

METRIC

MIL-PRF-23236C

12 August 2003

SUPERSEDING

MIL-PRF-23236B

11 August 1988

## PERFORMANCE SPECIFICATION

## COATING SYSTEMS FOR SHIP STRUCTURES

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

## 1. SCOPE

1.1 Scope. This specification covers five types of air pollution regulated ship and structure coatings that comply with the National Emission Standards for Hazardous Air Pollutants (NESHAP) for shipbuilding for state and federal regulations (except Type VIII and VIIIA). There are 17 classes of coating systems. There are four grades of coating systems based on temperature of application and cure. In addition to tanks, all paint systems qualified to this specification are suitable for use on any ship structures, interior or exterior, for corrosion control. Except for trace levels, all types are free of Lead, Chromium, Cadmium, and Asbestos (see 3.2.3). All types, except type IV, have levels of hazardous air pollutants (HAPs) that do not exceed applicable NESHAP levels (see 3.2.2). Dry Type V, VI, VII and VIII coating residues and debris are non-hazardous waste under U.S. Environmental Protection Agency (USEPA) regulations in effect on the date of this specification. Type VII coating will not have any solvent added to either the base resin component or the hardener component.

1.2 Classification.

1.2.1 Types. The types of coating systems are as follows:

- |         |   |   |
|---------|---|---|
| Type IV | - | A coating system with a maximum volatile organic content (VOC) of 340 grams per liter (g/L) (2.83 pounds per gallon (lb/gal), except for classes requiring use of an inorganic binder shop primer (see 3.2.2.2 and 6.6.5). May be used in any air quality management district regulating VOC. Use of pigments that are hazardous to workers is restricted (see 3.2.3.1).  |
| Type V  | - | A coating system having a maximum VOC content of 340 g/L (2.83 lb/gal) of coating, except for classes requiring use of an inorganic binder shop primer (see 3.2.2.2 and 6.6.5). Hazardous air pollutants (HAPs) in the solvent will not exceed VOC levels. (see 3.2.2.3). Use of pigments that are hazardous to workers or create hazardous waste is restricted to trace levels (see 3.2.3.2). May be used in any air quality management district regulating VOC. Dry coating is not a hazardous waste under USEPA regulations. |

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@navsea.navy.mil](mailto:commandstandards@navsea.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 [www.dodssp.daps.mil](http://www.dodssp.daps.mil).

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- Type VI - A coating system having a maximum VOC content of 250 g/L (2.08 lb/gal) of coating, except for classes requiring use of an inorganic binder shop primer (see 3.2.2.2 and 6.6.5). Hazardous air pollutants (HAPs) in the solvent will not exceed VOC levels (see 3.2.2.3). Use of pigments that are hazardous to workers or create hazardous waste is restricted (see 3.2.3.2). May be used in any air quality management district regulating VOC. Dry coating is not a hazardous waste under USEPA regulations.
- Type VII - A coating system having a maximum VOC content of 150 g/L (1.25 lb/gal) of coating, except for classes requiring use of an inorganic binder shop primer (see 3.2.2.2 and 6.6.5). Hazardous air pollutants (HAPs) in the solvent will not exceed VOC levels (see 3.2.2.3). Use of pigments that are hazardous to workers or create hazardous waste is restricted to trace levels (see 3.2.3.2). May be used in any air quality management district regulating VOC. Dry coating is not a hazardous waste under USEPA regulations. Coatings proposed for qualification testing to this Type have no solvent added to either the base resin component or the hardener component.
- Type VIII - Non-metallic functional powder coating system for severe marine service having a maximum VOC of 75 grams of solvent per 4.54 kilograms (0.17 pounds of solvent per 10 pounds) of powder.
- Type VIIIa - Functional powder coating system with two coats which may contain zinc for severe marine service with a maximum VOC of 75 grams of solvent per 4.54 kilograms (0.17 pounds of solvent per 10 pounds) of powder.

1.2.2 Classes. The classes of coating systems are as follows:

- Class 5 - A coating system without a shop primer (see 6.6.5) for use in fuel tanks, seawater ballasted fuel tanks, seawater tanks, and bilges and other ship structures interior and exterior. Class 5 coatings are not for use in tanks that may be used for fresh or potable water.
- Class 6 - A coating system where the first coat is a shop primer (see 6.6.5) for use in fuel tanks, seawater ballasted fuel tanks, seawater tanks, and bilges and other ship structures interior and exterior. Class 6 coatings are not for use in tanks that may be used for fresh or potable water.
- Class 7 - A coating system without a shop primer (see 6.6.5) for use in dedicated seawater ballast tanks. Class 7 coatings are not for use in tanks that may be used for freshwater, potable water, fuels, or other hydrocarbons.
- Class 8 - A coating system where the first coat is a shop primer (see 6.6.5) for use in dedicated seawater ballast tanks. Class 8 coatings are not for use in tanks that may be used for freshwater, potable water, fuels, or other hydrocarbons.
- Class 9 - A coating system without a shop primer (see 6.6.5) for use in dedicated potable or freshwater tanks. Class 9 coatings are not for use in tanks that may be used for seawater, fuels, or other hydrocarbons.
- Class 10 - A coating system where the first coat is a shop primer (see 6.6.5) for use in dedicated potable or freshwater tanks. Class 10 coatings are not for use in tanks that may be used for seawater, fuels, or other hydrocarbons.
- Class 11 - A coating system without a shop primer (see 6.6.5) for use in dedicated boiler feedwater (pure water) tanks. Class 11 coatings may not be used for seawater, potable water, freshwater, fuels or other hydrocarbons.
- Class 12 - A coating system which includes a shop primer (see 6.6.5) as the first coat for use in dedicated boiler feedwater (pure water) tanks. Class 12 coatings may not be used for seawater, potable water, freshwater, fuels or other hydrocarbons.
- Class 13 - A coating system without a shop primer (see 6.6.5) for use in dedicated chemical holding (ship sewage/waste) tanks (CHT tanks). Class 13 coatings may not be used for seawater, potable water, freshwater, fuels or other hydrocarbons.

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- Class 14 - A coating system which includes a shop primer (see 6.6.5) as the first coat for use in dedicated chemical holding (ship sewage/waste) tanks (CHT tanks). Class 14 coatings may not be used for seawater, potable water, freshwater, fuels or other hydrocarbons.
- Class 15a - A coating system intended as a repair or touch-up coating, without a shop primer, for use over oily surfaces that are prepared to bare metal surfaces where paint has been removed to the bare metal substrate.
- Class 15b - A coating system intended as a repair or touch-up coating, without a shop primer, for use over wet surfaces that are prepared to bare metal surfaces where the paint has been removed to the bare metal substrate.
- Class 15c - A coating system intended as a repair or touch-up coating, without a shop primer, for application and cure under (salt) water.
- Class 16 - A coating system without a shop primer for use as a deck coating in high wear areas such as passageways and machinery space decks.
- Class 17 - A coating system without a shop primer intended for use on properly cleaned and prepared bilge surfaces.
- Class 18 - A single-coat coating system without a shop primer.
- Class 19 - A coating system without a shop primer intended for use on well deck overhead areas of Landing Craft Air Cushion (LCAC) capable ships.

1.2.3 Grades. The grades of coating systems are as follows:

- Grade A - A coating system which can be applied down to a temperature of 32 °F (0 °C) and cured down to a temperature of 25 °F (-4 °C).
- Grade B - A coating system which is to be applied, and cured at temperatures above 32 °F (0 °C) up to 49 °F (10 °C).
- Grade C - A coating system which is to be applied and cured at a temperature above 50 °F (11 °C).
- Grade D - Powder coatings cured at a high temperature in accordance with manufacturer's instructions in order to meet all performance requirements of this specification.

## 2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 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 documents cited in sections 3 and 4 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 listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation (see 6.2).

## SPECIFICATIONS

### DEPARTMENT OF DEFENSE

- MIL-DTL-5624 - Turbine Fuel, Aviation, Grades JP-4, JP-5, and JP-5/JP-8 ST.
- MIL-DTL-24441/29 - Paint, Epoxy-Polyamide, Green Primer, Formula 150, Type IV.
- MIL-DTL-24441/35 - Paint, Epoxy-Polyamide, Red, Formula 156, Type IV.

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## STANDARDS

## FEDERAL

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

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Department of Defense Single Stocking Point for Specifications and Standards (DoDSSP), Standardization Document Order Desk, 700 Robbins Avenue, Bldg. 4D, Philadelphia, PA 19111-5094 or <http://astimage.daps.dla.mil/quicksearch/> or [www.dodssp.daps.mil](http://www.dodssp.daps.mil))

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

## PUBLICATIONS

## CODE OF FEDERAL REGULATIONS (CFR)

- 40 CFR 60, Appendix A, 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 Shipbuilding and Ship Repair (Surface Coating) Operations
- 40 CFR 82 - Protection of Stratospheric Ozone.
- 40 CFR 261, Appendix II, Method 1311
  - Toxicity Characteristic Leaching Procedure (TCLP).
- 40 CFR 355 Appendices A and B
  - The List of Extremely Hazardous Substances and Their Threshold Planning Quantities.
- 40 CFR 372.65 - Specific Toxic Chemical Listings.
- 29 CFR 1910, 1915, 1917, 1918, 1926, and 1928
  - Hazard Communication.
- 29 CFR 1990 - Identification, Classification, and Regulation of Potential Occupational Carcinogens.

(The Code of Federal Regulations (CFR) is for sale on a subscription basis by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 or <http://www.access.gpo.gov/nara/cfr/>. When indicated, reprints of certain regulations may be obtained from the Federal agency responsible for issuance thereof.)

## U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES

## NATIONAL INSTITUTE OF ENVIRONMENTAL HEALTH SCIENCES (NIEHS)

National Toxicology Program (NTP) latest annual Report on Carcinogens

(Application for copies of the NTP report should be addressed to NIEHS, Public Information Office, MD B2-04, Research Triangle Park, NC 27709 or <http://library.niehs.nih.gov/>.)

## DEPARTMENT OF LABOR

## OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA)

Validated Analytical Method ID-191, "Polarization Light Microscopy of Asbestos"

(Copies of OSHA documents can be obtained from <http://www.osha.gov/>.)

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NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH  
 NIOSH Analytical Method 7500, "SILICA, CRYSTALLINE, by XRD"

(Copies of NIOSH documents can be obtained from <http://www.cdc.gov/niosh>.)

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 the documents which are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)  
 ACGIH 0026 - Documentation of the Threshold Limit Value and Biological Exposure Indices.

(Application for copies should be addressed to the American Conference of Governmental Hygienists, 1330 Kemper Meadow Drive, Cincinnati, OH 45240.)

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)  
 ANSI Z400.1 - Hazardous Industrial Chemicals - Material Safety Data Sheets, Preparation

(Application for copies should be directed to the American National Standards Institute, 11 West 42<sup>nd</sup> Street, New York, NY 10036 or <http://www.ansi.org>.)

AMERICAN PUBLIC HEALTH ASSOCIATION (APHA)  
 Standard Methods for the Examination of Water and Wastewater, 20<sup>th</sup> Edition, 1998  
 2120 B - Visual Comparison Method  
 2150 B - Threshold Odor Test  
 2160 B - Flavor Threshold Test  
 4500 Cl-F - DPD Colorimetric Method  
 5330 C or D - Phenol, Direct Photometric Method

(Application for copies should be addressed to the American Public Health Association, 1015 Fifteenth Street, NW, Washington DC 20036.)

ASTM INTERNATIONAL  
 ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus  
 ASTM D93 - Standard Test Methods for Flash-Point by Pensky-Martens Closed Cup Tester. (DoD adopted)  
 ASTM D130 - Standard Method for Detection of Copper Corrosion from Petroleum Products by the Copper Strip Tarnish Test. (DoD adopted)  
 ASTM D156 - Standard Test Method for Saybolt Color of Petroleum Products (Saybolt Chromometer Method). (DoD adopted)  
 ASTM D381 - Standard Test Method for Gum Content in Fuels by Jet Evaporation. (DoD adopted)  
 ASTM D523 - Standard Test Method for Specular Gloss. (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 D910 - Standard Specification for Aviation Gasolines. (DoD adopted)  
 ASTM D1141 - Standard Practice for Substitute Ocean Water. (DoD adopted)  
 ASTM D1193 - Standard Specification for Reagent Water. (DoD adopted)  
 ASTM D1655 - Standard Specification for Aviation Turbine Fuels.  
 ASTM D2244 - Standard Test Method for Calculation of Color Differences from Instrumentally Measured Colored Coordinates. (DoD adopted)

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- ASTM D3272 - Standard Practice for Vacuum Distillation of Solvents From Solvent-Reducible Paints for Analysis.
  - ASTM D3278 - Standard Test Methods for Flash Point of Liquids by Small Scale Closed-Cup Apparatus. (DoD adopted)
  - ASTM D4060 - Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser.
  - ASTM D4138 - Standard Test Methods for Measurement of Dry Film Thickness of Protective Coating Systems by Destructive Means.
  - ASTM D4400 - Standard Test Method for Sag Resistance of Paints Using a Multinotch Applicator.
  - ASTM D4417 - Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel.
  - ASTM D4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
  - ASTM D4585 - Standard Practice for Testing Water Resistance of Coatings Using Controlled Condensation.
  - ASTM E260 - Standard Practice for Packed Column Gas Chromatography.
  - ASTM E1252 - Standard Practice for General Techniques for Obtaining Infrared Spectra for Qualitative Analysis.
  - ASTM F718 - Standard for Shipbuilders and Marine Paints and Coatings Product/Procedure Data Sheet. (DoD adopted)
  - ASTM G8 - Standard Test Method for Cathodic Disbonding of Pipeline Coatings
- ASTM and Other Specifications and Classifications for Petroleum Products and Lubricants, 6th Edition.

(Application for copies should be addressed to the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959 or <http://www.astm.org/>.)

INTERNATIONAL AGENCY FOR RESEARCH ON CANCER (IARC)  
International Agency for Research on Cancer (IARC) Monographs

(Application for copies should be addressed to the World Health Organization (WHO), Publication Center, 49 Sheridan Avenue, Albany, NY 12210.)

NSF INTERNATIONAL (NSF)  
NSF Standard 61 - Drinking Water System Components - Health Effects.

(Application for copies or information concerning qualification should be addressed to NSF International, 3475 Plymouth Road, Anne Arbor, MI 48113-0140.)

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)  
SSPC PA2 - Measurement of Dry Paint Thickness with Magnetic Gages.  
SSPC SP-10 - Near-White Blast Cleaning.  
SSPC SP-11 - Tool Cleaning to Bare Metal  
SSPC SP-15 - Commercial Grade Power Tool Cleaning

(Requests for copies should be addressed to the Society for Protective Coatings (SSPC), 40 24<sup>th</sup> Street, 6<sup>th</sup> Floor, Pittsburgh, PA 15222.)

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. Relative to preconstruction primers or shop primers, this document does not supersede ship fabrication documents. (see 6.1.1.3)



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## 3. REQUIREMENTS

3.1 Qualification. Coating systems furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified products list before contract award (see 4.2 and 6.3). Qualification inspection shall consist of compliance with Table I, Table II and Table III (Type VIII and Type VIIIa), verification of Table IV identification characteristics and compliance with all other applicable requirements of this specification.

3.1.1 Description of coatings. At the time of qualification submittal, manufacturer shall identify all coatings and coating components constituting the coating system being qualified by (a) Type, Class, and Grade for which qualification is sought, and (b) unique product nomenclature. At a minimum, this unique product nomenclature shall consist of component name, alpha-numeric identifier and color. Nomenclature shall be as specific as necessary to uniquely identify each total system component.

3.2 Materials. Each individual component and mixed final coating of the total coating system qualified to this specification shall, when mixed and applied in accordance with the manufacturer's instructions, be in accordance with the appropriate requirements. The composition of the coating furnished to this specification shall be the responsibility of the manufacturer, except as limited by this specification.

3.2.1 Description. Where coatings are composed of components to be mixed at the time of application, the proportions for the ratio of resin component to hardener shall be 4:1, 3:1, 2:1 or 1:1 by volume. Except for Type VIII (all Classes) and Class 18 (all Types) coatings, the coating system shall consist of at least two full coats (excluding shop primer) (see 6.6.3 and 6.6.5).

3.2.2 Component chemistry (except Type VIII and Type VIIIa). All coating systems, except the shop primer (see 6.6.5), shall be composed of two components: (a) one component shall contain (see 6.6.6) chemically cross linking resins (base) and (b) a second component which shall contain a curing agent (converter). The composition of the shop (preconstruction) primer (see 6.6.5) shall be the manufacturer's responsibility.

3.2.2.1 Powder coatings. Type VIII and Type VIIIa powders are single component materials and shall be applied by industry accepted application procedures in accordance with the powder manufacturers' instructions to obtain the performance requirements in this specification.

3.2.2.2 VOC limits. When tested as specified in 4.5.5, the VOC of all individual coatings of coating systems, except for inorganic binder shop primers (see 6.6.5) containing zinc metal as the major pigment (zinc rich), shall not be greater than that allowed for the type being qualified. Inorganic binder based shop primer (see 6.6.5) containing zinc metal as the major pigment (zinc rich) shall have a VOC not greater than 650 g/L (5.35 lb/gal) of solvent per liter of coating minus water. The selection of coating system solvents portion of Type IV coating systems is the responsibility of the manufacturer within the limitations of 3.2.2 and 3.2.3.1.

3.2.2.3 Hazardous air pollutant (HAP) content of types V, VI, VII, VIII and VIIIa coatings. When evaluated as specified in 4.5.6, the content of HAPs solvents in each individual liquid coating, including the shop primers (see 6.6.5), of Types V, VI, VII, VIII and VIIIa shall be not greater than the VOC limit prescribed for the specific types. Within this limitation and the requirement that the finished coating meet all requirements of this specification, Types V, VI and VII coating system solvent selection is the responsibility of the manufacturer.

3.2.3 Hazardous pigments and additives.

3.2.3.1 Type IV. When tested as specified in 4.5.10, Type IV coatings shall not contain the following materials in excess of the percentage by weight (%wt) of the dry coating listed:

- a. Asbestos or asbestos-form pigments - 0.0005%wt.
- b. Lead or its compounds - 0.005%wt.
- c. Cadmium or its compounds - 0.0005%wt.

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- d. Chromium or its chromium (III) compounds - 0.56%wt.
- e. Chromium (VI) compounds - 0.0005%wt.
- f. Crystalline silica - 1.0%wt.

3.2.3.2 Types V, VI, VII, VIII and VIIIa. When tested as specified in 4.5.10, the content of each soluble metal and total content of each metal of the coating shall not be greater than the values listed in Tables I and II. In addition, asbestos and asbestos form pigments shall not exceed 5 milligrams per liter (mg/L). Crystalline silica shall not exceed 1 percent by weight. If the total metal content for an individual metal is less than the allowed soluble metal content for that metal, the total metal value may be submitted for the soluble metal value and the actual test for soluble metal need not be performed.

TABLE I. Soluble metals content for types V, VI, VII, VIII and VIIIa coatings.

| <b>Soluble metal and/or its compound in each individual dry paint</b> | <b>Maximum, mg/L</b> |
|---|----------------------|
| Antimony  | 15                   |
| Arsenic   | 0.001                |
| Barium (excluding barite)   | 100                  |
| Beryllium   | 0.75                 |
| Cadmium   | 1                    |
| Chromium (VI)   | 5                    |
| Chromium and/or chromium (III)  | 560                  |
| Cobalt  | 80                   |
| 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 II. Total metals content for types V, VI, VII, VIII and VIIIa coatings.

| <b>Metal or its compounds in each individual dry paint</b> | <b>Maximum, %wt</b> |
|--|---------------------|
| Antimony   | 0.015               |
| Arsenic  | 0.001               |
| Asbestos   | 0.0005              |
| Barium (excluding barite)                                  | 0.10                |
| Beryllium  | 0.0002              |
| Cadmium  | 0.0005              |
| Chromium (VI) compounds                                    | 0.0005              |
| Chromium or Chromium (III) compounds                       | 0.56                |
| Cobalt*  | 0.005               |
| Copper   | 0.01                |
| Fluoride salts   | 0.18                |

TABLE II. Total metals content for types V, VI, VII, VIII and VIIIa coatings - Continued.

| <b>Metal or its compounds in each individual dry paint</b> | <b>Maximum, %wt</b> |
|--|---------------------|
| Lead   | 0.005               |
| Mercury  | 0.0002              |
| Molybdenum   | 0.35                |
| Nickel   | 0.02                |
| Selenium   | 0.001               |
| Silver   | 0.001               |
| Tantalum   | 0.100               |
| Thallium   | 0.007               |
| Tungsten   | 0.100               |
| Vanadium   | 0.01                |
| Zinc*  | 0.25                |

\* Total cobalt to effect drying of the coatings may exceed Table II limits and total zinc of shop primers may exceed Table II limits, but in neither case may soluble cobalt or soluble zinc exceed Table I limits. Zinc levels in Type VIIIa will exceed Table I and Table II limits since these coatings will contain sacrificial zinc for corrosion control.

3.3 Color and gloss (all types except type VIII and type VIIIa, all classes except class 16 and class 17, and all grades). When tested in accordance with the procedures of Table V, each topcoat of the coating systems shall have a 60-degree specular gloss of not less than 30 with the exception of specified primer or shop primer (see 6.6.5) coatings. Succeeding coats of the coating system shall be of contrasting color, and the top coat shall be white or a very light pastel shade. Primer shall be a contrasting color to the bare steel substrate.

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3.3.1 Color and gloss (types VIII and VIIIa). For the as-cured powder coatings to achieve the required performance of this specification, color and gloss of Type VIII and Type VIIIa powder coatings shall be within 0.5 Delta E ( $\Delta E$ ) unit of the following Federal Standard Number 595 Color Numbers; 60-degree specular gloss shall be as indicated below in Table III.

TABLE III. Color and gloss.

| Color                    | FED-STD-595 Color Number | Gloss (60° Specular)<br>Minimum/Maximum |
|--------------------------|--------------------------|---|
| Green (Formula 150)      | 24272                    | ---/7                                   |
| Haze Gray (Formula 151)  | 26270                    | ---/30                                  |
| White (Formula 152)      | 27886                    | 20/---                                  |
| Red (Formula 156)        | 20152                    | 5/25                                    |
| Light Gray (Formula 157) | 26622                    | 30/60                                   |
| Yellow (Formula 158)     | 23695                    | 20/---                                  |
| Beach Sand               | 22563                    | 35/60                                   |
| Rose-Wood                | 22519                    | 35/60                                   |
| Clipper Blue             | 24516                    | 35/60                                   |
| Sun Glow                 | 23697                    | 35/60                                   |
| Soft White               | 27880                    | 35/60                                   |
| Pastel Green             | 24585                    | 35/60                                   |
| Equipment Gray           | 26307                    | 35/60                                   |
| Green Gray               | 26496                    | 35/60                                   |
| Yellow Gray              | 26400                    | 35/60                                   |
| Pearl Gray               | 26493                    | 35/60                                   |
| Dark Gray                | 26081                    | 35/60                                   |
| Pastel Blue              | 25526                    | 35/60                                   |
| Black                    | 27038                    | 35/60                                   |

3.3.2 Color (classes 15, 16 and 17). Topcoat colors of Class 15, 16 and 17 coating systems shall be within 1.0 Delta E ( $\Delta E$ ) unit of the Federal Standard Number 595 colors #24272 Green, #26270 Haze Gray, #27886 White, #20109 Red, #26622 Light Gray and #27038 Black when tested in accordance with the procedures of Table V.

3.4 Potable and freshwater all types, classes 9 and 10 (all grades). See 4.5.11a and 4.5.11b for panel and test preparation.

3.4.1 NSF certification. Coatings for Class 9 and Class 10 shall be certified by NSF International to NSF Standard 61 for 500-gallon water storage tanks. The use of Underwriters Laboratories (UL) or other NAVSEA approved testing laboratories is also acceptable.

3.4.2 Color in water. When tested as specified in 4.5.11.1, color units shall not be greater than 10.

3.4.3 Taste in water. When tested as specified in 4.5.11.2, threshold taste values shall not be greater than 2.

3.4.4 Odor in water. When tested as specified in 4.5.11.3, threshold odor values shall not be greater than 2.

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3.4.5 Chlorine residual. When tested as specified in 4.5.11.4, chlorine residual shall not decrease in excess of 50 percent of concentration.

3.4.6 Phenol contamination. When tested as specified in 4.5.11.5, the cured film of each coating of the coating system shall not leach phenolic compounds in concentrations greater than 1 part per million (p/m).

3.4.7 Immersion resistance. When tested in accordance with 4.5.2.3, the total coating system shall show no pinhole rusting, cracking, loss of adhesion either between coats or to the substrate. There shall be no blistering rated in excess of ASTM D714, blister size number 4, Few. There shall be no surface imperfections (includes peeling) larger than 1.5 mm ( $1/16$ -inch) and any blistering shall be unbroken. Type VII coating system shall have no edge rusting. Blisters and surface imperfections smaller than 1.5 mm, which do not increase in size after the tenth cycle and that do not exceed 3 percent of the test panel surface area, shall not be considered failures. At the completion of the test, adhesion of the recoat to the original coating shall be at least 50 percent of that of the original coating area of the test panel to itself. Type VII edge rusting shall not exceed 0.1 percent of total edge length. Physical damage caused by handling may be ignored in condition evaluation.

3.5 Cathodic protection (CP) compatibility (all classes except 16, 17 and 19). When tested as specified in accordance with 4.5.16, the coating system shall not peel, flake, blister, dissolve or otherwise fail. Undercutting or peeling shall not exceed 4 percent of the area of the test panel and all undercutting and peeling shall be located adjacent to the holiday.

3.6 Drying or curing time (all types, all classes and all grades). When tested in accordance with the procedures of Table V, each individual coating of the coating system shall require not greater than 23 hours between coats for recoating and shall be ready for service within seven (7) days after the application of the last coat. Application and cure shall be at the temperature specified by the manufacturer. In the absence of manufacturer's guidance, the temperature selected shall be at the low end of the temperature range.

3.7 Flash point (all types, (except VIII and VIIIa), all classes, and all grades). When tested in accordance with the procedures of Table V, each individual coating of the coating system mixed for use shall not flash at temperatures lower than 38 °C (100 °F), except the shop primer (see 6.6.5), which shall not flash at a temperature lower than 10 °C (50 °F).

3.8 Application characteristics (all types (except type VIII and type VIIIa), all classes, and all grades). When tested as specified in 4.5.7 and 4.5.8, each individual coating of the coating system shall be readily applied by brush (touch up areas only), rolling and spray, using commercially available equipment specified by the manufacturer's data sheet. The coatings shall exhibit leveling without sagging when applied at film thickness recommended by the manufacturer. Manufacturer's product data sheets shall state at which temperature it will be necessary to use plural component spray equipment in order to achieve an acceptable surface appearance. Apply Type VIII and VIIIa in accordance with manufacturers instructions.

3.8.1 Edge coverage retention (Applicable to type VII, all classes and all grades). When tested as specified in 4.5.9, the retained percent dry film thickness (DFT) of coating on any single 90-degree outside edge test specimen shall be not less than 50 percent of the paint DFT on flat areas. The average coating (percent) retained on a 90-degree outside edge of no less than three specimens shall be an average minimum of 70 percent of the measured dry film thickness on the flat areas of the test specimen. There shall be no pin holes, cracks or other defects along the edge that extends more than 10 percent into the thickness of the coating on the edge, nor shall any defect extend completely to the metal of the test specimen. The edge coverage retention applies to the topcoat only and not to the primer.

3.8.2 Sag resistance (all types, classes and grades). When tested in accordance with Table V, sag resistance shall comply with the value submitted (3.12).

3.9 Immersion resistance (all types and grades). Any coating system failure prior to the completion of all class specific immersion cycles (see 4.5.2) shall constitute failure of the coating system to meet the requirements of this specification.

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3.9.1 Classes 5 and 6 (fuel and seawater). When tested as specified in 4.5.2.1, the total coating system shall show no pinhole rusting, cracking, loss of adhesion either between coats or to the substrate. There shall be no blistering rated in excess of ASTM D714, blister size number 4, Few. There shall be no surface imperfections (includes peeling) larger than 1.5 mm ( $\frac{1}{16}$ -inch) and any blistering shall be unbroken. Type VII coating system shall have no edge rusting. Blisters and surface imperfections smaller than 1.5 mm, which do not increase in size after the tenth cycle and that do not exceed 3 percent of the test panel surface area, shall not be considered failures. At the completion of the test, adhesion of the recoat to the original coating shall be at least 50 percent of that of the original coating area of the test panel to itself. Type VII edge rusting shall not exceed 0.1 percent of total edge length. Physical damage caused by handling may be ignored in condition evaluation.

3.9.2 Shop primer corrosion resistance (Class 6, 8, 10, 12, and 14). When prepared and tested as specified in 4.5.2(a), the shop primer shall protect the steel substrate for 1 year. After 1 year of exposure, the test panel shall be free of all iron corrosion products. Shop primer meeting the requirements of this specification may be retained for overcoating in non-critical areas such as interior habitability, work and machinery spaces, exterior freeboard, topside vertical areas and horizontal areas not scheduled to receive non-skid coating. Regardless of performance results, shop primer must be removed from critical ship areas such as tanks, bilges, voids, underwater hull, well deck overhead and topside horizontal areas where non-skid application is planned.

3.9.3 Classes 7 and 8 (seawater only). When tested as specified in 4.5.2.2, the total coating system shall show no pinhole rusting, loss of adhesion either between coats or to the substrate. There shall be no blistering rated in excess of ASTM D714, blister size number 4, Few. There shall be no surface imperfections (includes peeling) larger than 1.5 mm ( $\frac{1}{16}$ -inch) and any blistering shall be unbroken. Type VII coating system shall have no edge rusting. Blisters and surface imperfections smaller than 1.5 mm ( $\frac{1}{16}$ -inch), which do not increase in size after the tenth cycle and are not greater than 3 percent of the test panel surface area, shall not be considered failure. At completion of the test, adhesion of the recoat to the original coating shall be at least 50 percent of that of the original coating area of the test panel to itself. Type VII edge rusting shall not exceed 0.1 percent of total edge length. Physical damage caused by handling may be ignored in condition evaluation. For coating systems evaluated in Cycle B of paragraph 4.5.2.2.2, a "B1" rating must be achieved to meet this requirement.

3.10 Condition in container (all types, except VIII and VIIIa, all classes, and grades). When tested in accordance with the procedures of Table V, each individual coating component shall be usable; that is, shall be readily broken up with a paddle or mechanical stirring to a smooth uniform consistency, and shall not liver or show any other objectionable properties for at least one year. Coating shall apply satisfactorily when applied as specified in manufacturer's data sheet. See Table V.

3.10.1 Condition in container - types VIII and VIIIa. When tested to the appropriate section of the Table V test method, the Type VIII and Type VIIIa powders shall meet all applicable specification requirements when stored in original unopened containers at or below 72 °F (22 °C) and less than 50 percent relative humidity for a period of one year from date of manufacture.

3.11 Toxicity (all types, classes and grades). The materials used in the coating systems, unless specific material maximum levels are cited herein (see 3.2), shall have no known carcinogenic or potentially carcinogenic materials identified by OSHA as regulated carcinogens, or IARC latest monographs, or the latest NTP report, or ACGIH; and shall have no extremely hazardous substances (EHS) or toxic chemicals identified in 40 CFR 355 and 372, respectively. The manufacturer is responsible for maintaining carcinogenic free materials. The individual coatings shall not contain any of the following materials in excess of 0.06 percent by weight of the wet coating: chlorinated solvents, coal tar or coal tar derivatives (see 6.2 and 6.4). 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 of any individual coating of the coating system. The coating components and mixed coating shall have no adverse effect on the health of personnel when used for its intended purpose in accordance with the manufacturer's instructions. Questions pertinent to this toxicity requirement shall be referred by contracting activity to the qualifying activity. The qualifying activity will act as advisor to the contracting activity. The qualifying activity will arrange for review of questions by the appropriate departmental medical service.

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3.12 Identification characteristics (all types, classes and grades). Values for identification (ID) characteristics shall be those established for the product at the time submitted for qualification (see Table IV). The purpose of these values is to serve as a basis for determining that the material being offered is essentially the same as that which was approved under qualification testing. Identification characteristics for Grades A and B materials shall be at the low end of the temperature range. The qualification testing for all Types, Classes, and Grades shall be conducted at the low temperature in the range. Manufacturer shall provide ASTM method(s), FED-STD-141 methods, other consensus standards, or a copy of unique test methodology and any other necessary information on methodology used to determine reported ID characteristics.

TABLE IV. Identification characteristics values.

| Property   | Coating component <sup>1/</sup> | Coating <sup>2/</sup> | Coating system <sup>3/</sup> |
|--|---------------------------------|-----------------------|------------------------------|
| Chemical nature                                      | X                               |                       |                              |
| Principal constituents (10 percent or more of total) | X                               |                       |                              |
| Percent nonvolatile vehicle                          | X                               |                       |                              |
| Percent volatile                                     | X                               |                       |                              |
| Mass per liter (L) [gallon (gal)] <sup>6/</sup>      | X                               |                       |                              |
| Color  |                                 | X                     |                              |
| Viscosity <sup>6/</sup>                              |                                 | X                     |                              |
| Flash point <sup>6/</sup>                            | X                               | X                     |                              |
| Fineness of grind <sup>6/</sup>                      | X                               |                       |                              |
| Odor   | X                               | X                     |                              |
| Pot life <sup>5/</sup>                               |                                 | X                     |                              |
| Drying or curing time - Time to recoat               |                                 | X                     |                              |
| Gloss and appearance                                 |                                 | X                     |                              |
| Flexibility  |                                 | X                     | X                            |
| Mixing instructions <sup>5/ 6/</sup>                 |                                 |                       | X <sup>4/</sup>              |
| Application instructions                             |                                 | X <sup>4/</sup>       |                              |
| Sag resistance                                       |                                 | X <sup>5/</sup>       |                              |
| Fire resistance properties                           |                                 | X <sup>7/</sup>       | X <sup>7/</sup>              |

## Notes:

- <sup>1/</sup> Coating components are individually packaged components such as base component (part A) and converter component or hardener (part B). Indicates only applicable characteristics.
- <sup>2/</sup> Coating is the resin base and converter, and any other constituents, mixed for application.
- <sup>3/</sup> Coating system is the total system (number and types of coats and approximate dry film thickness as tested for qualification approval).
- <sup>4/</sup> Can be standard commercial or ASTM F718, except that shall include necessary 29 CFR Parts 1910, 1915, 1917, 1918, 1926 and 1928 and have attached, or incorporate, a Material Safety Data Sheet (MSDS) (see ANSI Z400.1).
- <sup>5/</sup> Not applicable to Types VIII and VIIIa. A minimum pot life of one hour is required.
- <sup>6/</sup> Not applicable to Type VIII or Type VIIIa.
- <sup>7/</sup> Manufacturer shall provide a flame spread index and a level of smoke generation, standard fire test method used and a list of standards organizations endorsing the results.

3.13 Aviation (JP-5 and F-76) fuel and gasoline (MOGAS and aviation gasoline) compatibility (All types, classes 5 and 6 all Grades). When tested as specified in 4.5.4, the cured total coating systems shall not contribute particulate or chemical contamination that is detrimental to subsequent logistics or aircraft operation. Particulate contamination occurs when solids, color bodies and fuel reaction bodies are leached from the coating. Chemical

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contamination evidences itself when the fuel becomes corrosive, shows increased existent gum, or suffers a loss in diethylene bromide.

3.13.1 Fuel color. When tested as specified in 4.5.4.2, the cured total coating system shall not effect the color of fuel:

- a. or JP-5 fuel: Saybolt color difference shall be not greater than 2.
- b. or aviation gas and MOGAS: there shall be no perceptible difference in color, turbidity, or precipitation.

3.13.2 Corrosion. When tested as specified in 4.5.4.3, JP-5 and aviation gas shall not become corrosive after contact with the coating system.

3.13.3 Existent gum. When tested as specified in 4.5.4.4, the cured total coating system effect on existent gum shall be as follows:

- a. The difference in existent gum (unwashed) shall be not greater than 4 milligrams (mg) per 100 milliliters (mL).
- b. The difference in existent gum (washed) shall be not greater than 2 mg per 100-mL.

3.13.4 Solids (total sediment). When tested as specified in 4.5.4.5, the total cured coating system shall not cause a difference in total sediment greater than 2 mg per liter (L).

3.13.5 Bromine. When tested as specified in 4.5.4.6, the effect of the total cured coating system on the ethylene dibromide content of aviation gas shall be that the difference in bromine content shall not be greater than 10 percent.

3.14 Resistance to fuel and seawater at 32 °C (90 °F) (all types, classes 5 and 6, all grades). When tested as specified in 4.5.2.4, coating:

- a. Shall not chalk.
- b. Shall not exhibit film failure such as peeling, blistering rated in excess of ASTM D714, blister size number 4, few, and there shall be no surface imperfections (includes peeling) larger than 1.5 mm (<sup>1</sup>/<sub>16</sub>-inch) and any blistering shall be unbroken. Type VII coating system shall have no surface or edge rusting.
- c. Shall show no loss of apparent hardness and adhesion when examined visually and knife test.

3.15 Resistance to hot water - simulated boiler feedwater (all types, classes 11 and 12, and grades). When tested as specified in 4.5.12, coating shall have no pinhole rusting. The ASTM D4541, Type II tester, adhesion of the tested system to itself and the substrate shall be not less than 50 percent of that of the original coating before testing. There shall be no blistering rated in excess of ASTM D714, blister size number 4, Few. There shall be no surface imperfections (includes peeling) larger than 1.5 mm (<sup>1</sup>/<sub>16</sub>-inch) and any blistering shall be unbroken. Type VII coating system shall have no edge rusting.

3.16 Resistance to chemical solutions - simulated collection holding and transfer (CHT; sewage waste) tanks (all types, classes 13 and 14 only, all grades). When tested as specified in 4.5.13, the coating shall have no pinhole rusting. After testing the ASTM D4541, Type II tester, cohesion and adhesion values of the tested system to itself and the substrate shall be at least 50 percent of the values for cohesion and adhesion of the untested original coating to itself and the substrate before testing. There shall be no blistering rated in excess of ASTM D714, blister size number 8, Few. There shall be no surface imperfections (includes peeling) larger than 1.5 mm (<sup>1</sup>/<sub>16</sub>-inch) and any blistering shall be unbroken. Type VII coating system shall have no edge rusting.

3.17 Resistance to condensing water - simulated tank top test (all types, classes, and grades). When tested as specified in 4.5.14, the coating system shall have no pinhole rusting. The ASTM D4541, Type II tester, adhesion values of the tested system to itself and the substrate shall be at least 50 percent of the values for adhesion of the

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untested original coating before testing. There shall be no blistering rated in excess of ASTM D714, blister size number 4, Few. There shall be no surface imperfections (includes peeling) larger than 1.5 mm (<sup>1</sup>/<sub>16</sub>-inch) and any blistering shall be unbroken. Type VII coating system shall have no edge rusting.

3.18 Ultraviolet fluorescence (applicable to primers of type VII, all classes, all grades). When tested in accordance with 4.5.15, the primer shall fluoresce with sufficient brightness that coverage of test panel can be visually ascertained.

3.19 Surface tolerant coating systems. Class 15 coating systems shall demonstrate adhesion values of at least 50 percent of the values obtained from testing when the same coating system is applied to a dry, clean SSPC SP - 15 surface condition. Test in accordance with 4.5.17.

3.20 Wear resistant coating systems. When applied to the test panels in accordance with the manufacturer's application instructions, Class 16 coating systems shall demonstrate a weight loss and thickness reduction no greater than 25 percent of the weight and thickness loss experienced by an equal dry film thickness of paint qualified to MIL-DTL-24441 when tested concurrently in accordance with 4.5.18.

3.21 Bilge coating systems. Class 17 coating systems shall demonstrate adhesion values of at least 50 percent of the value obtained when the same coating system is applied to dry, clean test panels prepared to surface cleanliness standards SSPC SP-11, Power Cleaning to Bare Metal. Test in accordance with 4.5.19.

3.22 Single coat coating system. Class 18 coating systems shall comply with all other class coating systems requirements when tested in accordance with the applicable test method cited in this specification (see 4.5.20 and 3.2.1).

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

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

3.24 Well deck overhead coating systems. Class 19 coatings systems, when tested in accordance with 4.5.21, shall exhibit heat resistance up to 260 °C (500 °F). There shall be no degradation or delamination of the coating from the test panel. Adhesion of the coating system to the panel following the elevated heat test shall be at least 50 percent of the adhesion value obtained prior to the test.

#### 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 be as follows:

- a. Qualification approval for Types V, VI and VII shall also constitute approval for Type IV coatings of the same class and grade.



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- b. Qualification approval for Types VI and VII shall also constitute approval for Types IV and V coating systems of the same class and grade.
- c. Qualification approval for Type VII shall also constitute approval for Types IV, V, and VI coatings of the same class and grade.
- d. Qualification approval for Types VIII and VIIIa is unique and not extended to other Types.

4.3 Conformance inspection. Conformance inspection shall consist of the conformance tests specified in Table V.

4.4 Panel preparation. Test plates of the nature and size specified in the applicable test method shall be coated in accordance with the manufacturer's application instructions. Each individual coating of the coating system shall be mixed in accordance with the manufacturer's mixing instructions.

4.5 Test procedures. Tests shall be conducted as specified in Table V. The temperature at which tests are conducted shall be in accordance with the applicable FED-STD-141 and ASTM test methods identified in Table V. For reduced temperature materials (Grade A and Grade B), the tests shall be conducted at the low end of the temperature range. Unless otherwise specified, test panel dimensions and test conditions, such as temperature etc., are nominal.

TABLE V. Test procedures.

| Characteristics                     | Requirements      | Test paragraph | Applicable FED-STD-141 method | Applicable ASTM test    | Table IV ID test | Conformance test   |
|-------------------------------------|-------------------|----------------|-------------------------------|-------------------------|------------------|--------------------|
| Chemical nature                     | 3.2.2 and Table V | ---            | ---                           | ---                     | X                | ---                |
| VOC                                 | 3.2.2.2           | 4.5.5          | ---                           | ---                     | ---              | ---                |
| Hazardous air pollutants (HAPs)     | 3.2.2.3           | 4.5.6          | ---                           | ---                     | ---              | ---                |
| Hazardous pigments                  | 3.2.3             | 4.5.10         | ---                           | ---                     | ---              | ---                |
| Color                               | 3.3               | ---            | ---                           | D2244 <sup>2/</sup>     | X                | ---                |
| Gloss                               | 3.3               | ---            | ---                           | D523                    | X                | ---                |
| Potable water                       | 3.4               | 4.5.110        | ---                           | ---                     | ---              | ---                |
| Color in water                      | 3.4.2             | 4.5.11.1       | ---                           | ---                     | ---              | <sup>3/ 4/</sup>   |
| Taste in water                      | 3.4.3             | 4.5.11.2       | ---                           | ---                     | ---              | ---                |
| Odor in water                       | 3.4.4             | 4.5.11.3       | ---                           | ---                     | ---              | ---                |
| Chlorine residual                   | 3.4.5             | 4.5.11.4       | ---                           | ---                     | ---              | ---                |
| Phenol                              | 3.4.6             | 4.5.11.5       | ---                           | ---                     | ---              | ---                |
| CP Compatibility                    | 3.5               | 4.5.16         | ---                           | ---                     | ---              | ---                |
| Drying or cure time                 | 3.6               | ---            | 4061                          | ---                     | ---              | ---                |
| Flash point                         | 3.7               | ---            | ---                           | D93 or D3278            | X                | X <sup>3/ 4/</sup> |
| Application characteristics (Mixed) | 3.8               | 4.5.7, 4.5.8   | ---                           | D823 Method B and D4417 | ---              | X <sup>3/ 4/</sup> |
| Edge coverage                       | 3.8.1             | 4.5.9          | ---                           | ---                     | ---              | ---                |

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TABLE V. Test procedures - Continued.

| Characteristics                                      | Requirements    | Test paragraph | Applicable FED-STD-141 method | Applicable ASTM test | Table IV ID test | Conformance test   |
|--|-----------------|----------------|-------------------------------|----------------------|------------------|--------------------|
| Fuel & fuel/seawater ballast service-Classes 5 and 6 | 3.9.1           | 4.5.2.1        | ---                           | ---                  | ---              | ---                |
| Shop primer - exterior                               | 3.9.2           | 4.5.2(a)       | ---                           | ---                  | ---              | ---                |
| Dedicated seawater service                           | 3.9.3           | 4.5.2.2        | ---                           | ---                  | ---              | ---                |
| Condition in container                               | 3.10 and 3.10.1 | ---            | 3011                          | ---                  | ---              | X                  |
| ID principal constituents                            | 3.12            | ---            | ---                           | ---                  | X                | ---                |
| ID percent nonvolatile vehicle                       | 3.12            | ---            | ---                           | ---                  | X                | ---                |
| ID percent volatile                                  | 3.12            | ---            | ---                           | ---                  | X                | ---                |
| ID mass (g/L) (lb/gal)                               | 3.12            | ---            | ---                           | ---                  | X                | X                  |
| ID color   | 3.12            | ---            | ---                           | ---                  | X                | X                  |
| ID viscosity   | 3.12            | ---            | ---                           | ---                  | X                | X <sup>3/</sup>    |
| ID flash point                                       | 3.12            | ---            | ---                           | ---                  | X                | X                  |
| ID fineness of grind                                 | 3.12            | ---            | ---                           | ---                  | X                | X                  |
| ID odor  | 3.12            | ---            | ---                           | ---                  | X                |                    |
| ID pot life  | 3.12            | 4.5.1          | ---                           | ---                  | X                | X <sup>3/ 4/</sup> |
| ID drying or curing time                             | 3.12            | ---            | ---                           | ---                  | X                | X <sup>3/</sup>    |
| ID gloss and appearance                              | 3.12            | ---            | ---                           | ---                  | X                | ---                |
| ID flexibility                                       | 3.12            | ---            | ---                           | ---                  | X                | ---                |
| ID sag resistance                                    | 3.12 and 3.8.2  | Table V        | ---                           | D4400                | X                | X <sup>3/ 4/</sup> |
| ID fire resistance properties                        | 3.12            | ---            | ---                           | ---                  | X <sup>3/</sup>  | ---                |
| Aviation fuel compatibility                          | 3.13            | 4.5.4          | ---                           | ---                  | ---              | ---                |
| Fuel color   | 3.13.1          | 4.5.4.2        | ---                           | ---                  | ---              | ---                |
| Corrosion  | 3.13.2          | 4.5.4.3        | ---                           | ---                  | ---              | ---                |
| Existent gum   | 3.13.3          | 4.5.4.4        | ---                           | ---                  | ---              | ---                |
| Solid (total sediment)                               | 3.13.4          | 4.5.4.5        | ---                           | ---                  | ---              | ---                |
| Bromine  | 3.13.5          | 4.5.4.6        | ---                           | ---                  | ---              | ---                |

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TABLE V. Test procedures - Continued.

| Characteristics  | Requirements | Test paragraph | Applicable FED-STD-141 method | Applicable ASTM test | Table IV ID test | Conformance test |
|--|--------------|----------------|-------------------------------|----------------------|------------------|------------------|
| Resistance to fuel and water at 32 °C (90 °F)            | 3.14         | 4.5.2.4        | ---                           | ---                  | ---              | ---              |
| Boiler feedwater service -Resistance to boiling water    | 3.15         | 4.5.11         | ---                           | ---                  | ---              | ---              |
| CHT service - resistance to chemical solutions           | 3.16         | 4.5.12         | ---                           | ---                  | ---              | ---              |
| Tank top - resistance to condensing water                | 3.17         | 4.5.13         | ---                           | ---                  | ---              | ---              |
| Ultraviolet fluorescence                                 | 3.18         | 4.5.14         | ---                           | ---                  | ---              | ---              |
| Surface tolerant coatings                                | 3.19         | 4.5.17         | ---                           | ----                 | ---              | ---              |
| Wear resistant coatings                                  | 3.20         | 4.5.18         | ----                          | ----                 | ---              | ----             |
| Bilge coating systems                                    | 3.21         | 4.5.19         | ----                          | ----                 | ---              | ----             |
| Single coat coating systems                              | 3.22         | 4.5.20         | ----                          | ----                 | ---              | ---              |
| Well deck overhead coating (class 19) resistance to heat | 3.24         | 4.5.21         | ---                           | ---                  | ---              | ---              |

## Notes:

<sup>1/</sup> All qualification tests shall be conducted on stored coatings after one year of storage. If all other requirements are met, qualification approval will be granted prior to receiving these results, but qualification approval will be withdrawn if results indicate non-compliance with this requirement. (see 3.10)

<sup>2/</sup> Shall be compared to company color card or to FED-STD-595 designated color. (see 3.6)

<sup>3/</sup> Combined A+B for test

<sup>4/</sup> Mixed A+B for Classes 15a, 15b, 15c, 16, 17 and 18.

4.5.1 Pot life (except Type VIII, Type VIIIa and single coat coatings). The coatings of the coating system shall be mixed from the components, in accordance with the manufacturer' instructions, in a container so as to result in approximately 3.78 L (1 gallon) of finished material. For routine testing, ambient conditions above 21 °C (70 °F) and 50 percent relative humidity shall be satisfactory. For referee tests, 21 ± 3 °C (70 ± 5 °F) and 80 ± 10 percent relative humidity shall prevail. The time between mixing and the loss of adequate brushing and spraying properties shall be determined (See 3.8, 4.5.7 and 4.5.8). Record the actual temperature, humidity, and the time of loss of adequate brushing and spraying properties. For reduced temperature coating systems (Grade A and Grade B), pot life of individual mixed coatings shall be determined at the lower end of the temperature range or as directed by the coating manufacturer. The pot life shall be a minimum of one hour in accordance with the requirements of 3.12.

4.5.2 Immersion resistance.

- a. Coating and atmospheric testing of classes 6, 8, 10, 12, and 14 shop primers. When the coating system includes a shop primer (see 6.6.5), the shop primer shall be applied as specified in the manufacturer's

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instructions and shall completely coat three [minimum size: 150 by 300 by 3 mm (6 by 12 by 1/8-inch) (nominal)] abrasive blasted, hot rolled, mild steel plates. The blast pattern shall be not greater than 0.08 mm (3 mil) (nominal) depth for shop primers having 0.13 mm (5 mils) or more dry film thickness (DFT) and 0.04 mm (1.5-mils) for systems having less than 0.13 mm (5-mils) DFT. The test panels shall have all mill scale, rust and rough edges completely removed and prepared to the manufacturer's recommended surface profile in accordance with SSPC-SP10. Qualification test report shall indicate degree of surface preparation and the profile achieved. The shop primer coated test panels shall be exposed for 1 year at a seashore exposure site no more than 300 meters (330 yards) from the high tide line. At the end of 1 year, corrosion shall be as specified in 3.9.2.

b. Application of all coatings, except shop primer.

- (1) The coating systems not applied over an aged shop primer (Classes 5, 7, 9, 11, 13, 15, 16, 17 and 18) shall be applied as specified in the manufacturer's instructions and shall completely coat three [minimum size: 150 by 300 by 3 mm (6 by 12 by 1/8-inch) (nominal)] abrasive blasted, hot rolled, mild steel plates. The blast pattern shall be not greater than 0.08-mm (3-mil) (nominal) depth for coating systems having 0.13 mm (5-mils) or more dry film thickness (DFT) and 0.04 mm (1.5 mils) for systems having less than 0.13-mm (5-mils) DFT. The test panels shall have all mill scale, rust and rough edges completely removed and prepared to applicable surface profile in accordance with SSPC-SP10 before coating.
- (2) Coating systems applied over shop primers after exposure [see (a) above]. The test panels with shop primer shall be cleaned and repaired with the shop primer in accordance with the manufacturer's product data sheet before proceeding with application of the remainder of the system.
- (3) Unless otherwise specified in the manufacturer's data sheet, 24 hours dry time shall be allowed between coats and 1 week at 21 °C (70 °F) (nominal) or equivalent between the last coat and immersion. Edges shall not receive extra paint thickness or be reinforced by additional coats unless such coating is specified in the manufacturer's ASTM F718 and product data sheets under application instructions. At test inspection points, the coatings shall be as specified for the appropriate type, class and grade.

4.5.2.1 Immersion test for fuel and seawater ballast exposure (all types, classes 5 and 6, all grades). Two coated panels shall be subjected to 25 cycles or to prior failure, whichever comes first, of the following test cycle. The cycle comprises three operations carried out in the order specified with panels prepared as specified in 4.5.2(a) and (b):

- a. Salt water immersion for 1 week (7 days): Immerse panels totally for 1 week in natural seawater or in ASTM D1141 substitute ocean water, at a temperature of  $27 \pm 6$  °C ( $80 \pm 10$  °F). There shall be no more than 8 hours between completion of step (a) and the beginning of step (b).
- b. Aromatic fuel immersion for 1 week (7 days): Following salt water immersion, immerse the panels totally in MIL-DTL-5624, ASTM D1655 or commercial JP-4, JP-5 at a temperature of  $27 \pm 6$  °C ( $80 \pm 10$  °F). There shall be no more than 8 hours between completion of step (b) and the beginning of step (c).
- c. Hot water immersion for two hours: This operation is intended to simulate conditions encountered in the use of tank cleaning equipment. Following fuel immersion, immerse the panels totally in hot, ASTM D1141 synthetic seawater or natural seawater having a salinity of 33 to 35 p/m chloride, for 2 hours at 80 °C (175 °F) (nominal).

Operations (a) to (c) constitute one complete test cycle. This cycle is repeated and coating deterioration recorded after each complete cycle. If coating is still satisfactory after 20 cycles, wipe lightly with a soft cloth and freshwater, allow 48 hours to thoroughly dry, and recoat the upper one third of one side of each panel, masking off the edges, approximately 13 mm (0.5-inch), and the bottom portion of the panel with one coat of the system finish

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coat of the coating system (or primer coat and finish coat if appropriate). Allow 1-week dry time at ambient laboratory conditions and complete immersion test with five additional test cycles. Test panels shall be inspected at the end of the tenth and twenty-fifth cycles for imperfections (see 3.9.1). On completion of testing, the coating system shall be evaluated for: pinhole rusting, ASTM D4541, Type II tester, adhesion of both the original and recoated surface areas, blistering larger than 1.5 mm ( $\frac{1}{16}$ -inch) in diameter, and surface imperfections larger than 1.5 mm ( $\frac{1}{16}$ -inch). Type VII coating systems shall be evaluated for edge rusting. The test results shall be in accordance with the requirements of 3.9.1.

4.5.2.2 Dedicated salt water ballast (all types, classes 7 and 8, all grades). Two test panels, prepared as specified in 4.5.2(a) and (b) above shall be tested in accordance with either of the following cycles (cycle A or cycle B):

4.5.2.2.1 Cycle A.

- a. Salt water Immersion for 5 days: Immerse panels with panels prepared as specified in 4.5.2(a) and (b) totally for 1 week in either natural seawater or ASTM D1141 Substitute Ocean Water solution at a temperature of  $27 \pm 6$  °C ( $80 \pm 10$  °F).
- b. Remove panels from test and allow to dry for 2 days.
- c. Hot water immersion for 2 hours: This operation is intended to simulate conditions encountered in the use of tank cleaning equipment. Following the drying period, immerse the panels totally in hot, synthetic seawater for 2 hours at 80 °C (175 °F) (nominal).

Operations (a) to (c) constitute one complete test cycle. This cycle is repeated and coating deterioration recorded after each complete cycle. If coating is still satisfactory after 25 cycles, wipe lightly with a soft cloth and freshwater, allow 48 hours to thoroughly dry, and recoat the upper one third of one side of each panel, masking the portion from the edge to 13 mm (1/2 inch) inward, with one coat of the finish coat of the coating system (or primer coat and finish coat if appropriate). Allow 1-week dry time and complete immersion test with 25 additional test cycles. Coating system shall be evaluated for pinhole rusting, ASTM D4541, Type II tester, adhesion of both original and recoated surfaces, blistering larger than 1.5 mm ( $\frac{1}{16}$  inch) in diameter, and surface imperfections larger than 1.5 mm ( $\frac{1}{16}$  inch). Type VII coating systems shall be evaluated for edge rusting. Test results shall be as specified in 3.9.3.

4.5.2.2.2 Test cycle B. This test cycle shall be performed by Det Norske Veritas, N-1322, HØvik, Norway, phone 47 67 57 00, FAX 47 67 57 99 11 and shall be as specified in the test program described in Paper no. 505 of the NACE Corrosion 96 Conference report. Surface preparation and paint application shall be as specified in 4.4 and 4.5 and shall be performed by Marine Materials AS, unless special application equipment is required that is not available to Marine Materials. With prior approval of NAVSEA, Marine Materials AS may arrange for application by others with supervision by Marine Materials AS. If coating system is still satisfactory after 20 cycles in the wave test chamber portion of the testing, surface prepare the tested coating as specified in 4.4. Recoat the central upper third of one side of each panel as specified in 4.4 and conduct an additional 5 cycles of the wave chamber test. After the additional testing in the wave chamber, the adhesion of the recoat and original coats shall be as specified in the requirements of 3.9.3. After completion, all testing panels shall be rated by the criterion of Paper No, 505 and assigned a rating. This rating shall be as specified in the requirements of 3.9.3. Test results shall also be as specified in 3.9.3.

4.5.2.3 Potable and freshwater immersion (all types, classes 9 and 10, all grades). Class 9 and 10 coatings for use in dedicated potable and freshwater tanks shall be tested to the following cycle with panels prepared as specified in 4.5.2(a) and (b):

- a. Immerse two panels totally for five days in ASTM D1193 (any type) distilled water, at a temperature of  $27 \pm 6$  °C ( $80 \pm 10$  °F).
- b. Remove panels from test and allow to dry for 2 days.

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- c. Hot water immersion for 2 hours: This operation is intended to simulate conditions encountered in the use of tank cleaning equipment. Following the drying period [see (b)], immerse the panels totally in ASTM D1193 (any type) distilled water for 2 hours at 80 °C (175 °F) (nominal).

Operations (a) to (c) constitute one complete test cycle. This cycle is repeated and coating deterioration recorded after each complete cycle. If the coating is still satisfactory after 20 cycles, wipe lightly with a soft cloth and freshwater, allow 48 hours to thoroughly dry, and recoat the upper one third of one side of each panel, masking the portion from the edge to 13 mm (½ inch) inward, with one coat of the finish coat of the coating system (or primer coat and finish coat if appropriate). Allow 1 week dry time and complete immersion test with 5 additional test cycles. Coating system shall be evaluated for pinhole rusting, ASTM D4541, Type II tester, adhesion of both original and recoated surfaces, blistering and surface imperfections larger than 1.5 mm (⅛ inch) in diameter. Type VII coating systems shall be evaluated for edge rusting. Evaluation results shall be as specified in 3.4.

4.5.2.4 Resistance to fuel and salt water at 32 °C (90 °F) (All types, classes 5 and 6, all grades). Panels shall be prepared in accordance with 4.5.2 except for size. Two test panels approximately 60- by 120 mm (2½ by 5 inches) shall be immersed in 500 mm (2 inches) of either natural sea water or ASTM D1141 Substitute Ocean Water solution covered by 50 mm (2 inches) of the fuel specified in 4.5.2.1 in a glass jar, closed and sealed. The jar shall be kept at 32 ± 3 °C (90 ± 5 °F) by partial immersion in a water bath or other means for 240 hours. The panel shall be removed, immediately examined for any change in appearance, chalking or color change, film failure such as blistering and rusting, or loss of apparent hardness and adhesion of the coating, and edge rusting by visual observation and method 6304.2 of FED-STD-141 (knife used may be sharp commercial pocket knife). Panels shall be in accordance with the requirements of 3.14.

4.5.3 Recoatability (except types VIII and VIIIa). Recoatability for qualification of the coating systems shall be determined as specified in 4.5.2.1, 4.5.2.2, 4.5.2.3, 4.5.13, 4.5.14, and 4.5.17. Recoatability shall be in accordance as specified in 3.4.7, 3.9.1, 3.9.3, 3.15, 3.16 and 3.17.

4.5.3.1 Recoatability (types VIII and VIIIa). Recoatability of the Type VIII and Type VIIIa powder coatings shall be demonstrated using the three-coat MIL-DTL-24441, Type III and the two-coat MIL-DTL-24441, Type IV systems. Recoatability shall be as specified in 3.9.1, 3.9.3, 3.15, 3.16, 3.17.

4.5.4 Test for aviation (JP-5 and F-76) fuel and gasoline (MOGAS and aviation gasoline) compatibility (classes 5 and 6 only). The effect of coating systems on fuel degradation shall be measured by comparison of test results obtained on fuel in contact with the coating system and the same age unexposed fuel.

4.5.4.1 Preparation for fuel samples for test.

- a. Apply coating systems to four steel rods, 19 by 190 mm (¾ by 7½ inches), drilled, threaded, and fitted with a 3- by 19 mm (⅛ by ¾ inch) all-thread bolt for suspension. Allow 7 days drying time at ambient laboratory temperature after application of last coat before immersion in fuel.
- b. Prepare approximately 5 L each of particle-free aviation gas and JP-5 fuel by repeated filtration through a Type AA millipore filter as specified in Appendix X of ASTM Standard on Petroleum Products and Lubricants, using 100/130 aviation gas in accordance with ASTM D910, or commercial 100LL aviation gasoline, and JP-5 fuel in accordance with MIL-DTL-5624.
- c. Wash coated test rods thoroughly with hot water at 82 ± 6 °C (180 ± 10 °F) for 15 to 30 minutes, drain, and dry. Mount test rod on a 6- by 180-mm (¼- by 7-inch) square plastic beaker cover (for 4-L beaker), center drilled for mounting test rod.
- d. Into four clean 2-L beakers, pour 1000 to 2000-mL of particle-free aviation gasoline. Into four clean 2-L beakers, pour 1000 to 2000-mL of particle-free JP-5 fuel. Cover two beakers of each fuel with rod-mounted cover (for exposed fuel samples). Cover two beakers of each fuel with 6 by 180 mm (¼by 7 inches) square plastic beaker covers, plain (for unexposed fuel samples). Store all beakers with fuel in

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dark and maintain at  $27 \pm 6$  °C ( $80 \pm 10$  °F) for 30 days. Swirl fuel by rotating beakers at least three times daily.

- e. On the 31st exposure day, test exposed and unexposed aviation and JP-5 fuel for color, corrosion, existent gum, and solids. Test exposed and unexposed aviation gas for bromine as specified in the following test procedures.

4.5.4.2 Fuel color (class 5 and 6 only). Color for JP-5 fuel shall be determined in accordance with ASTM D156. Record difference between exposed and unexposed fuels. Colors of exposed and unexposed aviation gas shall be compared visually. Record differences as pass or fail. Fuel color shall be as specified in 3.13.1.

4.5.4.3 Corrosion (class 5 and 6 only). Corrosiveness of both exposed and unexposed fuels shall be determined in accordance with ASTM D130. Corrosiveness shall be as specified in 3.13.2.

4.5.4.4 Existent gum (class 5 and 6 only). Existent gum (both washed and unwashed) shall be determined in accordance with ASTM D381. Determine differences between exposed and unexposed fuels. Existent gum shall be as specified in 3.13.3.

4.5.4.5 Solids (total sediment) (class 5 and 6 only). Solids shall be determined in accordance with ASTM D910 and ASTM Specifications and Classifications for Petroleum and Lubricants. Solids shall be as specified in 3.13.4.

4.5.4.6 Bromine (class 5 and 6 only). Bromine shall be determined on both exposed and unexposed fuels in accordance with the following procedure:

4.5.4.6.1 Apparatus.

4.5.4.6.1.1 Decomposition. The apparatus used for decomposition of bromides by sodium in liquid ammonia shall be as shown on figure 1. The center neck of the 250-mL, 2-neck, round bottom flask carries a Teflon™-sealed, corrosion resistant, steel stirring assembly. The side neck shall be fitted with a 2-hole rubber stopper through which pass an ammonia delivery tube and a vent protected by a drying tube containing Drierite or equal. After charging of the flask with liquid ammonia, the pictured rubber stopper shall be replaced with a 1-hole stopper fitted with a vent tube, also protected by a drying tube.

4.5.4.6.1.2 Titration. The apparatus used for following the titration of bromide shall be a continuous indicating hydrogen ion concentration (pH) meter such as the Beckman Model H-2 or equal, equipped with a glass electrode and a silver electrode [see note 1 of 4.5.6.6.3(c)]. A titration set-up shall be used, such as shown on figure 2 which shall accurately deliver slip-drop quantities of silver nitrate.

4.5.4.6.2 Materials and reagents. The following materials and reagents will be required:

- a. Dry ice and acetone for cooling.
- b. Drierite or equal.
- c. Ammonia.
- d. Sodium.
- e. Alcohol.
- f. Sodium hydroxide pellets.
- g. Ammonium persulfate.



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- h. Sodium arsenite, 10 percent.
- i. Nitric acid (HNO<sub>3</sub>) approximately 20 percent.
- j. Silver nitrate (AgNO<sub>3</sub>), 0.05N.

4.5.4.6.3 Procedure for the analyses of gasolines. The procedure for the analyses of decomposition of bromides shall be as follows:

- a. Cool the flask with a dry-ice, acetone slurry and introduce about 15 grams of ammonia (see note 2). Replace the rubber stopper carrying the delivery tube by the one fitted only with a protected vent and add a cube of freshly cut sodium having an edge dimension of about 5 mm (1/4-inch). Rotate the stirrer slowly by hand to partially dissolve the metal. Add exactly 50-mL of the gasoline under test (see notes 3 and 4), remove the cooling bath, and start the stirrer. As soon as the ammonia starts to evolve, disconnect the drying tube from the vent (see note 5). Continue the stirring until the ammonia has evaporated (about 20 minutes for a 15-gram charge). If the characteristic blue color of sodium in liquid ammonia should disappear during the earlier stages of the evaporation, add another piece of sodium.
- b. Upon evaporation of the ammonia, add 5-mL of alcohol to the mixture to decompose the excess sodium. Next, add 30-mL of water and stir to aid extraction of inorganic salts. Remove the reaction flask from the stirrer, washing down the stirrer with water, and transfer the contents to a separatory funnel. Separate the aqueous layer and extract the organic layer with two additional 30-mL portions of water. Combine the three aqueous extracts, evaporate to about 50-mL, and cool slightly. If, at this point, the mixture is not clear and contains a precipitate, filter and wash the paper several times with small portions of hot water. Evaporate the combined filtrate and washings to about 50-mL and cool slightly. Add 2 grams of sodium hydroxide pellets followed by 2 grams of ammonium persulfate. After the solids have dissolved, boil the solution for about 15 minutes (see notes 6 and 7). Cool the solution slightly, add 10-mL of a 10 percent solution of sodium arsenite, boil for 10 minutes, and then cool to room temperature. Make the solution acid to phenolphthalein by adding HNO<sub>3</sub> (20 percent) and determine the bromides as given below (see note 8).
- c. Immerse the titration electrodes into the solution, start the stirrer, and set the pH meter to read on the acid scale. If the pH meter shows an apparent pH reading of greater than 1.5, add more HNO<sub>3</sub>, until a reading of 0 to 1.5 is obtained. Next, titrate the bromides with 0.05N AgNO<sub>3</sub>, making a record of apparent pH versus mL AgNO<sub>3</sub> added. From a plot of the record of the data, determine the appropriate inflection points, and calculate the quantities of bromine by the formulas given below.

$$\text{g Br} = 0.003996B$$

or

$$\begin{aligned} \text{g Br/gal at } 15.6\text{ }^{\circ}\text{C (60 }^{\circ}\text{F)} &= 0.3025B[1 + 0.00065(t_F - 60)] \\ &= 0.3025B[1 + 0.00065(1.8 t_C - 281)] \end{aligned}$$

where:

- B = mL 0.05N AgNO<sub>3</sub> required to titrate bromide, and
- t<sub>F</sub> = temperature (°F) of gasoline when sampled
- t<sub>C</sub> = temperature (°C) of gasoline when sampled

Bromine shall be as specified in 3.13.5.

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## NOTES:

1. A heavy-gauge silver wire attached directly to the calomel jack of the pH meter may be used. The portion that dips into the liquid should be cleaned by rubbing lightly with fine emery paper and rinsing with ASTM D1193 (any type) distilled water.

2. It is convenient to use a lecture bottle as the source of ammonia. From such a container, gaseous ammonia may be introduced into the flask with virtually complete condensation at rates up to 2 grams per minute. The quantity of ammonia being added can be followed by periodic weighing of the lecture bottle. Steps involving the charging and evaporation of ammonia should be carried out in a hood.

3. In general, it may be advisable to pre-cool the sample by placing it in a flask surrounded by dry ice before introducing it into the sodium, liquid ammonia mixture. In such cases, care should be taken to protect the sample from moisture and from dissolving carbon dioxide. After adding a pre-cooled sample to the reaction mixture, the cooling vessel may be rinsed with about 10-mL of isooctane (at room temperature) and this rinsing may be added directly to the reaction mixture.

4. By using a slightly larger amount of ammonia (about 20 grams), it has been found that pre-cooling is not necessary. Under these conditions, a 50-mL, sample of gasoline (at room temperature) may be added directly into the reaction mixture without causing excessive boiling of the ammonia, provided the addition is as slow as from a pipette.

5. If indicating Drierite or equal is used, evolution of ammonia is evidenced by a color change.

6. During this period, it is important that the solution remain alkaline. Since sulfuric acid is one of the decomposition products of ammonium persulfate, the solution should be checked occasionally to assure alkalinity. This may be done by using litmus paper as an external indicator or methyl orange as an internal indicator, in the majority of cases, the 2 grams of sodium hydroxide specified will be entirely sufficient; however, should it be found that the solution is becoming acid, more sodium hydroxide should be used.

7. In some cases, a reddish solid or a dark solution may form during the oxidation step. Such behavior will not affect the analyses.

8. At this point, the solution may contain a precipitate. This is of no consequence and usually will redissolve on further acidification in the next step.

4.5.5 Volatile organic content (VOC). VOC for all types, classes, and grades, shall be determined in accordance with USEPA 40 CFR ch.1, part 60, appendix A, method 24. Solvent content shall be as specified in 3.2.2.2.

4.5.6 HAP content of coatings. Hazardous solvent content of each individual coating shall be determined in accordance with ASTM D3272 and ASTM E260. Solvent fractions shall be identified in accordance with ASTM E1252 with the results recorded as percent weight of the total paint. Alternate methods of analysis must be reviewed and approved by NAVSEA. Formulation data may 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. HAP content shall be specified in 3.2.2.3.

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4.5.7 Brushing and rolling properties (Not applicable to Types VIII and VIIIa). Coatings shall be prepared in accordance with manufacturer's directions. Coatings shall be applied without further reduction in accordance with method 4321.2 of FED-STD-141 for brushing and ASTM D5150 for rolling. For routine testing, ambient conditions above 21 °C (70 °F) and 50 percent relative humidity shall be satisfactory. For referee tests, 21 ± 3 °C (70 ± 5 °F) and 50 ± 5 percent relative humidity shall prevail. For reduced temperature coating systems, brushability and rolling properties shall be performed with mixed coating, components and equipment equilibrated at the lower end of the temperature range. The actual brushing can be performed at ambient laboratory conditions so long as the paint and equipment are at the low range application temperature. Brushing and rolling properties shall be as specified in 3.8.

4.5.8 Spraying properties. The coating shall be prepared in accordance with the manufacturer's directions. Without further reduction, spray a coating on an abrasive blasted steel panel to the recommended wet film thickness. For routine testing, ambient conditions above 21 °C (70 °F) and 50 percent relative humidity shall be satisfactory. For referee tests, 21 ± 3 °C (70 ± 5 °F) and 50 ± 5 percent relative humidity shall prevail. For reduced temperature coating systems, sprayability shall be performed with mixed coating, components and equipment equilibrated at the lower end of the temperature range. The actual spraying can be performed at ambient laboratory conditions so long as the paint and all equipment are at the low range application temperature. The equilibration requirement for mixed paint does not apply to spraying using spray equipment that mixes the components at the gun, either internally or externally, however, coating components and all equipment shall be at the low range application temperature. Observe for spraying properties in accordance with method 4331.2 of FED-STD-141. Spraying properties shall be as specified in 3.8. Type VIII and VIIIa powder coating shall be applied in accordance with manufacturer's instructions to meet 3.8.

4.5.9 Edge coverage retention (Applicable to topcoat only of Type VII all classes and grades). Panel preparation, paint application and percent of dry film thickness retained on an edge shall be as described in Appendix A of this specification. Scaled photomicrographs of each edge shall be taken. This test procedure will be conducted at government expense at the Naval Research Laboratory, Key West, Florida. Coating shall meet 3.8.1.

4.5.10 Hazardous pigments and additives. Soluble and total metal content, except tantalum and tungsten, shall be determined on pulverized dry paint film of the coating system in accordance with 40 CFR Part 261, Appendix II and the appropriate test listed below. Test sample shall consist of particle sieved through a U. S. sieve no. 50. Asbestos shall be analyzed in accordance with OSHA Validated Analytical Method ID-191, "Polarization Light Microscopy of Asbestos" with the coating sample treated as a bulk settled dust and test result reported as % by weight of the cured coating. Crystalline silica (respirable) shall be analyzed in accordance with NIOSH Analytical Method 7500 with the coating sample treated as a bulk settled dust. Soluble metal content shall be reported as milligrams per liter (mg/L). Total metal content shall be reported as %WT of the cured coating. The test results for each metal shall be in conformance with the appropriate requirements of 3.2.3.1, 3.2.3.2. Tantalum and tungsten soluble metal content and total metal content shall be analyzed as specified in 4.5.10.1. Formulation data may be used by manufacturers in lieu testing required under this paragraph to demonstrate compliance with hazardous metal content requirements of this specification. The manufacturer's formulation data must have a consistent and quantitatively known relationship to the testing required. Calculation of individual hazardous metal contents can be based on either manufacturer testing of batches or supplier data for raw materials used in the product. The coating manufacturer must provide for each individual hazardous metal a formulation value that will not be exceeded if a sample from any quality control approved production batch of the coating is tested in accordance with this paragraph. Type VIIIa may have a high zinc content due to the presence of sacrificial zinc.

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

| <b>Metal/material</b>            | <b>Digestion test method</b> |
|----------------------------------|------------------------------|
| 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                 |

TABLE VII. Methods for chemical analysis of water and waste, EPA-600/4-020, USEPA, 1979.

| <b>Metal/material</b> | <b>Test method</b>    |
|-----------------------|-----------------------|
| 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        |

4.5.10.1 Tantalum and tungsten content. The tantalum and tungsten content of the cured film shall be determined using any appropriate spectroscopy test method. Conduct the tests in accordance with the instrument manufacturer's directions for the use of the instrument. Manufacturer is responsible for establishing data supporting the test method choice and analytical accuracy. The test results for tantalum or tungsten shall be in conformance with the requirements of 3.2.3.1 and 3.2.3.2.

4.5.11 Potable water tests (classes 9 and 10).a. Test sample preparation.

- (1) Using an adjustable gap clearance film applicator ("doctor blade"), draw down a 305 mm (12 inch) wide by 408 mm (16 inch) long wet film of the first coat (primer) of the coating system on a flat thick polyethylene sheet (at least ½ inch). The coating shall be prepared (mixed) in accordance with manufacturer's instructions and the wet film thickness shall be the same as the manufacturer's recommended wet film thickness. Air dry this draw-down for 24 hours at 20 °C to 27 °C (68 °F to 81 °F).

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- (2) After the air dry of the first coat has been accomplished, using an adjustable gap clearance film applicator (“doctor blade”), draw down a 305-mm (12-inch) wide by 408 mm (16-inch) long wet film of the second coat (intermediate or topcoat, as applicable) of the coating system perpendicular to and across the dry first coat. The coating shall be prepared (mixed) in accordance with manufacturer’s instructions and the wet film thickness shall be the same as the manufacturer’s recommended wet film thickness. Air dry this draw-down for 24 hours at 20 °C to 27 °C (68 °F to 81 °F).
  - (3) Repeat the procedure in (2) above for each additional coating in the coating system.
  - (4) Allow the completed test sample to cure for 7 days at 20 °C to 27 °C (68 °F to 81 °F) after the application of the final coating.
- b. Bell jar preparation. Attach a bell jar of 500-mL capacity to the coated surface prepared in (a) above with molten paraffin wax. The bell jar shall be fitted with a tightly fitted stopper to prevent loss of volatile halogen reactants during testing.

4.5.11.1 Color in water (classes 9 and 10). Prepare for test as specified in 4.5.10. Fill the bell jar with 200 parts per million (p/m) chlorinated ASTM D1193 (any type) distilled water and age for 24 hours. Remove the chlorinated water by suction and rinse the bell jar twice with ASTM D1193 (any type) distilled water. Discard the 200 p/m and rinse waters. Prepare a solution of 0.2 p/m chlorinated ASTM D1193 (any type) distilled water and determine the exact chlorine concentration using the DPD colorimetric method of APHA method 4500-Cl F. Refill the bell jar with determined 0.2 p/m chlorinated distilled water solution. Age the 0.2 p/m chlorinated water solution for 24 hours in the bell jar at 20 °C to 27 °C (68 °F to 81 °F). Also retain and age the 200-mL of the 0.2 p/m chlorinated water solution (control) in a clean, sealed glass container at 20 °C to 27 °C (68 °F to 81 °F). Withdraw 100-mL of water from both the bell jar and the control, determine the color of the water in the bell jar and the retained control water using APHA method 2120 B. Correct the bell jar color value for any change in the control color by subtracting the color change value of the control from the color change value of the bell jar water. Color value shall be in accordance with the requirements of 3.4.2.

4.5.11.2 Taste in water (classes 9 and 10). To assure taster safety, the taste test shall be performed only after a coating system has been found to comply with all other requirements of this specification. The remaining chlorinated water in the bell jar in 4.5.10.1 shall be used for the taste in water test specified in APHA method 2150 B. The remaining water shall be withdrawn from the bell jar by suction and placed in a clean gall container and tightly sealed. The sealed container of chlorinated water shall be equilibrated to 40 °C (104 °F) in a water bath. Threshold taste values shall be in accordance with the requirements of 3.4.3.

4.5.11.3 Odor in water (classes 9 and 10). After the chlorinated water has been removed from the bell jar (4.5.10.1) for the taste in water test (4.6.2), rinse the bell jar twice with ASTM D1193 (any type) distilled water. Prepare a solution of 0.2 p/m chlorinated distilled water and determine the exact chlorine concentration using the DPD colorimetric method of APHA method 4500-Cl F. Refill the bell jar with determined 0.2 p/m chlorinated distilled water solution. Age the 0.2 p/m chlorinated water solution for 24 hours in the bell jar at 20 °C to 27 °C (68 °F to 81 °F). Conduct the odor in water test in accordance with APHA method 2160 B. The water bath temperature for this test shall be equilibrated to 40 °C (104 °F). Threshold odor values shall be in accordance with the requirements of 3.4.4.

4.5.11.4 Chlorine residual (classes 9 and 10). Prepare for test as specified in 4.5.10. Fill the bell jar with 200 p/m chlorinated ASTM D1193 (any type) distilled water and age for 24 hours. Remove the chlorinated water by suction and rinse the bell jar twice with ASTM D1193 (any type) distilled water. Discard the 200 p/m and rinse waters. Prepare a solution of 10 p/m chlorinated ASTM D1193 (any type) distilled water and determine the exact chlorine concentration using the DPD colorimetric method of APHA method 4500-Cl F. Refill the bell jar with determined 10 p/m chlorinated distilled water solution. Age the 10 p/m chlorinated water solution for 24 hours in the bell jar at 20 °C to 27 °C (68 °F to 81 °F). Also retain and age the 200-mL of the 10 p/m chlorinated water solution (control) in a clean, sealed glass container at 20 °C to 27 °C (68 °F to 81 °F). Determine the exact chlorine concentration of the water in the bell jar and the retained control water using the DPD colorimetric method of APHA

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method 5330 D. Correct the bell jar chlorine value for any loss in the control by subtracting the loss in chlorine p/m of the control from the loss of chlorine content in the bell jar water. Chlorine residual value shall be in accordance with the requirements of 3.4.5.

4.5.11.5 Phenol leaching (classes 9 and 10). After 4.12.1 through 4.12.4 testing is completed remove coating from the polyethylene surface. (Note: alternate method if coating cannot be removed from polyethylene surface, cast free films of each coating of the coating system. Cure at ambient laboratory conditions for 7 days.) Pulverize the coating film sample. (Note: If using alternate method, use equal weights of each coating of the coating system.) Sieve pulverized particles through a U. S. sieve no. 50. A 1-gram (nominal) sample of the sieved material shall be placed on a paper thimble and lowered into a Soxhlet extractor. The 500 ml flask in this assembly shall be filled with 300 ml of ASTM D1193 (any type) distilled water and several boiling chips. The sample shall be refluxed until a least four complete siphonings of the sample chamber has occurred (several hours). Pour off the liquid into a tightly sealed, clean glass flask for phenolic concentration testing. Determine phenolic compound concentration as specified in APHA method 5330 C or D. Phenolic compound concentration for each coating of the coating system shall be as specified in the requirements of 3.4.6.

4.5.12 Resistance to hot water - simulated boiler feedwater (all types, classes 11 and 12 only, and all grades). Class 11 and Class 12 panels shall be prepared in accordance with 4.5.2. Test panels shall be immersed to 150 mm (6 inches) of the 300 mm (12 inch length in 82 °C (180 F) distilled water in a beaker for 500 hours or to prior failure. The panel shall be removed, immediately examined. The extent, nature, and time of failure shall be reported in accordance with the requirements of 3.15.

4.5.13 Resistance to chemical solutions - simulated collection, holding and transfer tanks (CHT; sewage waste) (all types, classes 13 and 14 only, all grades). Paint system test panels shall be prepared as specified in 4.5.2. Test panels shall be tested to the following cycle:

- a. Immerse test panels in a solution consisting of Acetic acid in ASTM D1141 substitute or natural ocean water (solution I) adjusted to a pH of 3.8 to 4.0 for 14 days at a temperature of  $21 \pm 2.7$  °C ( $70 \pm 5$  °F).
- b. Remove from solution I and immerse panels in a solution consisting of 10 parts concentrated ammonium hydroxide in 90 parts ASTM D1141 substitute or natural ocean water (solution II) for 14 days at a temperature of  $21 \pm 2.7$  °C ( $70 \pm 5$  °F).
- c. Remove from solution II and immerse panels in a solution consisting of 7 parts concentrated sulfuric acid in 93 parts ASTM D1141 substitute or natural ocean water (solution III) for 14 days at a temperature of  $21 \pm 2.7$  °C ( $70 \pm 5$  °F).
- d. Remove from solution III and immerse panels in a solution consisting of 10 parts Urea in 90 parts ASTM D1141 substitute or natural ocean water (solution IV) for 14 days at a temperature of  $21 \pm 2.7$  °C ( $70 \pm 5$  °F).
- e. Remove from solution IV and immerse panels in 2 parts detergent (commercial solid dishwasher detergent) and 98 parts ASTM D1141 substitute or natural ocean water (solution V) for 14 days at a temperature of  $21 \pm 2.7$  °C ( $70 \pm 5$  °F).

Operations (a) to (e) constitute one complete test cycle (70 days). This cycle is repeated for a total test time of 140 days (20 weeks) and coating deterioration reported after each complete cycle. Care shall be taken not to contaminate solutions with carry over of solution between immersions. Panels may be rinsed if desired. Solutions shall be tested, refreshed or replaced as necessary to maintain solution composition. Coating system shall be evaluated for pinhole corrosion, ASTM D4541, Type II tester, adhesion of the original surfaces, ASTM D4541, Type II tester, adhesion of both original and recoated surfaces, blistering and surface imperfections larger than 1.5 mm ( $\frac{1}{16}$ -inch) in diameter. Coating systems shall be evaluated for edge rusting. Coating performance shall be as specified in 3.16. (See also 6.1.1.4)



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4.5.14 Resistance to condensing water - simulated tank top test (all types, classes, grades). Panels shall be prepared as specified in 4.5.2. Expose test panels in a condensing cabinet as specified in ASTM D4585 for 2000 hours at 38 °C (100 °F). Coating system shall be evaluated for pinhole corrosion, ASTM D4551 adhesion of the original surfaces, ASTM D4541, Type II tester, adhesion of both original and recoated surfaces, blistering and surface imperfections larger than 1.5 mm ( $\frac{1}{16}$ -inch) in diameter. Coating systems shall be evaluated for edge rusting. Test results shall be as specified in 3.17.

4.5.15 Ultraviolet fluorescence (Applicable to primers of all types all classes, all grades). Mix primer in accordance with the manufacturer's data sheet. Apply primer to any convenient substrate. Cure hard. In a darkened room, use a Spectroline BIB-150B Black Light Lamp (KTA-TATOR, Inc.) or equivalent 365 nanometer ultraviolet black light, to illuminate the primer. Determine if primer fluoresces uniformly and is sufficiently bright to easily ascertain presence of primer on all coated portions of substrate. Result shall be in accordance with the requirements of 3.18.

4.5.16 Cathodic protection (CP) compatibility. Two steel panels shall be prepared as specified in 4.5.2 and electrically connected to a commercial magnesium anode conforming to paragraph 5.1.2 of ASTM G8 and shall have a  $\frac{1}{4}$ -inch (nominal) hole drilled through the coating to the metal at the center of the test panel. The electrical resistance between a point on the surface of the anode and the metal in the drilled hole of the test panel shall be less than 0.01 ohm, when checked with an ohm meter. Connecting points on the test panel shall be coated with an epoxy compound for insulation. The test panel shall be installed in a modified ASTM G8 test in such a manner as to separate the test panel from the magnesium anode by two feet (nominal) for a period of 3 months. At the completion of the 6-month test, inspect each test panel for peeling, flaking, blistering, dissolving or other failure. Lifting, peeling or undercutting around the drilled hole shall be measured. Test results shall be in accordance with the requirements of 3.5.

4.5.17 Surface tolerant coating systems (not applicable to Type VIII or Type VIIIa). Establish a uniform rusted condition over the entire surface of six steel panels (150 by 300 by 3mm (6 by 12 by  $\frac{1}{8}$ -inch) by exposure for 300 hours in an ASTM B117 test apparatus. Surface preparation and paint application shall be as follows;

- a. The first pair of panels shall be painted with the coating system applied to one panel in the clean, dry, SP 15 condition and one panel in the SP 15 condition, but covered with a uniform film of oil similar to 10W40 motor oil. The film of oil shall be established by wiping an oil soaked rag over the panel until a uniform film is established. There shall be no "pooling" of oil on the surface. Paint the oily panel in accordance with the manufacturer's instructions and cure in accordance with the manufacturer's instructions, but for a minimum of seven days. Immerse both panels for 10 cycles, or to prior failure, in the desired test medium. At the end of the 10 cycles, remove from the desired test medium, dry for 48 hours and determine compliance with 3.19. Test for adhesion by method ASTM D4541, Type II tester.
- b. The second pair of panels shall be painted with the coating system applied to one panel in the clean, dry, SP 15 condition and one panel in the SP 15 condition, but covered with a uniform film of water. The film of water shall be established by wiping a sea water soaked rag over the panel until a uniform film is established. There shall be no "pooling" of water on the surface. Paint the wet panel in accordance with the manufacturer's instructions and cure in accordance with the manufacturer's instructions, but for a minimum of seven days. Immerse both panels for 10 cycles, or to prior failure, in the desired test media. At the end of the 10 cycles, remove from the desired test medium, dry for 48 hours and determine compliance with 3.19. Test for adhesion by method ASTM D4541, Type II tester.
- c. The third pair of panels shall be painted with the coating system applied to one clean, dry panel prepared in accordance with SP-2, Paragraph 5.3 and one panel prepared in accordance with SP-2, Paragraph 5.3 but do the surface preparation of the second panel underwater (sea water). Paint the first panel in the dry condition and paint the second panel underwater in accordance with the manufacturer's instructions and cure the second panel underwater in accordance with the manufacturer's instructions. Immerse both panels in sea water for six months, remove the panels, dry



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for 48 hours and determine compliance with 3.19. Test for adhesion by method ASTM D4541, Type II tester.

4.5.18 Wear resistant coating systems. Determine the wear resistance of the coating after 1000 cycles when tested in accordance with ASTM D4060. Coating shall comply with 3.20.

4.5.19 Bilge coating systems. Bilge coating systems shall be tested in accordance with the following test sequence:

- a. Paint and cure two steel test panels (150 by 300 by 3mm (6 by 12 by 1/8-inch) with Navy Formula 150 (Type IV) and one coat of Navy Formula 156 (Type IV). Observe the dry through times of MIL-DTL-24441. Scribe one panel to the metal substrate with a "X" and expose both panels for 300 hours in an ASTM B117 test apparatus.
- b. For one panel, remove all previously applied coatings (and corrosion products) at the "X" scribe mark by power tool cleaning to bare metal to achieve a SSPC SP-11 surface and feather the interface edges between the bare metal and intact paint. Create an area of at least 12 square inches. This is intended to simulate repair of a damaged area in a bilge coating.
- c. For the remaining panel, clean, degrease, remove any rust spots, lightly abrade with 100 grit sandpaper to break any remaining gloss and finally solvent clean the panel. Again, create a test area of at least 12 square inches.
- d. Apply to the prepared areas of the test panels the proposed bilge coating in the number of coats and with the procedure recommended by the coating manufacturer.
- e. Reimmerse the two panel thus prepared into the desired test medium for twelve test cycles or until prior failure.
- f. Following the twelve test cycles, remove the two panels from the immersion test and examine for compliance with 3.21. Bilge coating systems exhibiting delamination, blisters larger than 1.5 mm, rust breakthrough or any other coating failure compromising the substrate shall be considered a failure.

4.5.20 Single coat systems. Class 18, single coat systems, shall be tested to the requirements of Classes 5, 7, 9, 11, 13, 15, and 17 as requested in the manufacturer's application for qualification testing. The difference shall be in panel preparation. Class 18 coatings shall be applied in a single coat in accordance with the manufacturer's instructions.

4.5.21 Well deck overhead coating systems. The evaluation procedure for well deck overhead coating systems shall consist of the following steps:

- a. Two panels prepared as specified in 4.5.2 shall be coated with the well deck overhead coating system and cured for 30 days at an outdoor exposure site where the minimum ambient daytime temperature is 70 °F and minimum relative humidity is 50 percent.
- b. Each panel shall be exposed to a burn test where the panel is mounted at a 45-degree angle and a butane torch (or equal) heats the panel backside, which is uncoated. Temperature is measured on the bare uncoated backside (at the flame contact point) and on the front in the same general area as the flame contact on the back. The temperature at which the coating ignites is recorded. At that time the torch is removed and the coating is allowed to burn out. The time and temperature when the coating self extinguishes is recorded.

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- c. The heating sequence shall be for two hours at each of the temperatures in 50 degree Fahrenheit increments from 150 °F to 500 °F inclusive.
- d. Adhesion values in pounds per square inch shall be determined and recorded before and after the heat resistance test.
- e. Check for compliance with 3.24.

4.6 Toxicity. The contractor shall have the formulations and associated toxicological information available for review by the Navy Environmental Health Center (NEHC) as directed by the qualifying activity.

## 5. PACKAGING

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

## 6. NOTES

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

6.1 Intended use. Although the different types of coating systems of this specification afford superior protection for various shipboard tanks and similar ship applications, the coating systems are not necessarily interchangeable or of equal merit for all kinds of tanks and conditions of application. Classes 6, 8, 10, 12 and 14 are qualified systems, the first coat of which is a shop primer (see 6.6.5). All other classes are qualified without a shop primer. Class 15 coatings are not intended for new construction, but for limited touch-up only where localized repairs will be no more than 3 percent of the total surface area. Classes 16, 17 and 18 are for use as appropriate in either new construction or maintenance painting. Types VIII and VIIIa are powder coatings intended for use in severe marine service such as immersion and wet space application.

### 6.1.1 Coating selection.

6.1.1.1 Types IV, V, VI and VII, VIII and VIIIa. Type IV, V, VI and VII organic coatings are acceptable for use where environmental regulations limit VOC of organic coatings to a maximum of 340 grams of solvent per liter of coating. Types VI and VII have VOCs of less than 340 g/L. Inorganic zinc rich shop primers conform to environmental regulations limiting VOC to a maximum of 650 g/L. Types V, VI, VII, and VIII dried coating residues are non-hazardous waste under U. S. Environmental Protection Agency (USEPA) regulations in effect on the date of this specification. All types contain less lead, chromium, cadmium, asbestos and other hazardous ingredients than OSHA regulations allow or restrict in effect on the date of this specification.

6.1.1.2 Proprietary products. Depending on local application conditions, the acquisition guidance in 6.2 may also apply to selection of specific proprietary products within each type, class, and grade.

6.1.1.3 Shop primers. Shop primers (see 6.6.5) qualified with classes 6, 8, 10, 12, and 14 systems are not tested for weld through capability. The user of Classes 6, 8, 10, 12, and 14 systems in Navy ship construction or repair contracts should qualify all welding processes at the maximum manufacturer's recommended coating thickness where such coatings are used to NAVSEA Technical Publication S9074-AQ-GIB-010/248, "Requirements for Welding and Brazing Procedure and Performance Qualification." All modifications in coating formulations used as weld through pre-construction primers require re-qualification to NAVSEA Technical Publication S9074-AQ-GIB-010/248.

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6.1.1.4 Alternate test for resistance to chemical solutions. In addition to the test procedure of 4.5.13, coating systems proposed for qualification to Classes 13 and 14 of this specification will be tested to the following protocol:

- a. through e. As currently specified
- f. Fourteen-day immersion in 10% fatty acid, 90% seawater
- g. Fourteen-day immersion in 50% fatty acid, 50% seawater
- h. Fourteen-day immersion in 100% fatty acid

This alternate immersion resistance will not be required for qualification to this revision of this specification, but may be required by subsequent amendments or revisions. Data generated by Navy testing to this alternate requirement will be made available to manufacturers, for information purposes, who submit coating systems for qualification to paragraph 3.16. This alternate testing will not affect current qualifications.

6.2 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number, and date of this specification.
- b. Type, class and grade required (see 1.2).
- c. Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.2.1 and 2.3).
- d. Toxicity requirements (see 3.11 and 6.4).
- e. Packaging and labeling requirements (see 5.1 and 6.7). (Attention is directed to regulatory and safety requirements for labels.)

6.2.1 Acquisition guidance. Coatings in accordance with this specification vary to some extent in surface preparation required, and the effect of high humidity, slight surface moisture, and temperature during applications. Requirements for specific products can be found in contractor's instructions. Many factors affect the total overall cost per square foot per year for tank applications, possibly the least of which is the cost of the coating systems which average about 10 percent of the total cost. The number of coats per coating system and square foot coverage per liter, per gallon or per pound further complicate the equity of purchase solely on the basis of lowest cost per liter or cost per gallon. Contracting officers should therefore should fully consider such factors.

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. 23236 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 purchase 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.

6.4 Material safety data sheets. The contracting activity should be given a material safety data sheets (MSDS) at the time of contract award. The MSDS should be provided in accordance with FED-STD-313 and ANSI Z400.1. Contracting officers should identify those activities requiring copies of completed Material Safety Data Sheets (MSDS) prepared as specified in FED-STD-313. Additional required government information is contained in FED-STD-313. In order to obtain the MSDS, federal acquisition regulation (FAR) clause 52.223-3 must be in the contract.

6.5 Comparability. The comparability of types and classes of MIL-P-23236(SHIPS), DOD-P-23236A(SH), MIL-P-23236B(SH) and MIL-PRF-23236C is shown in Table VIII.

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TABLE VIII. Comparability data.

| Coating   | MIL-P-23236(SH) | DOD-P-23236A(SH) | MIL-P-23236B(SH) | MIL-PRF-23236C |
|-----------|-----------------|------------------|------------------|----------------|
| Type I    | X               | X                | X                | Deleted        |
| Type II   | X               | Deleted          | Deleted          | Deleted        |
| Type III  | --              | X                | X                | Deleted        |
| Type IIIa | --              | X                | Deleted          | Deleted        |
| Type IIIb | --              | X                | Deleted          | Deleted        |
| Type IV   | --              | --               | X                | X              |
| Type V    | --              | --               |                  | X              |
| Type VI   | --              | --               |                  | X              |
| Type VII  | --              | --               |                  | X              |
| Class 1   | X               | X                | X                | Deleted        |
| Class 2   | X               | Deleted          | X                | Deleted        |
| Class 3   | X               | Deleted          | Deleted          | Deleted        |
| Class 4   | X               | Deleted          | Deleted          | Deleted        |
| Class 5   | --              | --               | --               | X              |
| Class 6   | --              | --               | --               | X              |
| Class 7   | --              | --               | --               | X              |
| Class 8   | --              | --               | --               | X              |
| Class 9   | --              | --               | --               | X              |
| Class 10  | --              | --               | --               | X              |
| Class 11  | --              | --               | --               | X              |
| Class 12  | --              | --               | --               | X              |
| Class 13  | --              | --               | --               | X              |
| Class 14  | --              | --               | --               | X              |
| Class 15  | --              | --               | --               | X              |
| Class 16  | --              | --               | --               | X              |
| Grade A   | --              | --               | X                | X              |
| Grade B   | --              | --               | --               | X              |
| Grade C   |                 |                  |                  | X              |

6.6 Definitions. Interpretation of the meaning of coating related terms in this specification are to be consistent with the “Coatings Encyclopedic Dictionary”, Federation of Societies for Coating Technology, 492 Norristown Road, Blue Bell, PA 19422-2350. A limited number of definitions are given below.

6.6.1 Coating components (Except Type VIII and Type VIIIa). Coating components are individually packaged components such as base component (part A) and converter component or hardener (part B).

6.6.2 Coating. A coating is the resin component (base) and converter mixed and ready for application.

6.6.3 Coat. A coat is a single application of the coating which may be composed of multiple passes by application equipment.

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6.6.4 Coating system. A coating system is the total number of coats as specified by the manufacturer at the time of qualification testing and at the dry film thickness per coat as specified by the manufacturer at the time of qualification testing.

6.6.5 Shop primer (Except Type VIII and Type VIIIa). A quick drying material applied as a thin film to a metal surface after surface preparation (blast cleaning, etc.) to give protection before and during the fabrication process. Shop primers are also as known as prefabrication primers, after blast primers, after pickling primers, and preconstruction primers. In this specification, a shop primer is any coating having fast drying properties and intended for equivalent use.

6.6.6 MOGAS. MOGAS is motor vehicle gasoline.

6.7 Packaging recommendations. Suggested packaging requirements are contained on Tables IX and X.

TABLE IX. Packaging.

| Packaging   | Recommended requirements for direct Government acquisitions   |
|---|---|
| Containers (Except Type VIII and Type VIIIa)              | <p>(1) The components should be specified to be furnished in cans appropriate to kit requirements capable of holding 0.47 liters (L) (1-pint), 0.945L (1-quart), 3.78L (1-gallon) and 18.9L (5 gallons). Kits should consist of two containers, one of which should be large enough to contain all components for mixing purposes.</p> <p>(2) Multiple friction plug containers should be in accordance with PPP-C-96, Type V, Class 2. Interior coatings should be as specified therein. Exterior coatings, including side seam stripping, should be as specified therein for plan B. Wire handles as specified therein, should be provided for the 1-gallon container. Closure of the properly filled and sealed cans should be as specified in the appendix thereto.</p> <p>(3) All containers should comply with the requirements of the Uniform Freight Classifications (UFC), the National Motor Freight Classification (NMFC), and the applicable requirements of the Code of Federal Regulations 49CFR, Department of Transportation (DOT).</p> <p>(4) Unit of procurement: The paints covered by this specification should be purchased by volume. The unit of procurement should be in multiples of 1 L or 1 U.S. liquid gallon at 15.5 °C (60 °F).</p> |
| Commercial packaging (Including Type VIII and Type VIIIa) | <p>(1) Commercial packaging should be to ASTM D3951.</p> <p>(2) All containers should comply with the requirements of the Uniform Freight Classifications (UFC), the National Motor Freight Classification (NMFC), and the applicable requirements of the Code of Federal Regulations 49CFR, Department of Transportation (DOT).</p>  |
| Packing   | <p>Packing should be specified as follows:</p> <p>(1) Overseas delivery packing. Intermediate containers of like size kits of paint should be packed in close-fitting wood boxes conforming to PPP-B-601, overseas type, or PPP-B-621, class 2. Box closure and strapping should be as specified in the applicable box specification or the appendix thereto except that strapping should be flat and the finish B.</p> <p>(2) 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>(3) Commercial packing. The paint, in the unit kit and intermediate containers should, as applicable, be packed in multiples of like sizes in accordance with UFC, NMFC and 49CFR requirements.</p>  |
| Palletization   | Intermediate containers should be palletized in accordance with MIL-STD-147. Only one size unit or intermediate container should be placed on a pallet.   |
| Packaging   | Recommended requirements for direct Government acquisitions   |

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TABLE IX. Packaging - Continued.

| <b>Packaging</b>  | <b>Recommended requirements for direct Government acquisitions</b>  |
|---|---|
| Intermediate containers   | Paints should be packaged in intermediate containers as kits. Intermediate containers should be close-fitting corrugated fiberboard boxes in accordance with UFC, NMFC and 49CFR requirements. Fiberboard used in the construction of interior (unit and intermediate) and exterior containers, including interior packaging forms, should conform to the PPP-F-320. PPP-F-320 classes should be domestic fire-retardant or weather resistant fire-retardant (see 6.2). |
| Packing for acquisitions involving direct delivery to Navy ships or installations | Treated lumber and plywood. All lumber and plywood, including laminated veneer materials, used in shipping container and pallet construction, member, blocking, bracing, and reinforcing must be fire-retardant treated material in accordance with MIL-L-19140 as follows:<br>(a) General use, weather resistant:<br>MIL-L-19140, Type II, Category I.<br>(b) General use, non-weather resistant:<br>MIL-L-19140, Type I, Category I.                                  |
| Unit kits   | The paints covered by this specification should be packed and packaged as kits.   |
| Material safety data sheets (MSDS) and product/procedure data sheets              | A copy of the MSDS and company product data/procedure sheets should be attached to the shipping document for each destination (see 6.4).  |
| VOC Certification sheets  | VOC Certification sheets will be provided by the manufacturer for each batch of combined Parts A & B for each coat of the coating system when requested by the procuring activity.  |

TABLE X. Marking.

| <b>Marking type</b>            | <b>Recommended Marking</b>  |
|--------------------------------|---|
| 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.<br>(b) All individual containers should have the following marking:<br>"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."<br>(c) Each component container, shipping container, and palletized load should be marked with the appropriate hazardous symbol.<br>(d) Unit containers should be marked: "This product is Asbestos, Lead, Chromium, Cadmium free, except for possible trace levels." Types V, VI and VII should also be marked: "This product is free of volatile organic hazardous air pollutants (VOHAPS/HAPS), except for possible trace levels." |
| 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])."   |
| Hazardous air pollutants       | "Contains [insert HAP content here in g/L and lb/gal] solids (nonvolatiles) per 40 CFR 63."   |
| Shelf life                     | Each unit container, intermediate container where applicable, and shipping container should be marked as follows: "Date of first re-inspection (insert here date 2 years after date of manufacture)."   |

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6.8 Part or identifying number (PIN).

**M**                      **23236**                      -                      **X**                      **X**                      **X**  
 Prefix for Military      Specification                      Type (see code                      Class (see                      Grade (see  
 Specification                      Number                      below)                      code below)                      code below)

PIN Code:

| Type Code |      | Class Code |      | Grade Code |      |
|-----------|------|------------|------|------------|------|
| Type      | Code | Class      | Code | Grade      | Code |
| IV        | A    | 5          | 1    | A          | A    |
| V         | B    | 6          | 2    | B          | B    |
| VI        | C    | 7          | 3    | C          | C    |
| VII       | D    | 8          | 4    |            |      |
| VIII      | E    | 9          | 5    |            |      |
| VIIIa     | F    | 10         | 6    |            |      |
|           |      | 11         | 7    |            |      |
|           |      | 12         | 8    |            |      |
|           |      | 13         | 9    |            |      |
|           |      | 14         | 10   |            |      |
|           |      | 15a        | 11   |            |      |
|           |      | 15b        | 12   |            |      |
|           |      | 15c        | 13   |            |      |
|           |      | 16         | 14   |            |      |
|           |      | 17         | 15   |            |      |
|           |      | 18         | 16   |            |      |

Example: M23236-A2B



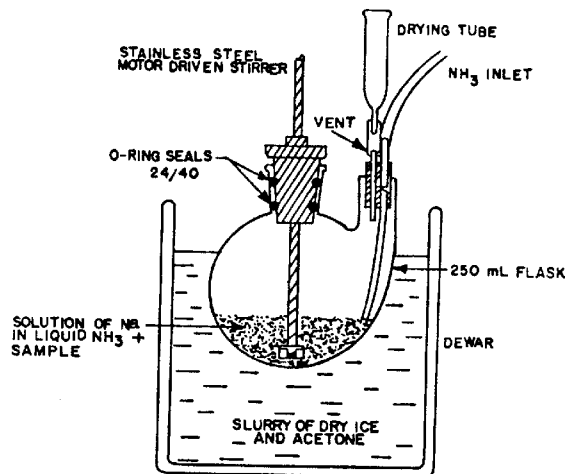
MIL-PRF-23236C

6.9 Subject term (key word) listing.

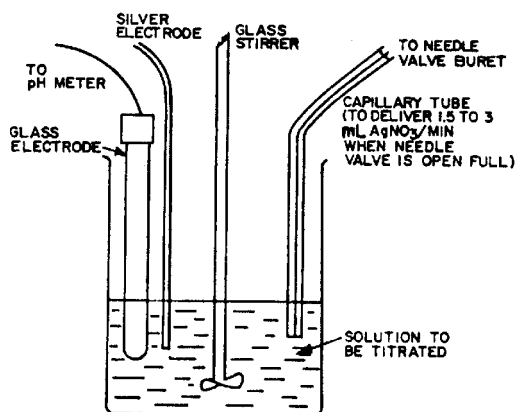
Asbestos  
Ballast  
Boilerwater  
Coating  
Fuel  
HAP  
Hazardous air pollutants  
Lead free  
Paint  
Potable  
Powder coating  
Seawater  
Sewage  
Ship  
Tank  
Volatile organic content  
VOHAP

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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SH 7092

FIGURE 1. Apparatus for the decomposition of organic halides.

SH 7093

FIGURE 2. Potentiometric titration assembly.

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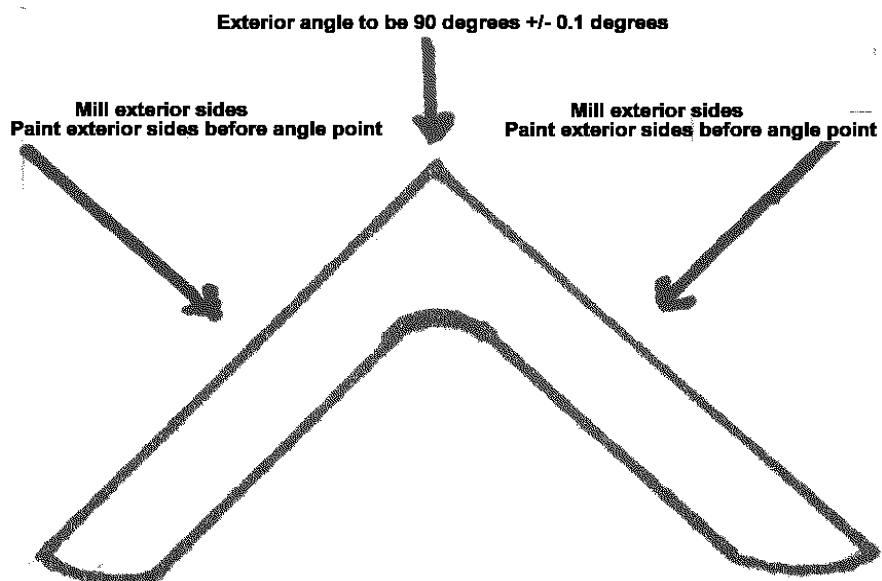


FIGURE 3. Structural angle milling and painting.

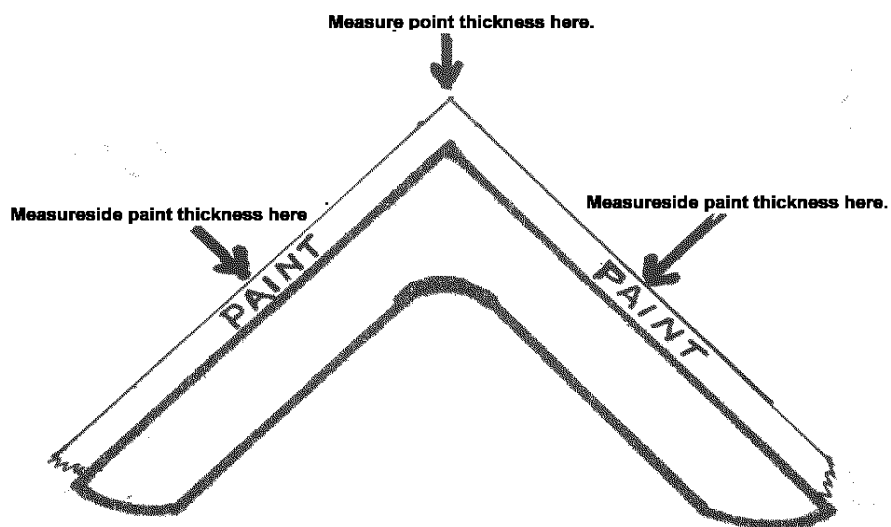


FIGURE 4. Paint film thickness measurement.

## MIL-PRF-23236C

Appendix A  
EDGE RETENTION TEST

A.1 Scope. This appendix is intended to provide the test method procedure referenced in paragraph 4.5.9 of this specification for compliance with paragraph 3.8.1 of this specification. This Appendix is a mandatory part of the specification. The information contained herein is intended for compliance.

A.2 Specimen preparation. The edge retention specimen should use an Aluminum Alloy 6061 structural angle (90-degree) section approximately 6 inches long. Preparation of the specimen for test will require three basic steps: sample machining to meet initial dimension requirements, grit blasting to provide acceptable anchor tooth and surface cleaning prior to coatings application. Procedures for preparation are as follows:

A.2.1 Sample machining. Both exterior surfaces should be milled so that faces are square (90-degree  $\pm$  0.1-degree) and have a surface finish of 63 micro-inch. The exterior edge should be left as a "sharp" edge with no radius tolerance or chamfer.

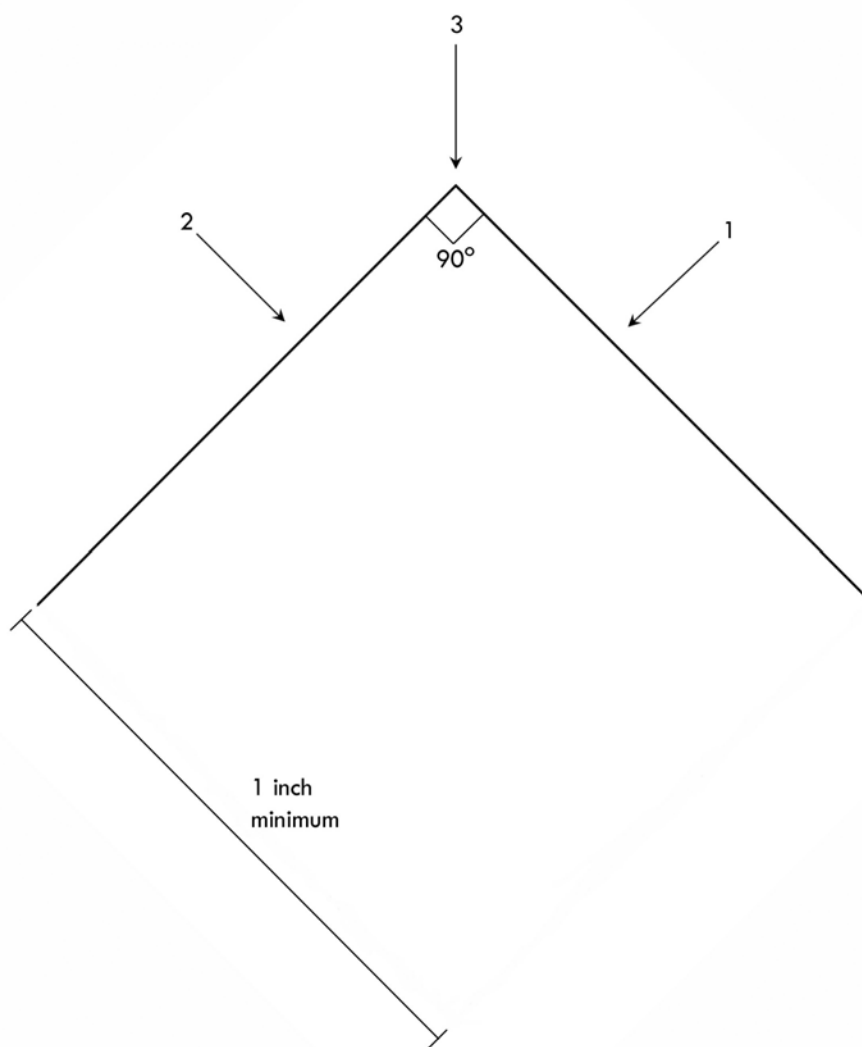
A.2.2 Grit blasting. Specimen should be grit blasted using  $Al_2O_3$  media to achieve an anchor tooth profile of 1-3 mil. Care should be taken to minimize rounding of the edge with excess blasting. Final edge radius should not exceed 0.04 inch ( $\pm$ 10 percent).

A.2.3 Cleaning. Specimen should be cleaned thoroughly with acetone or appropriate solvent to remove all traces of grease prior to abrasive blasting and coating application.

A.3 Paint application. Topcoat is then spray applied to unprimed metal, maintaining correct pump pressure and distance from substrate (approx. 18 inches) according to manufacturers recommendations. Paint is applied to both sides (first) and the edge (last) within one minute. Measure the wet film thickness on the flat sides to ensure compliance with minimum recommended film thickness. After paint application, cure the specimens at ambient laboratory conditions for a minimum of 72 hours before sectioning. (see figure A-1)

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## Appendix A

FIGURE A-1. Spray.

A.4 Dry film thickness. The test sample is cut at a minimum of ½-inch thicknesses, mounted in metallurgical sample holder and the cut is smoothed by sanding. The dry film thickness is measured using an optical microscope. Measurements are made at sufficient distance from the 90-degree angle to ensure there is no edge effect; this is dft (flat). The lowest thickness visible at the edge is also measured to determine dft (edge).

A.5 Edge retention calculation. The edge retention is calculated from:

$$\% \text{ Retention} = \text{dft (edge)} / \text{dft (flat)} \times 100 \text{ (see figure A-2)}$$

A.6 Pass/fail criteria. Three sectioned specimens shall be cut from each sample, the coating thickness measured and edge retention calculated. Any specimen with less than 50 percent edge retention shall constitute a failure. The average of the three shall not be less than 70 percent.

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Appendix A

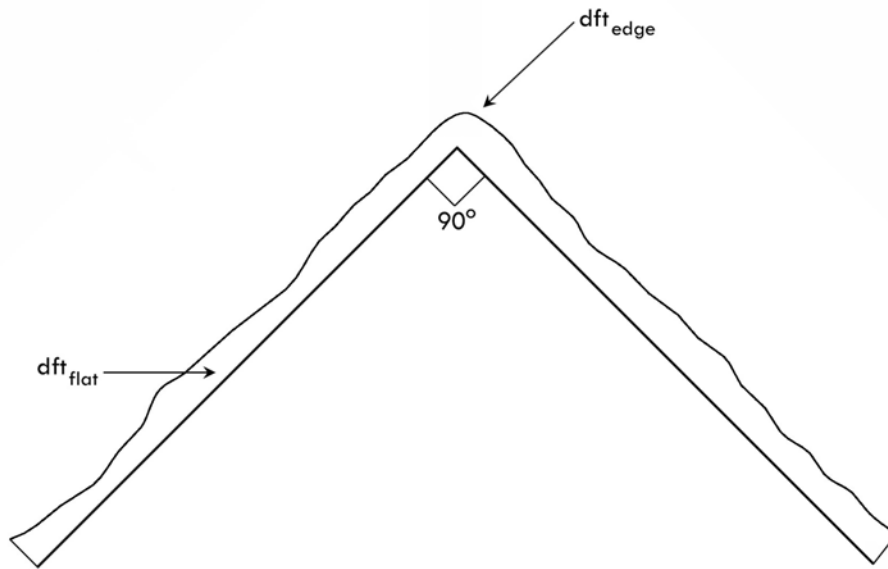


FIGURE A-2. Edge retention calculation.

NOTES:

1. Aluminum is used due to ease of availability, handling and cutting.
2. Mounting the sample in a metallurgical mount prevents damage to the edge during measurement and allows "polishing" of the specimen to highlight the interfaces for measurement.

Custodians:  
Army - MR  
Navy - SH  
Air Force - 99

Preparing Activity:  
Navy - SH  
(Project 8010-0182)

Review Activities:  
Navy - AS, CG  
Air Force - 03, 84  
CIV - 6FEE