

INCH-POUND

MIL-PRF-24647C

24 September 2001

SUPERSEDING

MIL-PRF-24647B

2 April 1991

(See 6.7)

PERFORMANCE SPECIFICATION

PAINT SYSTEM, ANTICORROSIVE AND ANTIFOULING, SHIP HULL

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

1. SCOPE

1.1 Scope. This specification covers ship hull anticorrosive and antifouling paint systems.

1.2 Classification. Paints covered by this specification are of the following types, classes, grades, and applications, as specified (see 6.2):

- | | | |
|----------|---|--|
| Type I | - | Paint systems having topcoats of ablative antifouling paints. |
| Type II | - | Paint systems having topcoats of nonablative antifouling paints. |
| Class 1A | - | Paint systems having copper based toxics in the antifouling topcoats. Paint systems for use on metal substrates, except aluminum alloys. |
| Class 1B | - | Paint systems having mixed-toxics in the antifouling topcoats. Paint systems for use on metal substrates, except aluminum alloys. |
| Class 1C | - | Paint systems having antifouling topcoats that are toxic-free. Paint systems for use on all metal substrates, including aluminum. |
| Class 2 | - | Paint systems use on aluminum. |

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 05Q, 1333 Isaac Hull Avenue SE, Stop 5160, Washington Navy Yard, DC 20376-5160 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document, or by letter.

AMSC N/A

FSC 8010

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

- Class 3A - Paint systems having antifouling topcoats containing only copper-based toxics for use on rubber.
- Class 3B - Paint systems having antifouling topcoats containing mixed-toxics for use on rubber.
- Class 3C - Paint systems having antifouling topcoats that are toxic-free for use on rubber.
- Grade A - Volatile organic content (VOC) of the antifouling topcoats will be a maximum of 3.4 pounds per gallon [lb/gal; 400 grams per liter (g/L)]. VOC of all other individual paints in the paint system will be in accordance with the requirements of Grade B.
- Grade B - VOC of each individual paint of the paint system will be a maximum of 2.8 lb/gal (340 g/L).
- Grade C - VOC of each individual paint of the paint system will be a maximum of 2.3 lb/gal (275 g/L).
- Grade D - VOC of each individual paint of the paint system will be a maximum of 0 lb/gal (0 g/L).

- Application 1 - Paint systems having red color antifouling for underwater hull, with a service life of five years.
- Application 2 - Paint systems having black color antifouling for waterline (boottop) of hull, with a service life of five years.
- Application 3 - Paint systems having gray color antifouling for underwater hull, with a service life of five years. (Application 3 for classes 1C, 2 and 3C only.)
- Application 4 - Paint systems having red color antifouling for underwater hull, with a service life of seven years.
- Application 5 - Paint systems having black color antifouling for waterline (boottop) of hull with a service life of seven years.
- Application 6 - Paint systems having gray color antifouling for underwater hull, with a service life of seven years. (Application 3 for classes 1C, 2 and 3C only.)

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 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

MILITARY

- MIL-DTL-24441 - Paint, Epoxy-Polyamide, General Specification for.

STANDARDS

FEDERAL

- FED-STD-141 - Paint, Varnish, Lacquer and Related Materials: Methods of Inspection, Sampling and Testing.
- FED-STD-313 - Material Safety Data, Transportation Data and Disposal Data for Hazardous Materials Furnished to Government Activities.
- FED-STD-595 - Colors Used in Government Procurement.

MILITARY

- MIL-STD-129 - Marking for Shipment and Storage.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available, Bldg. 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.1.2 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.

U. S. Environmental Protection Agency (EPA)

40 CFR 60 CH. 1, Appendix A, Method 24 - Determination of Volatile Matter Content, Water Content, Density, Volume Solids and Weight Solids of Surface Coatings.

40 CFR 150-180 - Federal Insecticide, Fungicide and Rodenticide Act (FIFRA).

40 CFR 63.780 U.S. EPA National Emissions Standards for Hazardous Air Pollutants, Shipbuilding and Ship Repair Coatings.

Code of Federal Regulations (CFR), Volume 40, Part 251, Appendix II [40 CFR 251, Appendix II] - Toxic Characteristics Leaching Procedure.

(Application for copies should be directed to the Superintendent of Documents, U. S. Government Printing Office, Washington, DC or to the organization listed above.)

Occupational Health and Safety Administration (OSHA)

29 CFR, Parts 1910, 1915, 1917, 1918, 1926, and 1928 - Hazard Communication Act, Final Rule.

(Application for copies should be directed to the Superintendent of Documents, U. S. Government Printing Office, Washington, DC or to the organization listed above.)

2.2 Nongovernment publications. The following document(s) 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)
 Threshold Limit Values (TLV) for Chemical Substances and Physical Agents in the Work Environment and Biological Exposure Indices. (Application for copies should be addressed to the American Conference of Governmental Hygienists, 6500 Glenway Avenue, Building D7, Cincinnati, OH 45211.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate. (DOD adopted)
- D 562 - Standard Test Method for Consistency of Paints Using the Stormer Viscometer. (DOD adopted)
- D 660 - Standard Test Method for Evaluating Degree of Checking of Exterior Paints. (DOD adopted)
- D 661 - Standard Test Method for Evaluating Degree of Cracking of Exterior Paints. (DOD adopted)
- D 714 - Standard Test Method for Evaluating Degree of Blistering of Paints. (DOD adopted)
- D 1475 - Standard Test Method for Density of Paint, Varnish, Lacquer, and Related Products. (DOD adopted)
- D 283 - Standard Test Method for Chemical Analysis of Cuprous Oxide and Copper Pigments.
- D 2000 - Standard Classification System for Rubber Products in Automotive Applications. (DOD adopted)
- D 2244 - Standard Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates. (DOD adopted)
- D 2369 - Standard Test Method for Volatile Content of Solvent-Reducible Paints. (DOD adopted)
- D 2621 - Standard Test Method for Infrared Identification of Vehicle Solids From Solvent-Reducible Paints.
- D 3278 - Standard Test Methods for Flash Point of Liquids by Setaflash Closed-Cup Apparatus. (DOD adopted)
- D 3335 - Standard Test Method for Low Concentrations of Lead, Cadmium, and Cobalt in Paint by Atomic Absorption Spectroscopy.
- D 3623 - Standard Method for Testing Antifouling Panels in Shallow Submergence.
- D 4400 - Standard Test Method for Sag Resistance of Paints Using a Multinotch Applicator.
- D 4938 - Standard Test Method for Erosion Testing of Antifouling Paints Using High Velocity Water.

- D 4939 - Standard Test Method for Subjecting Marine Anti-fouling Coating to Biofouling and Fluid Shear Forces in Natural Seawater.
- E 1347 - Standard Test Method for Color and Color-Difference Measurement by Tristimulus (Filter) Colorimetry.
- F 718 - Standard for Shipbuilders and Marine Paints and Coating Product/Procedure Data Sheet. (DOD adopted)
- F 1130 - Standard Practice for Inspecting the Coating System of a Ship.
- G 80 - Standard Test Method for Specific Cathodic Disbonding of Pipeline Coatings.

(Application for copies should be addressed to the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania, USA 19428-2959.)

(Nongovernment standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

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

3. REQUIREMENTS

3.1 Qualification. The paints furnished under this specification shall be products which are authorized by the qualifying activity for listing on the applicable qualified products list at the time of award of contract (see 4.3 and 6.4).

3.2 Description of paints. Each paint system being qualified to a type, class, grade and application of this document shall consist of the following individual paints:

a. Anticorrosive paint (primer), when required, intended for direct application to the substrate being painted.

b. Anticorrosive topcoat(s) intended for application over a primer. The topcoat of the anticorrosive layer shall be provided in FED-STD-595 color number 26270 (Haze gray), R₀1.8, and dark gray colors (see 3.4.1).

c. Tie coat(s), if required, intended for application to an anticorrosive paint and overcoated with antifouling paint.

d. Antifouling topcoat(s). Paint systems submitted for qualification to classes 1 and 2 of this specification shall be qualified with anticorrosive paints that conform to MIL-DTL-24441. If not qualified over MIL-DTL-24441, it will be assumed that the paints are not applicable over this primer system. Systems shall be qualified with a commercial product by the same manufacturer, used either directly or with an adhesion promoting coating (tie coat). Paint systems submitted for qualification to class 3

(rubber use) shall not need to qualify with anticorrosive coatings, but shall be qualified with any required adhesion promoting coat (tie coat).

3.2.1 System identification. Manufacturer shall at the time of qualification submittal identify by unique nomenclature (system name, alpha/numeric identification), the total system being qualified and each individual product constituting the system by unique alpha/numeric nomenclature (product name, alpha/numeric identification, color and required application thickness in thousandths of an inch). At a minimum, the manufacturer shall identify any of the following products which are included in the system being qualified using unique nomenclature (product name, alpha/numeric identification, color and required application thickness in thousandths of an inch).

- a. The product(s) constituting the antifouling paint topcoat(s).
- b. All types, classes, and grades - any required adhesion promoting (tie) coatings.
- c. Classes 1 and 2 - the commercial product designation for the vendor's approved MIL-DTL-24441 and commercial anticorrosive coatings being qualified with the antifouling paint topcoat(s).

3.2.2 System modifications. Given the long duration of selected tests, it is conceivable that certain commercial products may be modified over the course of the qualification process. The manufacturer shall note any changes. Examples include, but are not limited to, paint VOC reductions or slight additive modifications/additions. It is not the Government's intent to discourage positive formulation changes, however, the manufacturer shall provide a written certification and technical justification that such changes do not negatively affect the long-term properties of the material. Should the material properties discussed under tables I, II, or III be affected, new data shall be submitted.

3.2.3 Underwater hull cleaning. The vendor shall indicate the frequency and process for underwater hull cleaning, if applicable. Unless approved prior to testing, mechanical cleaning shall not be allowed as a supplemental measure to satisfy any of the requirements of paragraph 3.4.4.

3.3 Material requirements. The paint systems furnished under this specification, when mixed and applied in accordance with the manufacturer's instructions, shall produce a coating that satisfies all the requirements of this specification. The composition of the paint furnished under this specification shall be the responsibility of the manufacturer, except as limited by this specification.

3.3.1 Types. Two types of antifouling topcoats, which shall function in accordance with an identifiable toxic release mechanism, are specified in 3.3.1.1 and 3.3.1.2.

3.3.1.1 Type I. Type I is a paint system with an ablative antifouling topcoat which shall dissolve, polish, erode, or reduce in thickness as the primary condition for performing its antifouling function. The antifouling coating shall function by leaching process and may also be rejuvenated by optional mechanical underwater brushing or other cleaning.

3.3.1.2 Type II. Type II is a paint system with a nonablating antifouling topcoat which does not diminish in thickness during service. Most classes will function by leaching a toxic agent. Type II antifouling topcoats may also be rejuvenated by optional mechanical underwater brushing or other cleaning.

3.3.2 Classes.

3.3.2.1 Class 1.

3.3.2.1.1 Class 1A. The antifouling topcoat(s) in the Class 1A paint systems shall contain only copper compounds as the toxic agent(s). Class 1A paint systems are intended for use on non-aluminum metals (alloys of iron, nickel, or copper) substrates.

3.3.2.1.2 Class 1B. The antifouling topcoat(s) in the Class 1B paint systems shall contain a mixture of toxic agents, one or more of which shall be a copper compound. Class 1B paint systems are intended for use on non-aluminum metal (iron alloys, nickel alloys, copper alloys) substrates.

3.3.2.1.3 Class 1C. The antifouling topcoat(s) in the Class 1C paint systems shall not contain any toxic agent requiring EPA registration under FIFRA. Class 1C paint systems are intended for use on metal (iron alloys, aluminum alloys, nickel alloys, copper alloys) substrates and shall not contain ingredients which will cause aluminum corrosion.

3.3.2.2 Class 2. The antifouling topcoat(s) in the Class 2 paint systems shall contain a mix of toxic agents. Class 2 paint systems are intended for use on aluminum alloys and shall be free of copper compounds or other ingredients corrosive to aluminum.

3.3.2.3 Class 3.

3.3.2.3.1 Class 3A. The antifouling topcoat(s) in the Class 3A paint systems shall contain only copper compounds as the toxic agent(s). Class 3A paint systems are intended for use on rubber substrates.

3.3.2.3.2 Class 3B. The antifouling topcoat(s) in the Class 3B paint systems shall contain a mixture of toxic agents, one or more of which shall be a copper compound. Class 3B paint systems are intended for use on rubber substrates.

3.3.2.3.3 Class 3C. The antifouling topcoat(s) in the Class 3C paint systems shall not contain toxic agents requiring EPA registration under FIFRA. Class 3C paint systems are intended for use on rubber substrates.

3.3.3 Grades.

3.3.3.1 Grade A. The VOC of antifouling topcoats of grade A paints shall not exceed 3.4 lb/gal (400 g/L) when in the ready-to-apply condition. The VOC of all other individual paints in the paint system shall be a maximum of 2.8 lb/gal (340 g/L). Ready-to-apply condition includes any volatile solvents added to prepare the paint for application (see 3.7).

3.3.3.2 Grade B. The VOC of each individual paint in the grade B paint system shall not exceed 2.8 lb/gal (340 g/L) when in the ready-to-apply condition (see 3.7).

3.3.3.3 Grade C. The VOC of each individual paint in the grade C paint system shall not exceed 2.3 lb/gal (275 g/L) when in the ready-to-apply condition (see 3.7).

3.3.3.4 Grade D. Grade D paint system shall contain no VOC (see 3.7).

3.3.4 Applications.

3.3.4.1 Applications 1, 2 and 3. Applications 1, 2 and 3 paint systems shall have a minimum service life of 5 years without failure due to loss of adhesion, blistering, flaking, depletion by excessive ablation or loss of anti-fouling capability (excepting minor sliming and biofouling from the boottop to the light load line.).

3.3.4.2 Applications 4, 5 and 6. Applications 4, 5 and 6 paint systems shall have a minimum service life of 7 years without failure due to loss of adhesion, blistering, flaking, depletion due to excessive ablation or loss of antifouling capability (excepting sliming and biofouling from the boot top to the light load line).

3.3.5 Composition. The manufacturer is given his choice in the formulation of the paints described by this document, provided the end product conforms to all requirements of this specification. Soluble metals content and total metal content of each individual paint of the paint system shall not exceed the values listed in tables I and II when tested in accordance with 4.5.11. Copper and Zinc contents listed in tables I and II do not apply to antifouling topcoat paints or the total paint system of classes 1A, 1B, 2, 3A and 3B.

TABLE I. Soluble metals content.

Requirement	Maximum (soluble), mg/L
Metals content (soluble), mg/L	
Antimony and/or its compounds	15
Arsenic and/or its compounds	5
Barium and/or its compounds (excluding barite)	100
Beryllium and/or its compounds	0.75
Cadmium and/or its compounds	1
Chromium (VI) compounds	5
Chromium and/or chromium (III) compounds	560
Cobalt and/or its compounds	80
Copper and/or its compounds	25
Fluoride salts	180
Lead and/or its compounds	5
Mercury and/or its compounds	0.02
Molybdenum and/or its compounds	350
Nickel and/or its compounds	20
Selenium and/or its compounds	1
Silver and/or its compounds	5
Thallium and/or its compounds	7
Vanadium and/or its compounds	24
Zinc and/or its compounds	250

TABLE II. Total metals content.

Requirement	Metals content (total), weight percent Maximum
Metals content (total), weight percent	
Antimony and/or its compounds	0.05
Arsenic and/or its compounds	0.05
Barium and/or its compounds (excluding barite)	1.00
Beryllium and/or its compounds	0.0075
Cadmium and/or its compounds	0.01
Chromium (VI) compounds	0.05
Chromium and/or chromium (III) compounds	0.25
Cobalt and/or its compounds	0.80
Copper and/or its compounds	0.25
Fluoride salts	1.80
Lead and/or its compounds	0.10
Mercury and/or its compounds	0.002
Molybdenum and/or its compounds	0.35
Nickel and/or its compounds	0.20
Selenium and/or its compounds	0.01
Silver and/or its compounds	0.05
Thallium and/or its compounds	0.07
Vanadium and/or its compounds	0.24
Zinc and/or its compounds	0.50

3.3.5.1 Identification characteristics. Manufacturer shall disclose to the Government the identification characteristics required in table III in accordance with the test method listed therein for each individual paint (mixed and components, as applicable) in the paint system. Paint identification characteristics listed in table III, when tested in accordance with requirements in 4.3, shall conform to the values disclosed by the manufacturer.

3.3.5.2 Toxicity. Manufacturer shall prepare container label instructions for the paint in accordance with the OSHA requirements of 29 CFR, parts 1910, 1915, 1917, 1918, 1926, and 1928 (see 5.1). The paint shall contain no asbestos, asbestos from pigments, benzene, toluene, chlorinated solvents, hydrolyzable chlorine derivatives, coal tar or coal tar derivatives, tributyl tin compounds, or any ACGIH carcinogenic or ACGIH suspected carcinogenic compounds (see 3.5 and 6.3).

3.3.5.3 Toxic products. The material shall have no adverse effect on the health of personnel when used for its intended purpose. Questions pertinent to this effect shall be referred by the contracting activity to the appropriate departmental medical service who will act as an advisor to the contracting agency.

3.4 Qualitative requirements.

3.4.1 Color. Colors of the individual paints of the paint systems shall:

a. When tested in accordance with 4.5.8.1, the colors of the individual anticorrosive and tie coat paints, except R₀ color paints, shall be in accordance with the FED-STD-595 color provided as an identification characteristic for that paint.

b. When R_w is measured in accordance with 4.5.8.2, the R₀1.8 dark gray color anticorrosive topcoats of the paint system when measured as R_w, shall be R_w = 0.9 +/- 0.2.

c. The color of applications 1 and 4 antifouling topcoat paints shall be consistent with the pigments used. The color of application 2 and 5 antifouling topcoat paints shall be slightly darker than FED-STD-595 number 37056 when tested in accordance with 4.5.8. The color of applications 3 and 6 antifouling topcoat paints shall match color FED-STD-595 color number 26173 or 26270 as specified (see 6.2) when tested in accordance with 4.5.8.

If doubt exists as to whether the match in a. or c. is satisfactory, the color shall not exceed five color difference units in the direction of minus delta L when tested in accordance with table IV.

3.4.2 Condition in container. The coatings shall be readily mixed with a mechanical mixer to a smooth, uniform consistency after stirring for five minutes. Coatings shall not liver, hard settle, skin, seed or otherwise become unfit for use. Water based products shall not show phase separation, evidence of biological growth, putrefaction, corrosion of the container, or persistent foam which lasts more than 5 minutes. Test as specified in table IV.

TABLE III. Identification characteristics. 1/

Test	Applicable FED-STD-141 test method	Applicable ASTM test method
Pesticide (report manufacturing range or variation, +/- percent) <u>2/</u>	---	---
Volatiles (report manufacturing range or variation, +/- percent)	---	D 2369
Nonvolatile vehicle (report manufacturing range or variation, +/- percent)	4053.1	---
Consistency, gram equivalent KU (report Manufacturing range or variation, +/- KU)	---	D 562
Weight per unit volume (report manufacturing range or variation, +/- lb/gal)	---	D 1475
Drying to touch time (report - maximum not to exceed 2 hours at 20 degrees Celsius [°C], ASTM F 718 film thickness (68 degrees Fahrenheit [°F]))	4061.2	---
Drying hard time (report - maximum not to exceed 16 hours at 20°C [68°F], ASTM F 718 film thickness)	4061.2	---
Flash Point (report - minimum - to be not less than 21°C [70°] required)	---	D 3278
Volatile organic content (VOC) <u>3/</u>	---	D 2369
Pot life (where applicable) (report hours, temperatures)	---	---
Color		
R ₀ 1.8 <u>4/</u>	---	---
All other paint system colors	4250.1	---
Infrared spectra of nonvolatile vehicle	---	D 2621
Sag resistance (report minimum value)	---	D 4400
Toxicity <u>5/</u>	---	---
Erosion or ablation rate (type I only <u>2/</u> , <u>6/</u>)	---	---

1/ Manufacturing range percentages having variations of more than +/- 3 percent, without supporting documentation, will be rejected and can cause delay or rejection of qualification. Manufacturers shall provide documentation for any identification characteristics deemed non-applicable, i.e., dry-time for a tie-coat designed to be over-coated before completely drying. Also, should a suggested test method not be applicable for the product, the manufacturer shall report the data and an alternative test method.

2/ Antifouling topcoats only. Report methods used to determine.

3/ VOC shall be determined in accordance with 4.5.3.

4/ Determine in accordance with 4.5.8.

5/ Certify in accordance with 3.3.5.2.

6/ Manufacturer shall establish and report erosion rate range in thousandths of an inch per year. This number shall be consistent with application approval sought and 4.5.1.

TABLE IV. Test methods.

Requirements	Applicable FED-STD-141 test method	Applicable ASTM test method	Applicable MIL-PRF-24647 test method
*3.3.5 & TABLE I Pigment (pesticide), percent	4021.1	---	---
*3.3.5 & TABLE I Volatiles, percent	---	D 2369	---
*3.3.5 & TABLE I Nonvolatile vehicle, percent	4053.1	---	---
*3.3.5 & TABLE I Consistency, gram equivalent KU	---	D 562	---
*3.3.5 & TABLE I Weight per unit volume, lb/gal	---	D 1475	---
3.3.5 & TABLE I Copper content of pigment, percent	---	D 283	---
*3.3.5 & TABLE I Drying time	4061.2	---	---
*3.3.5 & TABLE I Flash point, °F	---	D 3278	---
3.4.1 Table I, 3.8 Color			
Applications 1 and 4	---	---	4.5.8
Applications 2, 3, 5 and 6	---	---	4.5.8
(Disputes only)	---	---	4.5.8
*3.3.5 & TABLE I Infrared spectra of nonvolatile vehicle	---	D 2621	---
*3.3.5 & TABLE I Sag resistance (10 required)	---	D 4400 (Method A)	---
3.3.5.2 Toxicity	---	---	3.3.5 and 3.5
3.3.3, 3.3.5 & TABLE I Lead content	---	D 3335	---
*3.4.2 Condition in container	3011.2	---	---
3.4.3.1 Shelf life	---	---	4.5.4.1
3.4.3.2 Partially full container	---	---	4.5.4.2
3.4.3.3 Accelerated storage stability	---	---	4.5.4.3
3.4.4 Resistance to tropical biofouling organism attachment	---	---	4.5.1
3.4.4.1 Erosion	---	D 4939/ D 4938	4.5.1.3
3.4.4.2 Shallow submergence	---	D 3623	4.5.1.4

Requirements	Applicable FED-STD-141 test method	Applicable ASTM test method	Applicable MIL-PRF-24647 test method
3.4.4.3 Ship tests	---	---	4.5.1.5
* See 4.4.			
*3.4.5 Spraying properties	---	---	4.5.5
3.4.6 Brushing properties	---	---	4.5.6
3.4.7 Rolling properties	---	---	4.5.7
3.4.8 Recoatibility	---	---	4.5.2
3.4.9 Cathodic protection compatibility	---	---	4.5.10
3.4.10.1 Freeze-thaw stability	---	---	4.5.9
* See 4.4.			

3.4.3 Storage stability. A previously unopened, original container of paint when stored and tested as required in 3.4.3.1 through 3.4.3.3 shall:

a. Readily mix with a mechanical mixer within five minutes to a smooth uniform condition.

b. Be free of grit(s), seed, tough or gummy sediment, skins, hard pigment settling, and persistent foam.

c. Not vary from the requirements established by table III by more than the following:

(1) ASTM D 562 consistency shall be not greater than ten Kreb units (KU) higher or lower than table III identification characteristic value.

(2) Dry-to-touch and dry-hard times shall not be more than 60 minutes longer than the maximum specified in table III.

(3) Color shall be as specified in 3.4.1.

(4) Each individual paint of the paint system shall be readily applied to the manufacturer's ASTM F 718 wet film thickness with no sagging, running, or streaking.

3.4.3.1 Shelf life. An original, unopened can matching manufacturer's specified quantity as stated on can's label which shall meet the requirements of 3.4.3 when tested as specified in 4.5.4.1.

3.4.3.2 Partially full container. Each individual paint or paint component shall meet the requirements of 3.4.3 when tested as specified in 4.5.4.2.

3.4.3.3 Accelerated storage stability. An unopened, original container of each individual paint shall meet the requirements of 3.4.3 when tested as specified in 4.5.4.3.

3.4.4 Resistance to tropical biofouling organism attachment (see 6.1.1). In all 3.4.4 tests, biofouling attributable to physical damage from handling that has removed the antifouling topcoat paints shall be ignored in the evaluation of biofouling resistance performance. Physical damage to the antifouling topcoat related to the toughness of the film to withstand immersion and fouling growth/release shall be considered as part of the percent of the total surface susceptible to marine fouling.

3.4.4.1 Erosion.

3.4.4.1.1 Type I and Type II, all grades, applications 4, 5, and 6, classes 1A, 1B, 2, 3A, and 3B paints shall meet the following requirements when tested in accordance with 4.5.1.3.1:

a. The anticorrosive paint layer shall not be exposed at any point due to erosion of the antifouling paint. The anticorrosive paint layers shall be free of peeling or flaking and shall not be rated: lower than 9 few for blistering.

b. The antifouling topcoat shall not be rated: (1) lower than 9 (any pattern type) for checking, (2) lower than 9 for cracking to the anticorrosive coating (any pattern type), and (3) lower than 9 few for blistering.

c. The ablation or erosion rate of the antifouling topcoat shall be consistent with the erosion rate identification characteristic (see table III).

d. The biofouling resistance rating of the antifouling topcoat shall not be less than 90 (slime excluded) at any time of the test.

3.4.4.1.2 Type I and Type II, all grades, applications 4, 5, and 6, classes 1A, 1B, 2, 3A, and 3B paints shall meet the requirements of 3.4.4.1.1 when tested in accordance with 4.5.1.3.2.

3.4.4.1.3 Type II, all grades, applications 1 through 6, classes 1C and 3C paints shall meet the following requirements when tested in accordance with 4.5.1.3.3:

a. For those panels with more than 25% hard fouling (i.e., barnacles, encrusting bryozoa, and tubeworms) after the static immersion period, 60% of this fouling shall release by a 20 knot velocity in channel flow testing.

b. 80% of the total panel surface shall be free of hard-fouling (i.e., barnacles, encrusting bryozoa, tunicates, and tubeworms) after each test run at 20 knots and 85% of the surface shall be free of hard fouling after testing at 30 knots.

c. Areas shall not accumulate fouling over a 1-year cycle. Any hard fouling not removed at the end of a test cycle shall be noted. This fouling in this area would be expected to grow over the next static immersion period. Under the next flow channel cycle, this fouling shall be exposed to more significant hydrodynamic forces and be removed. This is to say, the 2nd flow

channel run shall remove any fouling left from the 1st run, and the 3rd run shall remove any fouling left after the 2nd run, etc.

d. There shall be less than 1% of the antifouling coating affected by damage after the test period.

3.4.4.2 Shallow submergence.

3.4.4.2.1 Types I and II, classes 1A, 1B, 2, 3A and 3B, all grades, applications 1, 2 and 3 paints shall meet the following requirements when tested as specified in 4.5.1.4.1:

a. The anticorrosive paint layer shall not be exposed at any point due to erosion of the antifouling paint. The anticorrosive paint layers shall be free of peeling or flaking and shall not be rated: lower than 9 few for blistering.

b. The antifouling topcoat shall not be rated: (1) lower than 9 (any pattern type) for checking, (2) lower than 9 for cracking to the anticorrosive coating (any pattern type), and (3) lower than 9 few for blistering.

c. The biofouling resistance (FR) rating of the antifouling topcoat paint shall not be less than 90 (slime excluded) at any time during the test.

3.4.4.2.2 Types I and II, classes 1A, 1B, 2, 3A and 3B, all grades, applications 4, 5 and 6 paints shall meet the requirements of 3.4.4.2.1 when tested as specified in 4.5.1.4.2:

3.4.4.2.3 Type II, classes 1C and 3C, all grades, all applications shall meet the following requirements when tested in accordance with 4.5.1.4.3:

a. The anticorrosive paint layer shall not be exposed at any point due to erosion of the antifouling paint.

b. The antifouling topcoat shall not be rated: (1) lower than 9 (any pattern type) for checking, (2) lower than 9 for cracking to the anticorrosive coating (any pattern type), and (3) lower than 9 Few for blistering.

c. The biofouling resistance will reflect the total percentage of the surface covered with biofouling species. The observation shall account for: barnacles, encrusting bryozoa, bugula, hydroids, tunicates, tubeworms, and oysters. The presence of any adherent slimes and/or amphipods will reduce the rating by a total of 1%. In the presence of other macro-fouling, this reduction will not be applied. At the end of the test period, no more than 25% of the surface shall be covered for systems intended for application 1, 2, or 3. At the end of the test period, no more than 40% of the surface shall be covered for systems intended for application 4, 5, or 6.

3.4.4.3 Ship tests. Ship tests shall meet the requirements of 3.4.4.3.1 or 3.4.4.3.2, as appropriate as specified in 3.4.4.3.3 through 3.4.4.3.7. Ratings will exclude areas (e.g., docking blocks) not coated with the antifouling materials.

3.4.4.3.1 Type I, all classes, all grades, all applications paints shall meet the following requirements:

a. The antifouling topcoat shall have no biofouling of any kind, omitting nonadherent slime, on at least 95 percent of the area painted.

b. Antifouling topcoats shall be free of film failure, such as peeling, flaking, softening, dissolving, and not have eroded through to the anticorrosive. The antifouling paint shall not be rated: (1) lower than 9 (any pattern type) for checking, (2) lower than 9 for cracking to the anticorrosive coating (any pattern type), and (3) lower than 9 few for blistering.

c. The erosion rate of the antifouling topcoat shall be consistent with the erosion rate identification characteristic (table III).

d. Anticorrosive paint layer shall be free of peeling or flaking and shall not be rated less than 9 few for blistering.

3.4.4.3.2 Type II, all classes, all grades, all applications paints shall meet the following requirements for the service period required for the appropriate application:

a. Classes 1A, 1B, 2, 3A, and 3B shall have no biofouling of any kind, omitting slime, on at least 95 percent of the area painted. Classes 1C and 3C shall be free of adherent slime and shall have no adherent biofouling on 85 percent of area painted. Determination of these properties for classes 1C and 3C shall be conducted as soon as possible following a typical ship at-sea operating cycle and in no cases beyond 1 week of sitting pierside. For the class 1C and 3C systems, adherent is defined as that fouling that cannot be removed with a wipe of the hand. Small, local spots of peeling/damaged paint shall be considered biofouling sites for the purposes of this evaluation, despite the ability of a hand-wipe to remove any fouling present at the time.

b. The antifouling topcoats shall be free of general film failure, such as peeling, flaking, softening, dissolving, and shall not have eroded through to the underlying anticorrosive coating. The antifouling paint shall not be rated: (1) lower than 9 (any pattern type) for checking, (2) lower than 9 for cracking (any pattern type), and (3) less than 9 few for blistering.

c. Anticorrosive paints shall be free of peeling and flaking and shall not be rated less than 9 few for blistering.

3.4.4.3.3 Commercial ship patch test. A test patch on a commercial ship, applied and tested as specified in 4.5.1.5.1 shall meet the requirements of 3.4.4.3.1 or 3.4.4.3.2, as appropriate.

3.4.4.3.4 Commercial ship test. A full ship application on a commercial ship, applied and tested as specified in 4.5.1.5.2 shall meet the requirements of 3.4.4.3.1 or 3.4.4.3.2, as appropriate.

3.4.4.3.5 Government ship patch test. After completion of the second year of the tests required in 3.4.4.2, and/or 3.4.4.3.3, and/or 3.4.4.3.4, at the convenience of the Government, a ship patch of the proposed system applied to a Government ship and tested as specified in 4.5.1.5.3 for a minimum period of one year shall meet the requirements of 3.4.4.3.1 or 3.4.4.3.2, as appropriate.

3.4.4.3.6 Government full ship test. After completion of the fourth year of the tests required in 3.4.4.2 and/or 3.4.4.3.3 and/or 3.4.4.3.4, at the convenience of the Government, a full ship application of the proposed system shall be applied to a Government ship. Prior testing shall include at least one year of the testing required by 3.4.4.2 and/or 3.4.4.3.3 and/or 3.4.4.3.4. The paint systems, when tested as specified in 4.5.1.5.4 for a minimum period of one year, shall meet the requirements of 3.4.4.3.1 or 3.4.4.3.2, as appropriate.

3.4.4.3.7 Service life determination. The Government, as specified in 4.5.1.5.5, will monitor the performance of qualified products on operational ships to establish compliance with the five-year service requirement for application 1, 2 and 3 and the seven year requirement for application 4, 5 and 6 paint systems. The paint systems shall meet the requirements of 3.4.4.3.1 or 3.4.4.3.2, as appropriate.

3.4.5 Spraying properties. Each individual paint of the paint system, when mixed in accordance with manufacturer's instructions as listed on its corresponding ASTM F 718 Product Data, shall spray satisfactorily when tested as specified in 4.5.5. The dry film shall show no running, sagging, or streaking, blooming, blushing, bubbling, cratering, dusting, floating, fogging, hazing, mottling, orange peel appearance, pinholing, seeding, or streaking.

3.4.6 Brushing properties. Each individual paint of the paint system, mixed in accordance with ASTM F 718, shall brush easily and have good flowing and spreading qualities when tested as specified in 4.5.6. The dried film shall show no running, sagging, blooming, blushing, bubbling, cratering, dusting, floating, fogging, hazing, mottling, orange peel appearance, pinholing, seeding, or streaking.

3.4.7 Rolling properties. Each individual paint of the paint system, mixed in accordance with ASTM F 718 shall roll easily and have good flowing and spreading qualities when tested as specified in 4.5.7. The dried film shall show no running, sagging, blooming, blushing, bubbling, cratering, dusting, floating, fogging, hazing, mottling, orange peel appearance, pinholing, seeding, or streaking.

3.4.8 Recoatability. When tested as specified in 4.5.2, a recoat layer of antifouling paint shall show no peeling, flaking, or delamination from the overcoated antifouling paint layer. The recoat layer shall also meet all the requirements of 3.4.4.1.1 for type I paint and 3.4.4.1.2 for type II paint.

3.4.9 Cathodic protection (CP) compatibility. When tested as specified in 4.5.10, the test paint shall not peel, flake, blister, dissolve or otherwise fail. Lifting of the antifouling from the primer around the drilled hole shall not exceed 0.5 inch. This test shall not apply for coatings being qualified for class 3 (rubber substrates).

3.4.10 Water based paints (ONLY). Water based (emulsion or water thinned) shall comply with the following provisions:

3.4.10.1 Freeze-thaw stability. Each individual paint or paint component of the paint system shall meet the following requirements:

a. When opened, an original unopened container of each individual paint shall be free of putrefication, phase separation, livering, curling, hard-dry caking, and tough gummy sediments.

b. Each individual paint or paint component of the paint system shall be capable of being mixed with a paddle or mechanical mixer within five minutes to a smooth, uniform state, free of gritty particles, putrefication, phase separation, seeding, skins, pigment settling and persistent foam.

c. After mixing and testing in accordance with 4.5.9, each individual paint of the coating system shall be free of flocculation, gritty particles, putrefication, phase separation, seeding, skins, pigment settling, persistent foam and the consistency shall not be more than plus or minus (+/-) 8 KU when compared to the consistency of the paint when originally received.

d. Each individual paint of the paint system shall meet the requirements of 3.4.3.

3.5 Directions for use. The manufacturer shall provide written directions on each container for the mixing and applying of the paint supplied and this direction shall include all information necessary to comply with the OSHA Hazard Communication Act and FED-STD-313. In addition, the manufacturer shall provide an ASTM F 718 data sheet which shall separately detail requirements for small unit containers (metric and English equivalents of pint, quart, gallon) and large unit containers (metric and English equivalents of five-gallon). Commercial and ASTM F 718 data sheets shall be included in each shipment of the paint covered by this specification (see 6.5).

3.6 EPA registration number. A U.S. EPA FIFRA antifouling paint registration number is required for all class 1A, 1B, 2, 3A, and 3B antifouling topcoat paints submitted for qualification to, or supplied to this specification. The container label shall be EPA approved (see 5.1). The manufacturer qualifying a class 1C and 3C antifouling topcoat paint may substitute a legal determination or EPA finding that the product does not require registration under the provisions of FIFRA.

3.7 Volatile organic content (VOC). The VOC of each individual paint in the paint system, when in the ready-to-apply condition, shall not exceed that allowed for the specific grade (see 3.3.3) for which qualification is being sought when tested in accordance with 4.5.3. Ready-to-apply condition includes any volatile solvents (thinners) required by the manufacturer's ASTM F 718 data sheets to prepare the paint for application.

3.8 Workmanship. The material shall be produced in accordance with the best commercial practices and shall be of a quality necessary to ensure a uniform, packaged product in conformance with the requirements of section 3 when tested as specified in section 4. The paint described shall be suitable for the purpose intended (application to ship in dry-dock, under ambient condition, with conventional tools, and equipment).

3.9 NESHAP requirements. In accordance with U.S. EPA National Emissions Standards for Hazardous Air Pollutants (NESHAP), shipbuilding coating regulation (40 CFR 63.780), certificates of compliance shall be provided, as described in the U.S. EPA "Guidebook on How to Comply with the Shipbuilding and Ship Repair (Surface Coating) Operations NESHAP" (EPA-453/B-97-001,

January 1997, pages E-18, E-32, E-33). This certificate need only be provided once to each procuring activity for each coating formulation sold."

3.10 Marking requirements. Marking shall include hazardous warnings in accordance with MIL-STD-129 (see 4.7 and 6.2), FED-STD-313, and 29 CFR Parts 1910, 1915, 1917, 1918, 1926 and 1928, as applicable.

3.10.1 Special marking. Each unit container shall have the following information:

- a. Specification number.
- b. Type, class, grade and application.
- c. Color.
- d. Manufacturer's name, address, product commercial nomenclature designation, and QPL number.
- e. Hazardous materials information required by MIL-STD-129 (see 4.7 and 6.2), FED-STD-313, and 29 CFR Parts 1910, 1915, 1917, 1918, 1926, and 1928, as applicable.
- f. Required storage information including temperatures.
- g. Antifouling paints shall have the EPA approved label on each container. Containers of antifouling topcoat paints may have the marking information required in a. and f. above in printed materials affixed to the container in a weather-proof pouch to comply with EPA requirements.

3.10.2 Containers shall also be marked as follows:

"Contains a maximum of INSERT PROPER NUMBER HERE pounds per gallon (INSERT PROPER NUMBER HERE grams per liter) of volatile organic content (VOC) per 40 CFR CH. 1, Part 60, Appendix A, (U.S.EPA) method 24."

"This product may be thinned (INSERT QUANTITY and CONTAINER SIZE HERE) per five gallon container with IDENTIFY GENERIC AND TRADEMARK THINNER IDENTIFICATIONS HERE and will contain less than (INSERT VOC REGULATORY NUMBERS LEVEL HERE) volatile organic content (VOC) per 40 CFR CH. 1, Part 60, Appendix A, (U.S.EPA) method 24."

4. VERIFICATION QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in this specification where such inspections are deemed necessary to ensure that supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 4.3 and 4.5. The inspections set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

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

- a. Qualification inspection (see 4.3).
- b. Quality conformance inspection (see 4.4).

4.3 Qualification inspection. Qualification inspection shall consist of all tests specified in table IV and paragraph 4.7, except 4.5.1.5.5, ship service life determination test. The products tested shall be materials drawn from regular production stocks. A test report shall be provided to the contracting officer or agent. Testing of products on Government ships shall be conducted at the convenience of the Government.

4.4 Quality conformance inspection. Quality conformance inspection shall consist of the table IV tests marked with an asterisk (see 6.3). Tests shall be performed on each lot offered for delivery in accordance to the requirements of this specification.

4.4.1 Lot. A lot shall consist of an individual paint of the paint system of the same type, class, grade and application from a single uniform batch or a uniform blend of batches offered for delivery at one time.

4.4.1.1 Batch. A batch shall consist of a quantity of an individual paint of the paint system from a single finished product manufactured at the same time from the same units (sacks, cans, barrels, and so forth) or same supplier lot labeled ingredients.

4.4.2 Sampling. Two representative random samples from each lot shall be tested. The samples shall be packaged in separate containers. Minimum size for each sample shall be two containers of the size specified in the contract (see 6.2). If one or more defects are found in any sample, the entire lot shall be rejected. The contractor has the option of screening 100 percent of the rejected lot for the rejected characteristic(s), or providing a new lot which shall be inspected as specified in 4.4.

4.5 Test methods (all types). Test methods shall be as listed in table IV or as otherwise specified herein. The requirements listed in table IV shall be tested in accordance with the applicable tests and test paragraphs listed therein. Results of tests shall be in accordance with the requirements paragraph listed in table IV or in the test paragraph.

4.5.1 Resistance to tropical biofouling organism attachment.

4.5.1.1 Panel test requirements. Tests as specified in 4.5.1.3 and 4.5.1.4 shall be as follows:

a. Tests shall be conducted in Biscayne Bay, Florida; Daytona Beach, Florida; or Pearl Harbor, Hawaii.

b. Tests shall have six test panels prepared for each paint system required by ASTM D 3623 or D 4939, as appropriate.

c. Test panels shall be as follows: (1) Classes 1A, 1B, 1C test panels shall be made of the steel specified in ASTM D 4939; (2) Aluminum test panels for class 2 testing shall be ASTM B 209 (alloy 6061); (3) ASTM D 3623 test panels shall be a minimum of 1/8 inch thick; (4) Test panels for ASTM D 4939 shall be as required by ASTM D 4939; (5) Surface preparation of all steel and aluminum test panels shall be in accordance with ASTM D 4939 procedures; (6) Test panels for class 3 testing shall be of ASTM D 2000, type BC neoprene rubber having a Shore A Durometer 40 to 60 hardness and shall be at least 1/4 inch thick with surface preparation in accordance with the manufacturer's ASTM F 718 data sheet.

d. Test panels shall be prepared for the qualifying systems and the test paint systems. Paint thicknesses of each individual coating and the total system shall be in accordance with the manufacturer's ASTM F 718 data sheet. Application of paint films shall be nominal in thickness (nominal is defined as +/- 25 percent of stated dry film thickness [DFT]). For the purposes of confirming the system erosion rate (Type I antifoulings), the DFTs across the panel face shall be determined using standard statistical methods before and after test. The erosion rate shall be the change in the mode of the DFT before and after testing. Rubber test panels do not require anticorrosive primer. Test systems consist of the following:

(1) If the paint system is to be qualified over MIL-DTL-24441, type III, test paint system no. 1 shall consist of the qualifying company's type III MIL-DTL-24441 formulas of the anticorrosive system specified in ASTM D 4939 materials and procedure. Apply the manufacturer's ASTM F 718 antifouling system being qualified for use with this anticorrosion paint (see 3.3). Paints shall be applied and cured in accordance with the manufacturer's ASTM F 718 data sheet.

(2) If the paint system is to be qualified over MIL-DTL-24441, type IV, test paint system no. 2 shall consist of the qualifying company's type IV MIL-DTL-24441 formulas of the anticorrosive specified in ASTM D 4939. Apply the manufacturer's antifouling topcoat paint system (see 3.3). Paints shall be applied and cured in accordance with the requirements of the manufacturer's ASTM F 718 data sheet.

(3) Test paint system no. 3 shall consist of the manufacturer's commercial paint system and anticorrosive coatings, tie coats, if any, and antifouling paint(s) (see 3.3). Paints shall be applied and cured in accordance with the requirements of the manufacturer's ASTM F 718 data sheet.

e. Have erosion tests for all classes except for 1C and 3C conducted in accordance with ASTM D 4939. (For classes 1C and 3C, see 4.5.1.3.3.) An ASTM D 4939 cycle shall consist of 30 days static immersion followed by 30 days dynamic testing on a drum of 1.5 foot (nominal) diameter operated to provide a peripheral speed of 15+/-0.1 knots. Rate FR in accordance with ASTM D 3623. For the purposes of FR rating, the rating shall be calculated by subtracting from 100 the percent of the surface area covered with fouling, not the sum of individual species present. Fouling present within 25.4 mm (1 inch) of the panel edges shall be discounted. Rate test films for: (1) checking, in accordance with ASTM D 660, (2) cracking, in accordance with ASTM D 661, and (3) blistering, in accordance with ASTM D 714. Inspect test samples for exposed anticorrosion paint, as appropriate. Dry film thickness measurements shall be made after testing to confirm the paint erosion rate.

f. Have shallow submergence testing conducted in general accordance with ASTM D 3623. Immersion at the waterline as opposed to the 1- to 10-foot depth requirement is acceptable with prior NAVSEA approval. All panels in this test shall be under cathodic protection from a zinc anode. This shall be done with either an individual anode per panel or with a single anode of sufficient capacity to polarize the entire set of test samples. Rate as follows: (1) FR in accordance ASTM D 3623, (for the purposes of FR rating, the rating shall be calculated by subtracting from 100 the percent of the surface area covered with fouling, not the sum of individual species present) (2) checking, in accordance with ASTM D 660, (3) cracking, in accordance with ASTM D 661, and (4) blistering, in accordance with ASTM D 714. Inspect for exposed anticorrosion paint, as appropriate. Fouling at the panel edges shall be neglected. Of the six panels in test, three shall be left undisturbed, under immersion for the test duration. They shall not be rinsed in any fashion. The remainder may be removed on a regular schedule and rinsed with low pressure water (<50 psi) for inspection. At the end of the requisite exposure period, all panels shall be low pressure rinsed, inspected, and rated. Individual data shall be reported for all panels.

4.5.1.2 Ship test requirements. Ship tests (patch and full) required by 4.5.1.5 shall:

a. Have individual paints of the total system applied and cured in accordance with the requirements of the manufacturer's ASTM F 718 data sheet for those products (see 3.3).

b. Have the test ship(s) operate in high biofouling tropical or sub-tropical areas such as the Caribbean, Mediterranean or Western Pacific. Ship antifouling coatings shall not be underwater scrubbed or otherwise maintained. Data from ships subject to underwater maintenance shall not be accepted.

c. Have ship inspections conducted in accordance with ASTM F 1130. Rating of waterborne ships shall be in accordance with standard industry practices. Report:

- (1) checking in accordance with ASTM D 660,
- (2) cracking in accordance with ASTM D 661 and
- (3) blistering in accordance with ASTM D 714.

Biofouling or physical failure due to verifiable physical damage that has removed the anticorrosive paint to the steel hull or removed the antifouling paint to the anticorrosive layers may be subtracted from the percentage area biofouled or anticorrosive paint failure.

d. Have patch tests of 30 feet in width (minimum) located amidships with underwater hull systems running from the keel to the heavy load line and boottop systems running from the heavy load line to the light load line. Patch tests shall include:

(1) A 10-foot wide (minimum) section of the complete paint system being qualified.

(2) A 10-foot (minimum) wide section of the system being qualified with the type III or type IV of the MIL-DTL-24441 anticorrosive system.

(3) A 10-foot wide (minimum) section of an antifouling system already qualified to this specification. This shall be of the same class and type to the new system being qualified, (i.e., one shall use a Class 1C coating as a control for a Class 1C qualification process.)

(4) Manufacturer commercial ship patch tests shall be on commercial, Military Sealift Command (MSC), Maritime Administration (MARAD), or other Government agency ships. The application and inspections shall be certified and verified by a disinterested third party mutually agreed on by NAVSEA and the paint vendor and shall be at the vendor's cost. The ship operations (travel routes, ports, times in port and lay-up times) shall be reported.

(5) Tests of paint systems intended for rubber shall be conducted only on Government ships having extensive rubber surfaces.

e. Full ship applications shall consist of a full hull application of the manufacturer's total commercial system, except that the following shall be included:

(1) The antifouling paints and tie coats, if any, being qualified with the MIL-DTL-24441 type III and type IV anticorrosive system shall be applied as a belly band (either boottop to boottop via the keel or waterline to waterline via the keel, as appropriate) with a minimum width of 20 feet.

(2) Unless waived by the qualifying activity, there shall be a control paint system applied consisting of a system chosen from the QPL of this specification, or as otherwise approved by the qualifying activity. This control paint system shall be applied as a belly band (either boottop to boottop via the keel or waterline to waterline via the keel, as appropriate) with a minimum width of 20 feet.

(3) Commercial, MSC, MARAD, or other Government agency ships applications and inspections must be certified and verified by a disinterested third party mutually agreed on by NAVSEA and the paint vendor at the vendor's cost. The ship operations shall be certified and verifiable with travel, port time and lay-up times documented.

(4) The application and inspections of full ship applications to Government ships shall be at a Naval shipyard or under Navy contract at a

commercial shipyard. The application shall be inspected by a Navy representative at Navy cost.

4.5.1.3 Erosion. Erosion tests shall be prepared, installed, conducted, and inspected as required in 4.5.1.1. In addition, the tests shall be as follows.

4.5.1.3.1 Type I and Type II, classes 1A, 1B, 2, 3A, and 3B, all grades, applications 1, 2 and 3 paints shall be tested for biofouling resistance for two years (12 cycles). Paint systems shall meet the requirements of 3.4.4.1.1.

4.5.1.3.2 Type I and Type II, classes 1A, 1B, 2, 3A, and 3B, all grades, applications 5 and 6 paints shall be tested two and one-half years (15 cycles). Inspect test samples for exposed anticorrosion paint, as appropriate. Paint systems shall meet the requirements of 3.4.4.1.2.

4.5.1.3.3 Testing of systems belonging to class 1C or 3C shall be conducted as follows:

a. The testing shall consist of test panels subjected to a static exposure for a 2-4 month period (in Biscayne Bay, Florida or Pearl Harbor, Hawaii followed by flow channel testing (ASTM D 4938). This process is one cycle. The total test shall include a minimum of 4 and a maximum of 8 cycles or extend nominally one to two years in duration. Testing shall be completed until at least one observation of 25% hard fouling and one observation of 40% hard fouling (i.e., barnacles, encrusting bryozoa, and tubeworms) occurs following the static period or the maximum of 8 tests cycles are completed.

b. Each test panel shall be 6-inches by 12-inches by 0.125-inches thick. Four panels shall be subjected to testing. Test panels shall be exposed nominally 3 feet below the waterline. The test surface shall face horizontal down. (Only one side of the panel shall serve as the test surface. The backside of the panel shall be coated with a nontoxic material and secured in such a fashion to a backing plate to discourage fouling on this surface.

c. For testing, the panel shall be removed from the static test site and immersed into a flow channel apparatus for testing in general accordance with ASTM D 4938. Single-sided exposure of the test surface is acceptable. Should the flow channel not be co-located with the exposure site, transportation of the panels is acceptable provided that: (1) they are maintained in a wet condition immersed in a sample of the local seawater and (2) the transportation and flow channel testing can be initiated within 36 hours.

d. Within the flow channel, two panels shall be installed in the test section with a maximum velocity of 20 knots. Two shall be installed in the section with a maximum velocity of 30 knots.

e. The flow channel shall allow for incremental velocity testing up to the test speeds. The initial velocity (in the 20-knot section) shall be in the range of 3-6 knots. Increments in the test velocity shall be about 8%. The flow channel shall be run with fresh, natural seawater. A maximum temperature rise of 10°F is allowed between the background temperature and the test temperature. The complete test run shall extend for 36 hours (nominally).

f. At the conclusion of the flow channel run, the panels shall be removed from the test, photographed, and returned to the static exposure site. Panel shall remain wet in seawater during all phases of testing and transportation.

4.5.1.4 Shallow submergence. Shallow submergence tests shall be prepared, installed, conducted, and inspected as required in 4.5.1.1. In addition, the tests shall be as follows.

4.5.1.4.1 Types I and II, all classes, all grades, applications 1, 2 and 3 paints shall be tested for 24 months. Paint systems shall meet the requirements of 3.4.4.2.1.

4.5.1.4.2 Types I and II, all classes, all grades, applications 4,5 and 6 paints shall be tested for 30 months. Paint systems shall meet the requirements of 3.4.4.2.2.

4.5.1.5 Ship tests. Ship tests (patch or full applications) shall be installed, conducted, and inspected as required in 4.5.1.2. In addition, the tests shall be as follows.

4.5.1.5.1 Commercial ship patch test. Commercial test patch applications shall be for a period of five years. Test results shall meet the requirements of 3.4.4.3.3.

4.5.1.5.2 Commercial ship test. Commercial whole ship applications shall be for a period of five years. Test results shall meet the requirements of 3.4.4.3.4.

4.5.1.5.3 Government ship patch test. Government ship patch applications shall be for a period of two years (minimum) on a Navy ship. Test results shall meet the requirements of 3.4.4.3.5.

4.5.1.5.4 Government full ship test. Government full ship applications shall be for a period of one year (minimum) on a Navy ship. Test results shall meet the requirements of 3.4.4.3.6.

4.5.1.5.5 Service life determination. Paints in service on Navy ships will be monitored by the Government for five years or seven years, as appropriate. Paints shall meet the requirements of 3.4.4.3.7.

4.5.2 Recoatability.

4.5.2.1 Type I. Two panels from each set of test paint systems (see 4.5.1) shall be retrieved from those tested in 4.5.1.3.1 and 4.5.1.3.2, after completion of the required test. These panels shall be removed from test and shall be cleaned for a period not to exceed 2 minutes with fresh water at a nominal pressure of 750 pounds per square inch (lb/in²). Test panels shall not be allowed to dry between being removed from test and the pressure cleaning. Dry for 24 hours at ambient conditions. Recoat one-half of each test panel with one coat of the same topcoat as originally used. Recoating shall be in accordance with the manufacturer's ASTM F 718 instructions. Application and curing of this recoat paint film shall be in accordance with the manufacturer's ASTM F 718. The recoated panels shall be tested for 3 cycles as specified in 4.5.1.3. Rate as specified in 4.5.1.1. Test paints shall meet the requirements of 3.4.8.

4.5.2.2 Type II. Two panels of each set of test paint systems (see 4.5.1) shall be retrieved from those tested in 4.5.1.4.1 and 4.5.1.4.2, after completion of the required test. These panels shall be removed from test and shall be cleaned for a period not to exceed 2 minutes with fresh water at a nominal pressure of 750 lb/in². Test panels shall not be allowed to dry between being removed from test and the pressure cleaning. Dry for 24 hours at ambient conditions. Recoat one-half of each test panel with one coat of the same topcoat as originally used. Recoating shall be in accordance with the manufacturer's ASTM F 718 instructions. Application and curing of this recoat paint film shall be in accordance with the manufacturer's ASTM F 718. The recoated panels shall be tested for 3 months as specified in 4.5.1.4. Rate as specified in 4.5.1.1. Test paints shall meet the requirements of 3.4.8.

4.5.3 Volatile organic content (VOC). VOC shall be determined in accordance with EPA Method 24 (40 CFR part 60). The VOC of each paint shall comply with the requirements of 3.3.3, 3.5, table I and 3.7.

4.5.4 Storage stability.

4.5.4.1 Shelf life. After storage for two years under warehouse conditions, which is at or below 27°C (80°F) and at or below 50% relative humidity, for 1 year from the date of manufacture(see 4.5), the paint shall be tested for the properties required in 3.4.3, in accordance with the test listed in table III. Paints shall conform to the requirements in 3.4.3.1.

4.5.4.2 Partially full container. Store a sealed, two-thirds full container (250 milliliter [ml] or pint [pt]) of each individual paint for seven days at 140°F (60°C). Skinning shall be determined after 48 hours in accordance with method 3021.1 of FED-STD-141. After completion of the seven-day storage, the paint shall be tested for the properties required in 3.4.3, as specified in the test listed in table III. Paint shall conform to the requirements in 3.4.3.2.

4.5.4.3 Accelerated storage stability. After exposure to a temperature of 140°F (60°C) (nominal) continually for 30 days, a sealed, full one-quarter container of paint shall be tested for the properties required in 3.4.3, as specified in the test listed in table III. Paint shall conform to the requirements in 3.4.3.3.

4.5.5 Spraying properties. Each individual paint of the paint system shall be mixed in accordance with the manufacturer's ASTM F 718 data sheet. Using the manufacturer's ASTM F 718 designated spray equipment, spray each paint onto individual ground-glass panels to the manufacturer's ASTM F 718 recommended wet film thickness. The panel shall be observed for spraying properties. The dry film shall be inspected for running, sagging, or streaking, blooming, blushing, bubbling, cratering, dusting, floating, fogging, hazing, mottling, orange peel appearance, pinholing, seeding, or streaking in accordance with method 4331.1 of FED-STD-141. The test results for each individual paint shall meet the requirements of 3.4.5.

4.5.6 Brushing properties. The brushing properties of the paint shall be determined in accordance with method 4321.1 of FED-STD-141. The dry film shall be inspected for running, sagging, or streaking, blooming, blushing, bubbling, cratering, dusting, floating, fogging, hazing, mottling, orange

peel appearance, pinholing, seeding, or streaking. The test results for each individual paint shall meet the requirements of 3.4.6.

4.5.7 Rolling properties. The rolling properties of the paint in an "as received" condition shall be determined in accordance with method 4335 of FED-STD-141. The dry film shall be inspected for running, sagging, or streaking, blooming, blushing, bubbling, cratering, dusting, floating, fogging, hazing, mottling, orange peel appearance, pinholing, seeding, or streaking. The test results for each individual paint shall meet the requirements of 3.4.7.

4.5.8 Color.

4.5.8.1 Application 1, 2, 3, 4, 5 and 6 antifouling topcoat colors. Application 1 and 4 antifouling topcoats shall be visually consistent with the pigments used. The color of application 2, 3, 5 and 6 antifouling topcoat paints and individual paints (except anticorrosive topcoats in R₀ colors) shall be determined in accordance with method 4250.1 of FED-STD-141C Use at least three standard illuminants to compare the color. In case of doubt, color differences (delta L, delta a and delta b) shall be determined in accordance with ASTM D 2244 using a D-65 light source, a 45 degree illumination angle and a 0 degree viewing angle. Color shall be in accordance with the requirements of 3.4.1 a. and b., as appropriate.

4.5.8.2 Color of camouflage R₀ anticorrosive paints. Test panels of each R₀ dark gray color paint shall be prepared and allowed to cure at least 24 hours before testing. The ASTM D 2244 LH value (see paragraph 6.3 of ASTM D 2244) color of the R₀ anticorrosive topcoats shall be determined in accordance with ASTM E 1347. Before measuring the color, wet the surface of the painted test panel with water to which a small amount of colorless surfactant has been added (a water solution containing less than 1 percent surfactant). The area to be measured shall be completely coated with the water film when it is inserted into the reflectometer for measurement. Check the test panel for complete water coverage after the measurement is completed. If the water film does not completely cover the area just measured, discard the measurement and repeat the process until a measurement is obtained on a test panel having complete water coverage both at the start and the end of the measurement. This ASTM D 2244 LH value obtained is defined as R_w. The R_w measured shall conform to the appropriate requirements of 3.4.1b.

4.5.9 Freeze-thaw stability. A 1-pint, resin-lined, friction-top can shall be filled two-thirds full with the paint and the can tightly closed. The closed can and its contents shall be exposed three times to the following temperature cycle:

- a. Low temperature of 16 to 20°F (-9 to -7°C) for 16 hours.
- b. High temperature of 77 to 82°F (25 to 28°C) for 8 hours.

At the completion of the exposure cycles, the consistency and condition in container shall be determined, in accordance with ASTM D 562 and method 3011.2 of FED-STD-141. Consistency shall be compared with the original consistency to determine compliance with requirements in 3.4.10.2. The condition in container shall meet the requirements of 3.4.10.2.

4.5.10 Cathodic protection compatibility. Two steel panels from each set of test paint systems (see 4.5.1) shall be retrieved from those tested in 4.5.1.1 after completion of the required test. Each test panel shall be electrically connected by an insulated copper wire to a ASTM G 80 magnesium anode and shall have a 1/8-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 reinstalled in the ASTM D 3623 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 three-month test, inspect each test panel for lifting or undercutting around the drilled hole, peeling, blistering, dissolving, or other paint film defects. Test results shall be in accordance with the requirements of 3.4.9.

4.5.11 Soluble and total metal content. Soluble and total metal content shall be determined on a dry paint film mode from each individual paint of the paint system in accordance with the 40 CFR Part 281, Appendix II, Toxicity Characteristic Leaching Procedure (TCLP). Test results shall be in accordance with the requirements of 3.3.5.

4.6 Paints and coatings product/procedure data. Data sheets shall be in accordance with the requirements of 3.3.5.2, and 3.5. Manufacturer's commercial and ASTM F 718 data sheets shall reflect the information required in 3.2 for application purposes. The toxic(s) (pesticides, biocides, and so forth) used in the product being qualified shall be in accordance with the requirements of the class for which the product is being qualified (see 3.3.2 and 6.4).

4.7 Toxicological product formulations. The contractor shall have the toxicological product formulations and associated information available for review by the contracting activity to evaluate the safety of the material for the proposed use.

4.8 Inspection of packaging. The packaging, packing, marking and data sheets of the paint shall be examined to determine compliance with the requirements of Section 5 of this specification.

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 of Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES.

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

6.1 Intended use. This specification covers a variety of high grade, paint systems. These coatings are intended for application to ship hulls to prevent marine biofouling and corrosion. The type I antifouling topcoat paints are intended to polish (erode or ablate) under water flow conditions to provide a biofouling free, smooth hull for fuel efficiency. Type II antifouling topcoat paints are intended to provide biofouling control without eroding. Antifouling paint systems covered by this specification are provided in five classes that contain toxic agents and two classes that contain non-toxic agents. The seven systems covered by this specification include paints that can be applied to steel, aluminum, and rubber substrates. Antifouling paint conforming to present air protection regulations (1990) is required as grade A, but specification provides grades at lesser VOC levels to encourage manufacturers to develop more environmentally acceptable materials.

Except for the toxic agent containing antifouling topcoats of classes 1A, 1B, 2, 3A and 3B, the individual dried paint residues and dry paint contaminated debris may constitute nonhazardous waste.

6.2 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number and date of this specification.
- b. Type, class, grade, and application of paint required (see 1.2). If ordering Application 4 or 6 paint, specify color (see 1.2).
- c. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1 and 2.2).
- d. Certifications (if any) required (see 3.3.5.2).
- e. Required marking (see 3.10).
- f. Level of packaging and of packing required (see 5.1).
- g. Size of container required, if other than as specified (see 5.1).
- h. Special markings required (see 3.10.1).
- i. Data sheets (see 6.5).

6.3 Consideration of data requirements. This specification is cited in DoD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDL), as the source document for the following DIDs. When it is necessary to obtain the data, the applicable DIDs must be listed on the Contract Data Requirements List (DD Form 1423), except where the DoD Federal Acquisition Regulation Supplement exempts the requirement for a DD Form 1423.

Reference Paragraph	DID Number	DID Title	Suggested Tailoring
3.3.5.2	DI-E-2121	Certificate of Compliance	---
4.4	DI-MISC-80678	Certification/data report	10.3.1

The above DIDs were current as of the date of this specification. The current issue of the AMSDL must be researched to ensure that only current and approved DIDs are cited on the DD Form 1423.

6.4 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 No. 24647 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. The activity responsible for the Qualified Products List is the Naval Sea Systems Command, SEA 05Q, 1333 Isaac Hull Avenue SE, Stop 5160, Washington Navy Yard, DC 20376-5160 and information pertaining to qualification of products may be obtained from that activity. Application for qualification tests will be made in accordance with "Provisions Governing Qualification SD-6" (see 6.4.1).

6.4.1 Copies of "Provisions Governing Qualification SD-6" may be obtained upon application to Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

6.5 Material Safety Data Sheets and ASTM F 718 data sheets. Contracting officers will identify those activities requiring copies of completed Material Safety Data Sheets prepared in accordance with FED-STD-313 and ASTM F 718 data sheets. An MSDS and ASTM F 718 data sheet will be included with all packaged or packed paint containers (see 3.5 and 6.5). The pertinent Government mailing addresses for submission of data are in FED-STD-313.

6.6 Subject term (key word) listing.

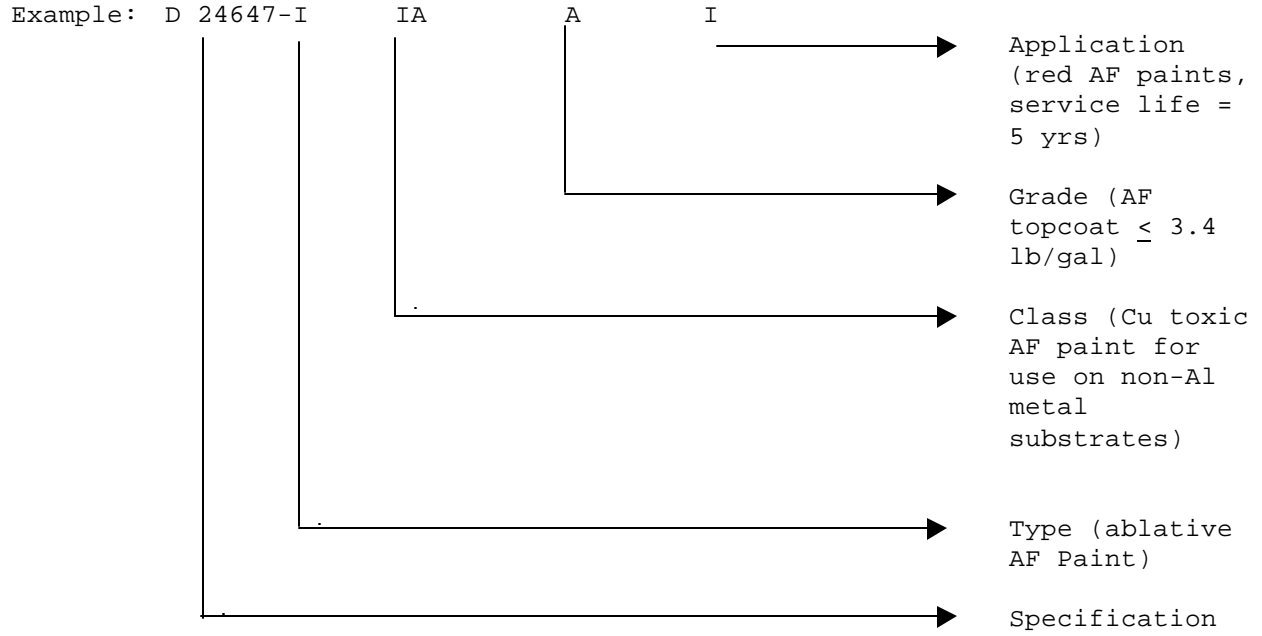
Ablative
Copper
Copper oxide
Erodible
Organotin
VOC

6.7 Changes to previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

6.8 Part or identifying number (PIN). The PIN to be used for antifouling coatings acquired to this specification are created as follows:

MIL-PRF-24647C

Specification	Type	Class	Grade	Application
D 24647	I-ablative	1A - copper toxic for use on metal substrates (not Al)	A - AF topcoats with VOC \leq 3.4 lb/gal (400 g/L)	1 - Red AF for underwater hull with service life of 5 years
	II-nonablative	1B - mixed-toxic for use on metal substrates (not Al) 1C - toxic-free for use on metal substrates (including Al) 2 - for use on aluminum 3A - copper toxic only for use on rubber 3B - mixed-toxic for use on rubber 3C - toxic-free for use on rubber	B - Paints with VOC \geq 2.8 lb/gal (340 g/L) C - Paints with VOC \geq 2.3 lb/gal (275 g/L) D - Paints with VOC = 0 (0 g/L)	2 - Black AF for underwater hull with service life of 5 years 3 - gray AF for underwater hull with service life of 5 years (For classes 1C, 2, and 3C only) 4 - Red AF for underwater hull with service of 7 years 5 - Black AF for waterline (boottop) with service life of 7 years 6 - gray AF for underwater hull with service life of 7 years (for classes 1C, 2, and 3C only)



Custodians:
Army - CR4
Navy - SH

Preparing activity:
Navy - SH
(Project 8010-0156)

Review activities:
Army - MR
Navy - CG

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4,5,6, and 7 and send to preparing activity.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:

1. DOCUMENT NUMBER
MIL-PRF-24647C

2. DOCUMENT DATE (YYYYMMDD)

3. DOCUMENT TITLE

PAINT SYSTEM, ANTICORROSIVE AND ANTIFOULING, SHIP HULL

4. NATURE OF CHANGE (*Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed*)

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (*Last, First, Middle Initial*)

b. ORGANIZATION

c. ADDRESS (*Include Zip Code*)

d. TELEPHONE (*Include Area Code*)

7. DATE SUBMITTED
(YYYYMMDD)

(1) Commercial
(2) DSN
(*if applicable*)

8. PREPARING ACTIVITY

a. NAME

b. TELEPHONE (*Include Area Code*)

(1) Commercial

(2) DSN

c. ADDRESS (*Include Zip Code*)

Commander, Naval Sea Systems Command
ATTN: SEA 05Q
1333 Isaac Hull Ave SE, Stop5160
Washington Navy Yard, DC 20376-5160

IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT:

Defense Standardization Program Office (DLSC-LM)
8725 John J. Kingman Road, Suite 2533,
Fort Belvoir, VA 22060-6221
Telephone (703) 767-6888 DSN 427-6888