, sags or streaks.

3.5.11 Rolling properties. The coating shall roll satisfactorily and shall dry to a uniform film, free from seeds, runs, sags, or streaks. The dried film shall show an even, smooth finish.

3.5.12 Spraying properties. The coating shall spray satisfactorily and shall show no running, sagging, streaking, or orange peel. The air-dried film shall show no seeding, dusting, floating, mottling, hazing, or other film defects.

3.5.13 Sag resistance. The sag resistance for each coat of the coating system shall be at least twice the manufacturer's recommended wet film thickness (WFT) for that coat.

3.5.14 Drying times.

3.5.14.1 Types III and IV coatings. The coating's set-to-touch time shall be no greater than 2 hours, and the dry-through time shall be no greater than 8 hours.

3.5.14.2 Types V and VI coatings. The coating's set-to-touch time shall be no greater than 1 hour, and the dry-through time shall be no greater than 4 hours.

3.5.15 Contrast ratio. The fully cured coating's contrast ratio shall be as follows:

<u>Color</u>	<u>Contrast ratio</u>
Gray and black colors	≥ 0.98
White colors	≥ 0.90
Red, yellow and orange colors	≥ 0.75
All other colors	≥ 0.80

3.5.16 Color. Immediately after mixing, the color of the coating shall match the following as specified:

a. Colors defined by tristimulus values shall match the following:

<u>Colors defined by tristimulus values</u>	<u>L</u>	<u>a</u>	<u>b</u>
Navy Haze Gray No. 27 (26270)	+56.0	-1.83	-1.37

b. All other colors shall match the FED-STD-595 number specified in Table IX.

c. Class 3 colors shall be matched to the appropriate FED-STD-595 semi-gloss color chip.

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3.5.16.1 Color deviation. The measured color deviation terms [ΔE , ΔA , ΔB , ΔL] from the appropriate Haze Gray No. 27 [see 3.5.16 (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:

Color deviation values				
Colors defined by tristimulus values	ΔE	ΔA	ΔB	ΔL
Navy Haze Gray No. 27 (26270)	0.5	0.3	0.3	0.3

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

3.5.17 Gloss. The 60° specular gloss of the coating shall be as follows:

<u>Class</u>	<u>Gloss</u>
1	≥85
2	45-60
3	7-12

3.5.18 Solar reflectance (grades B and C). Low solar absorbance coatings shall meet the following reflectance requirements:

<u>Wavelength range</u>	<u>Reflectance</u>
(Colors 26173, 26270, and 26373)	
800-1000 nanometers	≥0.60
1000-1500 nanometers	≥0.75
1500-2000 nanometers	≥0.60
(Color 26008)	
800-1000 nanometers	≥0.35
1000-1500 nanometers	≥0.50
1500-2000 nanometers	≥0.35

3.5.19 X-cut or cross-cut adhesion test

3.5.19.1 Types III and IV coatings. The coating system shall achieve a minimum ASTM D3359 classification of 4A or 4B.

3.5.19.2 Types V and VI coatings. The coating system shall achieve a minimum ASTM D3359 classification of 5A or 5B.

3.5.20 Overcoat adhesion. Fully cured coatings shall be able to be overcoated with each of the systems identified in 3.4 and 4.5.20, with no visible film irregularities. The overcoat shall not wrinkle or lift the first coat, and shall dry to a smooth, uniform finish. Coatings shall not require additional coats to only be applied over wet or touch-tacky surfaces. At a minimum, each overcoated panel shall achieve the same ASTM D3359 classification as when the system alone is tested per 4.5.19.

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3.5.21 Flexibility. A cured film of coating shall bend without cracking or flaking.

3.5.22 Water resistance. The coating system shall show no blistering or wrinkling when examined immediately after removal from distilled water. When examined 2 hours after removal, there shall be no softening, whitening, or dulling. After 24 hours of air-drying, the portion of the panel that was immersed shall be indistinguishable with regard to adhesion and general appearance from a panel prepared at the same time but not immersed, and shall retain at least 90 percent of the 60-degree specular gloss of the panel before immersion or any other panel made from the same batch.

3.5.23 Accelerated weathering.

3.5.23.1 Types III and IV coatings. The coating system shall show no evidence of chalking and a loss of not greater than 35 percent of the gloss measured before exposure. The color difference (ΔE) shall be not greater than 1.0 CIELAB units from the original values measured before exposure.

3.5.23.2 Types V and VI coatings. The coating system shall show no evidence of chalking and a loss of not greater than 10 percent of the gloss measured before exposure. The color difference (ΔE) shall not be greater than 0.5 CIELAB units from the original values measured before exposure.

3.5.24 Anti-stain properties (grade C only). The length of the longest running rust stain from the holiday on two of the three test panels shall not be greater than the length of the longest running rust stain on the control panel.

3.5.25 Long-term exterior exposure.

3.5.25.1 Types III and IV coatings. Coating systems shall meet the following requirements:

- a. 60-degree gloss not less than 50 percent of that measured prior to testing.
- b. Chalking shall receive an ASTM D4214 rating not less than number 8 of Figure 2.
- c. Checking shall receive an ASTM D660 rating not less than 9 (1 percent).
- d. Cracking shall receive an ASTM D661 rating not less than 9.
- e. Blistering shall receive an ASTM D714 rating not less than 10.
- f. 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 value, ΔE , shall be not greater than 2.0 CIELAB units.
- g. Tape test adhesion of the exposed coating shall achieve a minimum ASTM D3359 classification of 3A or 3B.

3.5.25.2 Types V and VI coatings. Coating systems shall meet the following requirements:

- a. 60-degree gloss not less than 80 percent of that measured prior to testing.
- b. Chalking shall receive an ASTM D4214 rating not less than number 8 of Figure 2.
- c. Checking shall receive an ASTM D660 rating not less than 9 (1 percent).
- d. Cracking shall receive an ASTM D661 rating not less than 9.
- e. Blistering shall receive an ASTM D714 rating not less than 10.
- f. 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 value, ΔE , shall be not greater than 1.0 CIELAB units.
- g. Tape test adhesion of the exposed coating shall achieve a minimum ASTM D3359 classification of 3A or 3B.

3.5.26 Recoating. The coating system must be able to be overcoated with the topcoat of the coating system after being exposed for one year. Recoating of the exposed system shall produce no film irregularities. The overcoat shall not wrinkle or lift any previous coat and shall dry to a smooth, uniform finish.

3.5.26.1 Types III and IV coatings. Once fully cured per manufacturer's ASTM F718 sheet, the overcoat applied to the exposed coating shall achieve a minimum ASTM D3359 classification of 3A or 3B.

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3.5.26.2 Types V and VI coatings. Once fully cured per manufacturer's ASTM F718 sheet, the overcoat applied to the exposed coating shall achieve a minimum ASTM D3359 classification of 4A or 4B.

3.5.27 Serviceability. The coating shall show no deficiencies that would limit its serviceability when examined during and after the minimum service period specified.

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 Qualification inspection. Qualification inspection shall consist of all of the tests listed in Table IV.

4.2.1 Qualification sample. The qualification sample shall be drawn from a production batch and shall consist of enough component materials (i.e., hardener and resin if a two component system) to create 4 liters (~1 gallon) of the final mixed coating.

4.2.2 Formulation changes. Any change in basic ingredients or manufacturing processes (other than minor changes in pigment concentrations strictly to adjust final coating system color) which would affect compliance with this specification must be reported to both the contracting activity and NAVSEA. The Government reserves the right to require that all tests specified in this specification be re-performed on a production batch of the coating produced under the new formulation or process before any shipment is accepted. Any formulation change not disclosed to NAVSEA will result in immediate disqualification of the product.

4.2.3 Extension of qualification. Testing and qualification of Grade C (LSA and Anti-Stain) products shall be automatically extended to Grades A and B. Testing and qualification of Grade B (LSA) products shall be automatically extended to Grade A. Testing and qualification of one color variant of a given Type, Class, and Grade product shall be automatically extended to all other colors for the same product (Type, Class, and Grade), providing the only difference in the product formulations is in the color pigment concentrations.

4.3 Conformance inspection. Conformance inspection shall consist of specific tests identified in Table IV.

4.3.1 Lot. The addition of any substance that was not present in the qualification sample requires requalification. For purposes of sampling and conformance inspection, a lot shall consist of all paint of the same formula number from a single uniform batch or uniform blend of batches (for plural component coatings) offered for delivery at one time. The addition of any substance to a batch shall constitute a new lot and full conformance testing is required.

4.3.2 Sampling for conformance testing. The contractor shall select a production sample sufficiently large enough to permit the performance of all conformance tests. If it is required, two representative packaged samples (four samples for plural component systems) shall be forwarded to a designated laboratory for verification tests. If sample panels are to be coated at the vendor's facility and forwarded to an external laboratory for testing, preparation of the panels and application of the coating system must be observed by a representative from the Defense Contracts Management Agency (DCMA).

4.3.3 Noncompliance. If a sample fails to pass its conformance inspections, the lot shall be rejected and the manufacturer shall notify the cognizant inspection activity of such failure and take corrective action on the materials or processes, or both, as warranted. Acceptance and shipment of the product shall be discontinued until corrective action, suitable to the inspection activity, has been taken. After the corrective action has been taken, conformance inspections shall be repeated on the new lot. In the event of failure after re-inspection, information concerning the failure shall be furnished to the cognizant inspection activity.

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TABLE IV. Tests.

Item	Qualification testing required	Conformance testing required	Requirement paragraph	Test method paragraph
Toxicity	Yes	No	3.5.1	4.5.1
Asbestos content	Yes	No	3.5.1.1	4.5.1.1
Total and soluble metal content	Yes	No	3.5.1.2	4.5.1.2
Hazardous air pollutant (HAP) content	Yes	No	3.5.1.3	4.5.1.3
Volatile organic content (VOC)	Yes	Yes	3.5.1.4	4.5.1.4
Silica content	Yes	No	3.5.2	4.5.2.1
Phthalic anhydride content	Yes	No	3.5.2	4.5.2.2
Drying oil acids	Yes	No	3.5.2	4.5.2.2
Identification spectra	Yes	No	3.5.2.1	4.5.2.3
Flash point	Yes	Yes	3.5.3	4.5.3
Condition in container	Yes	Yes	3.5.4	4.5.4
Storage stability – partial container	Yes	No	3.5.5.1	4.5.5.1
Storage stability – full container	Yes	No	3.5.5.2	4.5.5.2
Accelerated storage stability	Yes	No	3.5.5.3	4.5.5.3
Water content	Yes	No	3.5.6	4.5.6
Coarse particles	Yes	Yes	3.5.7	4.5.7
Consistency	Yes	Yes	3.5.8	4.5.8
Fineness of grind	Yes	Yes	3.5.9	4.5.9
Brushing properties	Yes	Yes	3.5.10	4.5.10
Rolling properties	Yes	Yes	3.5.11	4.5.11
Spraying properties	Yes	Yes	3.5.12	4.5.12
Sag resistance	Yes	Yes	3.5.13	4.5.13
Drying time	Yes	Yes	3.5.14	4.5.14
Contrast ratio	Yes	Yes	3.5.15	4.5.15
Color deviation	Yes	Yes	3.5.16.1	4.5.16.1
Gloss	Yes	Yes	3.5.17	4.5.17
Solar reflectance	Yes	Yes	3.5.18	4.5.18
Cross-cut adhesion	Yes	No	3.5.19	4.5.19
Overcoat adhesion	Yes	No	3.5.20	4.5.20
Flexibility	Yes	No	3.5.21	4.5.21
Water resistance	Yes	No	3.5.22	4.5.22
Accelerated weathering	Yes	No	3.5.23	4.5.23
Anti-stain	Yes	No	3.5.24	4.5.24
Long term exterior exposure	Yes	No	3.5.25	4.5.25
Recoat	Yes	No	3.5.26	4.5.26
Serviceability	Yes	No	3.5.27	4.5.27

4.4 Inspection conditions. Unless otherwise specified, all inspections shall be performed in accordance with the test conditions specified in section 9, routine and referee testing conditions, of FED-STD-141. The term referee conditions shall mean a temperature of 23±1 °C (73±2 °F) and a relative humidity of 50±4 percent. All paint test specimens shall be cured to service in accordance with manufacturer's ASTM F718 sheet before testing unless otherwise specified.

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4.4.1 Test panels and surface preparation. Unless otherwise specified, test panels shall be nominal 150 x 300 x 3 mm (6 x 12 x 0.125 inch) plate aluminum or cold rolled steel. 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 an average profile pattern of 0.051 to 0.076 mm (0.002 to 0.003 inch) on both sides. For direct-to-metal coating systems, the panels shall remain unprimed prior to application of the coating system. For coating systems requiring an anti-corrosive primer, the panels shall be primed with the primer included by the manufacturer as part of the coating system, or with a primer conforming to MIL-DTL-24441 if no primer component is identified by the manufacturer for the coating system.

4.5 Test methods.

4.5.1 Toxicity. To determine conformance with the requirements of 3.4, the material shall be evaluated by the Navy Environmental Health Center (NEHC) (see 6.2 and 6.5).

4.5.1.1 Asbestos content. Asbestos content shall be determined on a dry film of the coating in accordance with 29 CFR 1915.1001, Appendix K, and the results shall be recorded as a percent by weight of the dry coating film.

4.5.1.2 Soluble and total metal content. Soluble and total metal content, except tantalum and tungsten, shall be determined on a dry paint film of the coatings in accordance with the 40 CFR 261, Appendix II, Method 1311, and the appropriate test listed in Tables V and VI. Soluble metal content shall be reported as milligrams per liter (mg/L). Total metal content shall be reported as percent by weight of the dry coating film. Tantalum and tungsten soluble metal content and total metal content shall be analyzed as specified in 4.5.1.3.

TABLE V. Test methods for evaluating solid waste physical/chemical methods, EPA SW-846.

Metal/material	Digestion test method
All metals, except chromium (VI)	3050
Chromium (VI)	3060
Antimony	7040 or 7041
Arsenic	7060 or 7061
Barium	7080 or 7081
Cadmium	7131
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

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TABLE VI. Methods for chemical analysis of water and waste, EPA 600/4-79-020.

Metal/material	Test method
Beryllium	210.1 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 or 279.2
Vanadium	286.1 or 286.2
Zinc	289.1 or 289.2

4.5.1.2.1 Tantalum and tungsten content. The tantalum and tungsten content of the coating shall be determined using any appropriate spectroscopy test method. The tests shall be conducted in accordance with the equipment manufacturer's directions for the use of the instrument. The coating manufacturer is responsible for establishing data justifying the test method choice and analytical accuracy.

4.5.1.3 Hazardous air pollutants content. Formulation data shall be used by manufacturers in lieu of testing to demonstrate compliance with hazardous air pollutant requirements of this specification. The manufacturer's formulation data must have a consistent and quantitatively known relationship to the testing required. Calculation of individual HAP contents can be based on either manufacturer evaluation of batches or supplier data for raw materials used in the product. The coating manufacturer must provide, for each individual HAP, a formulation value that will not be exceeded if a sample from any quality control approved production batch of the coating is evaluated in accordance with this paragraph.

4.5.1.4 Volatile organic content (VOC). VOC for each batch (as described in 40 CFR 63.782) shall be determined in accordance with 40 CFR 60 Ch.1, Appendix A, Method 24, allowing the sample to reside at 22±1 °C (72±2 °F) for 24 hours prior to conducting the analysis. No oven heating is allowed.

4.5.2 Type II, III and IV resin characteristics.

4.5.2.1 Silica (SiO₂) content of vehicle. From a stoppered bottle or weighting pipette, the mass shall be accurately determined by difference, weigh approximately 3 grams of vehicle into a previously ignited and weighted 7.6 cm (3-inch) porcelain evaporating dish. Add 1 milliliter (mL) concentrated sulfuric acid. The sample shall be dried at 110 °C (230 °F) (nominal) in an oven for 1 hour followed by one hour in an oven at 165 °C (329 °F) (nominal). The dried sample shall be placed in a cold muffle furnace and the temperature shall be gradually increased over a period of 3 hours to 800 °C (1472 °F). This temperature shall be maintained for an additional hour. After cooling in a desiccator, the mass of the dish and the contents shall be determined and the percent of silica shall be calculated as follows:

$$\text{Percent silica} = \frac{\text{Mass of ash} \times 100}{\text{Mass of sample} \times \text{nonvolatile fraction}}$$

This nonvolatile fraction has been determined in accordance with ASTM D2369.

4.5.2.2 Phthalic anhydride and drying oil acids. Formulation data shall be used by manufacturers in lieu of testing to demonstrate the inclusion of unsaponifiable, drying oil acids and phthalic anhydride in the resin formulation.

4.5.2.3 Identification spectra. The copolymer shall be tested qualitatively by agitating a 0.5-gram sample of the extracted vehicle with three successive 20-mL portions of isopropanol, decanting of the alcohol and saving each portion. The infrared spectrum shall be scanned from 2 to 15 μm of a solvent-free film of both the isopropanol insoluble portion and the soluble portion after evaporation of the alcohol.

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4.5.3 Flash point. The flash point of each component shall be determined in accordance with ASTM D3278.

4.5.4 Condition in container. A container of each component shall be equilibrated to test laboratory conditions [nominal 23 °C (73 °F)]. Evidence of pressure or vacuum in the unopened container shall be noted. The container shall then be opened and examined in accordance with Method 3011.3 of FED-STD-141 for evidence of skinning, corrosion of container interior, odor of putrefaction, rancidity or souring, gel bodies, and hard settling. The components shall be hand-stirred 300 stirs in 2 minutes with a spatula appropriate to the container, stirring so as to ensure uniform distribution of any settled material.

4.5.5 Storage stability.

4.5.5.1 Partially-full containers (types II, III and IV only). Skinning for each component shall be determined in accordance with the following procedure. A 6-ounce sample of the coating material shall be measured into a 1-quart multiple friction top can that is already $\frac{3}{4}$ full with the coating material. The cover shall be secured on tightly and the can inverted momentarily. The can shall then be in an upright position in the dark (placing it under a box or in a drawer is satisfactory). The test shall be made at 22.2 °C to 26.7 °C (72 °F to 80 °F). The sample shall not be agitated or disturbed until inspected. The coating material shall be inspected for skinning after 48 hours. The cans shall then be resealed and aged for 7 days at 49 °C (120 °F) prior to re-inspection. After this period, the components shall be mixed in accordance with manufacturer's instructions, and the dry time, gloss, brush, roll and spray characteristics, viscosity and color deviation from the un-aged mixed coating determined per the applicable paragraphs of this specification.

4.5.5.2 Full container. A full quart can of each coating component shall be allowed to stand undisturbed for 12 months and then the contents tested in accordance with ASTM D1849. Each component shall be evaluated for pigment settling or caking. Each can shall then be agitated for 5 minutes on the paint shaker prior to re-inspection. The components shall then be mixed, and the dry time, gloss, brush, roll and spray characteristics, viscosity, and color deviation from the un-aged mixed coating determined per the applicable paragraphs of this specification.

4.5.5.3 Accelerated storage stability. After exposure to a temperature of 49 °C (120 °F) for a period of 7 days, a previously unopened, original container of each coating system component shall be examined.

4.5.6 Water content. The water content of the mixed coating shall be determined in accordance with ASTM D1364.

4.5.7 Coarse particles. The amount of coarse particles and skins shall be determined in accordance with ASTM D185.

4.5.8 Consistency (types II, III and V only). The consistency of the mixed coating shall be determined in accordance with ASTM D562 and reported in Kneb units.

4.5.9 Fineness of grind. The fineness of grind of the mixed coating shall be measured in accordance with ASTM D1210.

4.5.10 Brushing properties. The coating system shall be brushed per manufacturer's instructions to a test panel prepared in accordance with 4.4.1. The panel shall be visually inspected for defects.

4.5.11 Rolling properties. The coating system shall be rolled per manufacturer's instructions onto a test panel prepared in accordance with 4.4.1. The panel shall be visually inspected for defects.

4.5.12 Spraying properties. The coating system shall be sprayed onto a test panel prepared in accordance with 4.4.1. The panel shall be observed for spraying properties in accordance with Method 4331.2 of FED-STD-141.

4.5.13 Sag resistance. The sag resistance of the coating shall be determined in accordance with ASTM D4400.

4.5.14 Drying times. The set-to-touch and dry-through times shall be determined in accordance with ASTM D5895.

4.5.15 Contrast ratio. The contrast ratio of the fully cured coating shall be determined in accordance with ASTM D2805.

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4.5.16 Color testing.

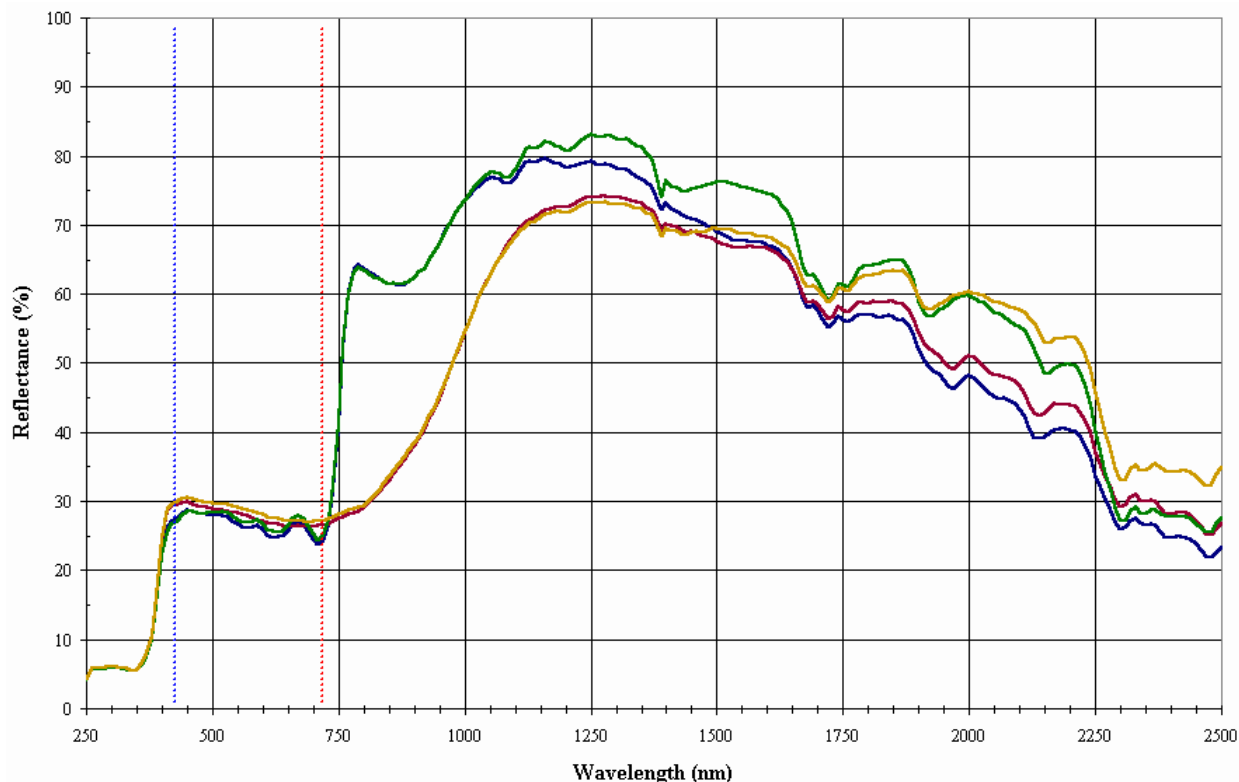
4.5.16.1 Instrumental color deviation determination. Test specimens shall be prepared in accordance with ASTM D823 Methods C or E using a nominal 0.006-inch blade film applicator onto a clear plate glass of not less than $\frac{3}{8}$ -inch (nominal) thickness that has been ground to a uniform finish 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, 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. After calibration of the instrument, the L, A, B color values of at least two FED-STD-595 color cards shall be measured of the color being procured which were received from the Government not greater than 1 year prior to the date of this use. E shall be calculated for each color card. The mean values of E, L, A, and B shall be determined for the color cards. These mean values will be used to calculate the color difference values. The color values of the test coating shall be measured immediately after mixing per manufacturer's instructions. The color deviation terms shall be calculated. If using an instrument that automatically calculates the color differences, the color card mean values shall be entered as the base line for the color difference calculations.

4.5.16.1.1 Referee color matching. If the coating measured in accordance with 4.5.16.1 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.

4.5.17 Gloss. The thoroughly mixed coating shall be applied to a standard black and white Leneta chart in accordance with ASTM D823. A film applicator shall be used that will produce a wet film thickness of 0.151 mm (0.006 inch). Allow to cure to service per manufacturer's ASTM F718 sheet under referee conditions in a dust free environment. Paint specimen shall be dry hard before gloss test. A longer cure time may be used if necessary to meet the gloss requirement of this specification. The 60-degree specular gloss of the fully cured coating shall be determined per ASTM D523.

4.5.18 Solar reflectance. A reflectometer capable of measuring reflectance at specific wavelengths shall be used to measure the visible and Near IR reflectance of the test cards produced in 4.5.17. Measurements shall be made at the wavelengths specified in 3.5.18, similar to Figure 2 below. Test results shall be in accordance with the requirements of 3.5.18. 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.

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FIGURE 2. Sample solar reflectance graph.

4.5.19 X-cut or cross-cut adhesion. Two panels shall be prepared in accordance with 4.4.1. The coating system shall then be applied and allowed to cure to service per the manufacturer's ASTM F718 sheet. For coating systems with a manufacturer's recommended total system Dry Film Thickness (DFT) greater than 15 mils, X-cut adhesion shall be determined in accordance with ASTM D3359, Method A. For coating systems with a manufacturer's recommended total system DFT of less than 15 mils, cross-cut adhesion shall be determined in accordance with ASTM D3359, Method B. If the total DFT is between 5-10 mils, the spacing between the lines in the Method B cross-hatch shall be doubled. If the total DFT is between 10-15 mils, the Method B line spacing shall be tripled.

4.5.20 Overcoat adhesion. Ten test panels shall be prepared in accordance with 4.4.1. The ten panels shall then be over-coated and tested as follows:

- a. Two panels shall be coated with one coat of the same coating system originally applied to the panel, at the manufacturer's recommended per coat DFT listed on the ASTM F718 sheet. After this coat has dried through as defined in ASTM D5895, a second coat of the product shall be applied to both panels, at the manufacturer's recommended per coat DFT. The panels shall be allowed to cure-to-service at referee conditions per the manufacturer's ASTM F718 sheet. If the total system DFT is greater than or equal to 15 mils, the overcoat adhesion of each panel shall be determined in accordance with ASTM D3359, Method A. If the total system DFT is less than 15 mils, the overcoat adhesion of each panel shall be determined in accordance with ASTM D3359, Method B. If the total DFT is between 5-10 mils, the spacing between the lines in the Method B cross-hatch shall be doubled. If the total DFT is between 10-15 mils, the Method B line spacing shall be tripled.

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- b. Two panels shall be coated with one coat of MIL-DTL-24441/20 or MIL-DTL-24441/29, Type III or IV formula 150 at a nominal wet film thickness of 0.076 to 0.101 mm (0.003 to 0.004 inch). After the panels have cured at referee conditions for 7 days, both panels shall be overcoated with the topcoat of the system being tested, applied at the manufacturer's recommended per-coat DFT listed on the ASTM F718 sheet. The panels shall be allowed to cure-to-service at referee conditions per the manufacturer's ASTM F718 sheet. The overcoat adhesion of each panel shall be determined in accordance with ASTM D3359, Method B. If the total DFT is between 5-10 mils, the spacing between the lines in the Method B cross-hatch shall be doubled. If the total DFT is between 10-15 mils, the Method B line spacing shall be tripled.
- c. Two panels shall be coated with one coat of MIL-PRF-24647 at a nominal wet film thickness of 0.076 to 0.101 mm (0.003 to 0.004 inch). After the panels have cured at referee conditions for 7 days, both panels shall be overcoated with the topcoat of the system being tested, applied at the manufacturer's recommended per-coat DFT listed on the ASTM F718 sheet. The panels shall be allowed to cure-to-service at referee conditions per the manufacturer's ASTM F718 sheet. The overcoat adhesion of each panel shall be determined in accordance with ASTM D3359, Method B. If the total DFT is between 5-10 mils, the spacing between the lines in the Method B cross-hatch shall be doubled. If the total DFT is between 10-15 mils, the Method B line spacing shall be tripled.
- d. Two panels shall be coated with one coat of TT-P-645 Navy formula 84 at a nominal wet film thickness of 0.076 to 0.101 mm (0.003 to 0.004 inch). After the panels have cured at referee conditions for 7 days, both panels shall be overcoated with the topcoat of the system being tested, applied at the manufacturer's recommended per-coat DFT listed on the ASTM F718 sheet. The panels shall be allowed to cure-to-service at referee conditions per the manufacturer's ASTM F718 sheet. The overcoat adhesion of each panel shall be determined in accordance with ASTM D3359, Method B. If the total DFT is between 5-10 mils, the spacing between the lines in the Method B cross-hatch shall be doubled. If the total DFT is between 10-15 mils, the Method B line spacing shall be tripled.
- e. Two panels shall be coated with one coat of the primer for any system qualified to MIL-PRF-23236, Type VII, in accordance with the manufacturer's ASTM F718 for the primer selected. After the panels have cured at referee conditions for 7 days, both panels shall be overcoated with the topcoat of the system being tested, applied at the manufacturer's recommended per-coat DFT listed on the ASTM F718 sheet. The panels shall be allowed to cure-to-service at referee conditions per the manufacturer's ASTM F718 sheet. The overcoat adhesion of each panel shall be determined in accordance with ASTM D3359, Method B. If the total DFT is between 5-10 mils, the spacing between the lines in the Method B cross-hatch shall be doubled. If the total DFT is between 10-15 mils, the Method B line spacing shall be tripled.

4.5.21 Flexibility. Coating film flexibility shall be determined in accordance with ASTM D522. The test panel shall be a flat metal plate of approximately 31 gauge. The panel shall be primed with either the primer specified by the manufacturer as part of the coating system, or a primer conforming to MIL-DTL-24441. The coating system shall then be applied to the primed panel, allowed to air-dry for 2 hours, and then baked for 24 hours at 100 to 105 °C (212 to 221 °F). The panel shall then be removed from the oven and allowed to stand for 30 minutes at laboratory temperature [nominal 23 °C (73 °F)]. The panel shall then be bent over a 6-mm (1/4-inch) mandrel or a tapered mandrel where the minimum diameter is 6 mm (1/4 inch) and the film examined at the bent under a magnification of five diameters.

4.5.22 Water resistance. Two panels shall be prepared in accordance with 4.4.1. A film of coating shall be applied to both test panels by drawing down in accordance with ASTM D823 to the manufacturer's recommended total system DFT. The coating film shall be allowed to cure to service per manufacturer's ASTM F718 sheet at referee conditions. Exposed uncoated metal surfaces shall be coated with wax or a primer conforming to MIL-DTL-24441. One panel shall then be immersed in distilled water at 23±1 °C (73±2 °F) for 18 hours in accordance with ASTM D1308. The exposed panel shall be examined for blistering per ASTM D714, and visually compared to the second, unexposed panel.

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4.5.23 Accelerated weathering. Two panels shall be prepared in accordance with 4.4.1, with the exception that the panels shall be 4 by 6 by 0.125 inches of cold rolled steel. The coating system shall then be applied to the panels by drawing down films of coating in accordance with ASTM D823 to the manufacturer's recommended total system DFT. The panels shall be allowed to cure to service per manufacturer's ASTM F718 data sheet at referee conditions. The initial color of the test panels shall be measured in accordance with ASTM E1347 on any suitable instrument. The initial 60-degree gloss of the test panels shall be measured in accordance with ASTM D523. The panels shall be exposed for 300 hours to accelerated weathering using Fluorescent UV-Condensation type apparatus in accordance with ASTM G154. The cycle shall be 4 hours UV exposure using a UVB-313 bulb at 60 °C (140 °F) and 4 hours condensation exposure at 40 °C (104 °F). After exposure, color and gloss shall be measured again in accordance with ASTM E1347 and D523. The color difference shall be calculated in accordance with ASTM D2244, and the gloss change shall also be calculated. Any chalking shall be evaluated in accordance with ASTM D4214.

4.5.24 Anti-stain. Four steel test panels shall be prepared in accordance with 4.4.1, with the exception that the panels shall be 4 by 6 by 0.125 inch cold-rolled steel. The coating 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 inches 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.

All four panels shall then 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 system panels.

4.5.25 Long-term exterior exposure. Four test panels shall be prepared in accordance with 4.4.1. The coating system shall be applied to the required total system DFT and allowed to cure to service per the manufacturer's ASTM F718 sheet between applications of each coat at referee conditions. The painted panels shall be cured for at least 7 days prior to mounting on the test rack. After this cure period, the 60-degree gloss for each panel shall be determined in accordance with 4.5.17 and recorded. 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 ASTM D1014. The fence shall be at a facility approved by the qualifying authority. Prior to initiating the test, photograph the wall of test panels (include a gray color scale in all photos and develop photographs to the scale). The test panels shall be exposed for period of 1 year (365 days). All panels shall be evaluated for checking in accordance with ASTM D660, cracking in accordance with ASTM D661, blistering in accordance with ASTM D714, and chalking in accordance with ASTM D4214. The 60 degree gloss for each panel shall again be determined in accordance with 4.5.17, and recorded. The gloss measurement for a panel after exposure shall be divided by the gloss measurement recorded before exposure for that panel, and the result multiplied by 100% to obtain the percent gloss retention for each panel. The percent gloss retention for all four panels shall be averaged, and the result recorded. Two of the exposed panels shall then be tested for adhesion in accordance with ASTM D3359, Method A for coatings with a total system DFT of greater than 15 mils, and Method B for coatings with a total system DFT of 15 mils or less. If the total DFT is between 5-10 mils, the spacing between the lines in the Method B cross-hatch shall be doubled. If the total DFT is between 10-15 mils, the Method B line spacing shall be tripled.

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4.5.26 Recoat. The remaining two test panels exposed in accordance with 4.5.25 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 referee conditions. The coating system topcoat shall then be brush applied to ½ of each of the two panels and the overcoated panels shall be cured for 48 hours at referee conditions. For coatings with a total system DFT greater than or equal to 15 mils, the adhesion of the overcoated panel shall be determined in accordance with ASTM D3359, Method A. For coatings with a total system DFT less than 15 mils, the adhesion of the overcoated panels shall be determined in accordance with ASTM D3359, Method B. If the total DFT is between 5-10 mils, the spacing between the lines in the Method B cross-hatch shall be doubled. If the total DFT is between 10-15 mils, the Method B line spacing shall be tripled.

4.5.27 Serviceability. The coating shall be applied in NAVSEA designated or approved representative areas aboard a U.S. Naval vessel for a minimum service period of 6 months.

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.

5.2 Label. Manufacturer shall prepare container label instructions for the coating in accordance with the requirements of 29 CFR 1910, 1915, 1917, 1918, 1926, and 1928 - Hazard Communication (see 6.8). To comply with the Environmental Protection Agency (EPA) National Emission Standards for Hazardous Air Pollution (NESHAP) requirements for shipbuilding and ship repair, the following two statements shall appear on each paint can label:

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

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 high grade coatings intended for use on exterior topside surfaces that are highly weather-resistant and characterized by excellent color and gloss retention, good drying, freedom from aftertack, and good flexibility. These coatings are non-lead, non-chromate, and non-asbestos containing materials. These coatings have been formulated to comply with air pollution regulations which allow a maximum VOC of 250 grams of solvent minus water per liter of paint (2.08 lb/gal) as delivered, and with California regulations which allow a maximum VOC of 100 g/L. These products are not to be thinned for any means of application. The coating may be applied with brush, roller or spray.

6.2 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number, and date of this specification.
- b. Color (FED-STD-595 color designation nomenclature recommended), Type, Class and Grade required (see 1.2).
- c. The specific issue of individual documents referenced (see 2.2.1, 2.2.2, and 2.3).
- d. Packaging requirements (see 5.1 and 6.9).
- e. Whether MSDS and ASTM F718 data sheets are required with each shipment (see 6.4).
- f. Batch VOC certification (see 6.7).

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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 qualification data set (QDS) No. 24635, 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 05Q, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or emailed to CommandStandards@navy.mil.

6.4 Material safety data sheets. Contracting officers will identify those activities requiring companies of completed Material Safety Data Sheets prepared in accordance with FED-STD-313. In order to obtain the MSDS, FAR clause 52.223-3 must be in the contract.

6.5 Toxicity evaluation. The NEHC requires sufficient information to permit a HHA of the product. Any questions concerning toxicity and requests for HHA should be addressed to the Commanding Officer, Navy Environmental Health Center, ATTN: Hazardous Materials Department, Industrial Hygiene Directorate, 620 John Paul Jones Circle, Suite 1100, Portsmouth, VA 20378-2103. Upon receipt of the HHA, a copy should be provided to Commander, Naval Sea Systems Command, ATTN: SEA 05M1, 1333 Isaac Hull Ave., SE, Stop 5133, Washington Navy Yard DC 20376-5133.

6.6 Unit of procurement. The paint covered by this specification should be purchased by volume of mixed coating, the unit being 1 liter or 1 U.S. liquid gallon at 15.5 °C (60 °F).

6.7 Volatile content. Contracting officers will require the contractor to provide the Government with a written Volatile Organic Content (VOC) certification, as described in 40 CFR 63.785(a)(2), for each batch of coating product from which any quantity of the coating product is supplied to the Government under the contract. The Government reserves the right to reject as defective any coating product for which the VOC certification has not been provided.

6.8 Material safety data sheets and ASTM F718. 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-131. Contracting officers will also require ASTM F718 data sheets to be included with each shipment of the material covered by this specification (see 6.2).

6.9 Suggested packaging requirements. Suggested packaging is contained in Table 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). For two component paints, the components should be sized to provide mixed coating in multiples of 1 U.S. liquid gallon or 1 L at 15.5 °C (60 °F).
Containers	<ul style="list-style-type: none"> (a) The components should be furnished in cans of appropriate volume such as 3.78L (1-gallon) or multiples thereof. (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. (c) Pails should be to PPP-P-704. (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). (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.
Intermediate containers	<ul style="list-style-type: none"> (a) Paints should be packaged in intermediate containers. (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. ASTM D4727 classes should be domestic fire-retardant or weather-resistant fire-retardant as specified.
Commercial packaging	<ul style="list-style-type: none"> (a) Commercial packaging should be to ASTM D3951. (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).
Packing	<p>Packing should be specified as follows:</p> <ul style="list-style-type: none"> (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. (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. (c) 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.
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> <ul style="list-style-type: none"> (a) General use, weather-resistant: MIL-L-19140, Type II, Category I. (b) General use, non-weather-resistant: MIL-L-19140, Type I, Category I.
MSDS and ASTM F718	A copy of the MSDS and ASTM F718 should be attached to the shipping document for each destination (see 6.4).
VOC certification sheets	VOC certification sheets for each batch of coating will be provided when requested by the procuring activity.

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TABLE VIII. Suggested marking.

Marking type	Recommended marking
Bar codes	Marking should include bar codes
Hazardous warnings	<p>(a) Labels should be in accordance with 29 CFR Parts 1910, 1915, 1917, 1918, 1926, and 1928.</p> <p>(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.”</p> <p>(c) Each component container, shipping container, and palletized load should be marked with the appropriate hazardous symbol in accordance with FED-STD-313.</p>
Volatile organic content (VOC)	“Contains (insert VOC content) grams per liter (insert VOC content in lb/gal) of volatile organic content per 40 CFR 60, Appendix A (EPA) Method 24. Maximum thinning allowed is (insert number in g/L, lb/gal, and volume/gal [if appropriate]).”
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.
Hazardous air pollutants	“Contains [insert HAP content here in g/L and lb/gal] solids (nonvolatiles) per 40 CFR 63.”

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TABLE IX. FED-STD-595 color numbers and descriptions.^{1/2/}

Class			Word description
(1)Gloss	(2)Semi-gloss	(3)Low gloss ^{3/}	
10371	---	---	Spar (U.S. Coast Guard)/buff (piping and valve marking)
---	26008	---	Low solar absorbent Gray (26008 for replacement of DOD-E-699 formula 20) (also with anti-stain properties)
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	Low solar absorbent gray # 17 (ocean gray, color #26173)
---	26231	36231	Gray # 23 (36231 for replacement of MIL-DTL-700 formula 20L)
---	26270	36270	Low solar absorbent gray # 27 (haze gray; 26270 for Navy semi-gloss requirements (also with anti-stain properties)
16307	26307	36307	Gray # 30 (Bulkhead gray)
---	26373	36373	Low solar absorbent Gray # 37 (Light Gray, Color #26373)
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)

NOTES:

- 1/ See FED-STD-595 for color cards.
- 2/ Table IX 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.
- 3/ Low gloss colors will be matched to the semi-gloss color chip.

6.10 Subject term (key word) listing.

Alkyd
 Anti-stain
 Gloss
 Low-gloss
 Low solar absorbant
 Non-lead
 Paint
 Polyol
 Polysiloxane
 Polyurea
 Polyurethane
 Semi-gloss
 Topcoat

6.11 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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Custodians:

Army – MI
Navy – SH
Air Force – 99

Preparing Activity:

Navy – SH
(Project 8010-2006-028)

Review Activities:

Army – MR
Navy – AS, CG
Air Force – 84

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>.