

INCH-POUND

MIL-DTL-24625A(SH)

02 April 2009

SUPERSEDING

MIL-A-24625(SH)

14 November 1983

DETAIL SPECIFICATION

ANODES, IMPRESSED CURRENT CATHODIC PROTECTION - PLATINIZED TYPE

MIL-A-24625, dated 14 November 1983, is hereby reactivated and may be used for either new or existing design acquisition.

This specification is approved for use by the Naval Sea Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers platinized anodes for impressed current cathodic protection applications.

1.2 Classification. Platinized anodes are of the following types, grades, classes, and applications as specified (see 6.2).

1.2.1 Types.

- a. Type I - Standard anode
- b. Type II - Diver replaceable anode

1.2.2 Grades.

- a. Grade A - Wire anode
- b. Grade B - Plate anode
- c. Grade C - Rod anode

1.2.3 Classes.

- a. Class 1 - Surface ship
- b. Class 2 - Submarine

1.2.4 Applications.

- a. Application A - Non-pressure underwater hull
- b. Application B - Pressure hull
- c. Application C - Tank
- d. Application D - Propulsor

Comments, suggestions, or questions on this document should be addressed to: Commander, Naval Sea Systems Command, ATTN: SEA 05M2, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or emailed to CommandStandards@navy.mil, with the subject line "Document Comment". Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <http://assist.daps.dla.mil>.

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1.3 Part or identifying number (PIN). PINs to be used for platinized anodes acquired to this specification are created as follows: (see 1.2.1 through 1.2.4 for PIN Code designations and 6.2)

M **24625** **:** **X** **X** **X** **X**

Prefix for Military Specification Type (see Grade (see Class (see code Application
Specification Number code below) code below) below) (see code
below)

Type Code		Grade Code		Class Code		Application Code	
Type	Code	Grade	Code	Class	Code	Application	Code
I	1	A	A	1	1	A	A
II	2	B	B	2	2	B	B
		C	C			C	C
						D	D

Example: M24625-1A1A
M24625-2B2B

2. APPLICABLE DOCUMENTS

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

2.2 Government documents.

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

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-S-901	-	Shock Tests, H.I. (High-Impact) Shipboard Machinery, Equipment, and Systems, Requirements for
MIL-DTL-915	-	Cable, Electrical, for Shipboard Use, General Specifications for
MIL-C-24217	-	Connectors, Electrical, Deep Submergence, Submarine
MIL-C-24231	-	Connectors, Plugs, Receptacles, Adapters, Hull Inserts, and Hull Insert Plugs, Pressure-Proof, General Specification for

(Copies of these documents are available online at <http://assist.daps.dla.mil/quicksearch/> or <http://assist.daps.dla.mil>, or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

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

NAVSEA S9320-AM-PRO-020	-	Underwater Cable Assembly and Encapsulated Components, Fabrication, Repair, and Installation Manual; Vol. II, Molding and Inspection Procedures for Fabricating Connector Plugs for Submarine Outboard Cables
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(Copies of this document are available from Naval Systems Data Support Activity (NSDSA) Commander, Code 5E30DP Bldg 1388, NAVSURFWARCENDIV NSDSA, 4363 Missile Way, Port Hueneme CA 93043-4307 or online at <https://mercury.tdmis.navy.mil>.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ASTM INTERNATIONAL

ASTM B487	-	Standard Test Method for Measurement of Metal and Oxide Coating Thickness by Microscopical Examination of a Cross Section (DoD adopted)
ASTM B489	-	Standard Practice for Bend Test for Ductility of Electrodeposited and Autocatalytically Deposited Metal Coatings on Metals
ASTM B567	-	Standard Test Method for Measurement of Coating Thickness by the Beta Backscatter Method (DoD adopted)
ASTM B568	-	Standard Test Method for Measurement of Coating Thickness by X-Ray Spectrometry (DoD adopted)
ASTM B571	-	Standard Practice for Qualitative Adhesion Testing of Metallic Coatings (DoD adopted)
ASTM B602	-	Standard Test Method for Attribute Sampling of Metallic and Inorganic Coatings
ASTM B748	-	Standard Test Method for Measurement of Thickness of Metallic Coatings by Measurement of Cross Section with a Scanning Electron Microscope
ASTM D543	-	Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents (DoD adopted)
ASTM E8	-	Standard Test Methods for Tension Testing of Metallic Materials (DoD adopted)
ASTM E290	-	Standard Test Methods for Bend Testing of Material for Ductility (DoD adopted)
ASTM E1003	-	Standard Test Method for Hydrostatic Leak Testing

(Copies of these documents are available from ASTM International, 100 Barr Harbor Dr., P.O. Box C700, West Conshohocken, PA 19428-2959 or online at <http://www.astm.org>.)

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

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3. REQUIREMENTS

3.1 First article. When specified (see 6.2), a sample shall be subject to first article inspection in accordance with 4.2.

3.2 Recycled, recovered, or environmentally preferable materials. Recycled, recovered, or environmentally preferable materials should be used to the maximum extent possible, provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life-cycle costs.

3.3 Construction.

3.3.1 Anodes. Anodes shall be constructed of platinized niobium or tantalum (for Class I only), with the exception of Grade C anodes.

3.3.1.1 Rod anodes. Grade C rod anodes shall be made as follows. The base for application of platinum shall be a rod (minimum of 0.375 inches in diameter) consisting of a copper core clad with niobium. The ratio of copper to niobium shall be 60 to 40 by cross-sectional area. The diameter of the anode rod and thickness of platinum cladding shall be sufficient to achieve the desired anode output characteristic and life (see 3.5.1 and 3.6.1).

3.3.1.2 Wire anodes. The specimen shall register a maximum resistance of 1.69 ohms per 100 feet at temperature 20 ± 4 °C. If the resistance is greater than 1.69 ohms per 100 feet, the specimen shall be declared unsatisfactory (see 4.4.6).

3.3.2 Anode holder. Anode holders shall be able to resist dissolution in accordance with 4.4.8. Grade C anodes shall withstand bending during field application to a radius greater than or equal to 3 inches. Edges shall provide a suitable and adequate bonding surface for surrounding coating. Holders shall be shock tested as specified in 4.4.7.

3.4 Material.

3.4.1 Platinum plating. The platinum plating shall consist of 99.9 percent pure platinum on an etched surface. Thickness of the plating shall be determined through calculations of dissolution at 50 percent of maximum current to last for 20 years, but, in no case, less than 0.002-inch. Verification of the calculations must be provided to the technical authority.

3.4.1.1 Adhesion. Adhesion of the platinum to the substrate shall be by a metallurgical bonding method (e.g., swaging, rolling, welding, explosion bonding). Electroplating of the platinum to the substrate is not allowed, except as approved by NAVSEA.

3.4.2 Niobium substrate. The substrate shall be 99.9 percent pure, annealed niobium.

3.4.2.1 Rod anodes. Within the base rod, the ratio of copper to niobium shall be 60 to 40 by cross-sectional area. The copper core shall be commercially pure annealed copper. The anode shall bend as specified in 4.4.3. Grade C rod anodes shall exhibit no visual cracking of the platinum plating when tested in accordance with 4.4.2 and 4.4.3.

3.4.3 Electrical cable. All electrical cable shall conform to MIL-DTL-915 with type, gauge, and length to be determined by ship procurement specifications. Cabling shall pass chemical resistance tests found in 4.4.8.

3.4.4 Watertight connection. Following hydrostatic cycling, there shall be no evidence of mechanical damage, water leakage, or impaired electrical characteristics. Additional requirement for Class 2 anodes are contained in NAVSEA Technical Manual, NAVSEA S9320-AM-PRO-020. The following electrical characteristics requirements shall be met following the watertight connection test (see 4.4.5).

3.4.4.1 Electrical resistance. The resistance measured from cable to anode shall be less than 0.01 ohm. This shall be measured using a meter with a resolution better than 0.1 milliohm.

3.5 Workmanship.

3.5.1 Platinized niobium. The surface of the platinized niobium shall be smooth and free of visible dents, cracks, kinks, and other defects of a similar nature that may affect serviceability.

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3.5.1.1 Platinized niobium rods (Grade C). Grade C anodes, when bent, shall be free of imperfections, including cracking and non-adhesion, when viewed at up to 4 times magnification. Ductility shall be tested in accordance with 4.4.3.

3.5.1.2 Adhesion. Adhesion of platinum plating to niobium substrate shall be tested in accordance with 4.4.2. The coating shall follow the guidelines for satisfactory adhesion as described in each relevant test found in ASTM B571.

3.5.2 Electrical cable. The surface of the electrical cable shall be without kinks, dents, cracks, and other defects that may affect serviceability.

3.6 Reliability and maintainability (R&M).

3.6.1 Anode life. Anodes shall have an expected life equal to 50 percent of the rated output for a 20-year life, but, in no case, less than 0.002-inch. The consumption factor to be assumed is 20 milligrams/Amp-year. The density of platinum is 21.45 grams/centimeters-cubed.

3.6.1.1 Type II anode replacement time. Diver replaceable anodes shall have a mean time to repair (MTTR) of one hour without the use of a cofferdam. All Type II anode metallic components exposed to seawater by the installation process shall be fabricated from a platinum-plated niobium material to prevent corrosion upon reactivation of the ICCP anode.

3.7 Operational requirements. Maximum operating current, operating (applied) voltage-to-current ratio, and voltage at anode working surface when at maximum operating current under standard conditions shall be as specified (see 6.2).

4. VERIFICATION

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

- a. First article inspection (see 4.2)
- b. Conformance inspection (see 4.3)

4.2 First article inspection. First article inspection shall be performed on three sample anodes. This inspection shall include all tests of 4.4.

4.3 Conformance inspection. Conformance inspection shall include the tests of 4.4.1, 4.4.4, 4.4.6, and 4.4.8.

4.3.1 Lot. For the purpose of sampling, a lot shall consist of all anodes of the same type from the same production run offered for delivery at one time. However, this lot shall not exceed a maximum of 200 prepared anodes or 1,000 feet (ten 100-foot coils) of platinized niobium wire.

4.3.2 Sampling for examination. A random sample of prepared anodes shall be selected from each lot in accordance with ASTM B602 at verification level II. Each sample specimen shall be examined to assure compliance with 3.4.1 and 3.4.2.

4.3.3 Sampling for testing. Sampling for the purpose of testing shall be conducted as dictated by the individual test procedures of 4.4.

4.4 Test procedures.

4.4.1 Appearance. The platinum coating shall be examined at up to 10 times magnification for conformance to the requirements of appearance as specified in 3.5.1.

4.4.2 Adhesion. Adhesion shall be tested in accordance to ASTM B571. Tests referring to palladium coating shall be used for the platinum coating of the anodes. Grade A anodes shall be tested in accordance with ASTM E8 tension testing of metallic materials.

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4.4.3 Ductility. Testing procedures ASTM E290 and B489 shall be followed for the ductility testing of the substrate and the platinum coating, respectively. Grade A anodes shall be tested in accordance with ASTM E8 tension testing of metallic materials. Grade C anodes shall have a ductility rating capable of making a 180-degree bend over a 3-inch radius.

4.4.4 Platinum thickness. Platinum thickness shall be determined by methods outlined in ASTM B487, ASTM B567, ASTM B568, or ASTM B748. The platinum thickness shall comply with 3.4.1. If the substrate is rough relative to the coating thickness, the interface of the coating cross-section may be too irregular to permit accurate measurement of the average thickness in the field of view. If this occurs, another sample shall be taken from the lot. If both samples are too irregular to obtain an average, the lot shall be rejected.

4.4.5 Watertight connection. The sample specimens used for destructive adhesion tests (see 4.4.2) may be used as specimens for the watertight connection test. Anodes shall be tested using ASTM E1003 or MIL-C-24217 for hydrostatic pressure testing. For purposes of determining test ranges, Class 2 connections are considered to operate within a hydrostatic pressure range of 0 to 10,000 pounds/inches-squared. Class 1 connections shall be tested to 1/10 the pressure of Class 2 connections.

4.4.5.1 Electrical resistance. Electrical resistance shall be measured using a meter with a resolution better than 0.1 milliohm. Anodes shall be set up for testing in the following ways:

- a. Pigtail connected anodes. The cable of the sample specimen shall be cut 6 inches above the anode connection.
- b. Pin connected anodes. The appropriate cable for the anode shall be attached and cut 6 inches above the anode connection.

4.4.6 Wire thickness. Each Grade A anode coil shall be tested for wire thickness. The sample specimen shall have each coil end attached to an ohm meter with a resolution better than 0.1 milliohm.

4.4.7 Shock. Anode holders shall conform to shock Grade B in accordance with MIL-S-901. Water intrusion through the anode gland following testing is unsatisfactory.

4.4.8 Chemical resistance. Testing shall be performed on the anode assembly in accordance with ASTM D543 for resistance to the following reagents:

- a. Acetone
- b. Sodium chloride solution
- c. Sodium hypochlorite solution acidified with dilute HCl to a pH < 4

5. PACKAGING

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

6. NOTES

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

6.1 Intended use. Anodes covered by this specification are intended for use with impressed current cathodic protection systems for corrosion protection of underwater surfaces. They are primarily designed for application in the water alongside the ship's or submarine's hull and within submarine ballast tanks.

6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, and date of this specification.

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- b. Anode classification and PIN (see 1.2 and 1.3).
- c. When first article is required (see 3.1).
- d. Operational requirements (see 3.7).
- e. Packaging requirements (see 5.1).

6.3 Subject term (key word) listing.

Control
Corrosion
Electrode
Plate
Platinum
Rod
Wire

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

Preparing Activity:
Navy - SH
(Project 5340-2008-004)

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at <http://assist.daps.dla.mil>.