

INCH-POUND

MIL-A-18001K

16 December 1991

SUPERSEDING

MIL-A-18001J

25 November 1983

(See 6.8)

MILITARY SPECIFICATION

ANODES, SACRIFICIAL ZINC ALLOY

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 anode design and fabrication such as cast-in cores for mounting purposes. The material described by this specification contains elements for which the Occupational Safety and Health Administration (OSHA) has set standards for exposure limits. Handling, storage, and application of this material should be in accordance with the most recent Code of Federal Regulations Title 29, Part 1910 and 1915 and any other safety and health regulations (local or otherwise) which may apply.

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).

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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Type ZBP - Zinc, bar (pipe core) (8 pound size).

Type ZDM - Zinc, segmented disc (machine formed interlocking core) (various sizes).

Type ZMP - Zinc, mooring chain (pipe core or pipe bushing core) (various sizes).

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	{ <ul style="list-style-type: none"> H - (hull slab) S - (submarine slab) T - (teardrop shape) E - (heat exchanger slab) R - (rod, cylindrical) P - (plate) B - (bar, square) D - (disc, segmented) M - (mooring chain) }	Designates shape or general use
Third letter	{ <ul style="list-style-type: none"> B - (brass straps) S - (steel strap) C - (core, strap) P - (pipe core) M - (machine formed interlocking core) N - (no core) }	Designates core

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

FEDERAL

- NN-P-71 - Pallets, Material Handling, Wood, Stringer Construction, 2-Way and 4-Way (Partial).
- QQ-B-639 - Brass, Naval: Flat Products (Plate, Bar, Sheet, and Strip).

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FEDERAL - Continued

- QQ-B-750 - Bronze, Phosphor; Bar, Plate, Rod, Sheet, Strip, Flat Wire, and Structural and Special Shaped Sections.
- PPP-B-26 - Bag, Plastic, General Purpose.
- PPP-B-601 - Boxes, Wood, Cleated-Plywood.
- PPP-B-621 - Boxes, Wood, Nailed and Lock-Corner.
- PPP-B-636 - Boxes, Shipping, Fiberboard.
- PPP-D-705 - Drum, Shipping and Storage: Steel, 16 and 30 Gallon Capacity.
- PPP-F-320 - Fiberboard: Corrugated and Solid, Sheet Stock (Container Grade) and Cut Shapes.

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- MIL-P-15011 - Pallets, Material Handling, Wood Post Construction, 4-Way Entry.
- MIL-L-19140 - Lumber and Plywood, Fire-Retardant Treated.

STANDARDS

FEDERAL

- FED-STD-H28 - Screw-Thread Standards for Federal Services.
- FED-STD-H28/7 - Screw-Thread Standards for Federal Services Section 7 Pipe Threads, General Purpose.

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

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Navy Publishing and Printing Service Office, BLDG 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- A 36 - Standard Specification for Structural Steel. (DOD adopted)
- A 53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless. (DOD adopted)
- A 513 - Standard Specification for Electric Resistance-Welded Carbon and Alloy Steel Mechanical Tubing. (DOD adopted)
- D 3951 - Standard Practice for Commercial Packaging. (DOD adopted)
- E 290 - Standard Test Method for Semi-Guided Bend Test for Ductility of Metallic Materials. (DOD adopted)

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E 536 - Standard Test Method for Chemical Analysis of Zinc and Zinc Alloys.

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

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

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

3. REQUIREMENTS

3.1 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.

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

Lead (max)	Iron (max)	Cadmium range	Copper (max)	Aluminum range	Zinc (min)
Percent	Percent	Percent	Percent	Percent	Percent
0.006	0.005	0.025-0.07	0.005	0.1-0.5	99.314

3.1.2 Steel straps and pipe cores. Types ZHS, ZHC, ZSS and ZTS anodes shall have steel strap cores conforming to ASTM A 36. Types ZEP and ZBP anodes shall have steel pipe cores conforming to ASTM A 53. Type ZMP anodes shall have steel pipe cores conforming to ASTM A 53 or A 513. 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 or fabricated anodes.

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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 brass or bronze straps shall be coated with zinc to a minimum thickness of 0.0005 inch. Lack of adhesion of the zinc coating at bend or absence of zinc coating at cut edges will not be cause for rejection of fabricated anodes. Cracks in the base metal shall be cause for rejection. 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 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.

3.1.5 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.

3.1.6 OSHA standards. The material described by this specification contains elements for which the Occupational Safety and Health Administration (OSHA) has set standards for exposure limits. Handling, storage, and application of this material should be in accordance with the most recent Code of Federal Regulations Title 29, Part 1910 and 1915 and any other safety and health regulations (local or otherwise) which may apply.

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. . 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.

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3.2.2 Type ZEP heat exchanger slab anode and type ZMP mooring chain anode (see figures 10 and 13). Type ZEP and ZMP 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 3.1.2. 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 figures 10 and 13.

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 3.1.2 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 4.4.2 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.

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 Core insert. The machine formed core insert specified in 3.1.4 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, ZRN and ZMP. The specified anodes shall conform to the dimensions shown on figures 1 to 13, 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. Thickness of type ZPN anode shall be either 1/2 or 1 inch, as specified (see 6.2).

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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 (20.4), 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. Dimensions shall be in accordance with figures 1 through 13.

3.4.1 Length and width of types ZHS, ZHB, ZHC, ZTS, ZPN, ZSS and ZBP anodes. The width and length of the zinc alloy on 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.

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. Except for ZEP anodes, 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. ZEP thickness measurements shall be taken at random, a distance from the edge of approximately one-half the radius of the anode. 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.

3.4.6 Stud hole elongation for type ZSS anodes. If specified (see 6.2), ZSS straps may be provided and modified as shown on figure 9A.

3.5 Marking of anodes.

3.5.1 Prohibition of painting. The zinc anodes, types ZHS, ZHB, ZHC, ZSS, ZBP and ZMP shall have the words, "DO NOT PAINT" die-stamped or cast on the exposed face of the anodes (see figures 4, 5, 7, 9, 11 and 13). No marking shall be required for types ZEP, ZPN, ZDM, ZTS and ZRN zinc anodes. For type ZMP, the nominal anode size shall be marked as specified on figure 13.

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3.5.1.1 Type ZHB anode markings. 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 Heat identification. Each anode shall be cast or die-stamped with the following: manufactures symbol, unique non-recurring heat number, and capital letter corresponding to the revision letter of the military specification to which the anode conforms. (For this specification issue, the letter "K" should be used.)

3.6 Mechanical properties.

3.6.1 Fracture or cracking. When tested in accordance with 4.4.4.1, type ZRN rods and ZPN plates shall not fracture or show signs of cracking.

3.6.2 Torsional shear strength. When tested in accordance with 4.4.4.2, 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. For the specific case of surface cracks, good commercial practice shall mean no visible surface cracks. 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.

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 (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection

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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 ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items shall 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 ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of the manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.2 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, poured or cast from one homogeneous heat or melt of a single charge of raw materials. The addition of any material to the heat or melt at any time constitutes a new lot.

4.2.2 Sampling for visual and dimensional examination. As a minimum, the contractor shall select a sample quantity of anodes from each lot in accordance with table II and inspect them in accordance with 4.3. If one or more defects are found in any sample, the entire lot shall be rejected. The contractor has the option of screening 100 percent of the rejected lot for the defective characteristic(s) or providing a new lot which shall be inspected in accordance with the sampling plan provided herein.

TABLE II. Sampling for visual and dimensional examination.

Lot size	Sample size	Accept	Reject ^{1/}
2 - 25	3	0	1
26 - 50	5	0	1
51 - 90	6	0	1
91 - 150	7	0	1
151 - 280	10	0	1
281 - 500	11	0	1
501 - 1200	15	0	1
1201 - 3200	18	0	1
3201 - 10,000	22	0	1
10,000 - over	29	0	1

^{1/} Rejected lots may be screened by the contractor and twice the sample size resubmitted for acceptance inspection and tested with same accept/reject criteria. All defective items must be replaced with acceptable items prior to lot acceptance. Resubmitted lots that fail retest shall be rejected.

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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, ZMP, and ZBP and five anode discs of type ZDM for the test specified in 4.4.2.

4.2.4 Sampling for chemical analysis. Anodes shall be taken from each homogenous lot to verify compliance with the chemical requirements of 3.1.1 and table I. As a minimum, the first, middle, and last poured anode shall be tested to verify compliance with the chemical requirements of 3.1.1 and table I. Failure to meet the requirements of 3.1.1 shall be cause for the rejection of the anode and the lot from which the failed anode originated. The drilling for chemical analysis shall be made with a special nonferrous drill bit. See 4.2.4.6, 6.5.1 and 6.5.2 for sample preparation and drilling procedure. 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. Chemical test records shall be retained to verify test results, for a minimum of 5 years.

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

4.2.4.3 Drilling points for types ZEP, ZMP, and ZBP. Type ZEP, ZMP, 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 Types ZRN and ZDM samples. 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. 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 larger 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. 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.

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4.2.5 Sampling for physical testing. At least five type ZRN and five type ZPN anodes shall be selected at random from a lot. Type ZRN anodes shall conform to the tests specified in 4.4.4. Type ZPN anodes shall conform to the test specified in 4.4.4.1.

4.2.5.1 Physical test sample dimensions for ZPN type anodes. ZPN test samples shall be cut from the plate anodes and shall be of the following dimensions:

Width: Twice the thickness of the anode.

Length: 12 inches (or to suit test apparatus).

4.3 Visual and dimensional examination. Each anode selected in accordance with 4.2.2 shall be examined for conformance to requirements of 3.3 through 3.7. If any number of anodes do not conform to 3.3 through 3.7 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 on each anode selected in accordance with 4.2.3.

4.4.2.1 Core bonding tests (types ZHS, ZHB, ZHC, ZSS, ZTS, ZMP, 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. At least 30 percent of this interface shall show no separation when examined at approximately 10X magnification. 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.

4.4.2.2 Alternate core bonding test (types ZHS, ZHB, ZHC, ZSS, ZTS, ZMP, 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.

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4.4.2.3 Type ZDM anode. A minimum 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. Sample anodes shall be discarded and not included in the delivery of material after the core bond tests are performed. The remaining lengths of ZRN and ZPN anodes may be included in the delivery of material after the physical tests of 4.4.4. 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, inductively coupled plasma, or directly coupled plasma spectrophotometers.

4.4.3.2 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 E 536 and accepted by the Government.

4.4.4 Physical tests.

4.4.4.1 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. Type ZPN anodes, selected in accordance with 4.2.5, shall be bent 45 degrees around a mandrel that has the diameter of three times the thickness of ZPN anodes. 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 by visual examination. Any evidence of cracking shall represent failure of the test and shall be cause for rejection of the entire lot.

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

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5. PACKAGING

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

5.1 General.5.1.1 Navy fire-retardant requirements.

- (a) Treated lumber and plywood. When specified (see 6.2), all lumber and plywood including laminated veneer material used in shipping containers and pallet construction members, blocking, bracing, and reinforcing shall be fire-retardant treated material conforming to MIL-L-19140 as follows:

Levels A and B - Type II - weather resistant.
Category 1 - general use.
Level C - Type I - non-weather resistant.
Category 1 - general use.

- (b) Fiberboard. Fiberboard used in the construction of interior (unit and intermediate) and exterior fiberboard boxes including interior packaging forms shall conform to the class domestic/fire retardant or class-weather/resistant/fire retardant materials requirements as specified (see 6.2), of PPP-F-320 and amendments thereto.

5.1.2 Cushioning, blocking and bracing. The anodes shall be cushioned, blocked and braced as applicable to prevent damage to packaged contents and packs during shipment, handling and storage.

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

5.2.1 Level A. Unless otherwise specified (see 6.2), type ZEP, style A and style B (2 to 6-inch diameter, inclusive) and type ZDM anodes shall be unit packed in quantities specified in table III, and snugly fitted into fiberboard boxes conforming to PPP-B-636, class-weather-resistant/fire retardant with type, variety, grade and style of the box at the supplier's option. Box closure shall be in accordance with method V of PPP-B-636. ZEP anodes shall be immobilized within the boxes with fiberboard of the same material as the box or other suitable separators so that cast-in cores cannot be loosened by impact or heavy loading.

5.2.2 Level C. Preservation shall be as specified under level A except that the fiberboard box shall be of the class-domestic/fire-retardant (see 5.1.1(b)). Box closure shall be in accordance with method I using pressure-sensitive adhesive tape in accordance with PPP-B-636.

5.2.3 Commercial. Commercial packaging (preservation and unit pack) shall be in accordance with ASTM D 3951.

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TABLE III. Anodes.

Anode	Quantity per unit package	Net weight per unit pack (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

5.3 Packing. Packing shall be level A, B or commercial, as specified (see 6.2).

5.3.1 Level A. Anodes, segregated for type, size and heat, shall be packed in accordance with 5.3.1.1 through 5.3.1.4.

5.3.1.1 Types ZHS, ZHB, ZHC, ZTS, ZPN, ZSS, ZBP, and ZEP (style B in sizes 9 and 11-inch diameter and style C) anodes. Anodes shall be packed in unit pallet loads or in boxes in accordance with 5.3.1.1.1 and 5.3.1.1.2.

5.3.1.1.1 Pallets. Pallets shall conform to MIL-P-15011 or NN-P-71, type IV. 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.

5.3.1.1.2 Boxes. The boxes shall conform to PPP-B-601 (overseas type) or PPP-B-621, class 2 with type, style and grade at the supplier's option. The gross weight of the box shall not exceed 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.

5.3.1.2 Types ZEP, style A and style B in sizes 2 to 6-inch diameter inclusive, and ZDM anodes. Anodes unit packed as specified in 5.2.1, shall be packed and snugly fitted into nailed wood or wood cleated plywood boxes as specified in 5.3.1.1.2.

5.3.1.3 Type ZRN anodes. Anodes shall be packed as specified in 5.3.1.1.2.

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5.3.1.4 Type ZMP anodes. Type ZMP anodes shall be bulk packed in metal drums conforming to PPP-D-705 and unless otherwise specified (see 6.2), type IV or V at the contractors option. The gross weight of each packed drum shall not exceed 1000 pounds.

5.3.2 Level B. Anodes, segregated for type, size and heat, shall be packed in accordance with 5.3.2.1 through 5.3.2.3.

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

5.3.2.1.1 Pallets. Pallets in accordance with 5.3.1.1.1.

5.3.2.1.2 Boxes. Boxes in accordance with 5.3.1.1.2 except boxes shall be of the domestic type or class.

5.3.2.2 Types ZEP, style A and style B in sizes 2 to 6-inch diameter inclusive, and ZDM anodes. Anodes unit packed as specified in 5.2.1 shall be packed and snugly fitted into wood or wood-cleated plywood boxes as specified in 5.3.1.1.2, except boxes shall be of the domestic type or class.

5.3.2.3 Type ZMP anodes. Type ZMP anodes shall be packed as specified in 5.3.1.4.

5.3.2.4 Type ZRN anodes. Anodes shall be packed as specified in 5.3.1.1.2 except that the containers shall be of the domestic type class.

5.3.3 Commercial. Commercial packing of anodes shall be in accordance with ASTM D 3951.

5.4 Marking. In addition to any special marking required (see 6.2), and herein, levels A, B and C (preservation) and levels A and B (packing) shall be marked in accordance with MIL-STD-129 including bar code markings. Commercial (preservation and packing) packs shall be marked in accordance with ASTM D 3951 including bar coding.

5.4.1 Special markings. ZMP anode packs shall contain the following markings:

"U.S. Navy Fleet Mooring Cathodic Protection Materials: Anodes for (chain size)-inch stud link chain."

"Anode Quantity (Insert Quantity)."

These markings shall appear on the side or top of drum in 1-inch high letters.

6. NOTES

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

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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, mooring chains, 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 Acquisition requirements. Acquisition documents must specify the following:

- (a) Title, number, and date of this specification.
- (b) Class and type (see 1.2).
- (c) Issue of DODISS to be cited in the solicitation, and is required, the specific issue of individual documents referenced (see 2.1.1 and 2.2).
- (d) Style of type ZEP, diameter of type ZEP, style B; size of type ZMP (see figure 13); 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).
- (e) Thickness of type ZPN anode, whether 1/2 or 1 inch (see 3.3.2.1).
- (f) Elongation of type ZSS anode straps (see 3.4.6).
- (g) When fire-retardant lumber and plywood is required (see 5.1.1(a)).
- (h) Class of fire-retardant fiberboard required (see 5.1.1(b)).
- (i) Level of preservation and packing required (see 5.2 and 5.3).
- (j) Quantity per unit pack if other than specified (see 5.2.1).
- (k) Container options, if other than suppliers (see 5.2.1, 5.3.1.1.2 and 5.3.1.4).
- (l) Special marking required (see 5.4).
- (m) Total number of anodes required (see 6.3).

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TABLE IV. National stock numbers.

Anode type	Weight-size	National stock number
ZHS-23	23 lbs	92-5430 277-7559
ZHS-42	42 lbs	134-8131
ZHB-23	23 lbs	662-9827
ZHC-23	23 lbs	813-6058
ZHC-42	42 lbs	488-0957
ZSS-12	12 lbs	290-8243
ZSS-12 (elongated hole)	12 lbs	
ZSS-24	24 lbs	
ZSS-24 (elongated hole)	24 lbs	
ZTS	5 lbs	
ZEP-A (square)	9 lbs	543-3032
ZEP-B (circular)	24 lbs	702-1664
"	16 lbs	702-1372
"	7.2 lbs	702-1371
"	4.9 lbs	527-2366
"	3.2 lbs	582-2011
"	1.8 lbs	582-2012
"	0.8 lbs	527-2368
ZEP-C (semi-circular)	23 lbs	702-1665
ZBP	8 lbs	526-3679
ZDM	1.050 in. dia	682-2174
"	0.825 in. dia	725-3999
"	0.625 in. dia	725-3998
"	0.500 in. dia	725-3997
ZMP	4 in. dia	
"	3.5 in. dia	
"	3 in. dia	
"	2.75 in. dia	
"	2.5 in. dia	
"	2.25 in. dia	
"	2 in. dia	
"	1.75 in. dia	
"	1.25 in. dia	
ZRN	1.315 in. dia	813-6057
"	1.050 in. dia	813-6056
"	0.840 in. dia	813-6055
"	0.675 in. dia	813-6054
"	0.540 in. dia	
"	0.405 in. dia	813-6053
ZPN	24 x 48 x 0.5 in.	290-3793
"	24 x 48 x 1 in.	

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6.3 Ordering by quantity. 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.

6.4 General forms and dimensions. 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 packaging or preparation for delivery of 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 Subject term (key word) listing.

Corrosion
Disc
Galvanic
Plate
Rod
Slab

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

Custodians:

Army - AR
Navy - SH
Air Force - 99

Preparing activity:

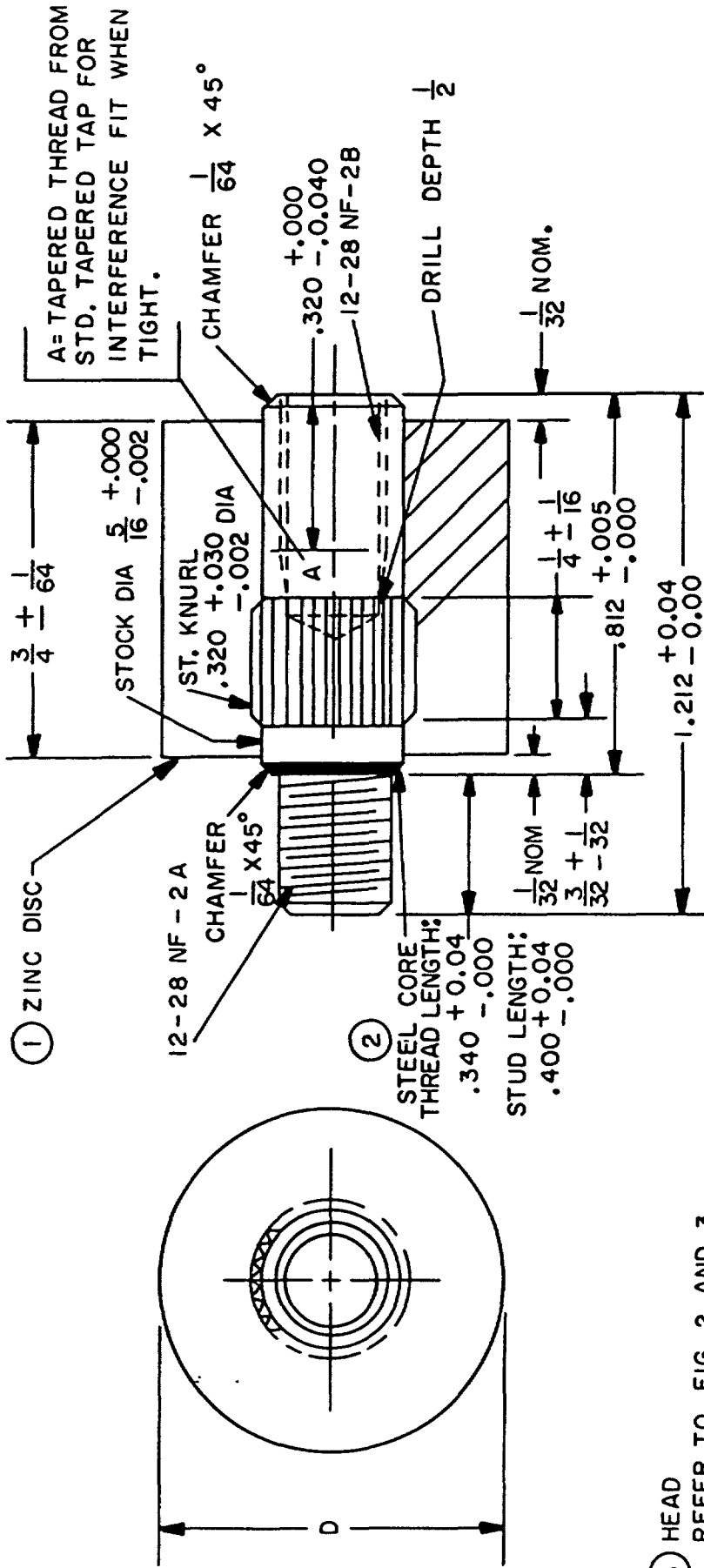
Navy - SH
(Project 5340-1975)

Review activities:

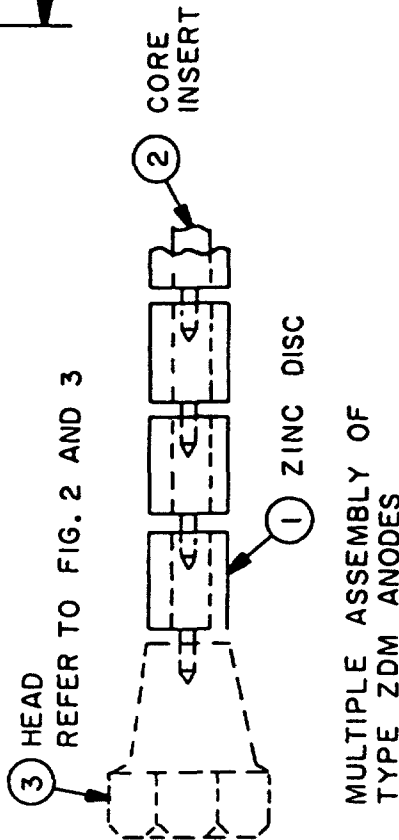
Army - CE, AT
Navy - YD
DLA - IS

User activities:

Army - ME
Navy - OS



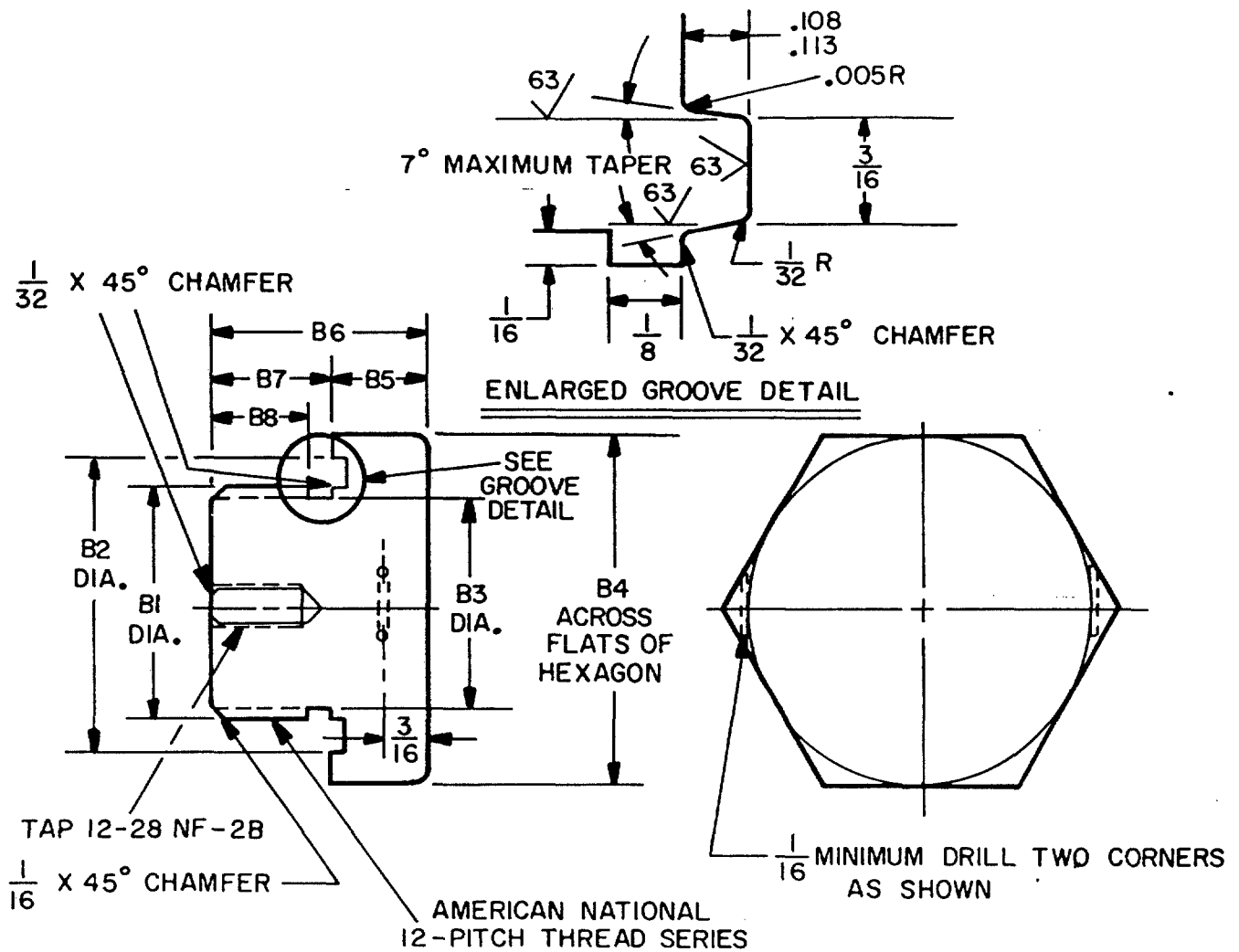
HEAD SIZE I.P.S.	D = DIAM. INCHES	NUMBER PER PKG	NET WT. PER PKG
1	1.050	50	8
3/4	0.825	100	10
1/2	0.625	200	12
3/8	0.500	200	8



NOTE: ALL DIMENSIONS ARE IN INCHES.

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

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ZINC COUPON	B1	B2	B3	B4	B5	B6	B7	B8
	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

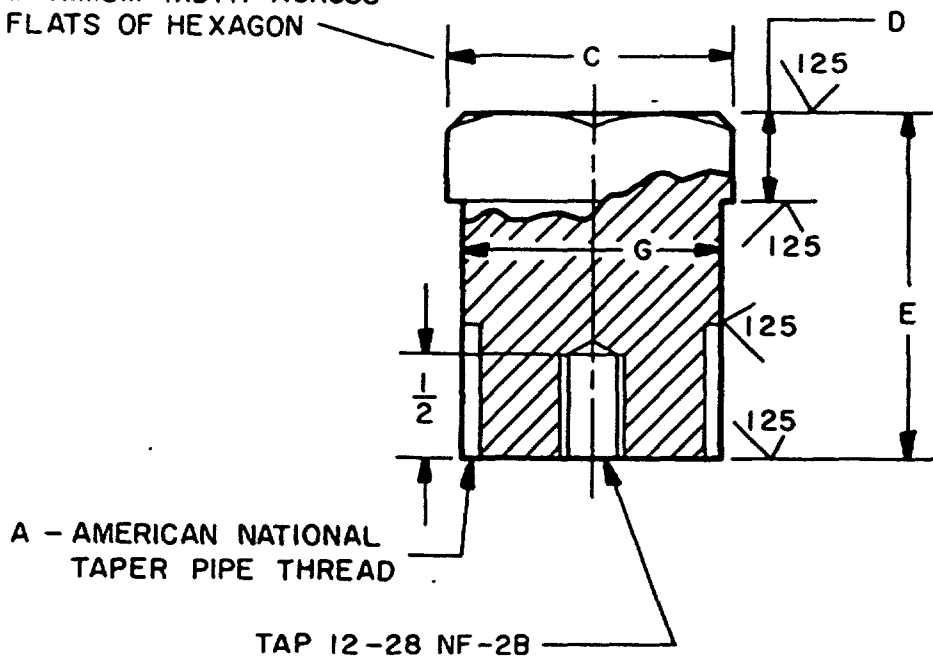
NOTES:

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.

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MAXIMUM WIDTH ACROSS FLATS OF HEXAGON



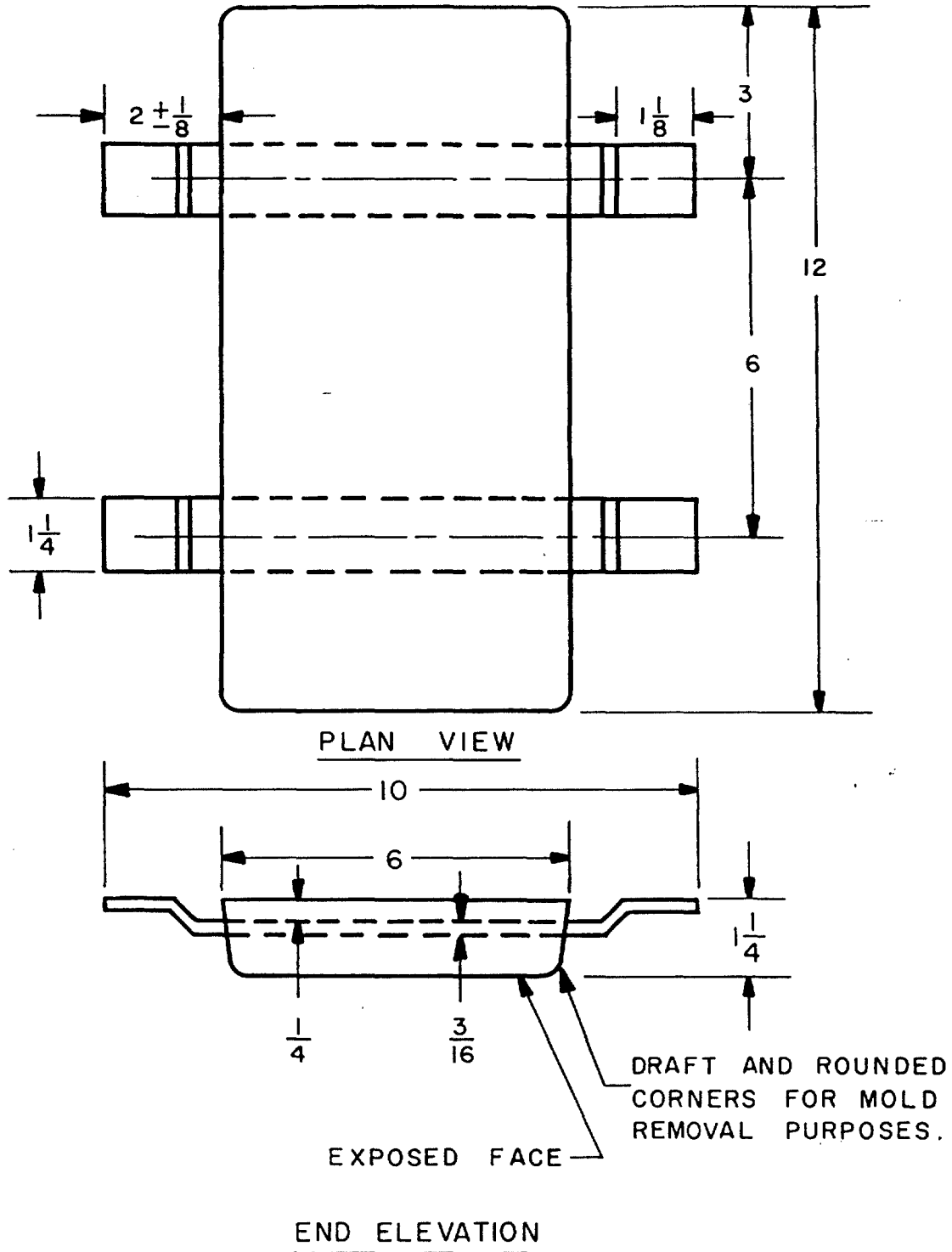
NOMINAL PIPE SIZE	A	C	D	E	G ±.003	ACTUAL DIAMETER OF ZINC ANODE
1	1	1-1/2	1/2	1-3/8	1.315	1.050
3/4	3/4	1-1/4	3/8	1-1/8	1.050	0.825
1/2	1/2	1	3/8	1	0.840	0.625
3/8	3/8	3/4	5/16	1	0.675	0.500

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.)

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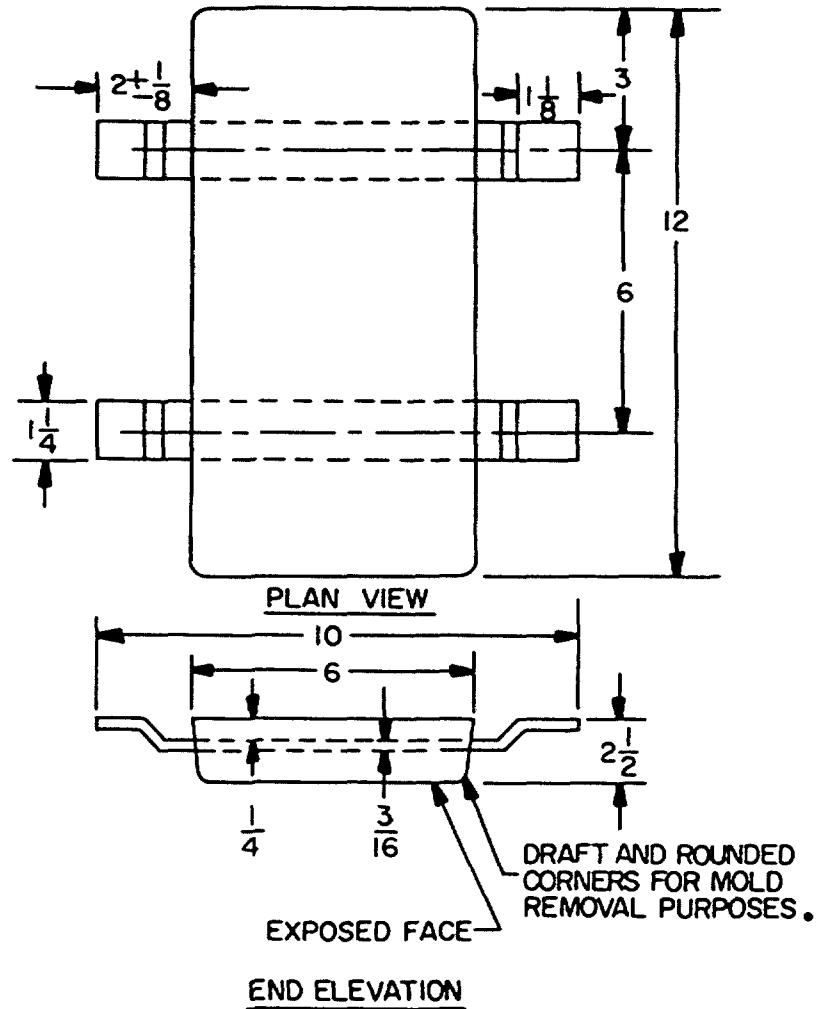
MINIMUM WEIGHT 21.5 POUNDS.

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 $\frac{1}{8}$.

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

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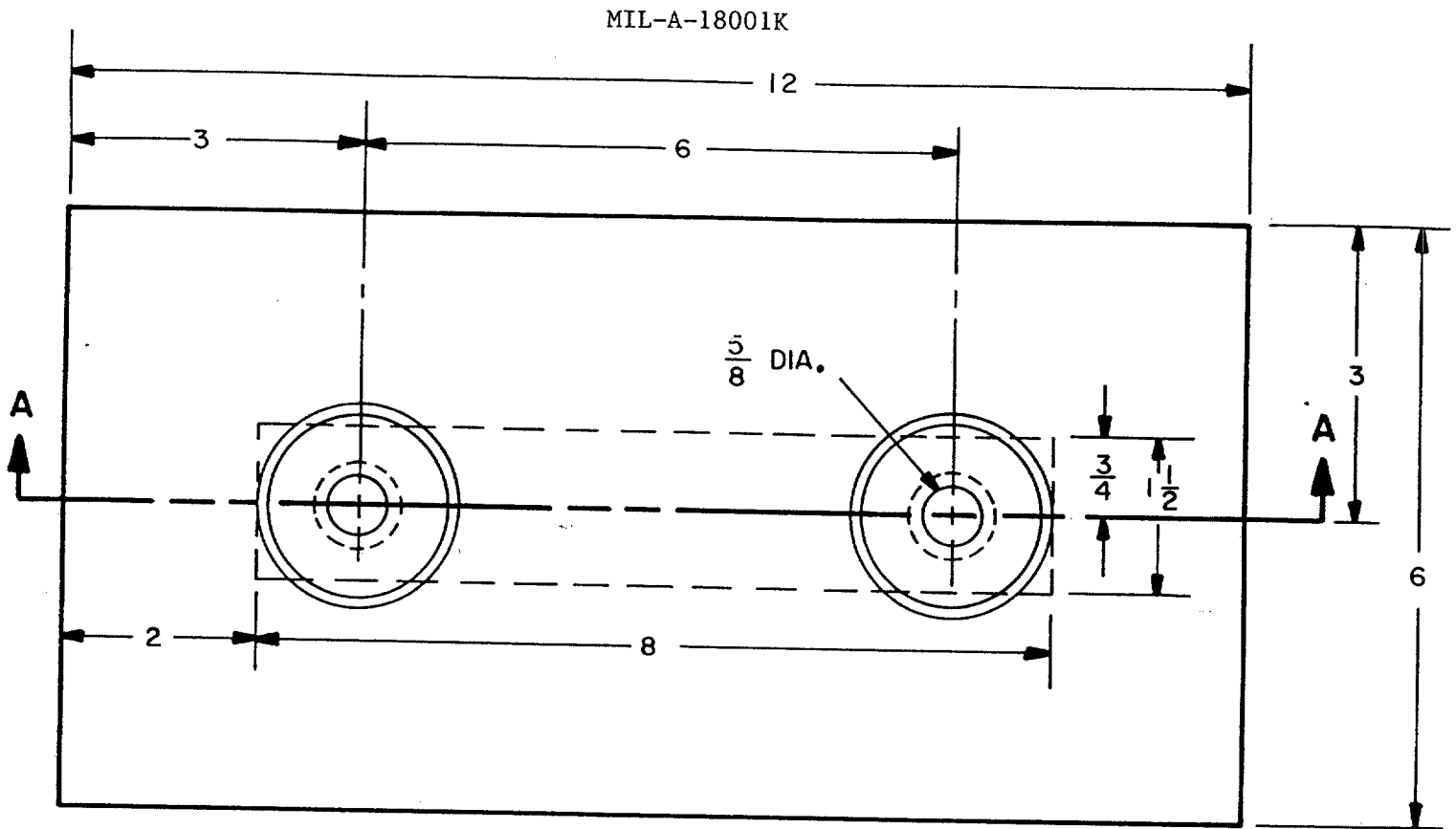


MINIMUM WEIGHT 41 POUNDS.

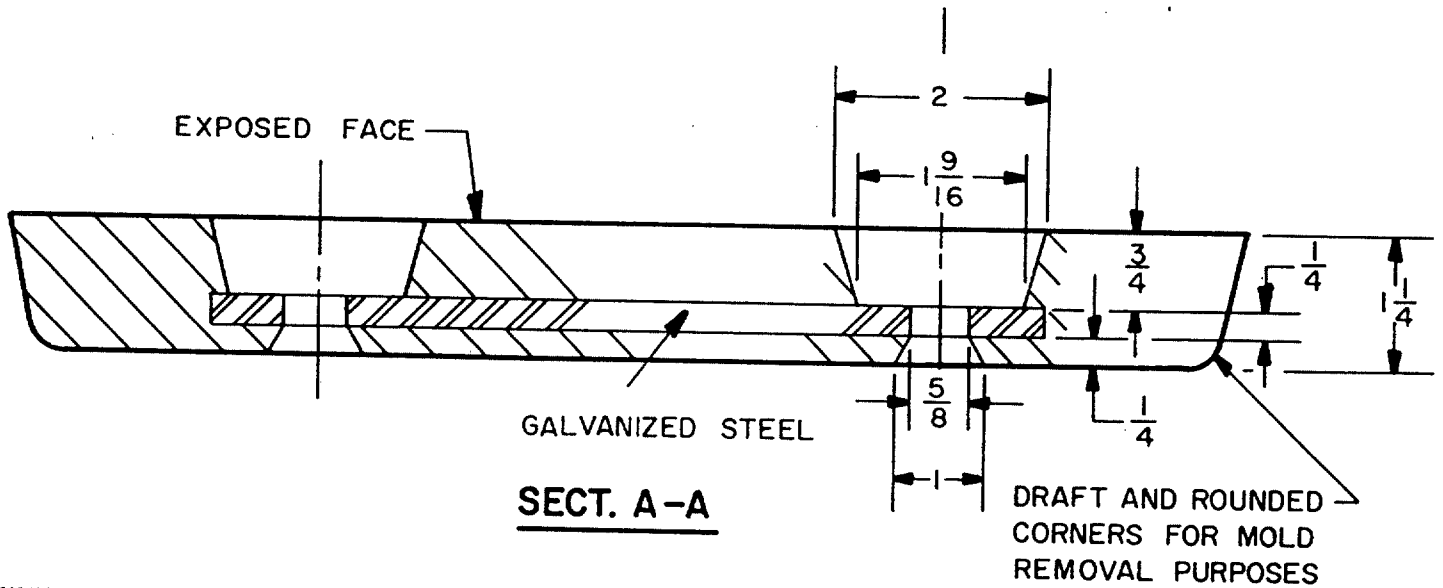
NOTES:

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.



PLAN VIEW



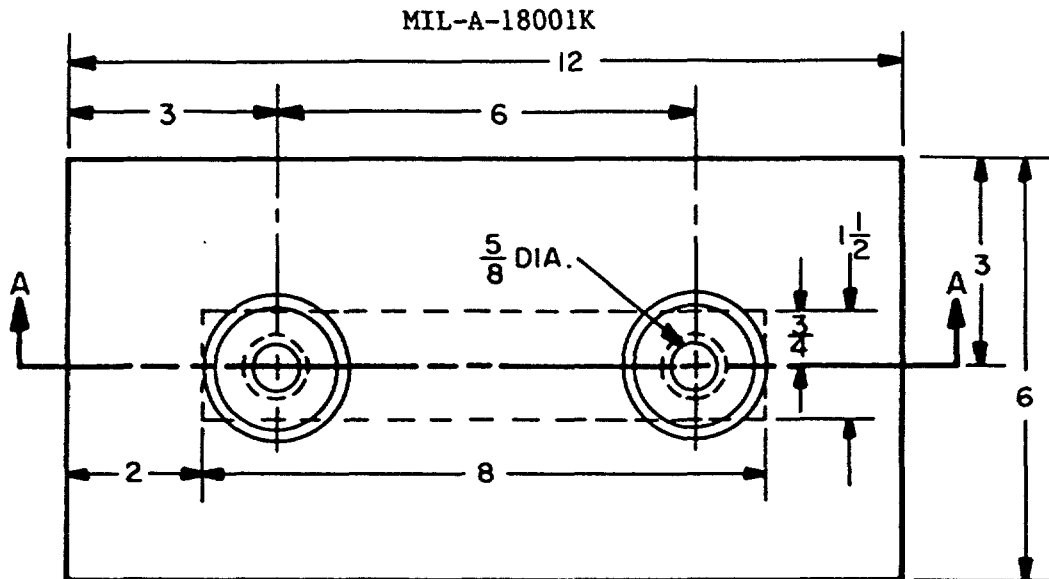
SECT. A-A

MINIMUM WEIGHT 20.4 POUNDS.

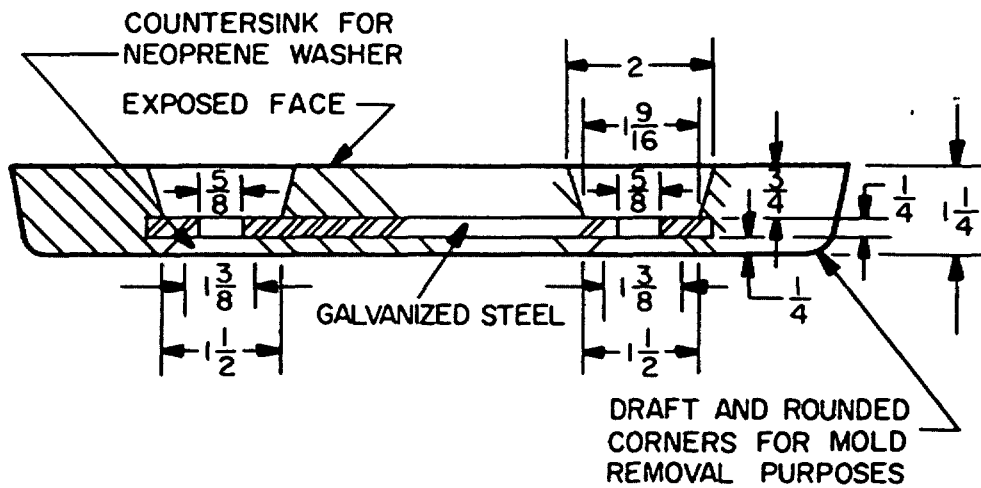
NOTES:

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.



PLAN VIEW



SECTION A-A

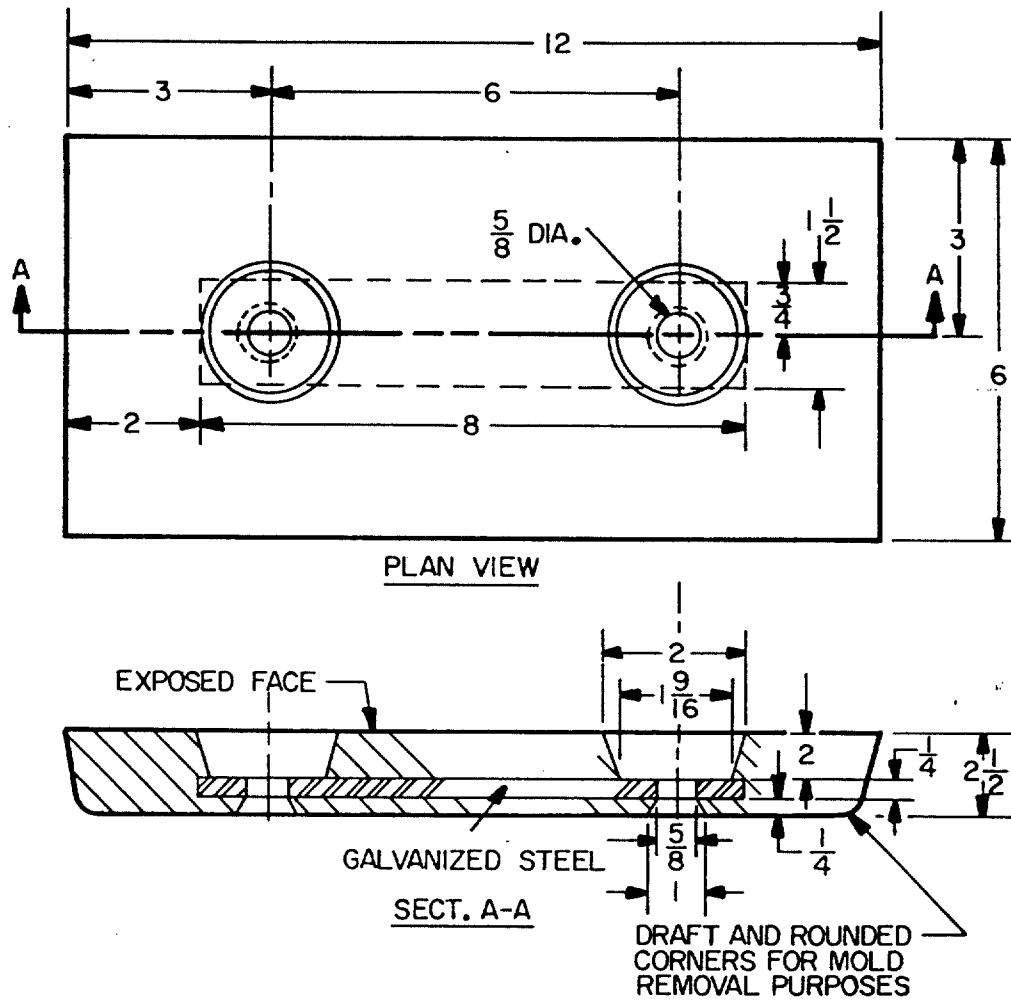
MINIMUM WEIGHT 20.4 POUNDS.

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

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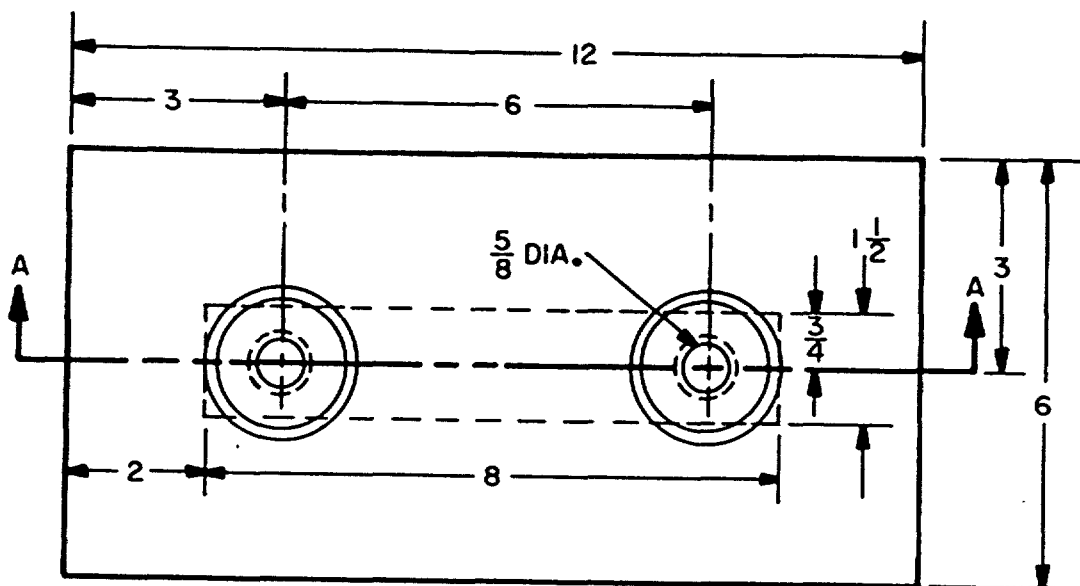
MINIMUM WEIGHT 39 POUNDS.

NOTES:

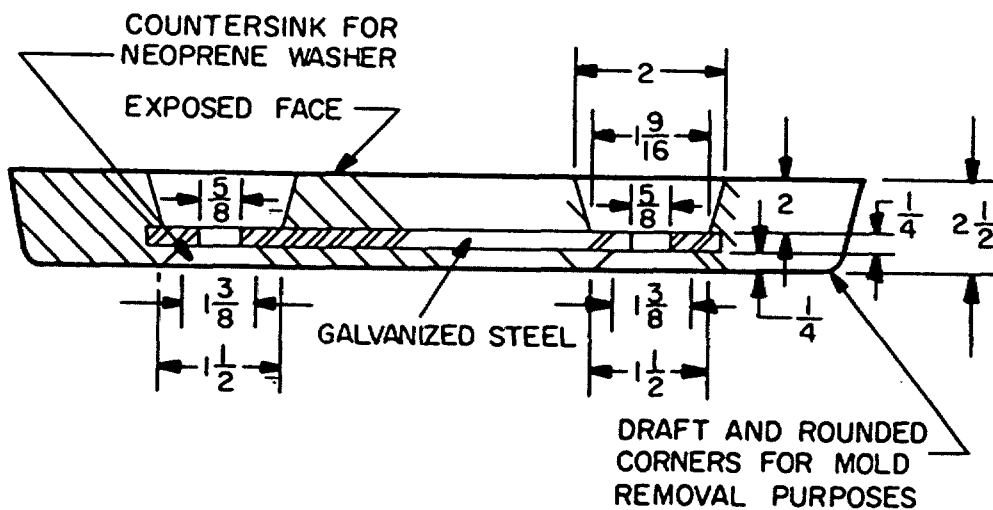
1. ANODE MAY BE CAST WITH EXPOSED FACE IN THE UP OR DOWN POSITION.
2. ALL DIMENSIONS ARE IN INCHES.
3. TOLERANCE PLUS OR MINUS $\frac{1}{8}$.

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

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PLAN VIEW



SECTION A-A

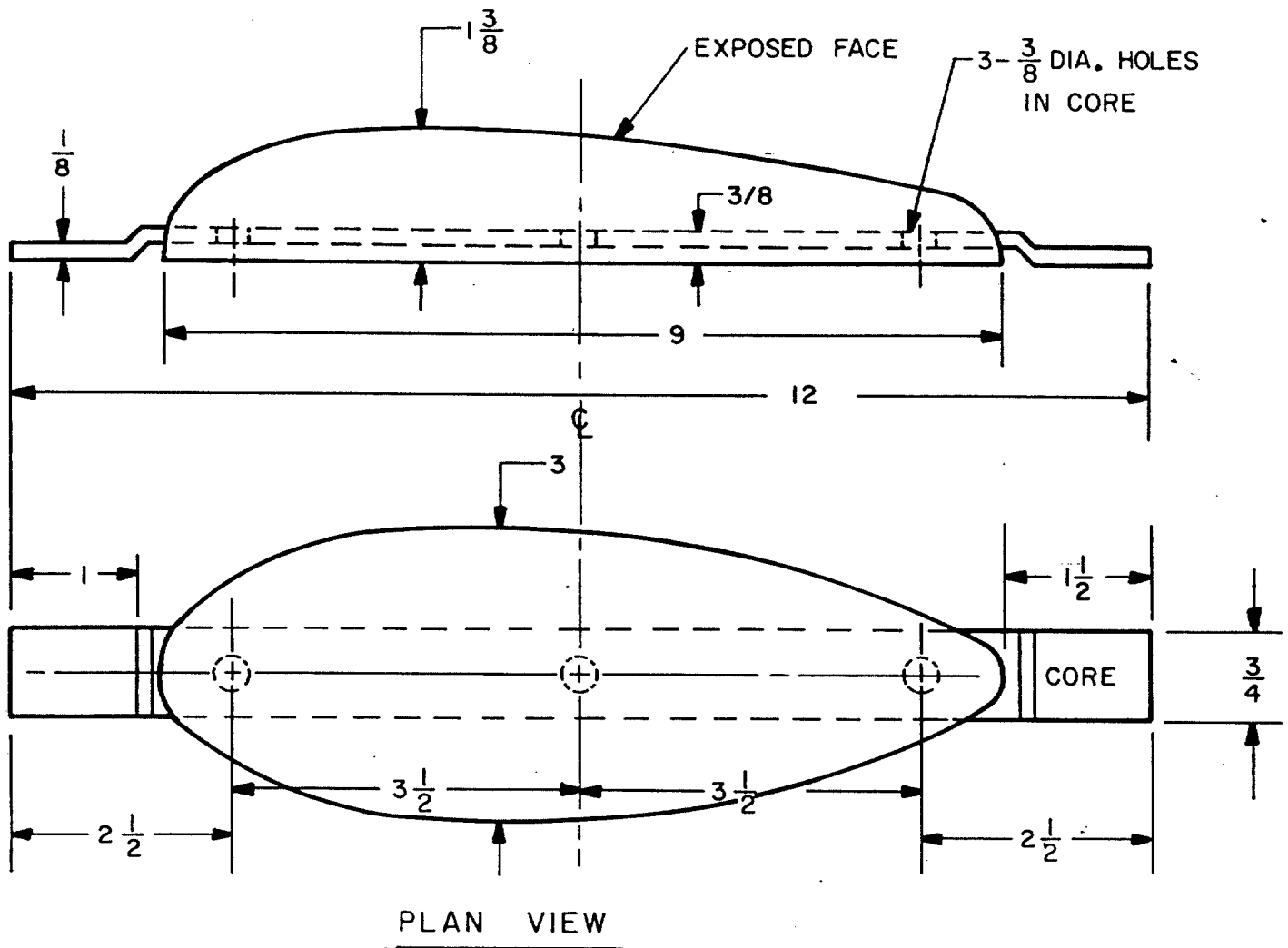
MINIMUM WEIGHT 39 POUNDS,

NOTES:

1. ANODE MAY BE CAST WITH EXPOSED FACE IN THE UP OR DOWN POSITION.
2. ALL DIMENSIONS ARE IN INCHES,
3. TOLERANCE PLUS OR MINUS 1/8.

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

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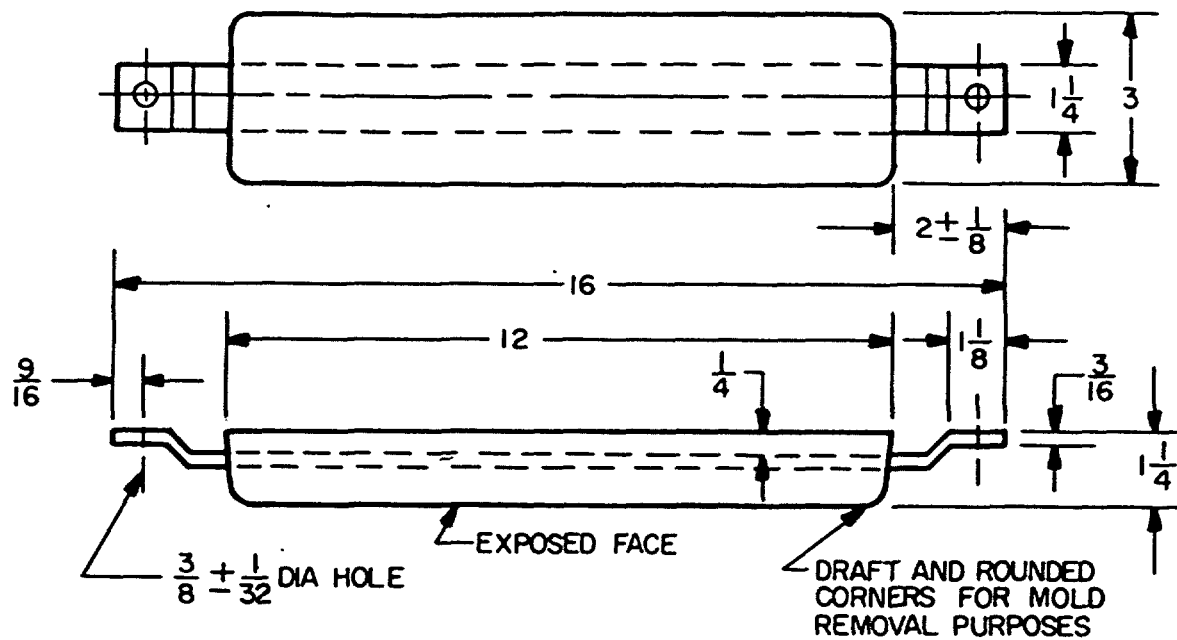
APPROX. WT. 5 LBS.

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.

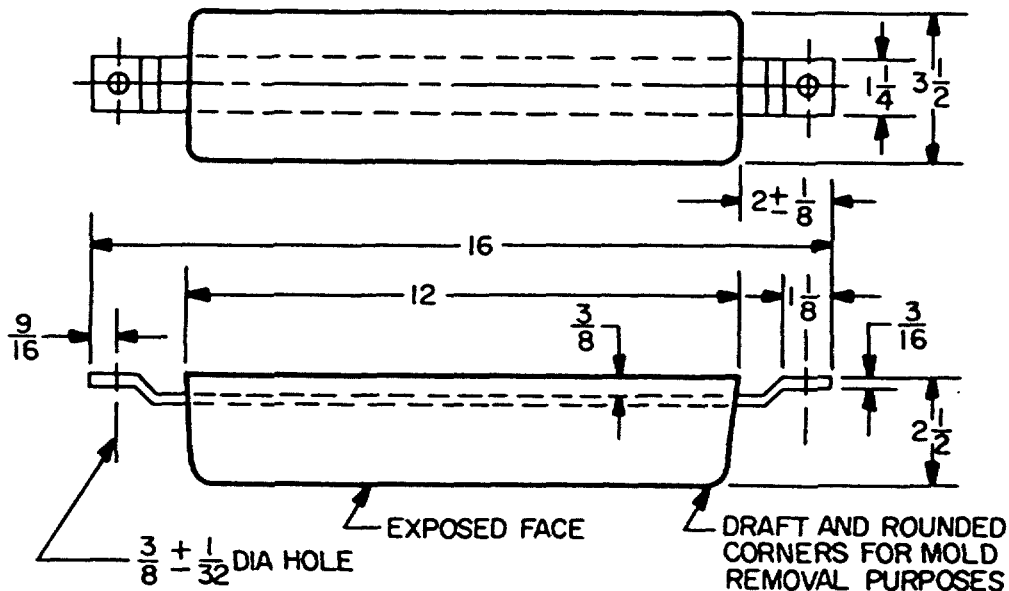
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MINIMUM WEIGHT 11 POUNDS.

NOTE: ANODE MAY BE CAST WITH STRAP IN THE UP OR DOWN POSITION. ALL DIMENSIONS (INCHES) REFER TO THE WIDER AND LONGER DIMENSIONS OF THE ANODE. TOLERANCES OTHER THAN AS SHOWN WILL BE PLUS OR MINUS $\frac{1}{8}$ INCH. MOUNTING HOLES IN STRAPS ARE OPTIONAL AND SHOULD BE SUPPLIED ONLY WHEN SPECIFIED.

(a) ZINC, SUBMARINE SLAB (STEEL STRAP), TYPE ZSS-12.



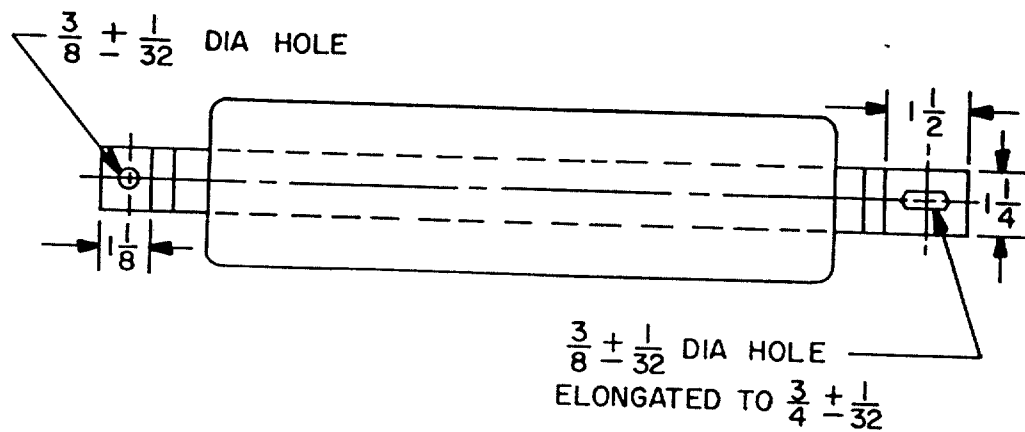
MINIMUM WEIGHT 21.5 POUNDS.

NOTE: ANODE MAY BE CAST WITH STRAP IN THE UP OR DOWN POSITION. ALL DIMENSIONS (INCHES) REFER TO THE WIDER AND LONGER DIMENSIONS OF THE ANODE. TOLERANCES OTHER THAN AS SHOWN WILL BE PLUS OR MINUS $\frac{1}{8}$ INCH. MOUNTING HOLES IN STRAPS ARE OPTIONAL AND SHOULD BE SUPPLIED ONLY WHEN SPECIFIED.

(b) ZINC, SUBMARINE SLAB (STEEL STRAP), TYPE ZSS-24.

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

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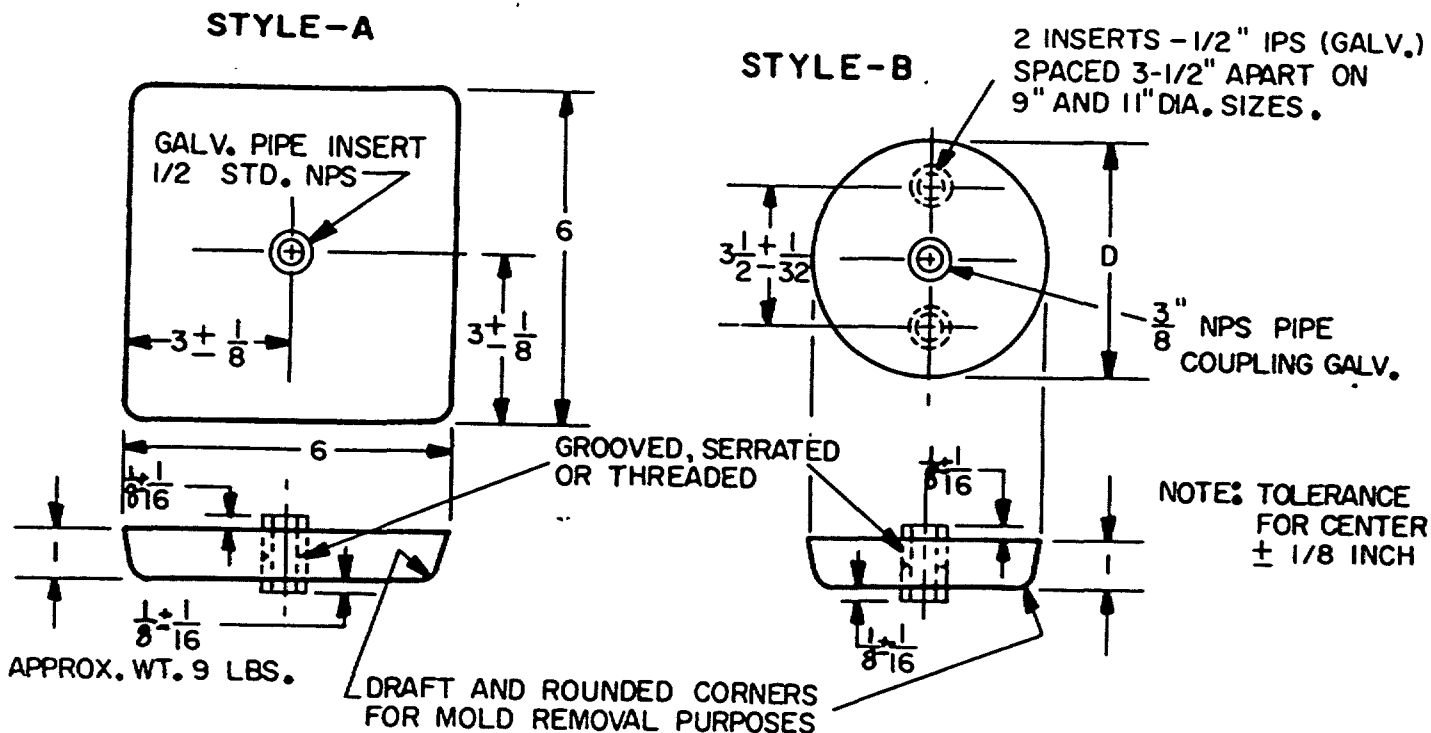
NOTES:

1. ALL DIMENSIONS ARE IN INCHES.
2. TOLERANCES OTHER THAN THOSE SHOWN SHALL BE PLUS OR MINUS 1/8.
3. THE ELONGATED STUD HOLE SHALL BE CENTERED 3/4 INCH FROM THE STRAP END.
4. THE OVERALL LENGTH OF THE ANODE SHALL BE $16 - \frac{3}{8}$ INCHES.
5. A MINIMUM OF 1/4 INCH OF STEEL SHALL SURROUND THE BOLT HOLES.
6. ALL OTHER DIMENSIONS ARE AS SHOWN ON FIGURE 9.

(c) Zinc, submarine slab (steel strap) with elongated strap end.

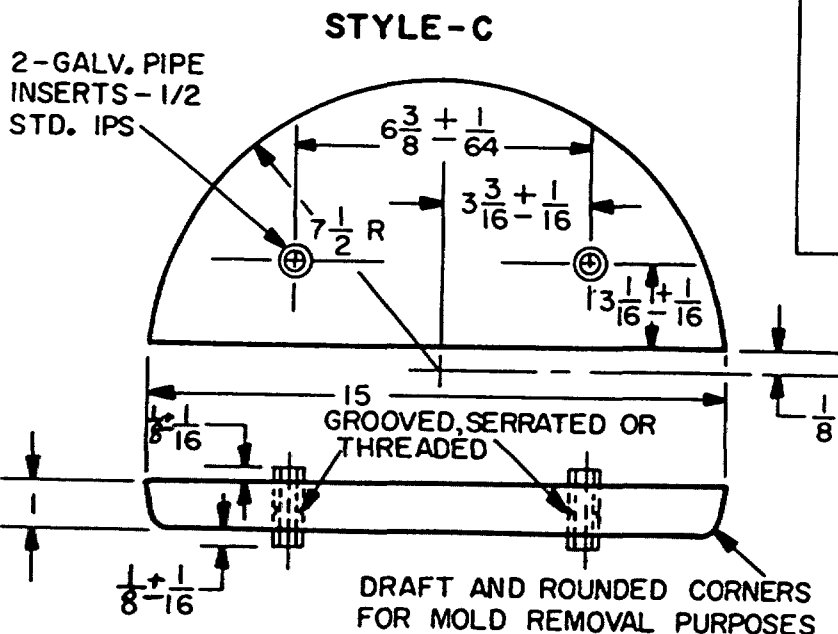
FIGURE 9. Zinc, submarine slab (steel strap). - Continued

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STYLE B

D = DIAMETER IN INCHES $\pm \frac{1}{8}$	APPROXIMATE WEIGHT (POUNDS)	SURFACE AREA (IN ²)
11	24	130
9	16	92
6	7.2	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

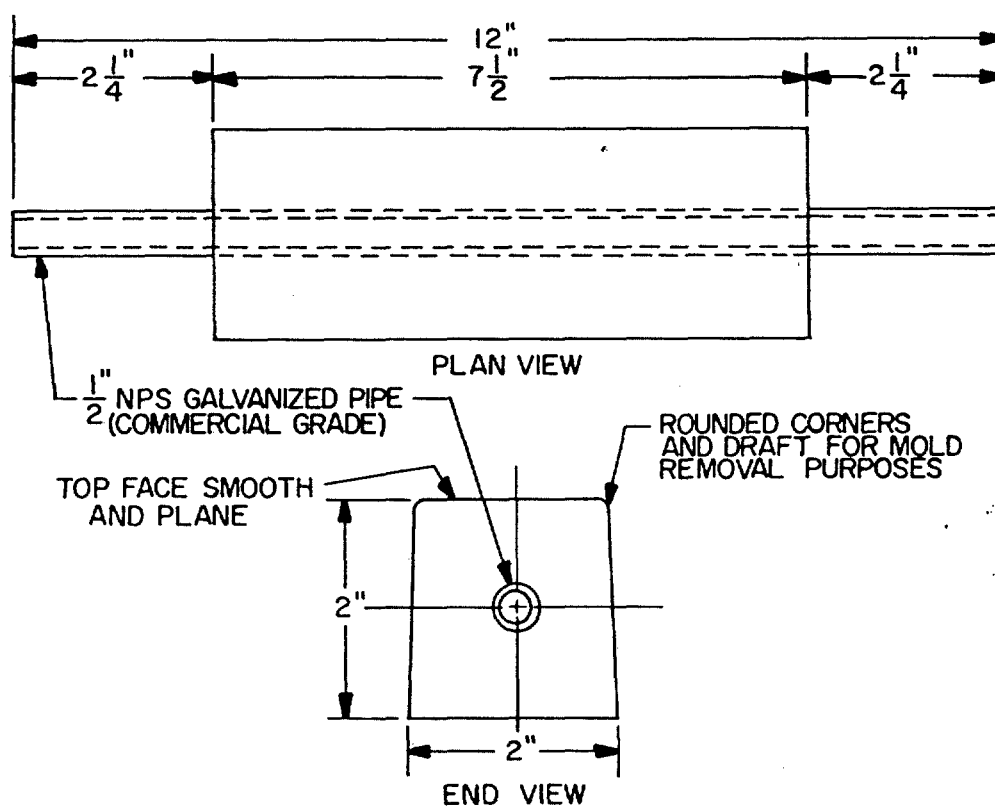
APPROXIMATE WEIGHT 23 POUNDS.

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.

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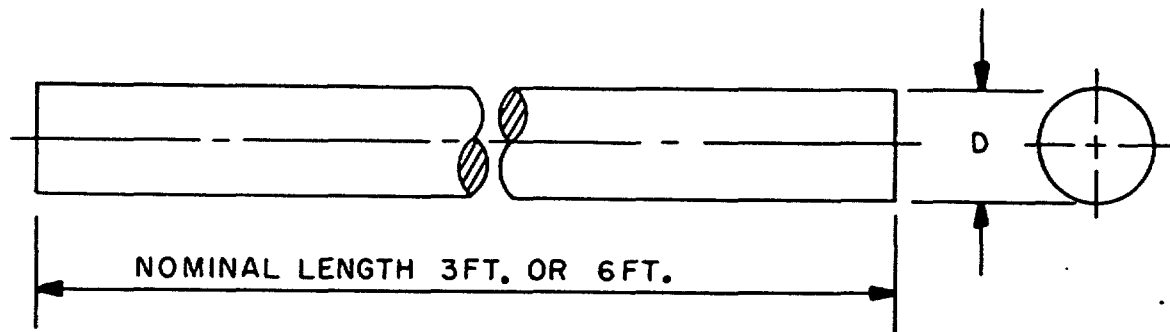
APPROXIMATE WEIGHT 8 POUNDS
 UNIT OF PURCHASE - POUND
 UNIT OF ISSUE - EACH

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.

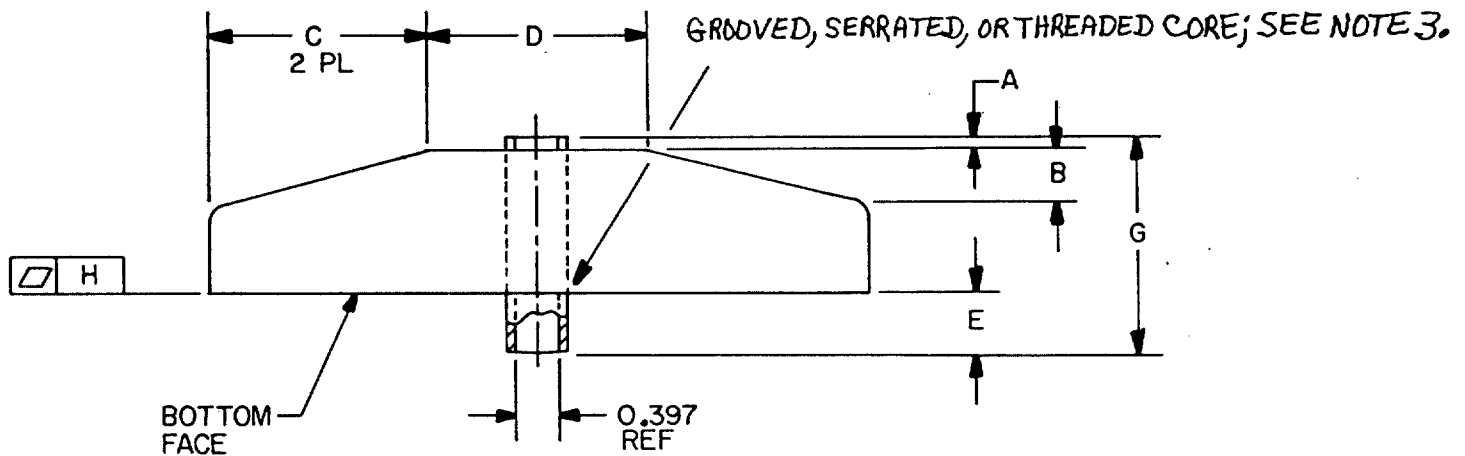
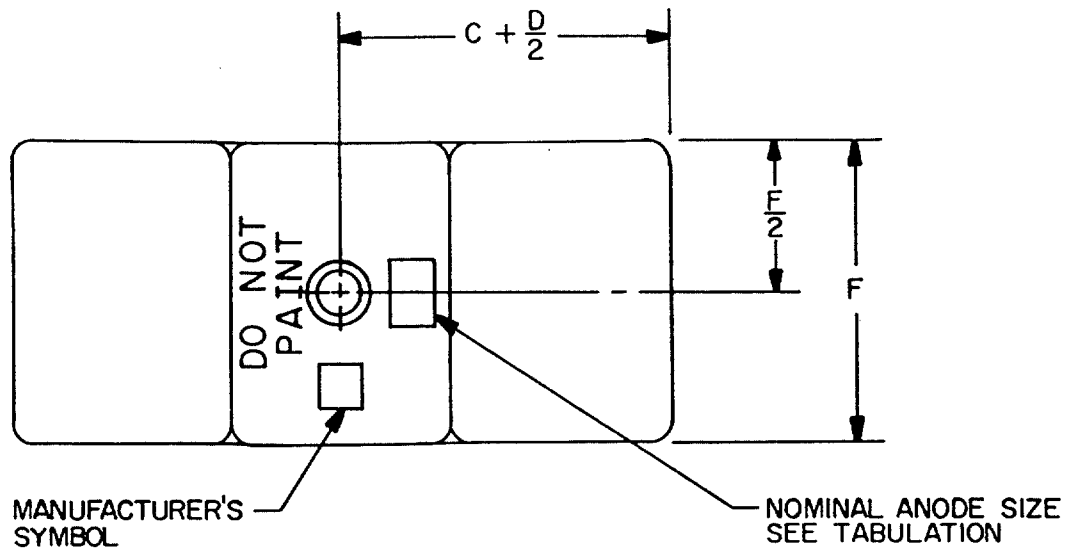
MIL-A-18001K



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.

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NOMINAL ANODE SIZE (INCH)	DIM. A +.06 -.03	DIM. B ±.06	DIM. C ±.06	DIM. D ±.06	DIM. E +.12 -.00	DIM. F ±.06	DIM. G +.06 -.00	ANODE APPROXIMATE WEIGHT (OUNCES) REF	FLATNESS H
1 1/4	.06	.12	.50	1.50	.12	1.19	.58	4.5	.06
1 3/4	.06	.38	.62	2.00	.12	1.50	.91	12.7	.06
2	.06	.37	.75	2.00	.12	1.62	1.08	17.5	.06
2 1/4	.06	.37	.75	2.00	.30	1.75	1.20	22.0	.09
2 1/2	.06	.50	.75	2.00	.30	1.94	1.33	27.1	.09
2 3/4	.06	.50	1.00	2.00	.34	2.06	1.56	32.6	.09
3	.06	.50	1.25	2.00	.34	2.25	1.56	39.8	.12
3 1/2	.06	.50	1.75	2.00	.38	2.38	1.75	57.3	.12
4	.06	.50	2.00	2.00	.50	2.69	1.88	70.5	.12

NOTES:

- FOR USE ON GRADE FM3 STUD LINK CHAIN.
- EXTERIOR EDGES AND CORNER RADII OF CAST ANODE SHALL BE 0.06 TO 0.19.
- PIPE CORE SHALL BE 9/16 INCH TUBING X 0.083 WALL CONFORMING TO ASTM A 513, TYPE S OR 3/8 INCH STANDARD SIZE PIPE CONFORMING TO ASTM A 53.

FIGURE 13. Zinc, mooring chain (pipe core or pipe bushing core), type ZMP.

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

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1. DOCUMENT NUMBER
MIL-A-18001K

2. DOCUMENT DATE (YYMMDD)
91/12/16

3. DOCUMENT TITLE

ANODES, SACRIFICIAL ZINC ALLOY

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

5. REASON FOR RECOMMENDATION

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