

MIL-A-18001J
 25 November 1983
 SUPERSEDING
 MIL-A-18001H
 28 June 1968
 (See 6.7)

MILITARY SPECIFICATION

ANODES, CORROSION PREVENTIVE, ZINC; SLAB DISC AND ROD SHAPED

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

1. SCOPE

1.1 Scope. This specification covers the requirements for zinc anodes (galvanic protectors) in the form of plates, slabs, discs and rods for corrosion protection (cathodic protection) of metals and alloys. It also includes features of design and fabrication such as cast-in cores for mounting purposes.

1.2 Classification. The anodes shall be of the following classes and types, as specified (see 6.2):

Class 1 - Cast-in cores

Type ZHS - Zinc, hull slab (steel straps) (23 and 42 pound sizes).
 Type ZHB - Zinc, hull slab (brass straps) (23 pound size).
 Type ZHC - Zinc, hull slab (core strap) (23 and 42 pound sizes).
 Type ZSS - Zinc, submarine slab (steel strap) (12 and 24 pound sizes).
 Type ZTS - Zinc, teardrop shape (steel strap) (5 pound size).
 Type ZEP - Zinc, heat exchanger or fair water disc (pipe core or pipe bushing core).

Style A - Square slab (9 pound size).
 Style B - Circular slab (various sizes).
 Style C - Semi-circular slab (23 pound size).

Type ZBP - Zinc, bar (pipe core) (8 pound size).
 Type ZDM - Zinc, segmented disc (machine formed interlocking core) (various sizes).

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 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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Class 2 - Plain, no cores

Type ZRN - Zinc, rod, no core, extruded, drawn or rolled.

Type ZPN - Zinc, plate, no core, rolled.

1.3 Key to symbols. The letter designations of types of anodes have the following meaning:

First letter Z - (zinc) designates anode metal.

Second letter	<table> <tbody> <tr><td>H - (hull slab)</td></tr> <tr><td>S - (submarine slab)</td></tr> <tr><td>T - (teardrop shape)</td></tr> <tr><td>E - (heat exchanger slab)</td></tr> <tr><td>R - (rod, cylindrical)</td></tr> <tr><td>P - (plate)</td></tr> <tr><td>B - (bar, square)</td></tr> <tr><td>D - (disc, segmented)</td></tr> </tbody> </table>	H - (hull slab)	S - (submarine slab)	T - (teardrop shape)	E - (heat exchanger slab)	R - (rod, cylindrical)	P - (plate)	B - (bar, square)	D - (disc, segmented)	Designates shape or general use
H - (hull slab)										
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T - (teardrop shape)										
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Third letter	<table> <tbody> <tr><td>B - (brass straps)</td></tr> <tr><td>S - (steel strap)</td></tr> <tr><td>C - (core, strap)</td></tr> <tr><td>P - (pipe core)</td></tr> <tr><td>M - (machine formed interlocking core)</td></tr> <tr><td>N - (no core)</td></tr> </tbody> </table>	B - (brass straps)	S - (steel strap)	C - (core, strap)	P - (pipe core)	M - (machine formed interlocking core)	N - (no core)	Designates core		
B - (brass straps)										
S - (steel strap)										
C - (core, strap)										
P - (pipe core)										
M - (machine formed interlocking core)										
N - (no core)										

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standards. Unless otherwise specified, the following specifications and standards of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation form a part of this specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

- QQ-B-639 - Brass, Naval: Flat Products (Plate, Bar, Sheet, and Strip).
- QQ-B-750 - Bronze, Phosphor; Bar, Plate, Rod, Sheet, Strip, Flat Wire, and Structural and Special Shaped Sections.
- PPP-B-601 - Boxes, Wood, Cleated-Plywood.
- PPP-B-621 - Boxes, Wood, Nailed and Lock-Corner.
- PPP-B-636 - Boxes, Shipping, Fiberboard.

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- MIL-P-15011 - Pallets, Material Handling, Wood Post Construction, 4-Way Entry.
- MIL-A-19521 - Anodes, Corrosion Preventive, Zinc, and Plugs, Zinc Anode Retaining; Design of and Installation in Shipboard Condensers and Heat Exchangers.

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STANDARDS

FEDERAL

- FED-STD-H28 - Screw-Thread Standards for Federal Services.
- FED-STD-H28/7 - Screw-Thread Standards for Federal Services, American Standard Pipe Threads (Except Dryseal and Hose Coupling Types).

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- MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
- MIL-STD-129 - Marking for Shipment and Storage.
- MIL-STD-1186 - Cushioning, Anchoring, Bracing, Blocking and Waterproofing; with Appropriate Test Methods.

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

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. The issues of the documents which are indicated as DoD adopted shall be the issue listed in the current DoDISS and the supplement thereto, if applicable.

ASTM

- A 36 - Structural Steel. (DoD adopted)
- E 290 - Semi-Guided Bend Test for Ductility of Metallic Materials. (DoD adopted)
- E 536 - Chemical Analysis of Zinc and Zinc Alloys.

(Application for copies should be addressed to the ASTM, 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., 1616 "P" Street, NW, Washington, DC 20036.)

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.)

(Industry association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

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2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein, the text of this specification shall take precedence.

3. REQUIREMENTS

3.1 Materials.

3.1.1 Zinc. The anodes shall conform to the composition specified in table I as determined by the methods specified herein. Total of elemental constituents not specified in table I shall not exceed 0.10 percent. Metallic elements not specified in table I are considered contaminants.

TABLE I. Chemical composition, zinc anodes (galvanic protectors).

Lead (max)	Iron (max)	Cadmium range	Copper (max)	Aluminum range	Zinc
Percent	Percent	Percent	Percent	Percent	Remainder
0.006	0.005	0.025-0.07	0.005	0.1-0.5	

3.1.2 Steel straps. Types ZHS, ZHC, ZSS and ZTS anodes shall have steel strap cores conforming to ASTM A 36. The steel shall be coated with zinc to a minimum thickness of 0.0005 inch. Hot dip or electrodeposition methods may be used. Either coating shall be adherent and free from flaking. The coating shall adhere tenaciously to the surface of the base metal. When the coating is cut or pried into, such as with a stout knife applied with considerable pressure in a manner tending to remove a portion of the coating, it shall only be possible to remove small particles of the coating by paring or whittling, and it shall not be possible to peel any portion of the coating so as to expose the steel. Lack of adhesion of the zinc coating at bends or absence of zinc coating at cut edges shall not be cause for rejection of fabricated anodes.

3.1.3 Brass straps. Type ZHB zinc anodes shall have brass strap cores conforming to alloy 482 of QQ-B-639 or phosphor bronze straps conforming to composition A of QQ-B-750. The maximum copper content in the zinc, as specified in table I, may be increased to 0.020 percent for type ZHB anodes.

3.1.4 Pipe cores. Types ZEP and ZBP zinc anodes shall have core inserts made from zinc coated steel pipe or pipe couplings. Minimum thickness of coating shall be as specified in 3.1.2.

3.1.5 Steel machine formed interlocking cores. Type ZDM zinc anodes shall have machine formed interlocking cores conforming to commercial grade mild or leaded steel. The cores shall be flash coated with zinc, tin or aluminum prior to assembly within the zinc anodes.

3.1.6 Heads. The head for type ZDM anodes (see piece 3 as shown on figure 1) shall conform to MIL-A-19521. Details of class A (straight thread) and class B (tapered thread) support plug heads are shown on figures 2 and 3.

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3.1.7 Recovered materials steel components only. Unless otherwise specified herein, all equipment, material and articles incorporated in the products covered by this specification shall be new and shall be fabricated using materials produced from recovered materials to the maximum extent practicable without jeopardizing the intended use. The term "recovered materials" means materials which have been collected or recovered from solid waste and reprocessed to become a source of raw materials, as opposed to virgin raw materials. None of the above shall be interpreted to mean that the use of used or rebuilt products is allowed under this specification unless otherwise specifically specified.

3.2 Manufacture.

3.2.1 Types ZHS, ZHB and ZHC hull slab anodes (see figures 4 through 7); types ZSS submarine slab anode and ZTS teardrop anodes (see figures 8, 9a and 9b). Type ZHS, ZHB, ZHC, ZSS and ZTS anodes shall be manufactured by any casting process suitable to the contracting agency provided the anodes meet the other requirements covered by this specification. Open or closed molds may be used. Cores and straps shall be positioned so that they are embedded 1/4 inch minus 1/16 inch or plus 1/8 inch as shown on figures 4 through 9 which may be measured from either surface of anode as applicable, except figure 9(b) which shall be embedded 3/8 inch minus 1/16 inch or plus 1/8 inch. A metallurgical bond shall be obtained between the zinc and the strap when tested as specified in 4.4.2 or 4.4.2.1. Type ZHC anodes designated as shown on figures 6A and 7A are intended for use with rubber washers for submarine application. Countersink for rubber washer may be cast or machined. Anode shall be manufactured so that countersink is centered on core hole and rubber washer fits snugly between hull and anode core to prevent anode movement or vibration. Type ZSS anodes designated as shown on figure 9 may be mounted by welding or by fasteners. Those intended to be attached by fasteners shall indicate the requirements for mounting holes in the strap. The mounting hole shall be counterbored on the structure side of the strap.

3.2.2 Type ZEP heat exchanger slab anode (see figure 10). Type ZEP anodes may be manufactured by any method suitable to the contracting agency provided the anodes meet the other requirements of this specification. The pipe core inserts shall conform to 3.1.4. A sound metallurgical bond shall be obtained between the core and anode material for at least 30 percent of the total surface of the core in contact with the anode as specified in 4.4.2 or 4.4.2.1. The position of the pipe core insert shall not vary more than plus or minus 1/8 inch from center as shown on figure 10.

3.2.3 Type ZBP, zinc bar anode (see figure 11). Type ZBP anodes may be manufactured by any method suitable to the contracting agency provided the anodes meet the other requirements of this specification. The position of the pipe core insert specified in 3.1.4 shall not vary more than plus or minus 1/4 inch from the center as shown on figure 11. The metallurgical bonding requirements between anode and core specified in 3.2.1 shall apply.

3.2.4 Types ZPN and ZRN anodes (no core) (see figure 12). Type ZPN and ZRN anodes (no core) shall be manufactured by any process suitable to the contracting agency provided the anodes pass the tests demonstrating mechanical properties (see 3.6) and other requirements covered by this specification.

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3.2.5 Type ZDM, zinc segmented disc, machine formed interlocking core anode (see figure 1). Type ZDM anode may be manufactured by any method suitable to the contracting agency provided the anodes meet the other requirements of this specification. Metallic bonding or an interference fit of the core into the anode shall be required so that an axial force applied from the stud end to remove the core insert is a minimum of 750 pounds.

3.2.5.1 The machine formed core insert specified in 3.1.5 shall be manufactured in accordance with details and tolerances shown in piece 2 of figure 1 FED-STD-H28 and FED-STD-H28/7. (This core insert has been designed for mass production by modern machine methods. The insert consists of an integral piece having a threaded male stud at one end and a tapped hole at the other end. Provision has been made to achieve self-locking characteristics to interlocking threaded assemblies of multiple segmented anode discs by interference fit of bottom male threads into a taper tapped hole.) These anodes shall screw together very snugly by hand tightening or by using simple hand tools such as pliers or pipe wrenches.

3.3 Dimensions.

3.3.1 Types ZHS, ZHB, ZHC, ZTS, ZSS, ZEP, ZBP, ZDM and ZRN. The specified anodes shall conform to the dimensions shown on figures 1 to 12, inclusive. Dimensions are in inches unless otherwise indicated.

3.3.2 Type ZPN anodes. Type ZPN anode shall be 48 inches in length by 24 inches in width.

3.3.2.1 Thickness of type ZPN anode shall be either 1/2 or 1 inch, as specified (see 6.2).

3.3.3 Weight. ZSS-24, ZSS-12, ZHC-42, ZHC-23, ZHS-42 and ZHS-23 shall have the following minimum weight requirements: ZSS-24 (21.5), ZSS-12 (11.0), ZHC-42 (39), ZHC-23 (21.5), ZHS-42 (41) and ZHS-23 (21.5) pounds, as indicated in parenthesis. The total weight of the specified type of anode received divided by the total number of anodes of that type, shall be equal to or greater than the minimum (that is, 21.5, 11.0, 39 or 41) weight of anode type specified. If the weight is less than the minimum weight for the type of anode specified, it shall be cause for rejection of the entire lot.

3.4 Permissible variations in dimensions.

3.4.1 Length and width of types ZHS, ZHB, ZHC, ZTS, ZPN, ZSS and ZBP anodes. The width and length of types ZHS, ZHB, ZHC, ZTS, ZPN, ZSS and ZBP anodes shall not vary more than plus or minus 1/8 inch, measured at widest surface of the tapered (for mold release) anode.

3.4.2 Length of type ZRN anodes. A variation of plus or minus 1 inch will be permitted based on nominal lengths of 3 and 6 feet.

3.4.3 Diameter of types ZEP, ZDM and ZRN anodes. The diameter or width, whichever is the larger, of type ZEP anode shall not vary from the specified dimension by more than plus or minus 1/8 inch. The diameter of the type ZDM anode shall not vary more than plus 0.025 or minus 0.005 inches from the specified diameter. The diameter of the ZRN anode shall not vary more than plus or minus 1/32 inch from the specified diameter.

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3.4.4 Thickness. The thickness of types of ZHS, ZHB, ZHC, ZTS, ZPN, ZSS, ZEP and ZBP zinc anodes shall not vary more than plus or minus 1/8 inch. Thickness measurements shall be taken at random 1 inch from any edge of the anode by means of a suitable caliper avoiding any surface irregularities which would interfere with a representative measurement. The thickness of type ZDM anode shall not vary more than plus or minus 1/64 inch.

3.4.5 Eccentricity of core in type ZDM anode. The cores of type ZDM anode shall be positioned axially and concentrically in the zinc disc. Eccentricity greater than 0.005 inch shall not be permitted.

3.5 Marking of anodes.

3.5.1 The zinc anodes, types ZHS, ZHB, ZHC, ZSS and ZBP shall have the words, "DO NOT PAINT" die-stamped or cast on the exposed face of the anodes (see figures 4, 5, 7, 9 and 11). No marking shall be required for types ZEP, ZPN, ZDM, ZTS and ZRN zinc anodes.

3.5.1.1 One end of each cast-in strap of each type ZHB anode shall be painted red so that the installing activity can distinguish it from type ZHS anodes. One coat of red paint shall be applied between the joggled bevel of the strap and zinc anode. The coating shall be approximately 1/2-inch wide and shall extend across one side of each strap so as to be readily visible when the anode is installed. The foot of the strap shall not be painted.

3.5.2 Manufacturer's symbol. A manufacturer's identifying symbol shall be cast or die-stamped on at least one surface of each zinc anode except type ZDM. A capital letter corresponding to the revision letter of the military specification to which the anode conforms shall also be used in addition to the manufacturer's symbol. (For this specification issue, the letter "J" should be used.)

3.6 Mechanical properties.

3.6.1 When tested in accordance with 4.4.5.1, type ZRN rods and ZPN plate shall not fracture or show signs of cracking.

3.6.2 When tested in accordance with 4.4.5.2, type ZRN anodes shall have a minimum torsional shear strength of 12,000 pounds per square inch (lb/in²).

3.7 Workmanship.

3.7.1 Zinc. The zinc anodes shall be free of flash burrs, cracks, blow holes, pipes and surface slag consistent with good commercial practice. The cast anodes shall be free of shrinkage cavities exceeding 1/4 inch in depth, except that anodes 2-inches thick or more shall be free of shrinkage cavities exceeding 3/8 inch in depth, when measured from a straight edge placed diagonally across the opposite edges of the anode, except for type ZPN anodes, the shrinkage cavities shall be measured over a 12 by 12 inch area. In addition to the above allowable shrinkage cavities, surface irregularities on the anode exceeding 1/8 inch in depth shall not be permitted on one face of slab or disc type anodes unless at least 1/8 inch of sound metal covers the entire strap of core area. Types ZDM and ZRN anodes shall be smooth on their curved surfaces.

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3.7.2 Metal cores. Metal core extensions from the anodes shall be smooth and free of sharp burrs. The cast-in cores shall have metallurgical bonds specified herein free of air pockets and inclusions consistent with good commercial practice.

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.

4.2 Quality conformance inspection.

4.2.1 Lot. For the purpose of sampling, a lot shall consist of all zinc anodes of the same class and type made from the same melt or production run offered for delivery at one time.

4.2.2 Sampling for examination. A random sample of anodes shall be selected from each lot in accordance with MIL-STD-105 at inspection level II. In terms of defects per 100 units, the acceptable quality level (AQL) shall be 4.0 for total defects.

4.2.3 Sampling for core bond tests. From each lot specified in 4.2.1, two anodes shall be selected at random of types ZHS, ZHB, ZHC, ZSS, ZTS, ZEP, and ZBP and five anode discs of type ZDM for the test specified in 4.4.2.

4.2.3.1 Resampling. In cases where one of the two anodes specified in 4.4.2 fails to pass the bond test, four additional anodes may be selected for retest at the request of the manufacturer.

4.2.4 Sampling for chemical analysis. Anodes shall be selected at random in accordance with 4.2.3, except that sufficient number of type ZDM anodes shall be selected to comply with 4.2.4.4. From each of the required anodes, one 2-ounce sample shall be taken by drilling or machining the material at the locations specified in 4.2.4.1 to 4.2.4.6, inclusive. The drilling or machining shall be done by the contractor. The drill or tool bit shall not penetrate into the core material of the cored type anodes. The drilled or machined anodes may be included in the delivery of the material, except type ZDM which shall be discarded.

4.2.4.1 Type ZHS, ZHB and ZPN anodes shall be drilled or machined at locations about 2 to 5 inches from the short edge as appropriate to keep away from the encased core.

4.2.4.2 Type ZSS, ZHC and ZTS anodes shall be drilled or machined at points not greater than 1/2 inch from the long edge.

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4.2.4.3 Type ZEP and ZBP anodes shall be drilled at points midway between outer edge of the core and the edge of the anode.

4.2.4.4 Type ZRN anodes shall have two 1-pound minimum sections cut from ends of a nominal length. Type ZDM anodes shall have a sufficient number of discs machined or drilled to make two 4-ounce quantities. The anode shall be sampled as specified in 4.2.4.5 and 4.2.4.6.

4.2.4.5 Type ZDM anodes shall be machined or drilled at the outer surface to a depth not exceeding 1/4 inch.

4.2.4.6 Surface chips. One 2-ounce sample for each anode specified in 4.2.4 shall be taken at the surface in contact with mold wall by drilling or machining to a maximum depth of 1/4 inch. The sample for types ZPN or ZRN shall be taken by drilling completely through both principal surfaces or through the diameter of the anode as applicable. The samples shall be collected in individual clean containers, and properly labeled as to lot, melt, and sample numbers. If the melt of each lot cannot be identified, four times the number of anodes shall be sampled as above. Sample chips may be taken from anodes which have passed the applicable bond tests. Samples shall be clean, free from dirt, oil, grit and foreign matter. The samples shall be sent to a laboratory satisfactory to the contracting agency. A method for sampling anodes for chemical analysis is specified in 6.5.

4.2.5 Sampling for physical testing. At least five type ZRN anodes shall be selected at random from a lot. Type ZRN anodes shall conform to the tests specified in 4.4.5.

4.3 Visual and dimensional examination. Each anode selected in accordance with 4.2.2 shall be visually examined for workmanship and dimensions. Where the number of anodes that do not conform to 3.4 through 3.7 are equal to or greater than the rejection number specified in 4.2.2 (AQL = 4.0), it shall be cause for rejection of the entire lot.

4.4 Tests. The following tests shall be performed.

4.4.1 Weight test. The entire lot of each type anode shall meet the weight requirements as specified in 3.3.3.

4.4.2 Core bonding test. One of the following core bonding tests shall be performed.

4.4.2.1 Core bonding tests (types ZHS, ZHB, ZHC, ZSS, ZTS, ZEP and ZBP). Each anode selected to represent the lot shall be cut along the axis of each strap or core, and the cut surface shall be ground reasonably smooth. These surfaces shall be polished with a 240-mesh emery abrasive until the zinc-strap interface is distinctly visible. This interface shall be examined carefully at approximately 10X magnification. The metallurgical bond between the zinc and the strap shall be continuous for at least 30 percent of the surface in contact with the anode. Zinc anodes may have a bead or buttress projecting from the anode edge along the strap not exceeding 1/4 inch. Less bond between core and zinc than specified herein shall be cause for rejection of the lot.

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4.4.2.2 Alternate core bonding test (types ZHS, ZHB, ZHC, ZSS, ZTS, ZEP and ZBP). Using any suitable method, the cores shall be torn from each anode selected to represent the lot. The use of a sledge hammer to break the zinc away from the cores has been found to be satisfactory. The area showing bond shall be established by visual inspection of the portion of the cores which were contained within the anode. Metallurgical bond between the zinc and the core shall be at least 30 percent of the total surface area of each core in contact with the zinc of the anode. For the purpose of determining the surface area of the encased core in the anode, marks shall be scribed on the strap around the periphery of each anode at locations where the straps protrude from the anode. The total area of the strap shall be computed between the scribe marks. The surfaces shall have a smooth grey matte finish where bonding has been adequate and either a shiny metallic or rough, dark or discolored finish where bonding has been inadequate. Examine both core and zinc mating surfaces. Less bond between core and zinc than that specified herein shall be cause for rejection of the entire lot.

4.4.2.3 Type ZDM anode. A steady pressure of 750 pounds from a hand operated pen press applied axially shall be required to remove the core from the anode.

4.4.2.4 Sample anodes, except the remaining lengths of type ZRN anodes, shall be discarded and not included in the delivery of material after the core bond tests are performed. Sampling for chemical analysis specified in 4.2.4 shall be made prior to discarding the anodes specified in 4.4.2.1 through 4.4.2.3.

4.4.3 Chemical analysis. The chips selected in accordance with 4.2.4 shall be analyzed to determine conformance with 3.1.1. A strong magnet shall be used to remove any iron contamination picked up during the preparation of the chips. The chips shall be washed in an iron-free degreasing solvent prior to analysis. If any sample does not conform to the chemical composition specified in table I, it shall be cause for rejection of the lot represented by the sample.

4.4.3.1 Determination of aluminum, cadmium, copper, iron and lead. The aluminum, cadmium, copper, iron and lead content of zinc shall be determined in accordance with the appropriate methods in ASTM E 536 using the atomic absorption spectrophotometer.

4.4.4 Spectrochemical analysis. Spectrochemical analysis shall be in accordance with any standard method approved by a standard issue body such as the American National Standards Institute or ASTM and accepted by the Government.

4.4.5 Physical tests.

4.4.5.1 Bend test. Type ZRN anodes, selected in accordance with 4.2.5, shall be bent 45 degrees around a mandrel of three times the diameter of the ZRN type anode. The anodes shall be bent in accordance with procedures specified in ASTM E 290. After bending, the convex surface of the specimens shall be inspected for cracking at 10X magnification. Any evidence of cracking shall represent failure of the test and shall be cause for rejection of the entire lot.

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4.4.5.2 Torsional shear test. Type ZRN anodes, selected in accordance with 4.2.5, shall be subjected to torsional shear at a rate of 10 to 12 revolutions per hour using a Tinius-Olson torsional shear apparatus, or equal. Failure of the anode to withstand a torsional shear of 12,000 lb/in² shall be cause for rejection of the lot.

4.5 Inspection of packaging. The packaging, packing and marking of the anodes shall be inspected for compliance with the requirements of section 5 of this specification.

5. PACKAGING

(The preparation for delivery requirements specified herein apply only for direct Government acquisition. For the extent of applicability of the preparation for delivery requirements of referenced documents listed in section 2, see 6.6.)

5.1 Preservation. Preservation shall be level A or C, as specified (see 6.2).

5.1.1 Level A. Type ZEP, style A and style B (2 to 6-inch diameter, inclusive) and type ZDM anodes shall be packaged in quantities specified in table II, unless otherwise specified (see 6.2), and snugly fitted into fiberboard boxes conforming to PPP-B-636, class water resistant. ZEP anodes shall be immobilized within the boxes with solid fiberboard or other suitable separators so that cast-in cores cannot be loosened by impact or heavy loading. The gross weight of the boxes shall not exceed the weight limitations of the fiber box specifications.

TABLE II. Anodes.

Anode	Number per package	Net weight per package (pounds)
Type ZEP, style A	5	45
Type ZEP, style B		
6-inch diameter	5	36
5-inch diameter	5	25
4-inch diameter	10	32
3-inch diameter	20	36
2-inch diameter	40	32
Type ZDM		
1-inch NPS	50	8
3/4-inch NPS	100	10
1/2-inch NPS	200	12
3/8-inch NPS	200	8

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5.1.2 Level C. The zinc anodes shall be preserved to afford protection against corrosion, deterioration and physical damage during shipment from the supply source to the first receiving activity for immediate use. Type ZEP anodes shall be packaged in such a manner that the cast-in cores cannot be loosened by impact or heavy loading. The contractor's normal retail or wholesale preservation methods may be utilized when such meets the requirements of this level.

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

5.2.1 Level A. Anodes, segregated for type and size, shall be packed in accordance with 5.2.1.1 through 5.2.1.4.

5.2.1.1 Types ZHS, ZHB, ZHC, ZTS, ZPN, ZSS, ZBP and ZEP (style B in sizes 9 and 11-inch diameter and style C) anodes shall be packed in unit pallet loads or in boxes in accordance with 5.2.1.1.1 and 5.2.1.1.2.

5.2.1.1.1 Pallets shall conform to MIL-P-15011. The anodes shall be secured to the pallet with tension tied, coated or galvanized, steel strapping applied lengthwise and girth-wise. Minimum size of the strapping shall be 3/4 by 0.035 inch. The gross weight of the pallet load shall not exceed 3,000 pounds.

5.2.1.1.2 The boxes shall conform to PPP-B-601 (overseas type) or PPP-B-621, class 2. The gross weight of the box shall not exceed approximately 500 pounds. Box closure and strapping shall be in accordance with the applicable box specification or appendix thereto. The boxes shall be modified by the addition of skids, for gross weights exceeding 200 pounds, in accordance with the applicable box specification.

5.2.1.2 Types ZEP, style A and style B in sizes 2 to 6-inch diameter inclusive, and ZDM anodes packaged as specified in 5.1.1 (see 6.2), shall be packed and snugly fitted into nailed wood or wood cleated plywood boxes conforming to PPP-B-621, class 2 or PPP-B-601 (overseas type), respectively. The gross weight of shipping containers shall not exceed approximately 200 pounds.

5.2.1.3 Type ZRN anodes shall be packed as specified in 5.2.1.1.2.

5.2.1.4 The anodes shall be cushioned, blocked and braced in accordance with MIL-STD-1186.

5.2.2 Level B. Anodes, segregated for type and size, shall be packed in accordance with 5.2.2.1 through 5.2.2.4.

5.2.2.1 Types ZHS, ZHB, ZHC, ZTS, ZPN, ZSS, ZBP and ZEP (style B in sizes 9 and 11-inch diameter and style C) anodes shall be packed in unit pallet loads or in boxes in accordance with the following.

5.2.2.1.1 Pallets shall be as specified in 5.2.1.1.1.

5.2.2.1.2 The boxes shall conform to PPP-B-621, class 1 or PPP-B-601 (domestic type). The gross weight of the box shall not exceed approximately 500 pounds. Box closure shall be in accordance with the applicable box specification or appendix thereto. The boxes shall be modified by the addition of skids, for gross weights exceeding 200 pounds, in accordance with the applicable box specification.

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5.2.2.2 Types ZEP, style A and style B in sizes 2 to 6-inch diameter inclusive, and ZDM anodes, packaged as specified in 5.1.1, (see 6.2) shall be packed and snugly fitted into nailed wood and wood-cleated plywood boxes conforming to PPP-B-621, class 1, or PPP-B-601 (domestic type), respectively. The gross weight of shipping containers shall not exceed approximately 200 pounds.

5.2.2.3 Type ZRN anodes shall be packed as specified in 5.2.1.3 except wood or wood-cleated containers shall be of the domestic type and for type 3 load in accordance with PPP-B-601.

5.2.2.4 The anodes shall be cushioned, blocked, and braced so as to prevent damage during shipment.

5.2.3 Level C. Zinc anodes that require overpacking for acceptance by the carrier shall be packed in exterior type shipping containers in a manner that will insure safe transportation at the lowest rate to the point of delivery. Containers and packing shall comply with Uniform Freight Classification Rules or National Motor Freight Classification Rules or other carrier rules as applicable to the mode of transportation.

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

6. NOTES

6.1 Intended use. The anodes are primarily intended for use in corrosion prevention in seawater of surface ship and submarine hulls, steel and aluminum equipment and structures, sea chests, sonar domes and the seawater side of condensers and other heat exchangers. The anodes may also be used for corrosion prevention of pipe lines and other installations underground. The use of a particular anode is determined by the nature and geometry of the structure to be protected. Refer to applicable installation instructions for types, amounts, locations, and mounting of anodes.

6.2 Ordering data. Acquisition documents should specify the following:

- (a) Title, number, and date of this specification.
- (b) Class and type (see 1.2).
- (c) Style of type ZEP, diameter of type ZEP, style B; diameter of type ZDM anode (see figure 1); pipe or bolt diameter of type ZRN required (see figure 12); length, width, and thickness of types ZHS (see figures 4 and 5); ZHC, ship or submarine usage with neoprene washers (see figures 6, 6A, 7 and 7A).
- (d) Thickness of type ZPN anode, whether 1/2 or 1 inch (see 3.3.2.1).
- (e) Level of packaging and packing required (see 5.1, 5.2, 5.2.1.2 and 5.2.2.2).
- (f) Number of anodes per package (see 5.1.1).
- (g) Special marking, if required (see 5.3).
- (h) Number of anodes required (see 6.3).

6.3 The order for anodes should specify the exact number of anodes required (see 6.2). Acquisition of anodes by weight is not practical and is not recommended.

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6.4 When material is ordered in the form of slabs, bars, discs, or rods, it is to be understood that these terms refer merely to the general form and dimensions of the material, and do not have any technical significance as to the methods of manufacture.

6.5 Sampling procedure.

6.5.1 Drilling procedure. The drilling for chemical analysis should be made with a special nonferrous drill in a clean location (used only for that purpose). The drilling bits should be kept clean of dirt, grit, and other foreign matter; kept properly sharpened; and used only for sampling purposes. After each use, the drilling bit should be immersed in a degreasing solvent and wiped dry with a clean rag. The drilling bits, when not in use, should be stored in an inhibited lubricating oil. The inhibited lubricating oil should be kept in a covered glass container provided with an air vent. The drilling bits should be wiped dry with a clean rag prior to use. Samples should be taken with a dry drill. If automatic power drilling equipment is available, a solid tungsten carbide or Tantung twist drill bit about 1/2 inch in diameter is suitable. Where a hand-held power drill is used, the samples should be taken by drilling with a solid tungsten carbide or Tantung twist drill bit about 1/4 inch in diameter. A smaller drill bit may be used where the size of the anode does not permit using the specified diameters. The drills may be used at high speeds and feeds.

6.5.2 Machining procedure. The chips for chemical analysis should be made with a special nonferrous tool in a place which has been cleaned for that specific purpose. Instructions specified in 6.5.1 apply to the use and care of this tool.

6.6 Sub-contracted material and parts. The preparation for delivery requirements of referenced documents listed in section 2 do not apply when material and parts are acquired by the contractor for incorporation into the equipment and lose their separate identity when the equipment is shipped.

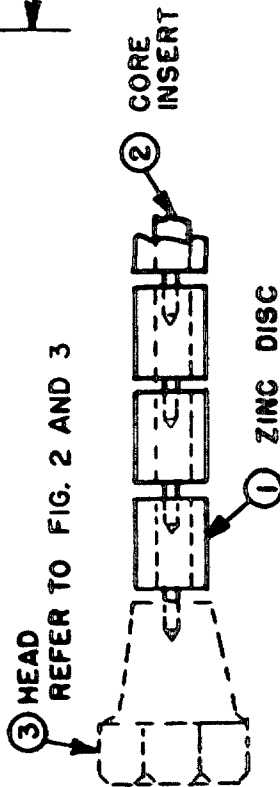
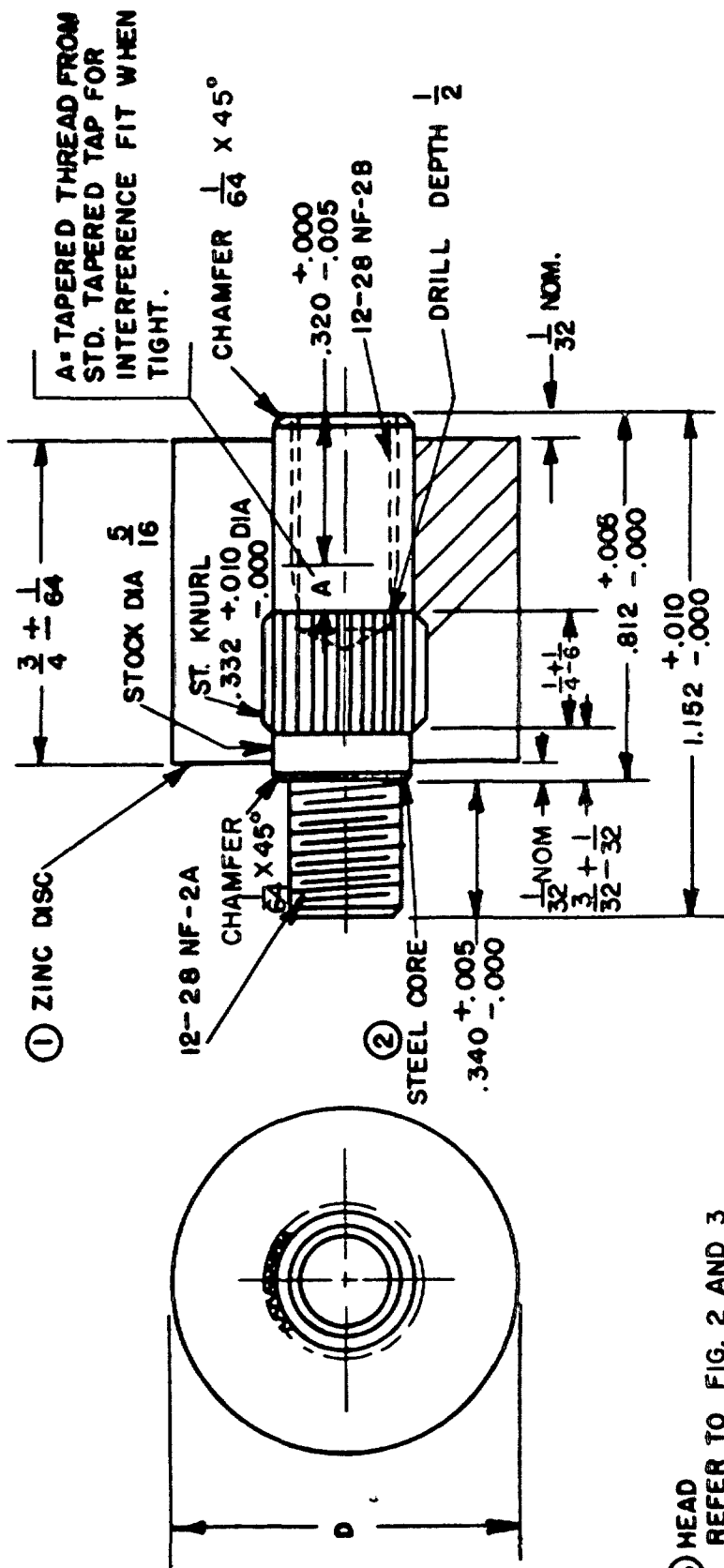
6.7 Changes from previous issue. Asterisks are not used in this revision to identify changes with respect to the previous issue, due to the extensiveness of the changes.

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

Preparing activity:
 Navy - SH
 (Project 5340-1512)

Review activities:
 Army - CE, AT
 Navy - YD
 DLA - IS

User activities:
 Army - ME
 Navy - OS



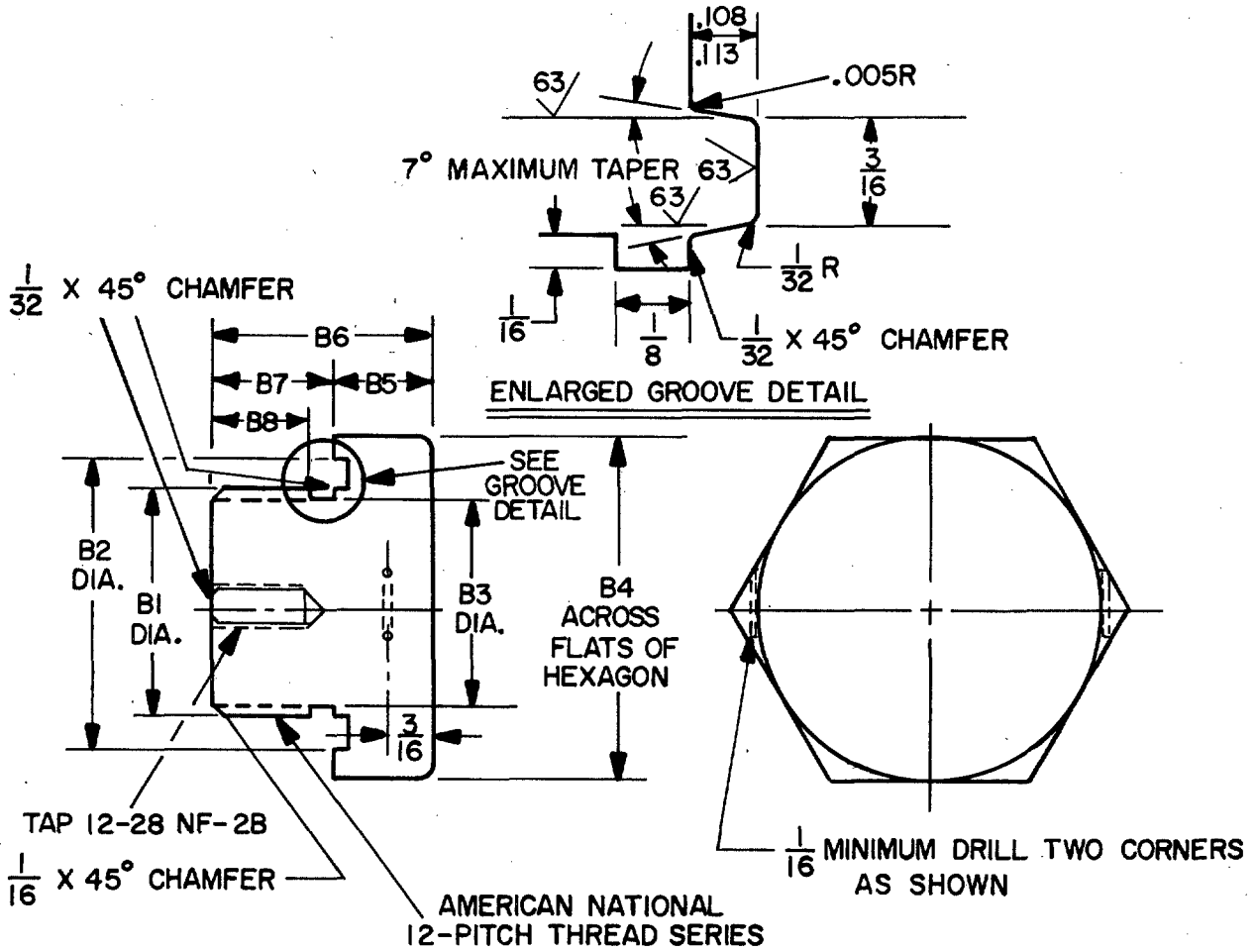
MULTIPLE ASSEMBLY OF
TYPE ZDM ANODES
SM4061A

HEAD SIZE I.P.S.	D=DIAM. INCHES	NUMBER PER PKG	NET WT. PER PKG
1	1.050	50	8
3/4	0.825	100	10
1/2	0.625	200	12
3/8	0.500	200	6

NOTE: All dimensions are in inches.

FIGURE 1. Zinc, segmented disc, machine-formed interlocking core, type ZDM.

MIL-A-18001J



SH 12339

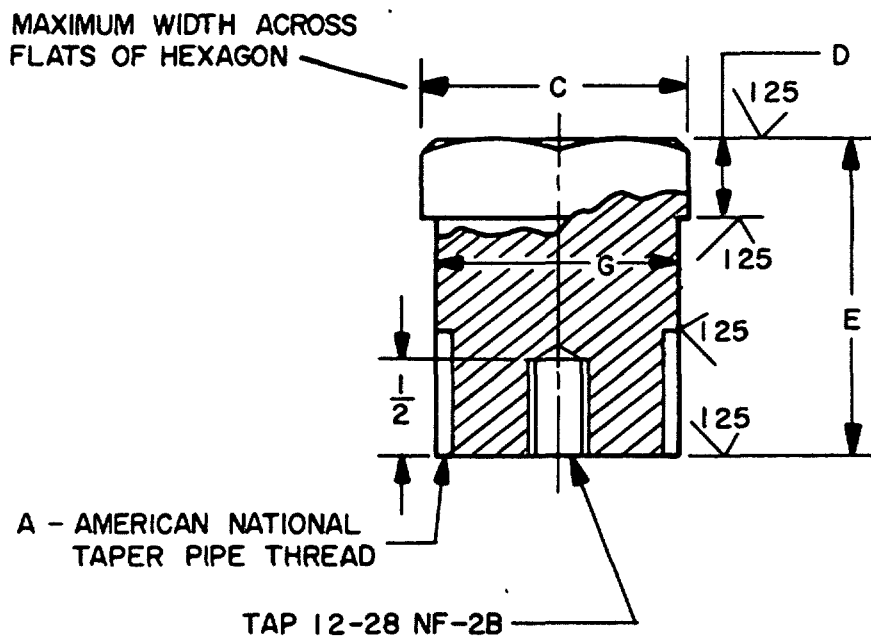
Zinc coupon	B1	B2	B3	B4	B5	B6	B7	B8
Diameter	External thread							
0.825	1-1/16- 12 UN-2	1-7/16	15/16	1-11/16	1/2	1-1/8	5/8	1/2
1.050	1-5/16- 12 UN-2	1-11/16	1-3/16	1-15/16	1/2	1-3/8	7/8	3/4

NOTES:

1. All fractional dimensions to have a tolerance of plus or minus 1/64 inch.
2. All dimensions are in inches.

FIGURE 2. Class A (straight thread O-ring seal) support plug for ZDM anode.

MIL-A-18001J



SH 12340

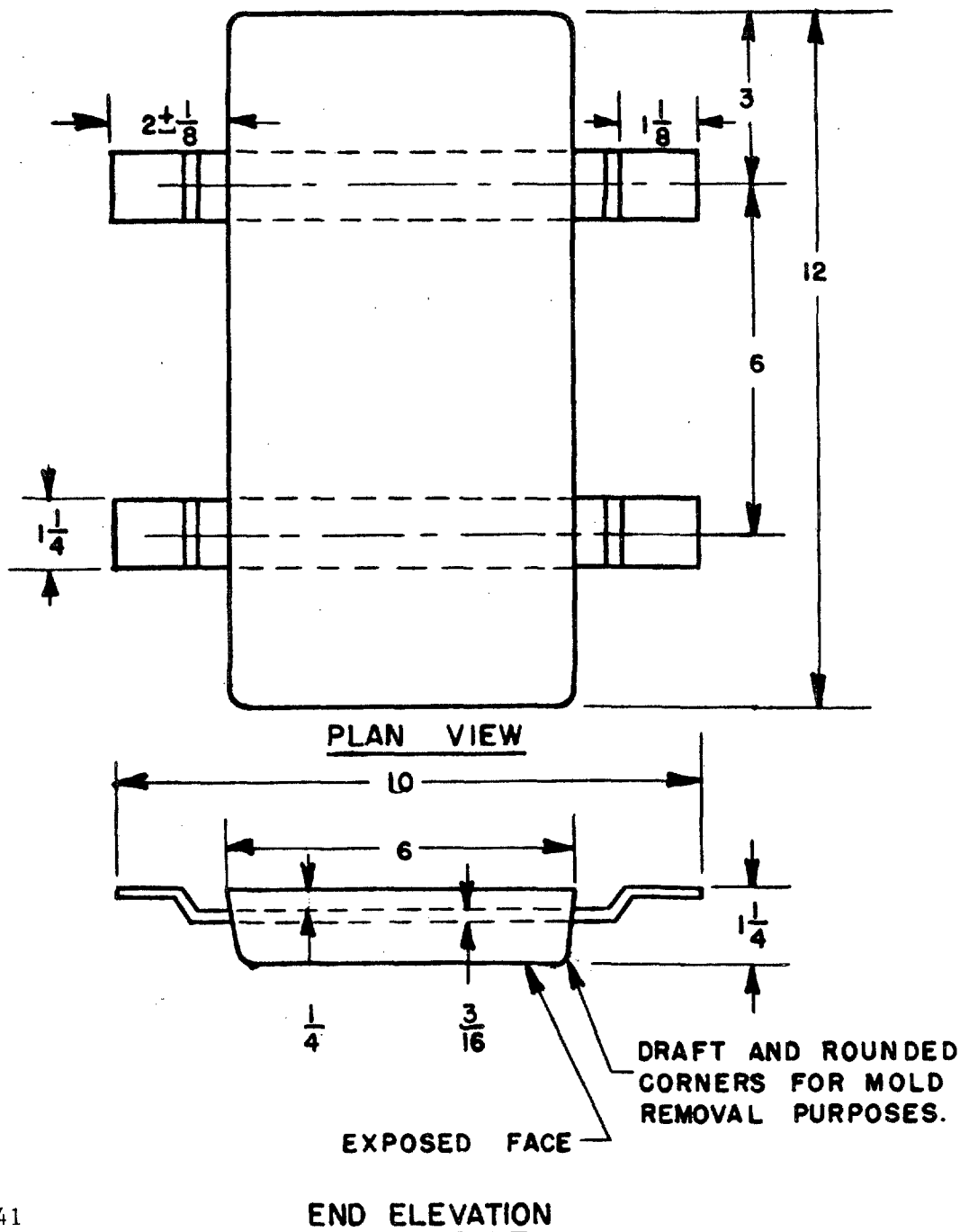
Nominal pipe size	A	C	D	E	G ±.003	Actual diameter of zinc anode
1	1	1-1/2	1/2	1-3/8	1.315	1.050
3/4	3/4	1-1/4	3/8	1-1/8	1.050	0.825
1/2	1/2	1	3/8	1	0.840	0.625
3/8	3/8	3/4	5/16	1	0.675	0.500

NOTES:

1. All fractional dimensions to have a tolerance of plus or minus 1/64 inch.
2. All dimensions are in inches.

FIGURE 3. Class B (tapered pipe thread) support plug for ZDM anode.
(Replacement use only, not for new construction.)

MIL-A-18001J



SH 12341

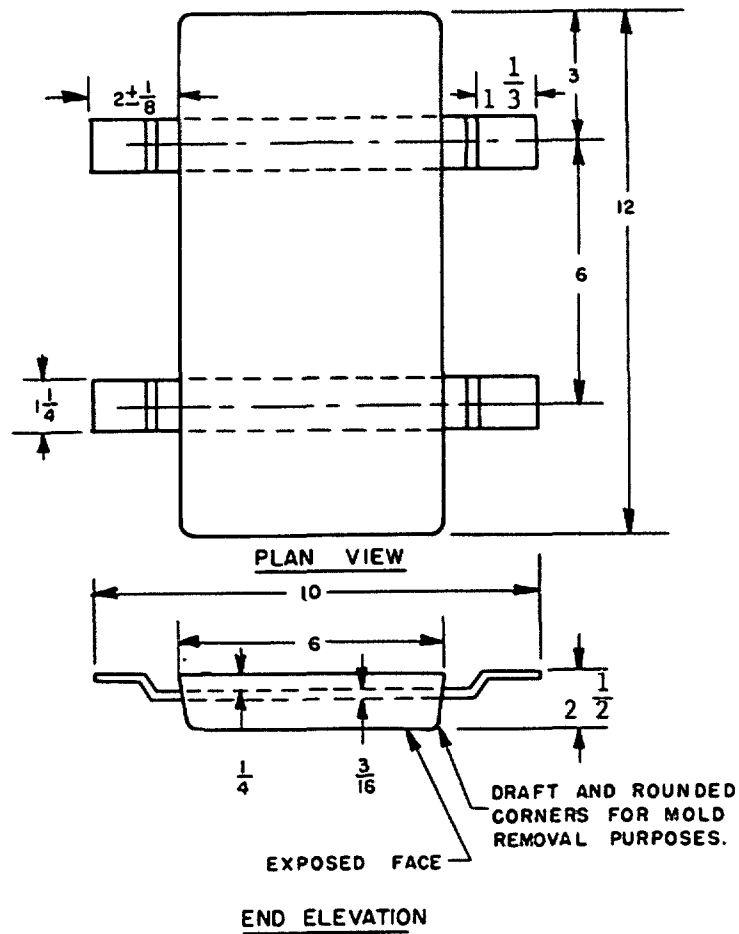
Minimum weight 21.5 pounds.

NOTES:

1. Anode may be cast with strap in the up or down position. All dimensions (inches) refer to the wider and longer edges of the anodes.
2. Tolerance plus or minus 1/8.

FIGURE 4. Zinc hull slab (steel straps), type ZHS-23;
zinc hull slab (brass straps), type ZHB.

MIL-A-18001J



SH 12342

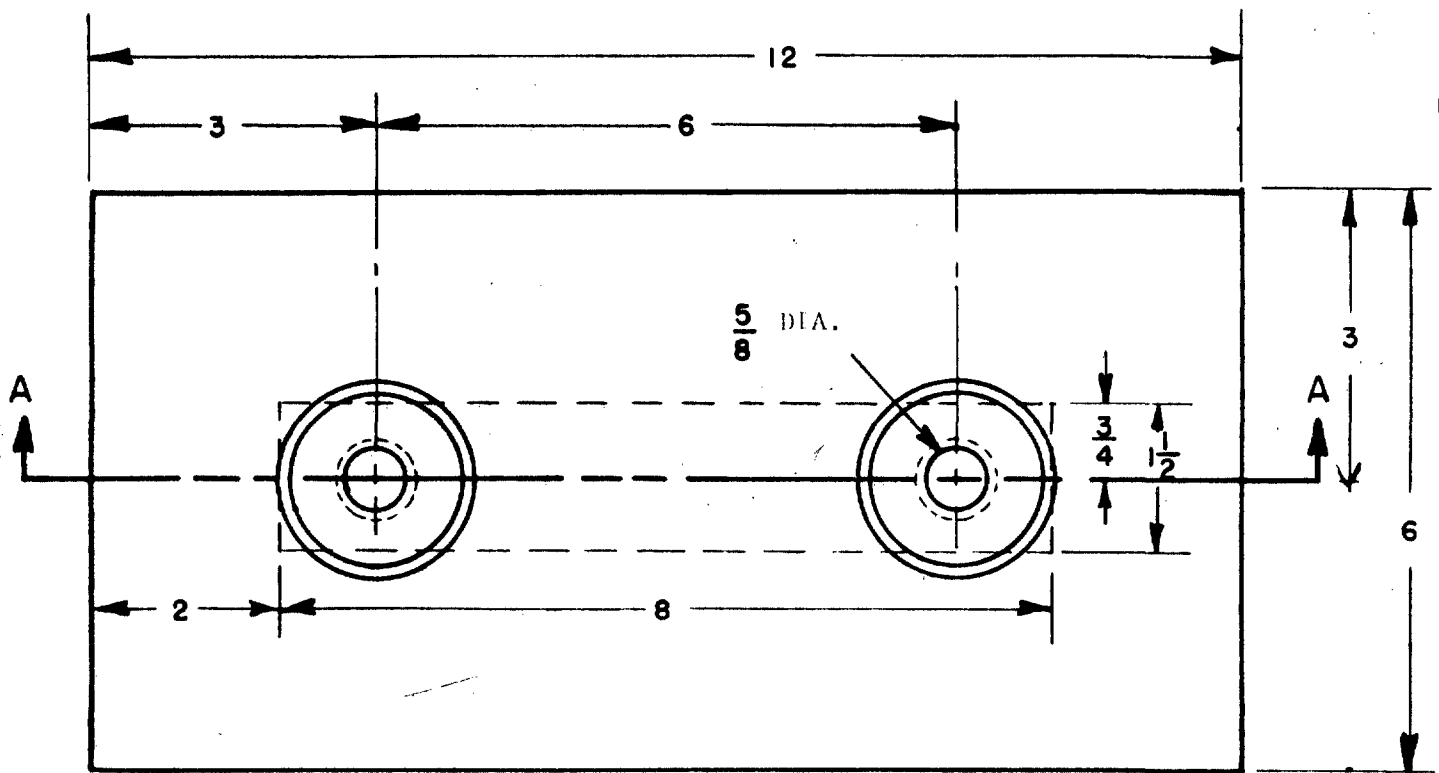
Minimum weight 41 pounds.

NOTES:

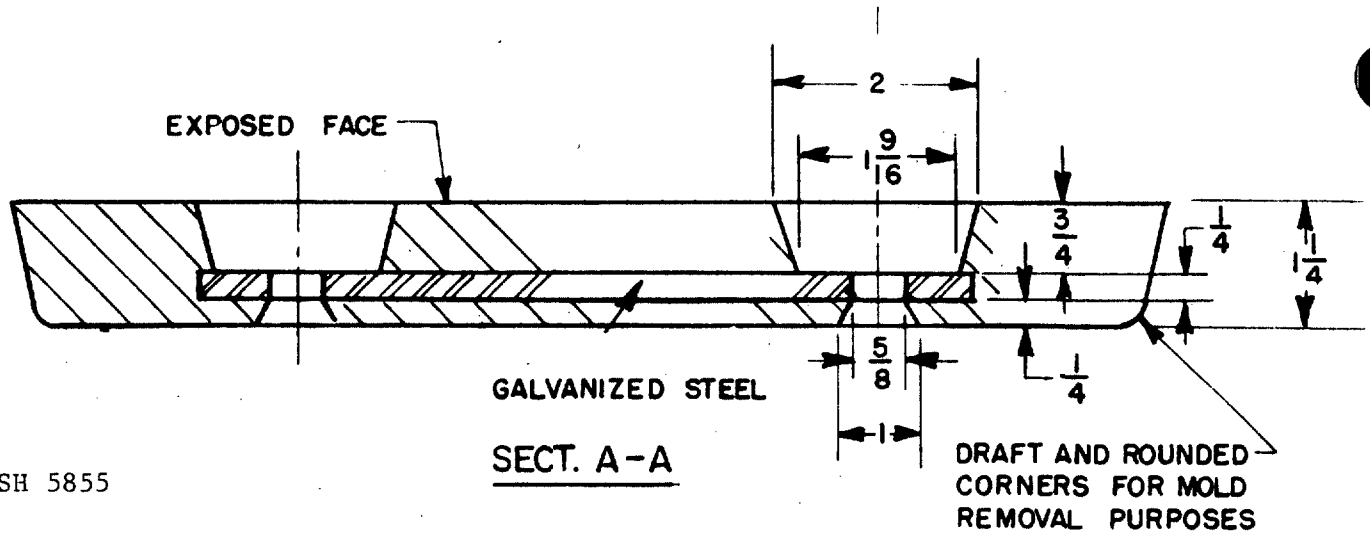
1. Anode may be cast with strap in the up or down position. All dimensions (inches) refer to the wider and longer edges of the anodes.
2. Tolerance plus or minus $1/8$.

FIGURE 5. Zinc hull slab (steel straps), type ZHS-42.

MIL-A-18001J



PLAN VIEW



GALVANIZED STEEL

SECT. A-A

DRAFT AND ROUNDED
CORNERS FOR MOLD
REMOVAL PURPOSES

SH 5855

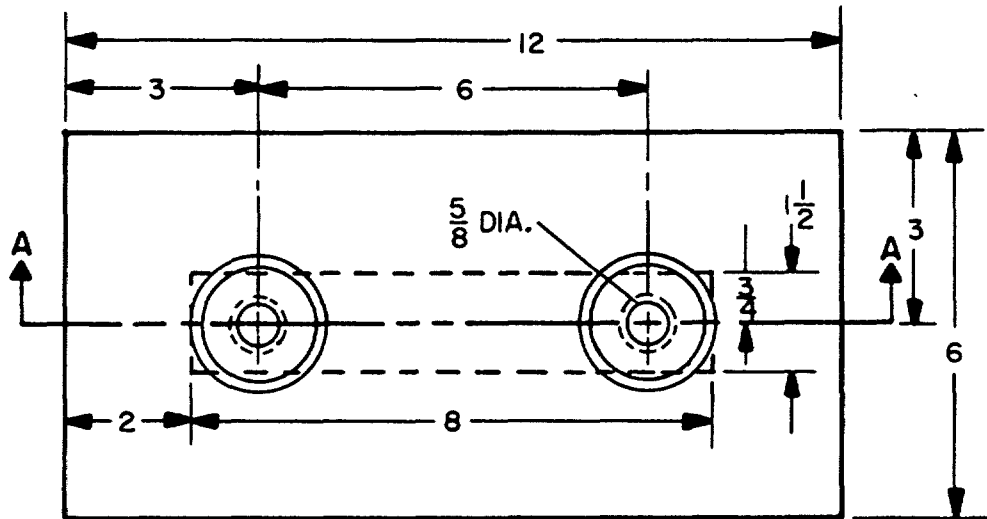
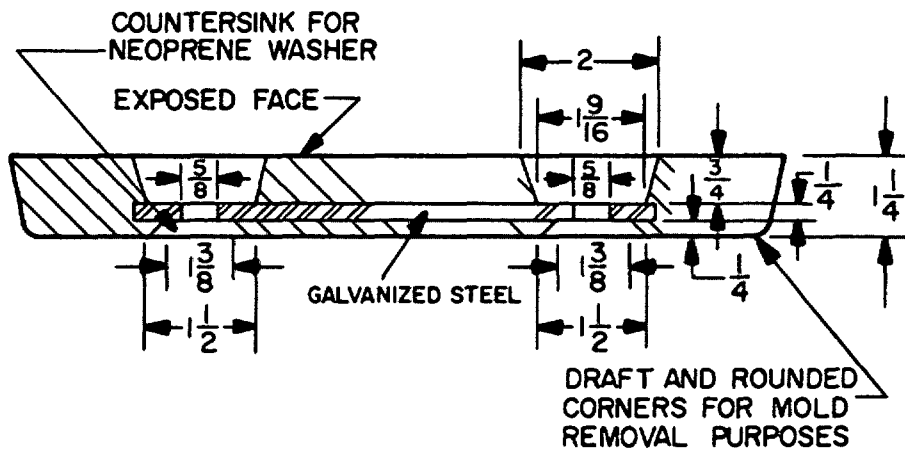
Minimum weight 21.5 pounds.

NOTES:

1. Anode may be cast with exposed face in the up or down position.
All dimensions are in inches.
2. Tolerance plus or minus 1/8.

FIGURE 6. Zinc hull slab (core strap), type ZHC-23.

MIL-A-18001J

PLAN VIEWSECTION A-A

SH 12344

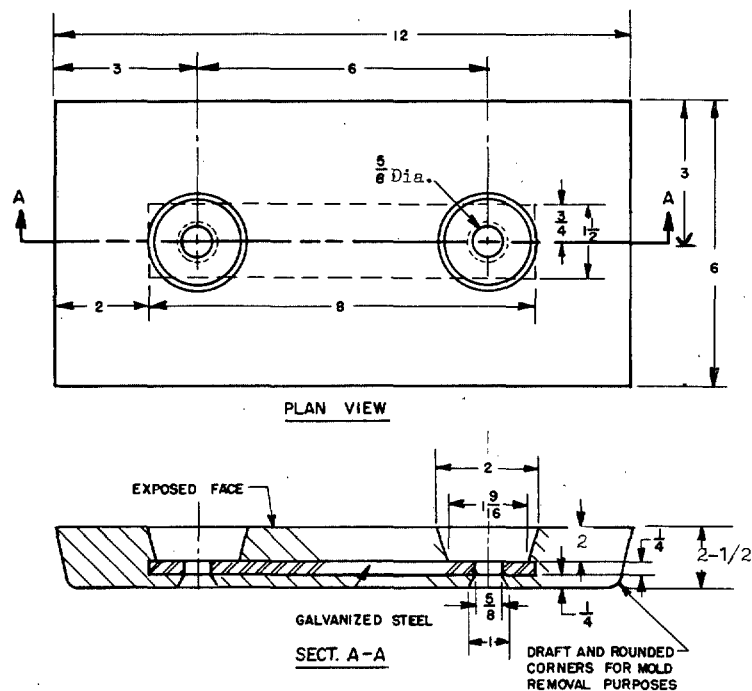
Minimum weight 21.5 pounds.

NOTES:

1. Anode may be cast with exposed face in the up or down position.
All dimensions are in inches.
2. Tolerance plus or minus $\frac{1}{8}$.

FIGURE 6A. Zinc hull slab (core strap), type ZHC-23, submarine application.

MIL-A-18001J



SH 12345

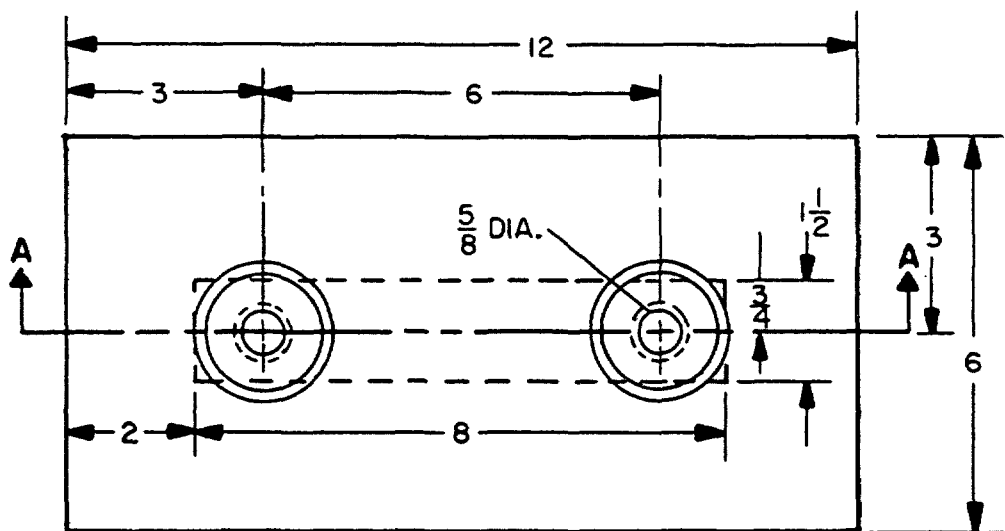
Minimum weight 39 pounds.

NOTES:

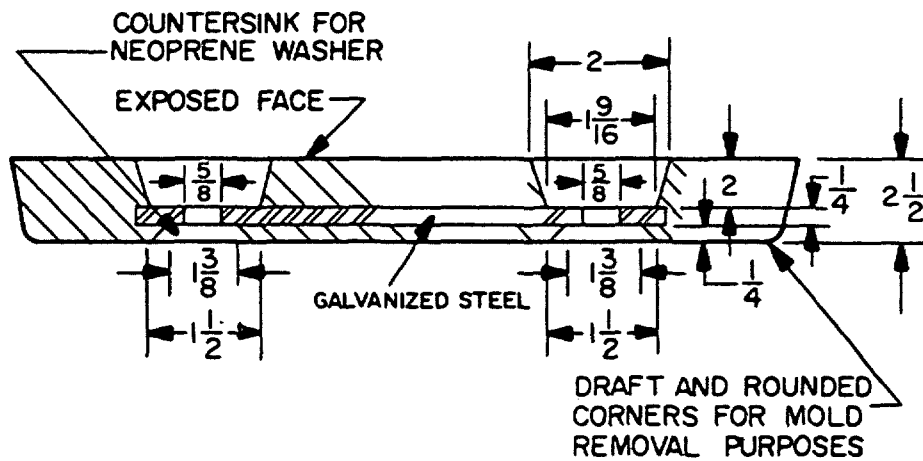
1. Anode may be cast with exposed face in the up or down position.
All dimensions are in inches.
2. Tolerance plus or minus 1/8.

FIGURE 7. Zinc hull slab (core strap), type ZHC-42.

MIL-A-18001J



PLAN VIEW

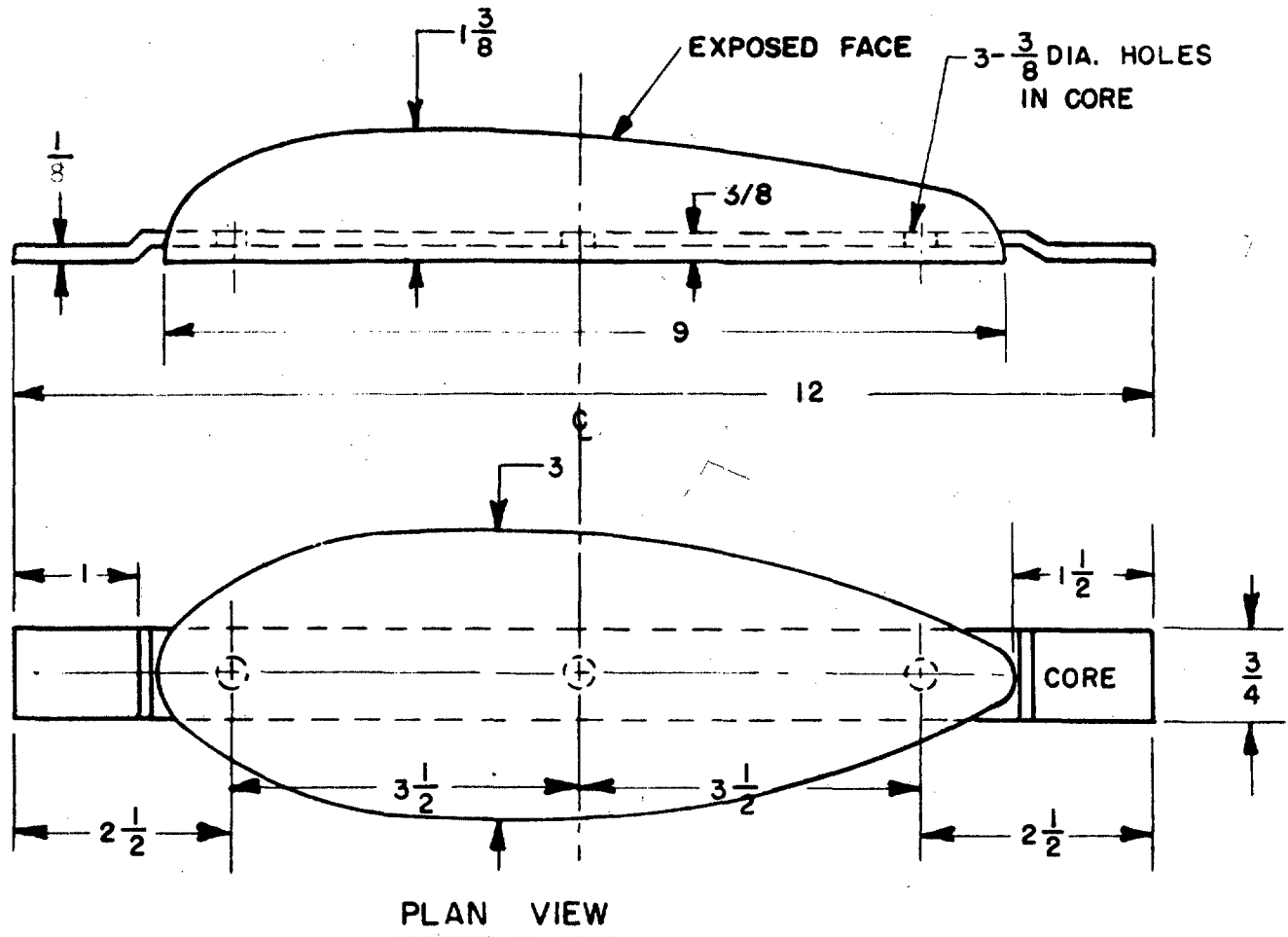


SECTION A-A

SH 12346

FIGURE 7A. Zinc hull slab (core strap), type ZHC-42, submarine application.

MIL-A-18001J



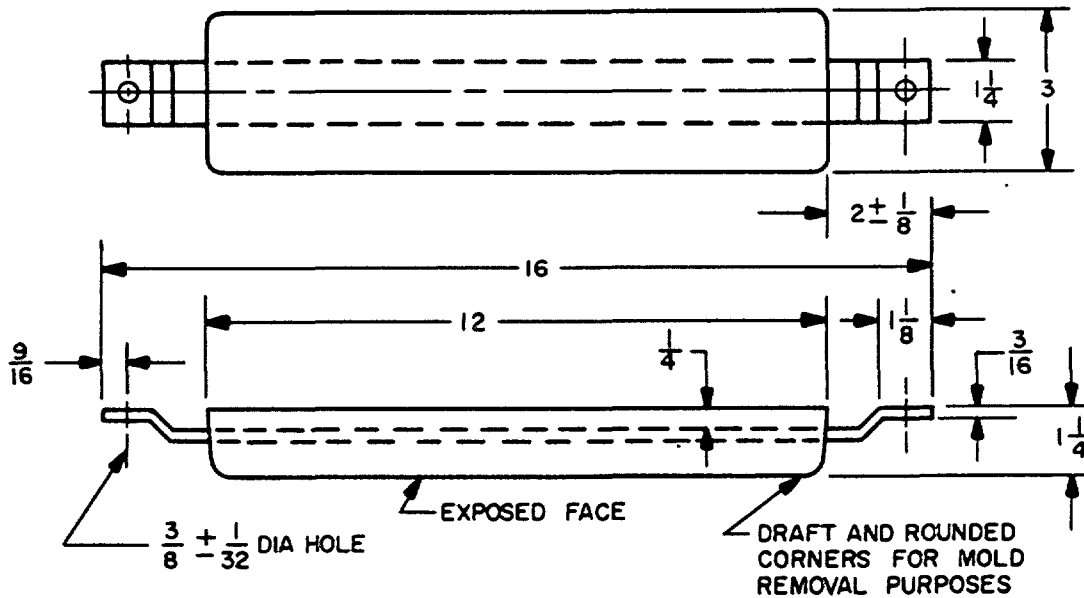
APPROX. WT. 5 LBS.
SH 5856

NOTES:

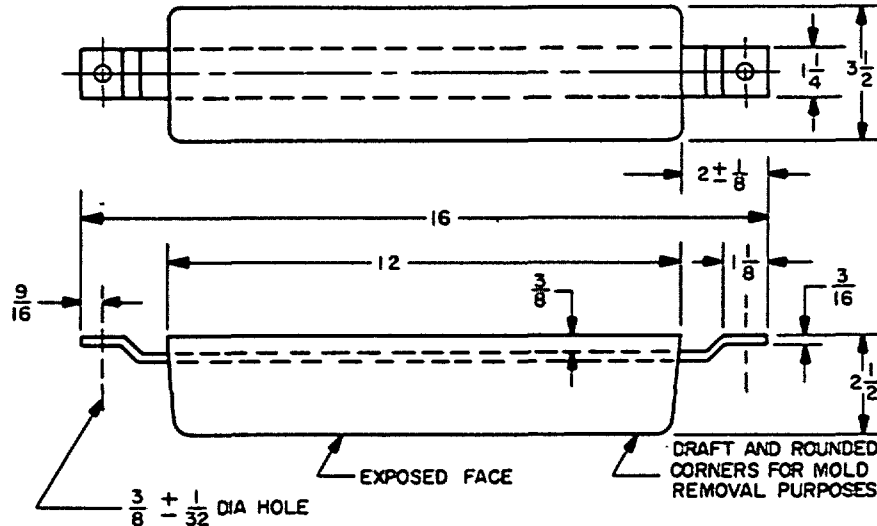
1. Anode may be cast with exposed face in the up or down position.
All dimensions are in inches.
2. Tolerance plus or minus $\frac{1}{8}$.

FIGURE 8. Zinc, teardrop (steel strap), type ZTS.

MIL-A-18001J



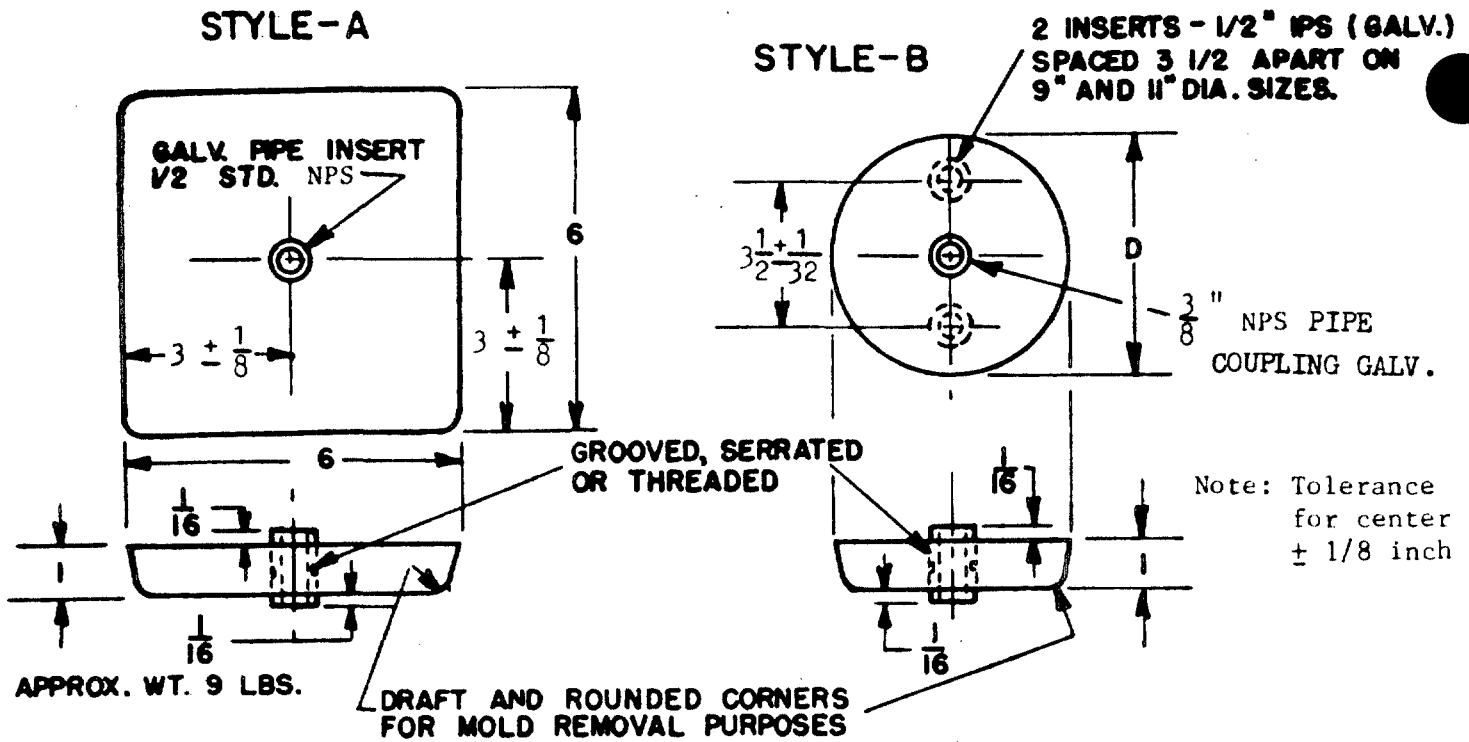
(a) Zinc, submarine slab (steel strap), type ZSS-12.



(b) Zinc, submarine slab (steel strap), type ZSS-24.

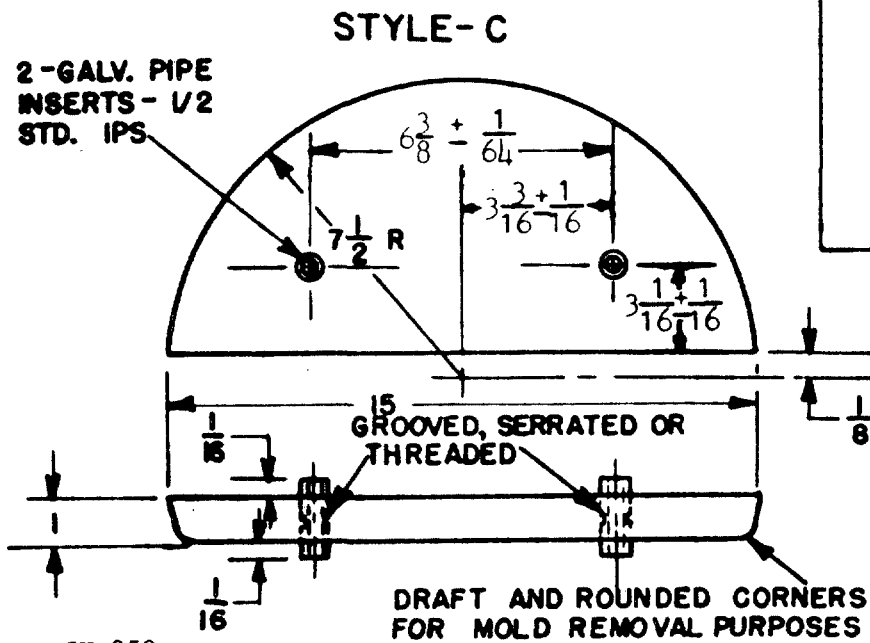
FIGURE 9. Zinc, submarine slab (steel strap).

MIL-A-18001J



Style B

D = Diameter in inches $\pm 1/8$	Weight (pounds)	Surface area (in ²)
11	24	130
9	16	92
6	7.1	47
5	4.9	36
4	3.19	26
3	1.78	16
2	0.79	9



Style A - Square slab
Style B - Circular slab
Style C - Semi-circular slab

SH 959

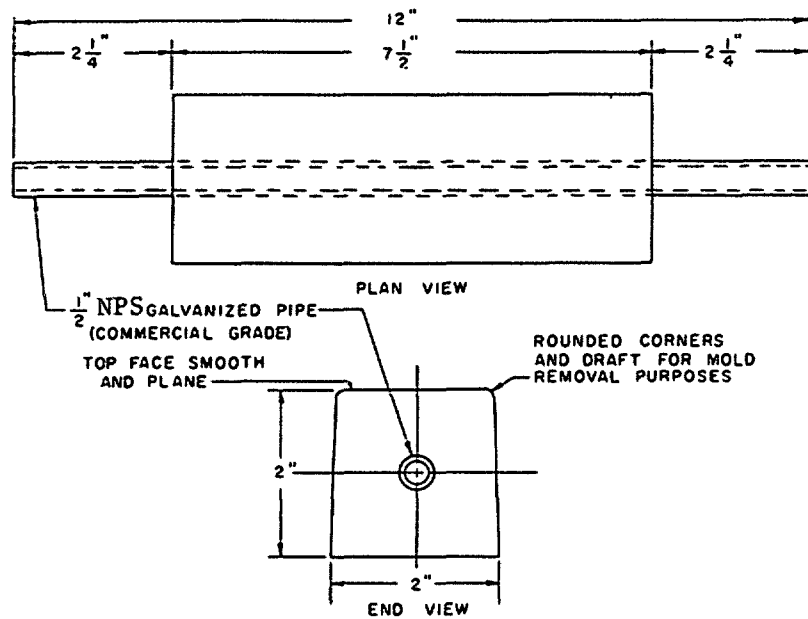
Approximate weight 23 pounds.

NOTES:

1. All dimensions are in inches.
2. Tolerance other than as shown will be plus or minus 1/8.

FIGURE 10. ZEP heat exchanger slab.

MIL-A-18001J



SH 964

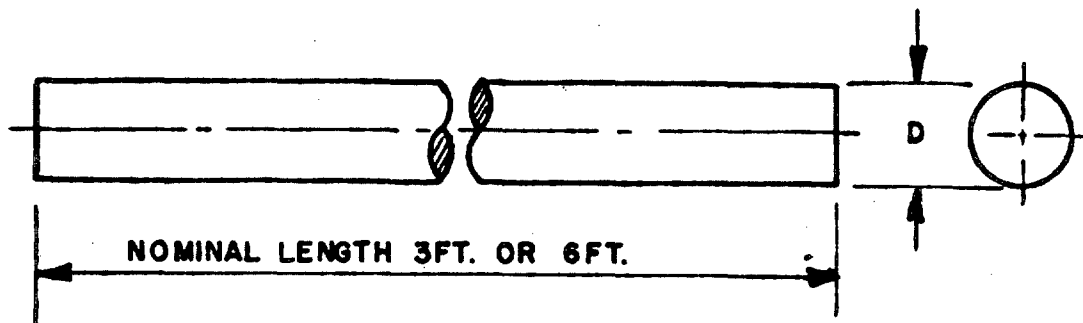
Approximate weight 8 pounds
unit of purchase - pound
unit of issue - each

NOTES:

1. All dimensions (inches) refer to the wider and longer dimensions of the anode.
2. Tolerance plus or minus 1/8.

FIGURE 11. Zinc, bar (pipe core), type ZBP.

MIL-A-18001J



SH 962A

D = Diameter in inches (nominal)	Iron pipe size (inches)	Approximate weight per foot (pounds)
0.405	1/8	0.39
0.540	1/4	0.70
0.675	3/8	1.11
0.840	1/2	1.68
1.050	3/4	2.52
1.315	1	4.12

FIGURE 12. Zinc, rod (no core), type ZRN.

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL*(See Instructions - Reverse Side)*1. DOCUMENT NUMBER
MIL-A-18001J2. DOCUMENT TITLE
ANODES, CORROSION PREVENTIVE, ZINC; SLAB DISC AND ROD SHAPED

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)*CUT ALONG THIS LINE.
(TO DETACH THIS LINE.)