

METRIC

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23 October 1986
SUPERSEDING
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(See 6.8)

MILITARY SPECIFICATION

PAINT, ANTIFOULING, SHIP HULL (METRIC)

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

1. SCOPE

1.1 Scope. This specification covers antifouling paint systems for application to ships with steel or aluminum hulls for life cycles up to 5 years.

1.2 Classification. Coating systems shall be of the following types and grades as specified (see 6.2):

Type I - Ablative coatings
Type II - Nonablative coatings

Grade A - For use on steel hulls
Grade B - For use on aluminum hulls
Grade C - For use on neoprene rubber

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standards. The following specifications and standards form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation.

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 5523, Department of the Navy, Washington, DC 20362-5101 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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SPECIFICATIONS

FEDERAL

PPP-P-704 - Pails, Metal: (Shipping, Steel, 1 Through 12 Gallons).

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MIL-A-21412 - Anodes, Corrosion Preventive, Magnesium Alloy, Cast or Extruded Shapes with Cast-In Cores.
 MIL-P-24441 - Paint, Epoxy-Polyamide General Specification for.
 MIL-P-24441/1 - Paint, Epoxy-Polyamide, Green Primer, Formula 150, Type I.
 MIL-P-24441/2 - Paint, Epoxy-Polyamide, Exterior Topcoat, Haze Gray, Formula 151, Type I.
 MIL-P-24441/5 - Paint, Epoxy-Polyamide, Exterior Topcoat, Dark Gray, Formula 154-R₀ = 3.6, Type I.

STANDARDS

FEDERAL

FED-STD-141 - Paint, Varnish, Lacquer and Related Materials: Methods of Inspection, Sampling and Testing.
 FED-STD-313 - Material Safety Data Sheets, Preparation and the Submission of.

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MIL-STD-129 - Marking for Shipping and Storage.
 MIL-STD-147 - Palletized Unit Loads.

2.1.2 Other Government documents. The following other Government documents form a part of this specification to the extent specified herein. Unless otherwise specified, the issues shall be those in effect on the date of the solicitation.

ENVIRONMENTAL PROTECTION AGENCY (EPA)

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)

(Application for copies should be addressed to the Environmental Protection Agency, Office of Pesticide Programs, Registration Division, Washington, DC 20460.)

(Copies of specifications, standards, and other Government documents required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted shall be those listed in the issue of the DoDISS specified in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS shall be the issue of the nongovernment documents which is current on the date of the solicitation.

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AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- A 109 - Standard Specification for Steel, Strip, Carbon, Cold-Rolled. (DoD adopted)
- D 93 - Standard Test Methods for Flash Point by Pensky-Martens Closed Tester. (DoD adopted)
- D 1141 - Standard Specification for Substitute Ocean Water. (DoD adopted)
- D 1475 - Standard Test Method for Density of Paint, Varnish, Lacquer, and Related Products. (DoD adopted)
- D 1737 - Standard Test Method for Elongation of Attached Organic Coatings with Cylindrical Mandrel Apparatus. (DoD adopted)
- D 2369 - Volatile Content of Coatings. (DoD adopted)
- D 3278 - Standard Test Methods for Flash Point of Liquids by Setaflash Closed-Cup Apparatus.
- D 3623 - Standard Test Method for Antifouling Panels in Shallow Submergence.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

NATIONAL MOTOR FREIGHT TRAFFIC ASSOCIATION, INC., AGENT
National Motor Freight Classification

(Application for copies should be addressed to the National Motor Freight Traffic Association, Inc., ATA TRAFFIC DEPT., 2200 Mill Road, Alexandria, VA 22314.)

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT
Rules and Regulations, Rules 102 and 442

(Application for copies should be addressed to the South Coast Air Quality Management District, 9150 E. Flair Drive, El Monte, CA 91731.)

UNIFORM CLASSIFICATION COMMITTEE AGENT
Uniform Freight Classification Ratings, Rules and Regulations

(Application for copies should be addressed to the Uniform Classification Committee Agent, Tariff Publication Officer, Room 1106, 222 South Riverside Plaza, Chicago, IL 60606.)

(Nongovernment standards and other publications are normally available from the organizations which prepare or which 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 specification and the references cited herein (except for associated detail specifications, specification sheets or MS standards), the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

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3. REQUIREMENTS

3.1 Qualification. Coating systems furnished under this specification shall be those systems which are authorized by the qualifying activity for listing on the applicable qualified products list at the time set for opening of bids (see 4.4 and 6.3).

3.2 Description. The antifouling coating shall be the topcoat of a system that includes a primer. Antifouling coatings submitted for qualification to this specification shall be usable with the MIL-P-24441 hull primer coating systems either directly, or with an intermediate tie-coat. The principle toxic components in the finished paint shall be either a tributyltin copolymer or cuprous oxide or both. Other biocides may be used as supplementary antifouling agents in the formulation.

3.3 Materials. The antifouling coating furnished under this specification, when mixed and applied in accordance with the manufacturer's instructions, shall produce a top coat that will incorporate the toxin. The manufacturer is given latitude in the selection of the raw materials and process of manufacture but shall be restricted by the requirements of this specification.

3.3.1 Types. Two types of antifouling coatings 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 an ablative coating which shall dissolve, polish, erode or reduce in thickness as the primary condition for performing its antifouling function (see 1.2).

3.3.1.2 Type II. Type II is a nonablative coating which shall not dissolve, polish, erode or reduce in thickness as the primary condition for performing its antifouling function. Its primary function shall be by the leaching process and may also exercise the option to be rejuvenated by mechanical underwater brushing.

3.3.2 Grades.

3.3.2.1 Grade A. Grade A toxicants shall be either tin or tin and copper compounds.

3.3.2.2 Grade B. Grade B toxicant shall be 100 percent tin compounds and free of copper compounds.

3.3.2.3 Grade C. Grade C toxicant shall be 100 percent copper compounds and free of tin compounds.

3.4 Working characteristics. Coatings shall be readily applied by brush, roller or spray, using commercially available equipment. The coatings shall exhibit leveling without excessive sagging when applied at the proper film thickness as recommended by the manufacturer. Adhesion between coats shall be adequate for performance in service without undue restrictions concerning timing, temperature and other conditions associated with application. The application range shall be between minus 1 to plus 35 degrees Celsius ($^{\circ}\text{C}$) (30 to 95 degrees Fahrenheit ($^{\circ}\text{F}$)) and shall cure at minus 1°C (30°F) in 24 hours.

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3.4.1 Condition in container. The coatings shall be usable, shall be readily broken up with a paddle to a smooth uniform consistency and shall not liver. The coatings shall not increase more than one-third in viscosity, or alternatively shall have no viscosity increase which cannot be compensated for by the addition of a maximum of 15 percent of thinner similar to that used in the coating, or increase more than one-fifth of the time to dry, nor show any other objectionable properties for at least 1 year when stored at temperatures between 2 to 35°C (35 to 95°F).

3.4.2 Directions for mixing and application. Written directions for mixing and application as recommended by the manufacturer including working life, application temperature limitations and safety precautions shall be provided.

3.4.3 Compatibility. Antifouling coatings used with either MIL-P-24441 or an equivalent epoxy primer system shall show no loss of adhesion, blistering, or other failure when tested in accordance with 4.6.9, 4.6.10, 4.6.11 and 4.6.12.

3.4.4 Recoatibility of antifouling paint. Types I and II coatings shall be recoatable after service exposure, without use of a tie-coat and shall show no loss of adhesion when tested in accordance with 4.6.12.1 and 4.6.12.2.

3.4.5 Recoatibility over aged primer. Types I and II coating systems shall be applicable over an aged (in-service) polyamide epoxy coating in good condition (and show no loss of adhesion) when tested in accordance with 4.6.12.3. Recoatibility for grade C shall not apply.

3.5 Identification. Values for the following characteristics shall be established for each coating system prior to qualification testing:

- (a) Mass per liter, gallon
- (b) Color
- (c) Viscosity
- (d) Fineness of grind
- (e) Odor
- (f) Appearance
- (g) Pigment
- (h) Tin
- (i) Copper
- (j) Other biocides

These values shall serve as a basis for determining that the material being offered is the same as that which was approved under qualification testing. Subject to acceptance by NAVSEA, alternative means of identification (for example, infrared spectrographic examination and chemical analysis) may be substituted for the above characteristics, provided appropriate data are submitted by the contractor.

3.6 Antifouling coating characteristics. Antifouling coating characteristics shall be as specified in table I.

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TABLE I. Antifouling coating characteristics.

Characteristics	Requirements
Pot life (where applicable) (min)	8 hours
Volatiles, percent by mass of paint (max)	60 percent
Nonvolatile content, percent by mass of paint (min)	40 percent
Flash point (min)	21°C (70°F)
Adhesion	Shall not delaminate
Mass per liter (min)	4.5 kg (10 pounds)
Dry to touch, 20°C (68°F)	2 hours maximum
Flexibility (1/8 inch mandrel)	Shall not crack

3.7 Cathodic disbondment. Antifouling coating systems shall demonstrate compatibility with impressed current cathodic protection and shall not delaminate or blister when tested for 720 hours in accordance with 4.6.9. Cathodic disbondment shall not apply to grade C.

3.8 Panel performance. Grades A and B coating systems tested in accordance with 4.6.10, 4.6.11 and 4.6.12 shall remain free of marine fouling (slime excepted) in the central portion of the panel as required in 3.8.1 through 3.8.3. There shall be no loss of adhesion between antifouling and anticorrosion systems and shall show no evidence of blisters. Grade C coating shall be applied directly to neoprene rubber.

3.8.1 Static immersion. Types I and II coatings shall be 100 percent free of marine fouling, which includes barnacles, other crustacea, tube worms, and grass for a period of 2 years for type I and 18 months for type II, when tested in accordance with 4.6.10.1. (The area starting from the edge and extending 12 millimeters (mm) (1/2 inch) inward is exempted.)

3.8.2 Dynamic immersion. Type I coatings shall not be eroded to the primer system or to neoprene rubber base (if grade C), or permit biofouling to occur that is not removed on the next dynamic cycle for a minimum of 18 cycles (3 years), when tested in accordance with 4.6.11.

3.8.2.1 Surface roughness after cyclic exposure. Type I coatings shall demonstrate no increase in average surface roughness above the initial 200 root mean square (rms) (maximum) measurement when tested in accordance with 4.6.11.1.

3.8.2.2 Erosion rate. The erosion rate shall be approximately 4.0 ± 0.1 micrometers (μm) per month, when tested for 12 cycles (2 years) in accordance with 4.6.11.2.

3.8.3 Ship installed panels. In addition to the static and dynamic immersion requirements of 3.8.1 and 3.8.2, type I coatings shall be tested for 3 years in accordance with 4.6.12 for conformance to 3.8 through 3.8.2.2.

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3.9 Environment. Prior to submittal for qualification, the coating shall have been registered by the manufacturer with the Environmental Protection Agency under regulations which have been promulgated under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). These regulations require the registration of any product that is considered a pesticide. Information concerning the requirements for registration, application forms, and instructions for application can be obtained from the Environmental Protection Agency Office of Pesticide Programs, Registration Division, Washington, DC 20460.

3.9.1 Toxic materials. 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 activity.

3.9.2 Solvents. The preparation of the type II coating for spraying and the use of solvents shall comply with regulations (rule 442) promulgated by the South Coast Air Quality Management District of California. Any type II coating submitted for qualification under this specification shall not contain photochemically reactive solvents. A photochemically reactive solvent is any solvent with an aggregate of more than 20 percent of its total volume composed of the chemical compounds classified below or which exceeds any of the following individual percentage composition limitations, referred to the total volume of the solvent.

- (a) A combination of hydrocarbons, alcohols, aldehydes, ethers, esters, or ketones having an olefinic or cycloolefinic type of unsaturation except perchloroethylene: 5 percent.
- (b) A combination of aromatic compounds with eight or more carbon atoms to the molecule except ethylbenzene, methyl benzoate and phenyl acetate: 8 percent.
- (c) A combination of ethylbenzene, ketones having branches hydrocarbon structures, tri-chloroethylene or toluene: 20 percent.

NOTE: Although rule 442 specifies that marine coatings may not contain photochemically reactive solvents, pesticides are exempted, and under FIFRA, antifouling paints are defined as pesticides.

3.9.3 Organotin release rates. The static organotin release for grade A materials, expressed as organotin shall not exceed 0.1 microgram per square centimeter per day ($\mu\text{g}/\text{cm}^2/\text{day}$) when tested in accordance with 4.6.13.

3.9.4 Material safety data sheet. The contracting activity shall be provided a material safety data sheet (MSDS) at the time of contract award. The MSDS is Form OSHA-20, found in and part of FED-STD-313. The MSDS shall be included with each shipment of the material covered by this specification (see 6.6).

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4. 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, 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 the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items must meet all requirements of sections 3 and 5. The inspection 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 assuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling in quality conformance does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to acceptance of defective material.

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

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

- (a) Qualification inspection (see 4.4).
- (b) Quality conformance inspection (see 4.5).

4.4 Qualification inspection. Qualification inspection shall be conducted at a laboratory satisfactory to the Naval Sea Systems Command. Qualification inspection shall consist of the tests specified in 4.6.1 through 4.6.13.

4.4.1 Requalification. Requalification will be required every 3 years, and shall consist of the tests specified in 4.6.1 through 4.6.8.

4.5 Quality conformance inspection. Quality conformance inspection shall consist of the tests specified in 4.6.1 through 4.6.8.

4.5.1 Lot. A lot shall consist of paint of the same type and grade from a single uniform batch or a uniform blend of batches offered for delivery at one time.

4.5.2 Sampling. A random sample from each lot of at least 2 percent shall be used for testing.

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4.6 Tests.

4.6.1 Pot life. Where applicable, the coatings of the coating system shall be mixed in accordance with the manufacturer's instructions, in a suitable container so as to result in approximately 1 liter (1 quart) of finished material. For quality conformance inspection, ambient conditions above 21°C (70°F) and 50 percent relative humidity shall be satisfactory. Pot life shall meet the requirements specified in table I.

4.6.2 Volatile content. Volatile content shall be determined in accordance with ASTM D 2369 to determine conformance with the requirement specified in table I.

4.6.3 Nonvolatile content. Nonvolatile content shall be determined in accordance with method B of ASTM D 2369, to determine conformance with the requirement specified in table I.

4.6.4 Flash point. Flash point shall be determined in accordance with ASTM D 93 or ASTM D 3278 to determine conformance with the requirement specified in table I.

4.6.5 Adhesion. Adhesion shall be determined in accordance with test method 6301 of FED-STD-141 to determine conformance with the requirement specified in table I, on panels prepared and coated in accordance with 4.6.10.

4.6.6 Mass per liter. Mass per liter shall be determined in accordance with ASTM D 1475 to determine conformance with the requirement specified in table I.

4.6.7 Dry to touch. Dryness shall be determined in accordance with test method 4061 of FED-STD-141 to determine conformance with the requirement specified in table I.

4.6.8 Flexibility. The flexibility of a 2 to 3 mil film thickness shall be determined in accordance with ASTM D 1737 to determine conformance with the requirement specified in table I.

4.6.9 Cathodic disbondment and accelerated blistering resistance. The test procedures described herein are designed to determine the comparative cathodic disbondment characteristics of commercial antifouling hull coatings. The purpose of the testing is to demonstrate that the commercial antifouling coating submitted for approval as a qualified hull coating shall be compatible with an impressed current cathodic protection (ICCP) system. Grade C coatings shall not be tested in accordance with the tests specified in 4.6.9 through 4.6.9.2.2.

4.6.9.1 Test panel preparation. Duplicate test panels coated with the antifouling system submitted for approval shall be prepared either over a system conforming to MIL-P-24441 or an equivalent anticorrosion system. The equivalent coating shall be applied in accordance with the manufacturer's instructions and the MIL-P-24441 coating shall be applied in three separate coats as follows:

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Coat No. 1 - MIL-P-24441/1, Formula 150, 2-3 mils DFT
 Coat No. 2 - MIL-P-24441/2, Formula 151, 2-3 mils DFT
 Coat No. 3 - MIL-P-24441/5, Formula 154-R₀ = 3.6, 2-3 mils DFT

This is to be followed by the antifouling coating being tested and applied in accordance with the manufacturer's instructions. The total dry film thickness (DFT) of the anticorrosion and antifouling coatings shall be between 10-15 mils. The coatings shall be applied to ordinary strength steel plates in accordance with ASTM A 109. The dimensions of the test plate shall be 250 by 300 by 3 mm (10 by 12 inches by 1/8-inch). The test plate shall be pre-drilled so as to provide a 5 mm (3/16-inch) diameter hole 13 mm (1/2 inch) from the 250 mm (10 inch) edge on centerline. The test plates shall be blasted to a uniform white appearance with a surface profile of between 1.0 to 2.0 mils (peak-to-valley). Care shall be exercised during blasting of the test plates so as to prevent excessive warpage of the plates. Prior to coating, a 600 mm (24 inch) length of insulated electrical lead wire (AWG No. 14, stranded copper, type CP insulation) shall be mechanically connected to the test panel at the pre-drilled hole using a brass machine screw (10/24, 13 mm (1/2-inch) length) nut and washers. After connection, the electrical continuity of the lead wire and connection to the panel shall be checked by a resistance measurement with a volt-ohm-meter. The resistance shall be less than 0.01 ohm. After making and checking the lead wire connection, the connection shall be coated (3M Co., Scotchweld Structural Epoxy No. 1838, or equal). After making the lead wire connection to the test panel, the edges of the test panel shall be stripe coated so as to extend a minimum of 13 mm (1/2 inch) from the edge. The stripe coat shall set to touch before the full prime coat is applied. After stripe coating the edges, the test panels shall be coated using standard spray equipment. The MIL-P-24441 coating system or equivalent shall be allowed to dry for 16 to 24 hours between coats at $21 \pm 1^\circ\text{C}$ ($70 \pm 5^\circ\text{F}$). The antifouling coating to be qualified shall be allowed to dry in accordance with the best practice deemed acceptable by the manufacturer. After application, the dry film thickness of the coated test panels shall be measured and recorded. The coated test panels shall be inspected with a low voltage (67.5 volt) wet sponge-type holiday detector and any detected holidays shall be suitably repaired, prior to the start of the test. The coated test panel shall then receive one intentional holiday centered on one side of the test panel. The holiday shall be made by drilling a radial hole through the coating, using a drill that has a diameter of 6 mm (0.25 inch). The hole shall not penetrate through the metal panel, but shall remove all coating within the drill diameter, leaving exposed bright metal.

4.6.9.2 Test procedures. Test panels shall all be vertically suspended and totally immersed in a plastic vessel (minimum capacity of 100 liters) (25 gallons) filled with a synthetic seawater electrolyte consisting of potable tap water to which has been added 1 percent, by mass, of the following technical grade salts, calculated on an anhydrous basis: sodium chloride, sodium sulfate and sodium bicarbonate. The test panels shall be spaced equi-distantly from a magnesium anode (MIL-A-21412, class 2, type MRW-2.5F) centered in the test vessel. The side of the test panel with the holiday shall face the anode. The lead wires from each test panel shall be attached to the anode lead wire using a split bolt electrical connector suitable to fit the lead wires. The initial liquid level in the test vessel shall be maintained by daily additions of potable water as required. The duration of the tests shall be 30 days. Upon termination of the test period, a physical examination of the test panels shall be performed. The

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physical examination shall determine the extent to which the coating has been disbanded around the intentional holiday. The extent of cathodic disbondment shall be determined by making cuts with a sharp knife through the coating intersecting at the holiday and lifting all loose and disbanded coating with the point of the knife. The area of disbondment shall then be estimated. Photographs shall be taken of each panel after the physical examination.

4.6.9.2.1 Report requirements. For qualification, a report of the test results prepared by an independent laboratory shall be required. The report shall include the following:

- (a) Average dry film thickness of each coated panel.
- (b) The unsealed area (square inch) of each test panel.
- (c) A photograph of each test panel (holiday site) upon completion of the physical examination.

4.6.9.2.2 Qualification criteria. The requirements for qualification based on the subject test shall be that the coating submitted for qualification shall not exhibit any disbonding or blistering and shall be in accordance with 3.7.

4.6.10 Panel preparation. For grades A and B, test panels shall be cleaned after blasting with dry compressed air or vacuum. Three coats of MIL-P-24441 primer shall be applied, each 2-3 mils thick, or an equivalent primer as specified by the manufacturer. The antifouling coating shall be applied in accordance with the manufacturer's instructions (see 3.8). Grade C coatings shall be applied directly to neoprene rubber base.

4.6.10.1 Static immersion. Types I and II panel tests shall be conducted at commercial semitropical and cold water test sites in accordance with ASTM D 3623. A set of four panels, each of steel and aluminum and 250 by 300 by 3 mm (10 by 12 inches by 1/8 inch) shall be prepared. Type I panels shall be exposed for a minimum of 24 months and type II panels for a minimum of 18 months, for conformance to 3.8.1. The test sites shall have the full range of biofouling organisms which shall include barnacles, tubeworms and algae.

4.6.11 Dynamic immersion (drum cycle). Type I coating shall be applied to a set of four panels 75 by 175 by 3 mm (3 by 7 inches by 1/8 inch) with a radius of curvature of 450 mm (18 inches) similar to the test drum along the length of the panel or to a neoprene base of the same dimension. The coating shall be tested on a dynamic spinning facility exposed to the same test site (see 4.6.10.1) and operating to the following criteria:

- (a) Rotational speed - 15 knots at periphery of 18 inch drum.
- (b) Dynamic speed - 30 days continuous rotation (immersed).
- (c) Static cycle - 30 days continuous static immersion.

A complete cycle shall consist of one dynamic and one static immersion alternately. The duration of the test shall be 6 cycles (1 year). Test results shall conform to 3.8.2.

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4.6.11.1 Surface roughness after cyclic exposure. Type I coating will be evaluated by David W. Taylor Naval Ship Research and Development Center (DTNSRDC) for 12 cycles (2 years) in accordance with the screening test used for the selection of smooth hull coatings through alternate static and dynamic exposures. After each interval of 3 cycles (6 months) of static and dynamic exposure, surface roughness measurements shall be made with a Perthometer C5D instrument. Test results shall be as specified in 3.8.2.1.

4.6.11.2 Erosion rate. Thickness readings of type I coatings shall be made on the panels tested as specified in 4.6.11.1 before and after 3 cycles on the rotating drum test specified in 4.6.11. The rate of erosion shall be as specified in 3.8.2.2.

4.6.12 Recoatibility of aged (ship installed) antifouling paint. A set of four steel or neoprene rubber bonded to steel panels 250 by 300 by 3 mm (10 by 12 inches by 1/8 inch) each shall be installed on the outboard side of the ship's bilge keel on the port and starboard sides. The panels shall be secured with fittings that will permit installation and retrieval while the ship is waterborne. The panels shall be prepared in accordance with 4.6.10 and used to conduct tests for 4.6.12.1 and 4.6.12.2.

4.6.12.1 Type I. Two panels shall be prepared as specified in 4.6.10. After 1 year of exposure, the panels shall be retrieved, given a water wash and recoated with the paint under test. After 48 hours, the panels shall be reinstalled on the ship for a minimum service exposure of 1 year and shall meet the requirements of 3.4.4, when tested in accordance with 4.6.5.

4.6.12.2 Type II. Two test panels from 4.6.12 shall be retrieved after 1 year of exposure and shall be cleaned by low pressure (120 to 1000 pounds per square inch (lb/in²)) water wash and then recoated with the antifouling paint being tested. After 48 hours, the panels shall be reinstalled on the test ship for a minimum service exposure of 1 year and shall meet the requirements of 3.4.4, when tested in accordance with 4.6.5.

4.6.12.3 Recoatibility of aged (ship installed) primer. Two panels primed with three coats of MIL-P-24441 or an equivalent primer and aged for a minimum of 1 year shall be retrieved and cleaned to remove any fouling by high sweep sanding or water wash. Two coats of type I or II shall be applied over a fresh mist coat of MIL-P-24441, or a tie-coat specified by the manufacturer. After 48 hours, the panels shall be reinstalled on the ship for a minimum service exposure of 1 year when tested in accordance with 4.6.5. Testing for recoatability of aged (ship installed) primer for grade C coatings shall not apply.

4.6.13 Organotin leach rate - (expressed as tin). The candidate paint shall be applied, to a 250 by 300 by 3 mm (10 by 12 inches by 1/8 inch) steel panel which has been primed with an anticorrosion paint system. The panel shall be immersed in synthetic seawater made in accordance with ASTM D 1141, in a 50 mm wide by 300 mm deep by 400 mm high (2 inches wide by 12 inches deep by 16 inches high), aluminum (alloy 5052) tank. The panel shall be equally spaced from the tank side walls and bottom to permit water circulation. A pump shall be used to circulate the water at 9 to 10 liters per minute. The tank shall be placed in a temperature controlled waterbath that shall maintain a temperature of plus or minus 0.5°C (1°F). A carbon column containing Calgon's OL 20 by 50 activated carbon shall be used to keep the organotin concentration in the tank below

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50 parts per billion (p/b). A variable speed peristaltic pump shall be used to circulate the water through the carbon column. The pumping rate shall be adjusted so that the organotin removed by the carbon column shall be approximately the same as that released from the coating. Activated carbon shall be replaced when effluent from the column exceeds 10 p/b tin. The test panel shall be aged for 30 days in the test assembly to assure that a stable release rate of the organotin shall be reached. During this 30 day period, samples of the tank water and carbon column effluent shall be taken every 3 days. Based on the analysis of these samples, the pumping rate shall be adjusted so that the tank concentration is stabilized between 20 and 50 p/b. The pH of the tank water shall be measured daily and adjusted to 8.0 ± 0.2 using HCl or NaOH during this period. After the 30 day aging period, the release rate shall be measured during a 14-day test period. A minimum of 10 tank and carbon column effluent samples shall be taken during the 14-day test period. The pH and temperature shall be measured and recorded when samples are taken and the pH adjusted to 8.0 ± 0.2 using HCl or NaOH. A 10 milliliter (mL) sample of the carbon column effluent as well as the test tank water shall be removed and placed in 200 mL volumetric flasks. Five mL of concentrated HCl shall be added to each flask, followed by occasional shaking during the next 30 minutes. Ten mL of methylisobutylketone (MIBK) shall then be added to the flask and the mixture shall be shaken vigorously for 30 seconds. Samples of the MIBK shall be analyzed for tin by atomic absorption spectrophotometer (AAS). The graphite furnace of the AAS shall be operated according to the following schedule:

<u>Step</u>	<u>Temperature (°C)</u>	<u>Ramp time (seconds)</u>	<u>Hold time (seconds)</u>
1. Dry	100 (212°F)	25	60
2. Char	700 (1292°F)	25	60
3. Atomize	2700 (4892°F)	0	8

Light source: Tin electrodeless discharge lamp (EDL)

Wavelength: 224.6 nanometer

Background corrector: On

Standards in the range of 0 to 300 p/b shall be prepared by dilution of 97 percent pure tributyltin oxide (TBTO) in MIBK. The standards shall be analyzed by the AAS graphite furnace. A blank containing 10 mL of synthetic seawater and no organotin shall also be analyzed to zero the instrument and establish a baseline. A calibration curve shall be plotted using the peak height absorbance and the tin concentration. The concentration of a sample shall be determined from this calibration graph. Appropriate dilutions shall be used so that the concentration shall be in the 0 to 300 p/b linear range. Glassware, sample cups, and so forth, that are to be reused shall be carefully cleaned using acetone to remove all traces of organotin and MIBK.

4.6.13.1 Calculations. The release rate in $\mu\text{g}/\text{cm}^2/\text{day}$ shall be calculated utilizing the following formula:

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$$L.R. = \frac{(T_c - CE_c) (F) (1440)}{A}$$

A

Where:

- L.R. = leach rate in $\mu\text{g}/\text{cm}^2/\text{day}$
 T_c = tank concentration for tin in p/b as measured by the atomic absorption (AA)
 CE_c = carbon column effluent for tin in p/b as measured by the AA
 F = flow rate through the carbon column in liters per minute
 1440 = number of minutes per day
 A = painted area of the test panel, in cm^2

AAS readings shall be recorded as tin, not organotin, and the release rate is, likewise, calculated as tin. To find tributyltin, multiply by 2.5.

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

5. PACKAGING

(The packaging requirements specified herein apply only for direct Government acquisition.)

5.1 Packaging. Coatings shall be packaged in 4- or 20-liter (1- or 5-gallon) pails as specified (see 6.2) and shall conform to type II, class 3 of PPP-P-704. Interior coating is not required. Wire handles or bails shall be treated to resist corrosion.

5.2 Packing. Packing shall be level A, B, or C, as specified (see 6.2).

5.2.1 Levels A and B.

5.2.1.1 Pails. Pails shall be packed as specified in 5.1. Pails require no further packing for levels A and B. When specified (see 6.2), pails shall be palletized in accordance with MIL-STD-147.

5.2.2 Level C. Coatings, packaged as specified in 5.1 shall be packed in containers acceptable to the common carrier which will insure safe delivery at destination in a satisfactory condition at the lowest applicable rate. Container packing or method of shipment shall comply with the Uniform Freight or National Motor Freight Classification Rules or Regulations or other carrier rules as applicable to the mode of transportation.

5.3 Marking. In addition to any special marking required herein, or by the contract or order (see 6.2), interior packages and shipping container shall be marked in accordance with MIL-STD-129.

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5.3.1 Special marking. Each container of paint shall have the following additional information:

- (a) Specification number.
- (b) Type as specified.
- (c) Color designation and number (if applicable).
- (d) Manufacturer's designation.
- (e) Manufacturer's name and address.
- (f) Manufacturer's lot number and date of manufacture.
- (g) EPA registration number.
- (h) EPA approved label.

5.3.1.1 Mixing and use instructions. Each component container shall be marked with the "INSTRUCTIONS FOR USE". NOTE: Refer to manufacturer's written mixing and spraying instructions prior to use.

5.3.1.2 Air pollution compliance. For those products which have been approved for use in areas with regulations controlling the emission of solvents into the atmosphere (see 3.9.2 and 6.4), containers shall include the following: "Complies with air pollution regulations".

5.3.1.3 Caution label. Each container shall have a caution label marked with the following:

"CAUTION

Avoid skin contact during application. Chemicals may cause irritation or skin sensitization. In case of contact, wash skin thoroughly with soap and water."

5.3.1.4 Interior containers shall be identified in accordance with FED-STD-313. For shipping containers and palletized unit loads, a copy of the MSDS shall be attached to the shipping document for each destination (see 3.9.4). The contractor shall furnish a copy of the OSHA-20 form to NAVSEA with application for product qualification.

6. NOTES

6.1 Intended use. Type I coating is an underwater hull antifouling coating for use over an anticorrosion primer system to serve a minimum life of 5 years. Type II coating is an underwater antifouling coating for use over an anticorrosive system to serve a minimum of 2 years.

6.2 Ordering data. Acquisition documents should specify the following:

- (a) Title, number and date of this specification.
- (b) Type and grade required (see 1.2).
- (c) Whether 4- or 20- liter (1- or 5- gallon) pail is required (see 5.1).

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- (d) Level of packing required (see 5.2).
- (e) Whether palletization of pails is required (see 5.2.1.1).
- (f) Special marking required (see 5.3).

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time set for opening of bids, qualified for inclusion in Qualified Products List QPL-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 55Z3, Department of the Navy, Washington, DC 20362-5101 and information pertaining to qualification of products may be obtained from that activity. Application for qualification tests shall be made in accordance with "Provisions Governing Qualification SD-6" (see 6.3.1).

6.3.1 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.

6.4 Formulations which comply with air pollution regulations may be required for use in areas with regulations controlling the emission of solvents into the atmosphere (see 3.9.2).

6.5 Film thickness. Manufacturers should include in their recommended film thickness, a safety factor or leeway which will consist of 1 extra year of projected wear for each 3 years of service and will indicate a film thickness increase for speeds in excess of 20 knots.

6.6 Material safety data sheets. Contracting officers will identify those activities requiring copies of completed Material Safety Data Sheets prepared in accordance with FED-STD-313. The pertinent Government mailing addresses for submission of data are listed in appendix B of FED-STD-313.

6.7 Subject term (key word) listing.

- Anticorrosion
- Antifouling
- Copper
- Epoxy
- Paint
- Ship hull
- Tin
- Toxic components

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6.8 Changes from previous issue. Asterisks are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Custodians:

Army - ME

Navy - SH

Preparing activity:

Navy - SH

(Project 8010-1136)

Review activity:

Army - MR

User activity:

Navy - CG

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions - Reverse Side)

1. DOCUMENT NUMBER

DOD-P-24647A

2. DOCUMENT TITLE

PAINT, ANTIPOULING, SHIP HULL (METRIC)

3a. NAME OF SUBMITTING ORGANIZATION

4. TYPE OF ORGANIZATION (Mark one)

 VENDOR USER MANUFACTURER OTHER (Specify): _____

b. ADDRESS (Street, City, State, ZIP Code)

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER (Last, First, MI) - Optional

b. WORK TELEPHONE NUMBER (Include Area Code) - Optional

c. MAILING ADDRESS (Street, City, State, ZIP Code) - Optional

8. DATE OF SUBMISSION (YYMMDD)

(TO DETACH THIS FORM, CUT ALONG THIS LINE.)

INSTRUCTIONS: In a continuing effort to make our standardization documents better, the DoD provides this form for use in submitting comments and suggestions for improvements. All users of military standardization documents are invited to provide suggestions. This form may be detached, folded along the lines indicated, taped along the loose edge (*DO NOT STAPLE*), and mailed. In block 5, be as specific as possible about particular problem areas such as wording which required interpretation, was too rigid, restrictive, loose, ambiguous, or was incompatible, and give proposed wording changes which would alleviate the problems. Enter in block 6 any remarks not related to a specific paragraph of the document. If block 7 is filled out, an acknowledgement will be mailed to you within 30 days to let you know that your comments were received and are being considered.

NOTE: This form may not be used to request copies of documents, nor to request waivers, deviations, or clarification of specification 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.

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