INCH-POUND
MIL-DTL-24779B(SH)
23 July 2009
SUPERSEDING
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DETAIL SPECIFICATION

ANODES, SACRIFICIAL, ALUMINUM ALLOY

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

1. SCOPE

1.1 Scope. This specification covers conventional and low voltage aluminum alloy sacrificial anodes for U.S. Navy ships, submarines, and marine structures.

1.2 Classification. Anodes are of the following types and styles, as specified (see 6.2). Anodes that require a higher degree of tolerance in either machining or casting are designated by "-CT".

1.2.1 Conventional aluminum types.

a. Type AHS – Aluminum, hull slab (steel strap core) (see Figures A-1 to A-3)
b. Type ASS – Aluminum, submarine slab (steel strap core) (see Figures A-4, A-6, and A-8)
c. Type ATS – Aluminum, teardrop shape (steel strap core) (see Figure A-9)
d. Type AHC – Aluminum, hull slab (steel core) (see Figures A-10, A-11, A-14, and A-15)
e. Type AEP – Aluminum, fairwater disc (pipe core or pipe bushing core) (see Figures A-18 to A-26)
   (1) Style A – Square slab (see Figures A-18 to A-19)
   (2) Style B – Circular slab (see Figures A-20 to A-25)
   (3) Style C – Semi-circular slab (see Figure A-26)
f. Type ABP – Aluminum, bar (pipe core) (see Figure A-27)
g. Type APN – Aluminum, plate (no core) (see Figures A-28 to A-29)

1.2.2 Low voltage aluminum types.

a. Type LHS – Low Voltage Aluminum, hull slab (steel strap core) (see Figures A-1 to A-3)
b. Type LSS – Low Voltage Aluminum, submarine slab (steel strap core) (see Figures A-4 to A-8)
c. Type LTS – Low Voltage Aluminum, teardrop shape (steel strap core) (see Figure A-9)
d. Type LHC – Low Voltage Aluminum, hull slab (steel core) (see Figures A-10 to A-17)
e. Type LEP – Low Voltage Aluminum, fairwater disc (pipe core or pipe bushing core) (see Figures A-18 to A-26)
   (1) Style A – Square slab (see Figures A-18 and A-19)
   (2) Style B – Circular slab (see Figures A-20 to A-25)
   (3) Style C – Semi-circular slab (see Figure A-26)
f. Type LBP – Low Voltage Aluminum, bar (pipe core) (see Figure A-27)

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

g. Type LPN – Low Voltage Aluminum, plate (no core) (see Figures A-28 and A-29)

h. Type LES – Low Voltage Aluminum, submarine disc (I-beam with welded bushing core)

(1) Style A – Chamfered rectangular slab (see Figure A-31)

(2) Style B – Square slab (see Figure A-32)

1.2.3 Close tolerance low voltage aluminum types.

a. Type LEP-B-CT – Low Voltage Aluminum, Close Tolerance, fairwater disc (pipe core or pipe bushing core) (see Figure A-30)

b. Type LSS-CT – Low Voltage Aluminum, Close Tolerance, submarine slab (steel strap core) (see Figure A-33)

1.2.4 Other anode geometries. Other geometries are acceptable as approved by NAVSEA.

2. APPLICABLE DOCUMENTS

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

2.2 Government documents.

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

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-A-18001 - Anodes, Corrosion Preventive, Zinc; Slab Disc and Rod Shaped.

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

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

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

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1910 - Occupational Safety and Health Standards

29 CFR 1915 - Occupational Safety and Health Standards for Shipyard Employment

(Copies of these documents are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20401 or online at www.gpoaccess.gov/index.html.)

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

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	-	Standard Specification for Carbon Structural Steel (DoD adopted)
ASTM E34	-	Standard Test Methods for Chemical Analysis of Aluminum and Aluminum-Base Alloys (DoD adopted)
ASTM E290	-	Standard Test Methods for Bend Testing of Material for Ductility (DoD adopted)
ASTM E1251	-	Standard Test Method for Analysis of Aluminum and Aluminum Alloys by Atomic Emission Spectrometry

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

EUROPEAN COMMITTEE FOR STANDARDIZATION

BS EN 10016	-	Non-alloy steel rods for drawing and/or cold rolling
BS EN 10025	-	Hot rolled products of structural steels
BS EN 10305-1	-	Steel tubes for precision applications

(Copies of these documents are available online from IHS at www.ihs.com.)

NACE INTERNATIONAL (NACE)

NACE Standard TM0190	-	Impressed Current Laboratory Testing of Aluminum Alloy Anodes

(Copies of this document are available from NACE International, 1440 South Creek Drive, Houston, TX 77084-4906 or online at http://web.nace.org/departments/store/.)

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP-10	-	Near-White Blast Cleaning

(Copies of this document are available from SSPC Publication Sales, 40 24th Street, 6th floor, Pittsburgh, PA 15222-4656 or online at www.sspc.org.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text 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 Qualification. Anodes furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified products list before contract award (see 4.2 and 6.3).

3.2 Material. 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 shall be in accordance with 29 CFR 1910 and 1915 and any other safety/health regulations (local or otherwise) that may apply.

3.2.1 Chemical composition. The chemical composition shall be specified in Table I (see 4.6.3.1 and 4.6.3.2).

TABLE I. Chemical composition.

	Conventional Aluminum	Low Voltage Aluminum
Element	**Weight (percent)**	**Weight (percent)**
Indium	0.014 – 0.020	<0.005
Gallium	N/A	0.092-0.110
Zinc [1/]	4.0 – 6.5	<0.15
Silicon	0.08 – 0.20	<0.10
Copper	0.004 maximum	<0.005
Iron	0.090 maximum	<0.08
Mercury	0.001 maximum	<0.005
Tin	0.001 maximum	0.001 maximum
Nickel		<0.005
Magnesium		<0.010
Manganese		<0.010
Aluminum [1/]	Remainder	Remainder

NOTE:
[1/] Aluminum and zinc raw material purity shall be a minimum 99.8 percent by weight.

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

3.3 Service performance. The aluminum alloy anodes covered by this specification shall remain electrochemically active and provide continuous in service cathodic protection until they are consumed. Anode properties shall meet the requirements as specified in Section 3, given the range of operating conditions normally encountered during extended marine service (for example, transition from sea to brackish water, or varying seawater temperatures, and salinity).

3.3.1 Conventional aluminum anode qualification.

3.3.1.1 Long-term seawater immersion performance. The anode current capacity calculated shall be at least 1150 ampere-hours per pound (2535 ampere-hours per kilogram) for each anode, when tested in accordance with 4.2.1.2. In addition, the free corrosion potential of each anode tested at the end of the long-term seawater immersion test shall be between -1.05 and -1.15 volts versus saturated silver/silver chloride in seawater.

3.3.1.2 Short-term electrochemical performance. Short-term electrochemical test shall be conducted in accordance with 4.2.2. Required anode current capacity shall be at least 1150 ampere-hours per pound (2535 ampere-hours per kilogram) for each anode and the anode operating potential of each anode shall be between -1.05 and -1.15 volt versus saturated silver/silver chloride in seawater.

3.3.2 Low voltage aluminum anode qualification.

3.3.2.1 Long-term seawater immersion performance. The anode current capacity shall be at least 750 ampere-hours per pound (1656 ampere-hours per kilogram) for each anode, when tested in accordance with 4.2.1.2. In addition, the free corrosion potential of each anode tested at the end of the long-term seawater immersion test shall be between -0.800 and -0.900 volt versus saturated silver/silver chloride in seawater.

3.3.2.2 Short-term electrochemical performance. Short-term electrochemical test shall be conducted in accordance with 4.2.2. Required anode current capacity of each anode shall be a minimum of 816 ampere-hours per pound (1800 ampere-hours per kilogram) and the anode operating potential of each anode shall be between -0.780 and -0.830 volt versus saturated silver/silver chloride in seawater.

3.4 Construction.

3.4.1 Steel straps/cores. Type AHS/LHS, ASS/LSS, ATS/LTS, and AHC/LHC anodes shall have strap cores of a steel material in accordance with ASTM A36/A36M.

3.4.2 Pipe cores. Type ABP/LBP and AEP/LEP anodes shall have core inserts from mild steel pipe or pipe couplings in accordance with ASTM A36/A36M or BS EN 10305-1.

3.4.3 I-beam with welded bushing core. Type LES shall have I-beam welded to threaded bushing as shown on Figures A-31 and A-32. Steel material shall be in accordance with ASTM A36/A36M or BS EN 10016 and BS EN 10025.

3.4.4 Steel core surface preparation. Steel core material shall be free of surface oxides such as rust, or other coatings including galvanizing, cadmium, or tin. The steel core shall be abrasive blasted to a near white finish in accordance with SSPC SP-10 and cast within the aluminum anode within 4 hours after blasting to insure minimal buildup of surface oxides.

3.4.5 Weight. Minimum weight requirements are specified on Figures A-1 through A-33. 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 weight of anode type specified (see 4.5). 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.

3.4.6 Dimensions. Anode dimensions shall be as specified on Figures A-1 through A-33 (see 4.5). Table II provides additional information regarding dimensions, tolerances, and the mounting of anodes.

3.4.6.1 Stud hole elongation of ASS/LSS type anodes. When specified (see 6.2), ASS/LSS straps may be modified as shown on Figure A-8.

TABLE II. Dimension, tolerance, and mounting notes.

Conventional Anode Type	Low Voltage Anode Type	Figures	Comments
AEP	LEP	A-18 to A-26	The diameter of type AEP/LEP anodes shall not vary by more than 0.13 inch (3 millimeters) from the specified diameter.
AHS ASS AHC	LHS LSS LHC	A-1 to A-8 A-10 to A-17	Cores and straps for anode types AHS/LHS, ASS/LSS, and AHC/LHC shall be positioned so they are embedded 0.25 inch (6.5 millimeters) minus 0.06 inch (1.5 millimeters) plus 0.13 inch (3 millimeters), as shown on Figures A-1 to A-8 and A-10 to A-17, which may be measured from either surface, as applicable.

TABLE II. Dimension, tolerance, and mounting notes – Continued.

Conventional Anode Type	Low Voltage Anode Type	Figures	Comments
ATS	LTS	A-9	Cores and straps for anode type ATS/LTS shall be positioned so they are embedded 0.25 inch (6.5 millimeters) plus or minus 0.13 inch (3.0 millimeters), as shown on Figure A-9, which may be measured from either surface, as applicable.
AHC	LHC	A-11 A-13 A-15 A-17	The type AHC/LHC anodes shown on Figures A-11, A-13, A-15, and A-17 are intended for use with rubber washers. Countersinks for rubber washers shall be cast or machined. The anodes shall be manufactured so the countersinks are centered on the core straps.
ASS	LSS	A-4 to A-8	Type ASS/LSS anodes shown on Figures A-4 to A-8 may be mounted by welding or by fasteners. Those intended to be attached by fastener shall have appropriate mounting holes in the straps.
AEP ABP	LEP LBP	A-18 to A-26 A-27	For type AEP/LEP and ABP/LBP anodes, the position of the pipe core insert shall not vary more than 0.13 inch (3 millimeters) from the center.
AES	LES	A-31 A-32	For type AES/LES anodes, the position of the I-beam insert shall not vary more than 0.12 inch (3 millimeters) from the center.

3.4.6.2 Close tolerance dimensions. Some applications require more stringent dimensional and tolerance control. These geometries are designated with a "-CT" following their classification type and style as given in 1.2.3. Table III provides additional information regarding dimensions, tolerances, and the mounting of anodes. Other geometries are acceptable as approved by NAVSEA.

TABLE III. Dimension, tolerance, and mounting notes for close tolerance conventional and low voltage aluminum anodes.

Low Voltage Anode Type	Figures	Comments
LSS-10-CT	A-33	Cores and straps for anode types LSS-10-CT shall be positioned so they are embedded 0.25 inch (6.5 millimeters) minus 0.06 inch (1.5 millimeters) plus 0.12 inch (3 millimeters), as shown on Figure A-33 which may be measured from either surface, as applicable.

3.5 Marking. Each anode shall be cut or die-stamped with the manufacturer's symbol and a unique, nonrecurring heat number. All anodes in this specification shall have the anode type and the words "DO NOT PAINT" die-stamped or cast on the exposed face of the anodes as specified on Figures A-1 – A-33.

3.6 Workmanship. Consistent with good commercial practice, the aluminum anodes shall be free of flash, burrs, cracks, blow holes, and surface slag (see 4.5). The cast anodes shall be free of shrinkage cavities exceeding 0.25 inch (6.35 millimeters) in depth, except that anodes 2 inches (5.08 centimeters) thick or more shall be free of shrinkage cavities exceeding 0.375 inch (9.53 millimeters) in depth, when measured from a straight edge placed diagonally across the opposite edges of the anode. In addition to the above allowable shrinkage cavities, surface irregularities including cracks and blowholes on the anode exceeding 0.125 inch (3.18 millimeters) in depth shall not be permitted on one face of slab or disc type anodes unless at least 0.125 inch (3.18 millimeters) of sound metal covers the entire strap. Metal core extension from the anode shall be smooth and free of sharp burrs.

3.7 Core bonding. The gap between the aluminum alloy and the steel strap/core shall be less than 0.002 inch (50.8 micrometers) for at least 50 percent of the interfacial length (see 4.6.1).

3.8 Bend. Any evidence of cracking is cause for rejection of the entire lot (see 4.6.2).

4. VERIFICATION

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

a. Qualification (see 4.2).

b. Conformance (see 4.3).

4.2 Qualification. Qualification of anodes shall consist of successfully meeting all of the requirements in Section 3. The manufacturer shall successfully pass a long-term seawater immersion test of at least four Type ASS-10/LSS-10 anodes of 12 months or longer duration (see 4.2.1) and a short-term electrochemical test (see 4.2.2). Anode types may be modified with approval from NAVSEA.

4.2.1 Long-term seawater immersion test.

4.2.1.1 Long-term seawater immersion test site requirements. The test site shall be on or near the ocean or an estuary thereof, providing an undiluted natural seawater environment to within a 3-foot spherical radius of each anode in test. Similarly, not less than 80 percent of the immersed portion of the “infinite steel cathode” shall be immersed in undiluted natural seawater. These requirements shall be maintained during all seasons and tidal conditions. This allows for some surface dilution from rain and river sources. The “infinite steel cathode” shall have sufficient exposed steel surface area to permit galvanic coupling of all anodes in test without significant cathodic polarization of the steel.

4.2.1.2 Long-term seawater immersion test procedures. Each of four ASS-10/LSS-10 anodes chosen at random from a representative heat of a production run of anodes shall be galvanically coupled to an “infinite steel cathode” in seawater for a minimum period of one year. This test shall run concurrently with a test of at least two ZSS-24 zinc anodes in accordance with MIL-A-18001 for comparative purposes. The back of each anode shall be wire brushed and degreased prior to application of two to three coats of epoxy in accordance with MIL-DTL-24441 to a total dry film thickness of 8 to 10 mils. The anodes shall then be weighed to the nearest 0.1 pound (45.36 grams) on a certified calibrated balance. The anode should be mounted to dielectric plate of minimum dimensions the width and length of the anode to further preclude the possibility of corrosion of the back surface causing loss of the anode. Six-gauge copper wire shall be used to galvanically couple each anode through a 1-ohm shunt resistor to an infinite steel seawall. All underwater electrical connections shall be sufficiently waterproof to survive the duration of the test without loss of continuity. The shunt shall be used to monitor current weekly. Anodes shall be immersed at least three feet (0.91 meter) below low tide level and separated from each other by a minimum distance of eight feet (2.44 meters). Individual anode current shall be measured weekly by measuring voltage drop across the 1-ohm shunt resistor to an accuracy of 0.1 millivolt. Potential of the seawall shall be measured monthly at each anode site immediately adjacent to the seawall. Potential of the seawall shall not measure more negative than minus 700 millivolts with respect to a silver/silver-chloride reference cell at any site. Upon conclusion of the test, electrical connections to the seawall are to be disconnected and the anodes shall remain in seawater. One hour after disconnection each anode open-circuit potential shall be recorded. All anodes shall then be removed from seawater, all electrical connections removed from each anode, and the anodes shall be cleaned with a high-pressure water blast to remove fouling and corrosion products. Each anode shall again be weighed to the nearest 0.1 pound (45.36 grams), and weight loss recorded. A plot of current as a function of time is to be produced for each anode. Integrate the area under the current versus time curve to determine the total charge passed in ampere-hours. The anode

current capacity for each anode shall be determined by dividing the total charge passed in ampere-hours by each anode's weight loss in pounds (or kilograms).

4.2.2 Short-term electrochemical test. Two anodes shall be selected, one each from the start and end of each lot, for the anode operating potential and current capacity characteristics test. The anode operating potential and current capacity characteristics shall be determined in accordance with the latest revision of NACE Standard TM0190.

4.3 Conformance. Conformance inspection shall consist of the examinations and tests specified in 4.2.2, 4.5, and 4.6. Failure to meet requirements in any sample shall result in the rejection of the entire lot. The contractor has the option of correcting the discrepancy, retesting, and resubmitting a conforming lot or submitting a new lot, which shall be inspected and tested as specified herein. Resubmitted lots that fail retest shall be rejected and not resubmitted again.

4.3.1 Sampling lot. For the purpose of sampling, a lot shall consist of all anodes of the same type and style poured from one homogenous 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.

4.4 Summary of requirements and tests/examinations. Table IV summarizes the requirements with reference sections and corresponding tests/examinations for verification of satisfying each requirement.

TABLE IV. Summary of requirements and tests/examinations.

Section	Requirement	Qualification	Conformance	Test/Examination
3.3.1.1 3.3.2.1	Long-term seawater immersion performance	☑		4.2.1 Long-term seawater immersion test.
3.3.1.2 3.3.2.2	Short-term electrochemical performance	☑	☑	4.2.2 Short-term electrochemical test
3.4.5 3.4.6 3.6	Weight, dimensions, and workmanship	☑	☑	4.5 Examination
3.7	Core bonding	☑	☑	4.6.1 Core bonding test
3.8	Bend (APN/LPN only)	☑	☑	4.6.2 Bend test
3.2.1	Chemical composition	☑	☑	4.6.3 Chemical analysis

4.5 Examination.

4.5.1 Sampling for examination. A random sample of anodes shall be selected from each lot as specified in Table V.

TABLE V. Sampling for examination.

Lot size	Sample size
3-25	3
26-50	5
51-90	6
91-150	7
151-280	10
281-500	11
501-1,200	15
1,201-3,200	18
3,201-10,000	22
10,001-over	29

4.5.2 Examination procedure. Anodes selected as specified in 4.5.1 shall be measured for weight and dimension, and visually inspected under 10× magnification for workmanship (see 3.4.5, 3.4.6, and 3.6).

4.6 Test methods. (see 4.2)

4.6.1 Core bonding test.

4.6.1.1 Sampling for core bond tests. Two anodes from each lot shall be selected at random for the core bonding test.

4.6.1.2 Resampling. In cases where one of the two anodes tested fails to pass the core bond test, four additional anodes may be selected for retest at the discretion of the manufacturer.

4.6.1.3 Core bonding test procedure. Each anode selected to represent the lot shall be cut with a hacksaw or the equivalent along the major axis of each strap or core. The cut surfaces shall be polished with a 60 (or finer) mesh abrasive until the aluminum alloy-steel core/strap interface is distinctly visible. The gap between the aluminum alloy and the steel strap/core shall be less than 0.002 inch (0.005 centimeter, 50 micrometers) for at least 50 percent of the interfacial length when measured with an appropriate device such as a Feeler Gauge. Aluminum alloy anodes may have a bead or buttress not exceeding 0.25 inch (6.35 millimeters) projecting from the anode along the strap/core. The steel strap aluminum alloy interface shall show no evidence of red rust; however, blue or black oxide is acceptable. Evidence of red rust on the cut surface shall be cause for rejection of the lot (see 3.7).

4.6.1.4 Disposition of anodes subjected to core bond tests. All sample anodes shall be discarded and not included in the delivery of material after the core bonding tests are performed.

4.6.2 Bend test.

4.6.2.1 Sampling for bend test for types APN/LPN anodes. At least five anodes of these types shall be selected from each lot for each of these tests.

4.6.2.2 Physical test sample dimensions for APN/LPN type anodes. APN/LPN test samples shall be cut from the plate anodes and shall be of the following dimensions: width: 2× thickness, length: 12 inches or to suit the test apparatus.

4.6.2.3 Bend test procedure. Type APN/LPN anodes shall be bent 45 degrees around a mandrel of three times the thickness of the anode being tested. The anodes shall be bent in accordance with ASTM E290. After bending, the convex surface of the specimens shall be visually inspected for cracking (see 3.8).

4.6.3 Chemical analysis.

4.6.3.1 Sampling for chemical analysis. Two anodes shall be selected at random from each lot for chemical analysis test. Alloy sample shall be obtained by drilling or machining the alloy so that the sample represents the bulk material.

4.6.3.2 Chemical analysis methods. Optical Emission Spectrometry (ASTM E1251), Atomic Absorption, and D.C. Plasma Spectrophotometric analyses shall be determined by any standard method approved by a Non-Government standards body such as the American National Standards Institute or ASTM International (for example, ASTM E34) and accepted by the Government.

4.6.3.3 Determination of zinc, mercury, tin, bismuth, copper, iron, cadmium, titanium, and magnesium. The percent composition of these elements in the aluminum alloy shall be determined using atomic absorption spectrophotometry or optical emission spectrometry (see 3.2.1).

4.6.3.4 Determination of indium, gallium, lead, boron, silicon, and aluminum. The percent composition of these elements in the aluminum alloy shall be determined by D.C. plasma spectrophotometry or optical emission spectrometry (see 3.2.1).

5. PACKAGING

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

6. NOTES

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

6.1 Intended use. The anodes are intended for use as aluminum alloy sacrificial anodes for the cathodic protection of metals and alloys aboard U.S. Navy ships and submarines. The anodes are not intended for use in any area exposed to flammable material (such as compensating fuel tanks) or where deteriorated pieces of alloy may cause problems (such as for suction inlets).

6.2 Acquisition requirements. Acquisition documents should specify the following:

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

b. Type and style anode required (see 1.2.1, 1.2.2, and 1.2.3).

c. When stud hole elongation is allowed (see 3.4.6.1).

d. Packaging requirements (see 5.1).

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Products List QPL No. 24779 whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from Commander, Naval Sea Systems Command, ATTN: SEA 05M2, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or emailed to CommandStandards@navy.mil. An online listing of products qualified to this specification may be found in the Qualified Products Database (QPD) at http://assist.daps.dla.mil.

6.4 Subject term (key word) listing.

Cathodic protection

Hull slab

Submarine slab

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

CONVENTIONAL AND LOW VOLTAGE ALUMINUM ANODE DRAWINGS

A.1 SCOPE

A.1.1 Scope. This Appendix defines the geometry and tolerances for conventional and low voltage aluminum sacrificial anodes. This Appendix is a mandatory part of the specification. The information contained herein is intended for compliance.

A.2 APPLICABLE DOCUMENTS

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

A.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 these documents are those cited in the solicitation or contract.

AMERICAN WELDING SOCIETY

AWS D1.1 - Structural Welding Code - Steel

(Copies of this document are available from The AWS Store, Customer Service, 2671 W. 81st Street, Hialeah, FL 33016 or online at www.awspubs.com.)

ASME INTERNATIONAL (ASME)

ASME B1.1 - Unified Inch Screw Threads, (UN and UNR Thread Form)

ASME B1.2 - Gages and Gaging for Unified Inch Screw Threads

ASME Y14.38 - Abbreviations and Acronyms for Use on Drawings and Related Documents

ASME Y14.5 - Mathematical Definition of Dimensioning and Tolerancing Principles

(Copies of these documents are available from ASME International, 22 Law Drive, P.O. Box 2900, Fairfield, NJ 07007-2900 or online at www.asme.org)

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M - Standard Specification for Carbon Structural Steel (DoD adopted)

ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

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

EUROPEAN COMMITTEE FOR STANDARDIZATION

BS EN 288 - Specification and Approval of Welding Procedures for Metallic Materials

BS EN 10016 - Non-alloy steel rods for drawing and/or cold rolling

BS EN 10025 - Hot rolled products of structural steels

BS EN 10305-1 - Steel tubes for precision applications

(Copies of these documents are available online from IHS at www.ihs.com.)

A.3 NOTES

A.3.1 Dimensions and tolerances. Wherever possible, dimensions and standards have been defined in both US/Imperial and International/Metric versions. Where a tolerance is not specifically defined, the default tolerance shall be ±0.12 inch (3 millimeters) for linear dimensions and ±2 degrees for angles. Dimensioning shall be interpreted in accordance with ASME Y14.5

A.3.2 Minimum weights. The minimum weights shown in the drawings are calculated by averaging the CAD-derived "minimum weight". Unless otherwise shown, these weights include a four degree draft, 0.188 inch (4.5 millimeters) radius corner rounds, and core volume is subtracted from the casting volume. The "minimum weight" is calculated from the minimum material tolerances on the casting but with nominal size steel cores. Density of both aluminum alloys (conventional and low voltage) is assumed to be 2.70 grams per cubic centimeter. Density of all steel components is assumed to be 7.86 grams per cubic centimeter.

A.3.3 Centering of cores. Unless otherwise shown, all cores shall be centered in the casting to within ±0.13 inch (3 millimeters).

A.3.4 Screw threads. Unless otherwise noted, screw threads shall be per ASME B1.1. Inspection is required with GO/NO GO gauges in accordance with ASME B1.2. Tapped holes shall be countersunk to the major diameter.

A.3.5 Abbreviations. Abbreviations are in accordance with ASME Y14.38.

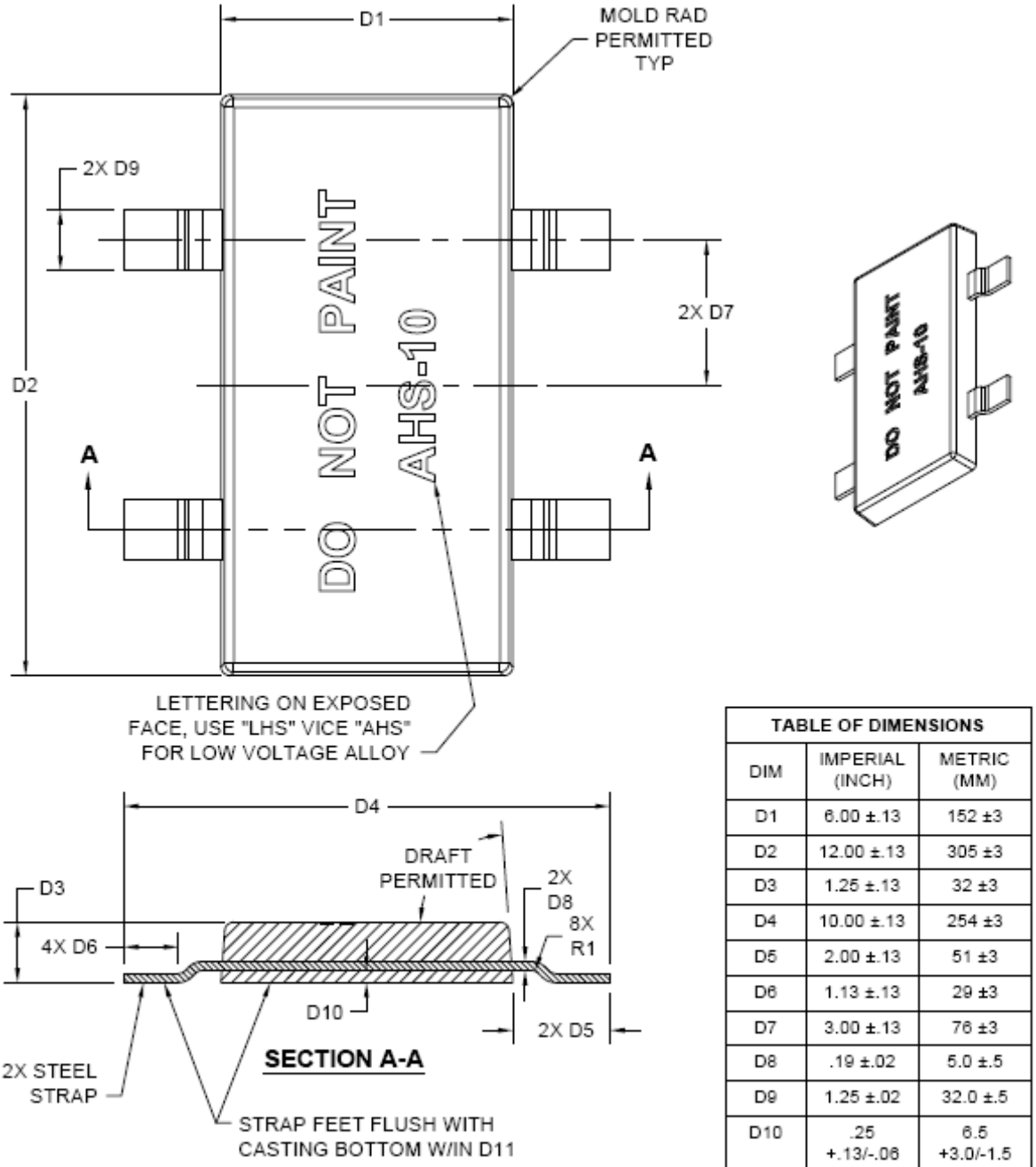


TABLE OF DIMENSIONS		
DIM	IMPERIAL (INCH)	METRIC (MM)
D1	6.00 ±.13	152 ±3
D2	12.00 ±.13	305 ±3
D3	1.25 ±.13	32 ±3
D4	10.00 ±.13	254 ±3
D5	2.00 ±.13	51 ±3
D6	1.13 ±.13	29 ±3
D7	3.00 ±.13	76 ±3
D8	.19 ±.02	5.0 ±.5
D9	1.25 ±.02	32.0 ±.5
D10	.25 +.13/-.06	6.5 +3.0/-1.5
D11	±.06	±1.5
R1	.18 MIN	4.5 MIN

SKETCH A1: HULL SLAB (STEEL STRAPS), 1.25" THICK, TYPE AHS-10 OR LHS-10
MINIMUM WEIGHT = 9.1 LB / 4.1 KG

FIGURE A-1. Aluminum hull slab (steel straps), type AHS-10/LHS-10.

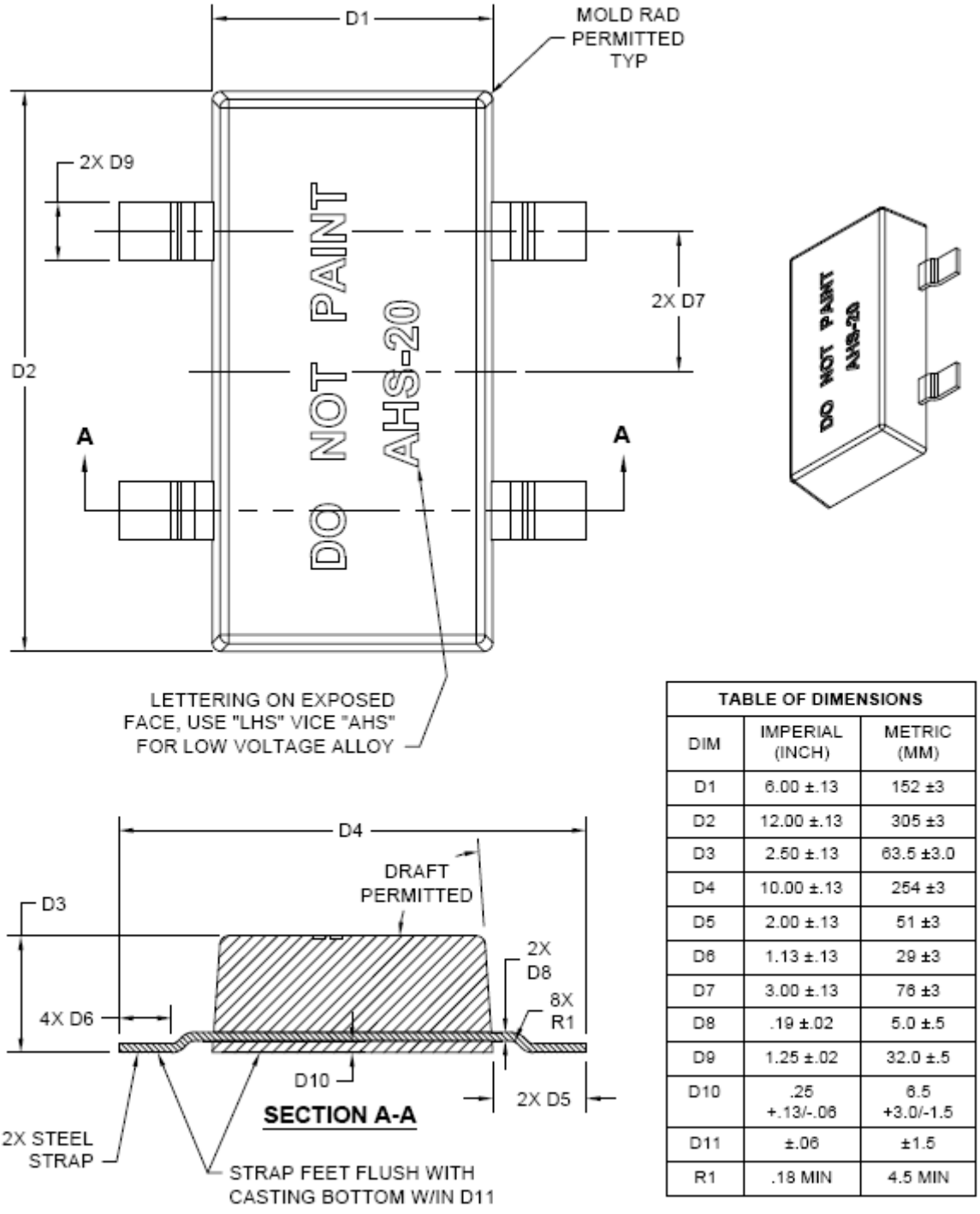


TABLE OF DIMENSIONS		
DIM	IMPERIAL (INCH)	METRIC (MM)
D1	6.00 ±.13	152 ±3
D2	12.00 ±.13	305 ±3
D3	2.50 ±.13	63.5 ±3.0
D4	10.00 ±.13	254 ±3
D5	2.00 ±.13	51 ±3
D6	1.13 ±.13	29 ±3
D7	3.00 ±.13	76 ±3
D8	.19 ±.02	5.0 ±.5
D9	1.25 ±.02	32.0 ±.5
D10	.25 +.13/-.06	6.5 +3.0/-1.5
D11	±.06	±1.5
R1	.18 MIN	4.5 MIN

SKETCH A2: HULL SLAB (STEEL STRAPS), 2.50" THICK, TYPE AHS-20 OR LHS-20
MINIMUM WEIGHT = 17.2 LB / 7.8 KG

FIGURE A-2. Aluminum hull slab (steel straps), type AHS-20/LHS-20.

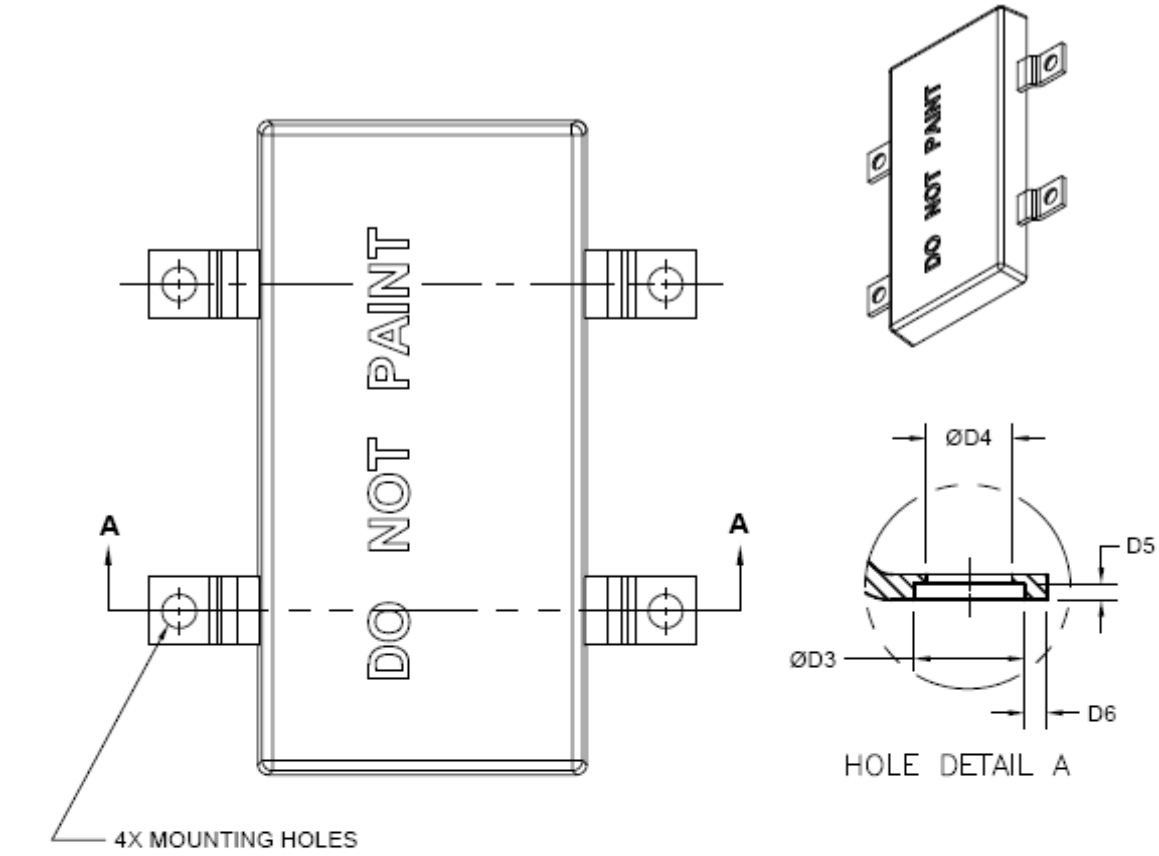


TABLE OF DIMENSIONS		
DIM	IMPERIAL (INCH)	METRIC (MM)
D1	0.56 ±.06	14.3 ±1.5
D2	8.88 ±.06	225.4 ±1.5
D3	0.81 +.06/-.00	20.6 +1.5/-.0
D4	0.625 +.030/-.000	16.0 +.8/-.0
D5	0.12 ±.02	3.0 ±.5
D6	0.08 MIN	2.0 MIN

SKETCH A3: HULL SLAB (STEEL STRAPS), OPTIONAL MOUNTING HOLES WITH 90° COUNTERBORES

1. SEE SKETCH A1 OR A2 FOR OTHER ANODE DIMENSIONS.
2. MOUNTING HOLES AND COUNTERBORES SHALL ONLY BE PROVIDED WHEN SPECIFIED.

FIGURE A-3. Aluminum hull slab (steel straps), type AHS/LHS with 90 degree counterbore.

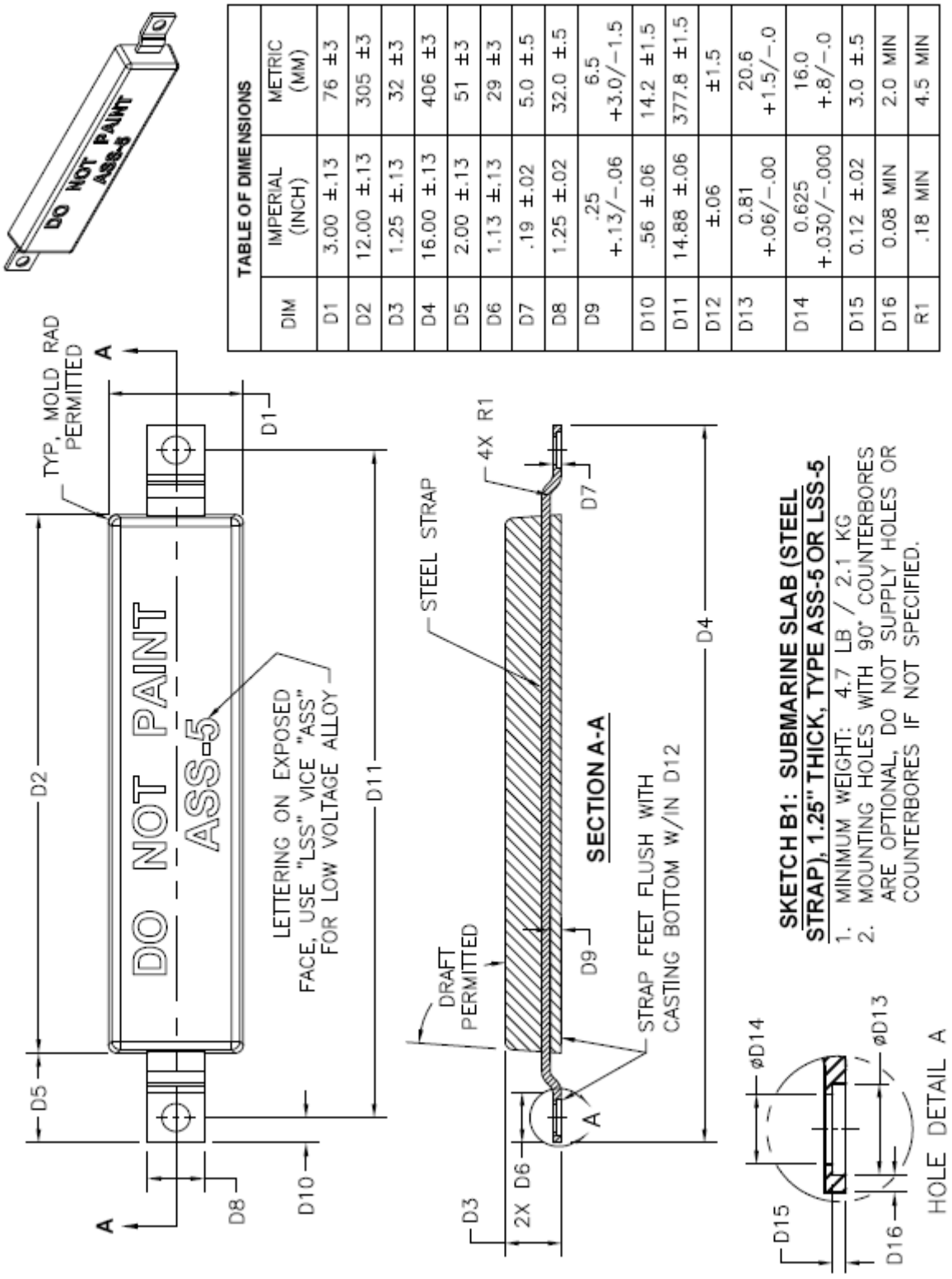


TABLE OF DIMENSIONS		
DIM	IMPERIAL (INCH)	METRIC (MM)
D1	3.00 ±.13	76 ±3
D2	12.00 ±.13	305 ±3
D3	1.25 ±.13	32 ±3
D4	16.00 ±.13	406 ±3
D5	2.00 ±.13	51 ±3
D6	1.13 ±.13	29 ±3
D7	.19 ±.02	5.0 ±.5
D8	1.25 ±.02	32.0 ±.5
D9	.25 +.13/−.06	6.5 +3.0/−1.5
D10	.56 ±.06	14.2 ±1.5
D11	14.88 ±.06	377.8 ±1.5
D12	±.06	±1.5
D13	0.81 +.06/−.00	20.6 +1.5/−.0
D14	0.625 +.030/−.000	16.0 +.8/−.0
D15	0.12 ±.02	3.0 ±.5
D16	0.08 MIN	2.0 MIN
R1	.18 MIN	4.5 MIN

FIGURE A-4. Aluminum, submarine slab (steel strap), type ASS-5/LSS-5.

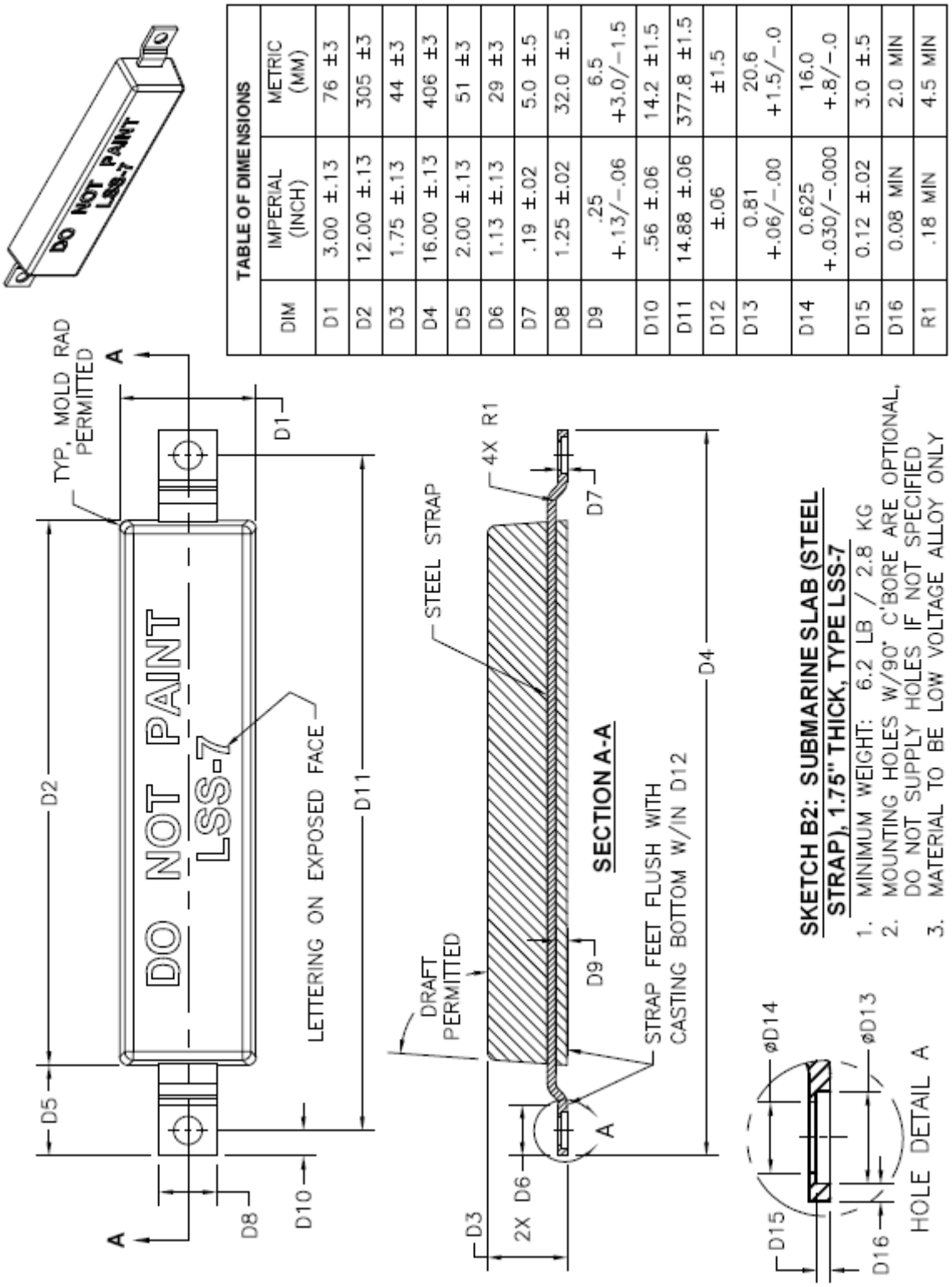


TABLE OF DIMENSIONS		
DIM	IMPERIAL (INCH)	METRIC (MM)
D1	3.00 ±.13	76 ±3
D2	12.00 ±.13	305 ±3
D3	1.75 ±.13	44 ±3
D4	16.00 ±.13	406 ±3
D5	2.00 ±.13	51 ±3
D6	1.13 ±.13	29 ±3
D7	.19 ±.02	5.0 ±.5
D8	1.25 ±.02	32.0 ±.5
D9	.25 +.13/−.06	6.5 +3.0/−1.5
D10	.56 ±.06	14.2 ±1.5
D11	14.88 ±.06	377.8 ±1.5
D12	±.06	±1.5
D13	0.81 +.06/−.00	20.6 +1.5/−.0
D14	0.625 +.030/−.000	16.0 +.8/−.0
D15	0.12 ±.02	3.0 ±.5
D16	0.08 MIN	2.0 MIN
R1	.18 MIN	4.5 MIN

This low voltage anode shall be used in applications where equivalent ampere-hour of corresponding zinc anode (ZSS-12) is required.

FIGURE A-5. Aluminum, submarine slab (steel strap), type LSS-7.

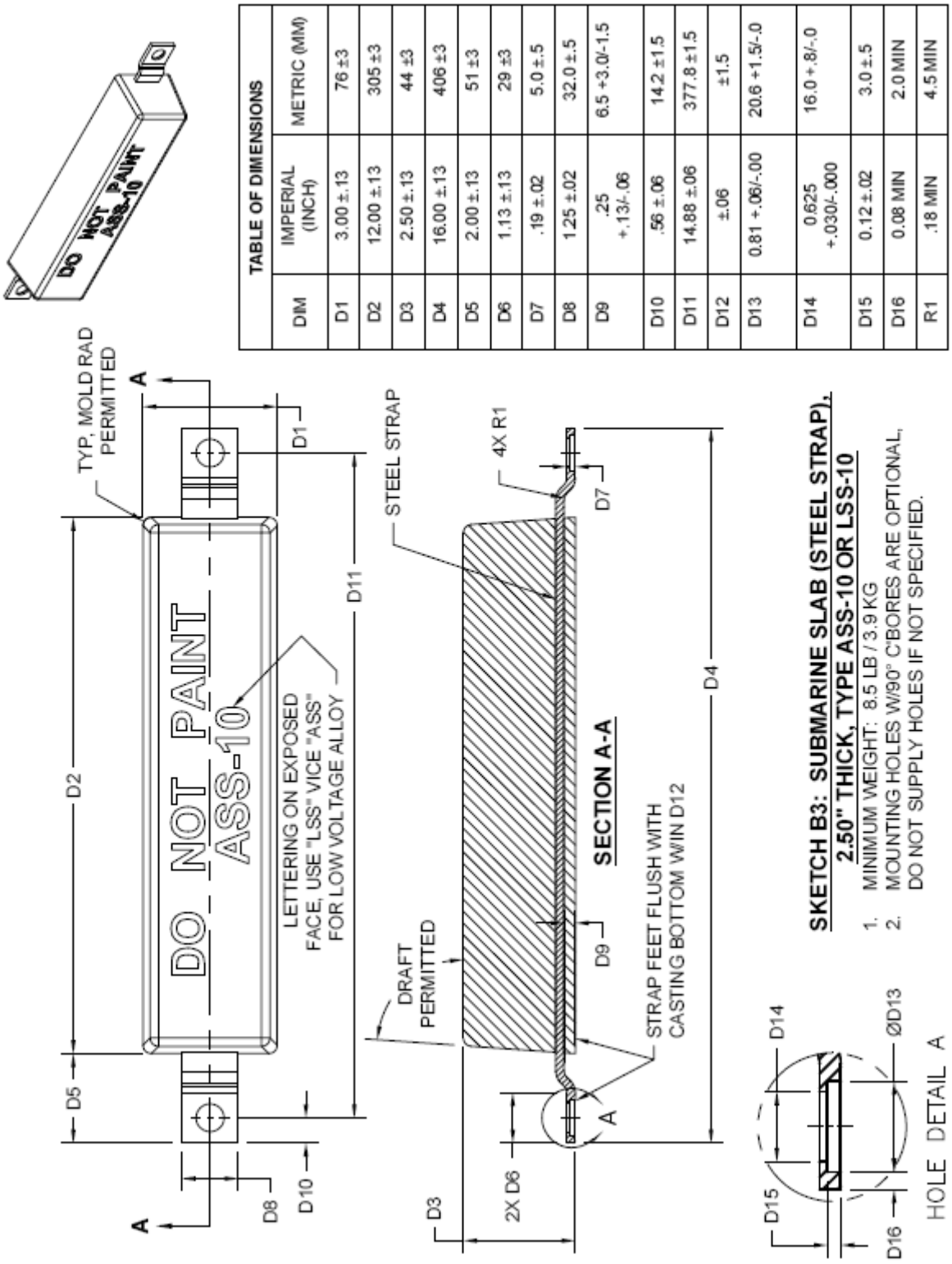


TABLE OF DIMENSIONS		
DIM	IMPERIAL (INCH)	METRIC (MM)
D1	3.00 ±.13	76 ±3
D2	12.00 ±.13	305 ±3
D3	2.50 ±.13	44 ±3
D4	16.00 ±.13	406 ±3
D5	2.00 ±.13	51 ±3
D6	1.13 ±.13	29 ±3
D7	.19 ±.02	5.0 ±.5
D8	1.25 ±.02	32.0 ±.5
D9	.25 +.13/-.06	6.5 +3.0/-1.5
D10	.56 ±.06	14.2 ±1.5
D11	14.88 ±.06	377.8 ±1.5
D12	±.06	±1.5
D13	0.81 +.06/-.00	20.6 +1.5/-.0
D14	0.625 +.030/-.000	16.0 +.8/-.0
D15	0.12 ±.02	3.0 ±.5
D16	0.08 MIN	2.0 MIN
R1	.18 MIN	4.5 MIN

FIGURE A-6. Aluminum, submarine (steel strap), type ASS-10/LSS-10.

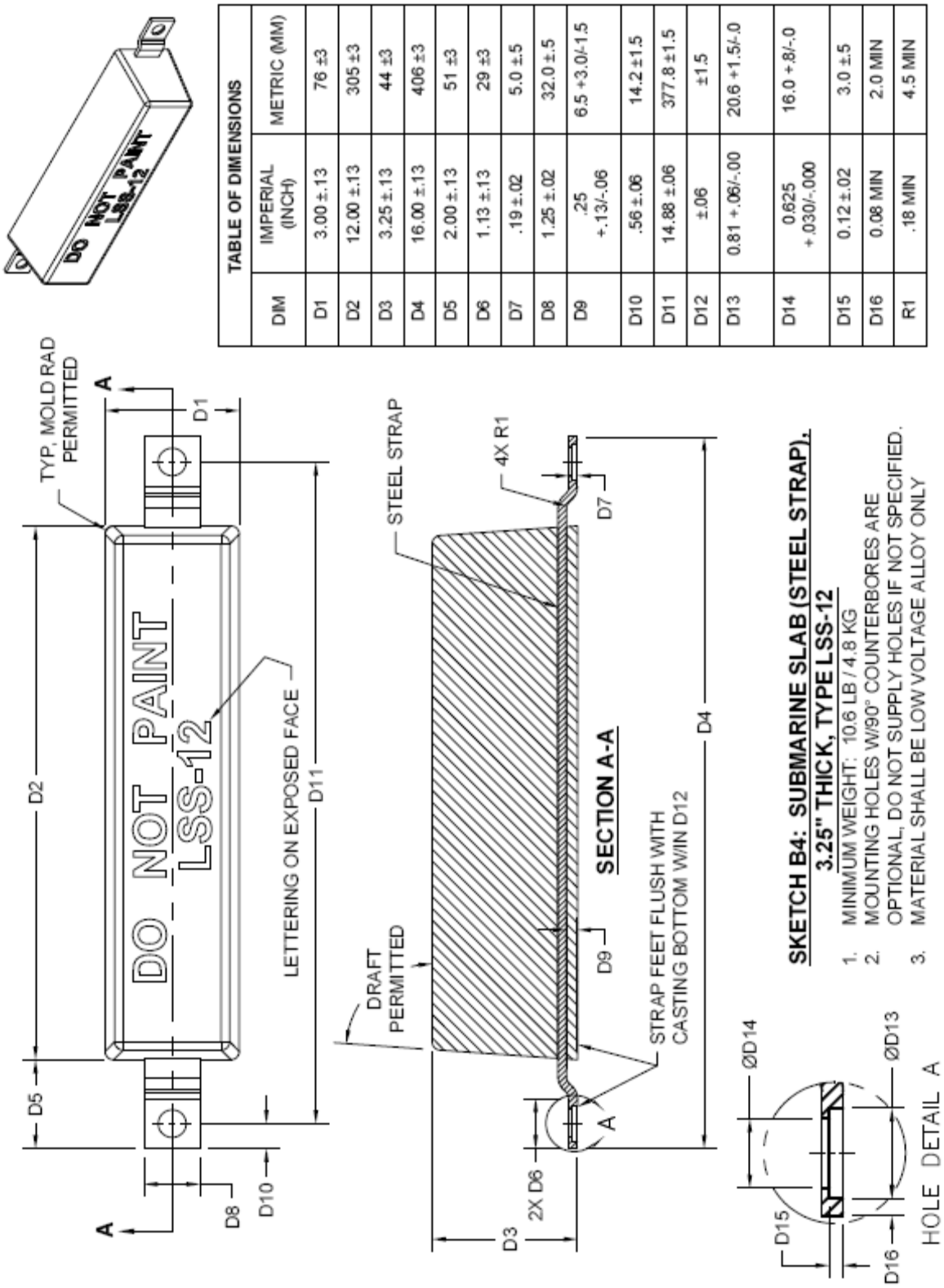


TABLE OF DIMENSIONS		
DIM	IMPERIAL (INCH)	METRIC (MM)
D1	3.00 ±.13	76 ±3
D2	12.00 ±.13	305 ±3
D3	3.25 ±.13	44 ±3
D4	16.00 ±.13	406 ±3
D5	2.00 ±.13	51 ±3
D6	1.13 ±.13	29 ±3
D7	.19 ±.02	5.0 ±.5
D8	1.25 ±.02	32.0 ±.5
D9	.25 +.13/-.06	6.5 +3.0/-1.5
D10	.56 ±.06	14.2 ±1.5
D11	14.88 ±.06	377.8 ±1.5
D12	±.06	±1.5
D13	0.81 +.06/-.00	20.6 +1.5/-.0
D14	0.625 +.030/-.000	16.0 +.8/-.0
D15	0.12 ±.02	3.0 ±.5
D16	0.08 MIN	2.0 MIN
R1	.18 MIN	4.5 MIN

This low voltage anode shall be used in applications where equivalent ampere-hour of corresponding zinc anode (ZSS-24) is required.

FIGURE A-7. Aluminum, submarine (steel strap), type LSS-12.

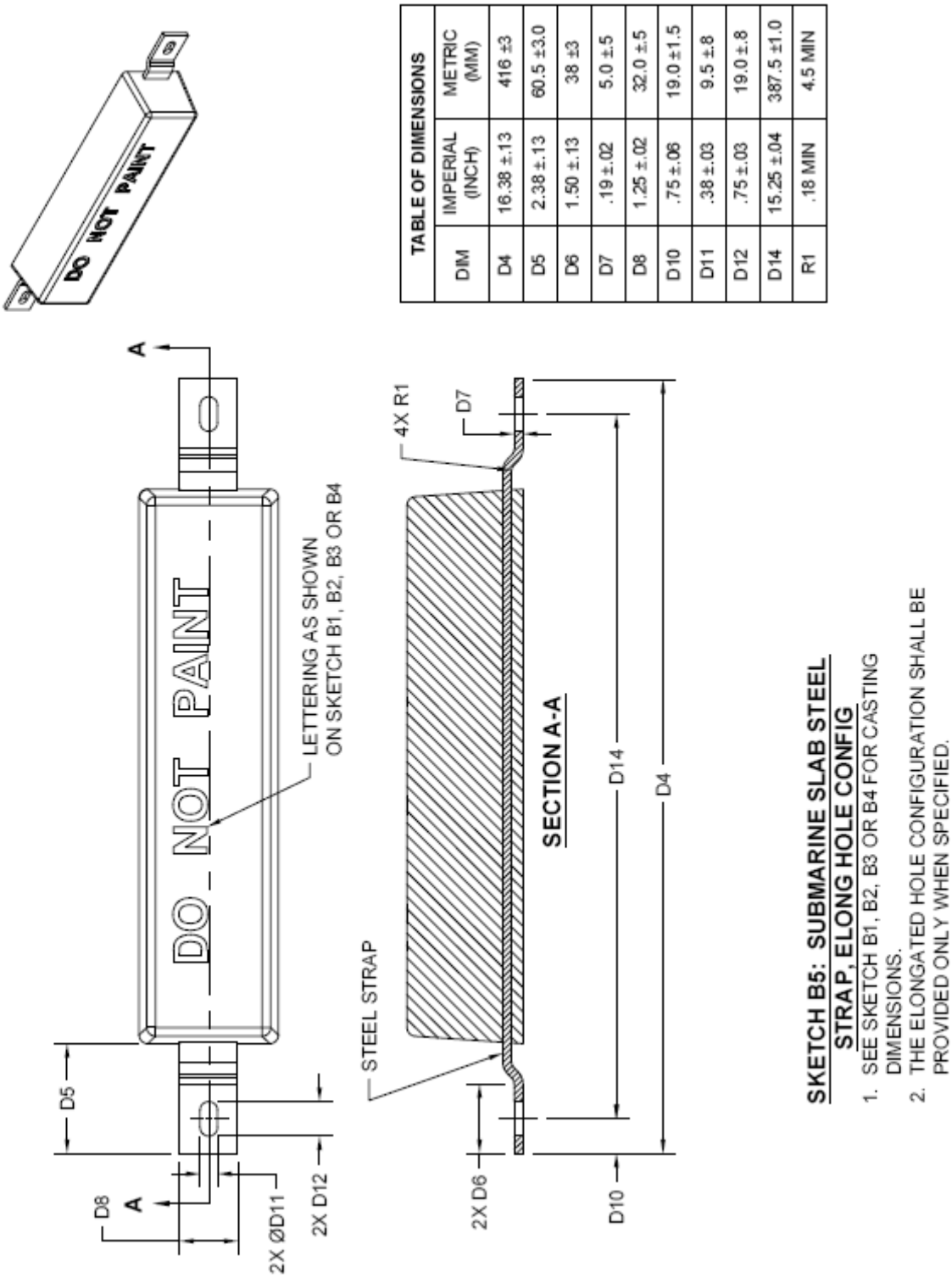


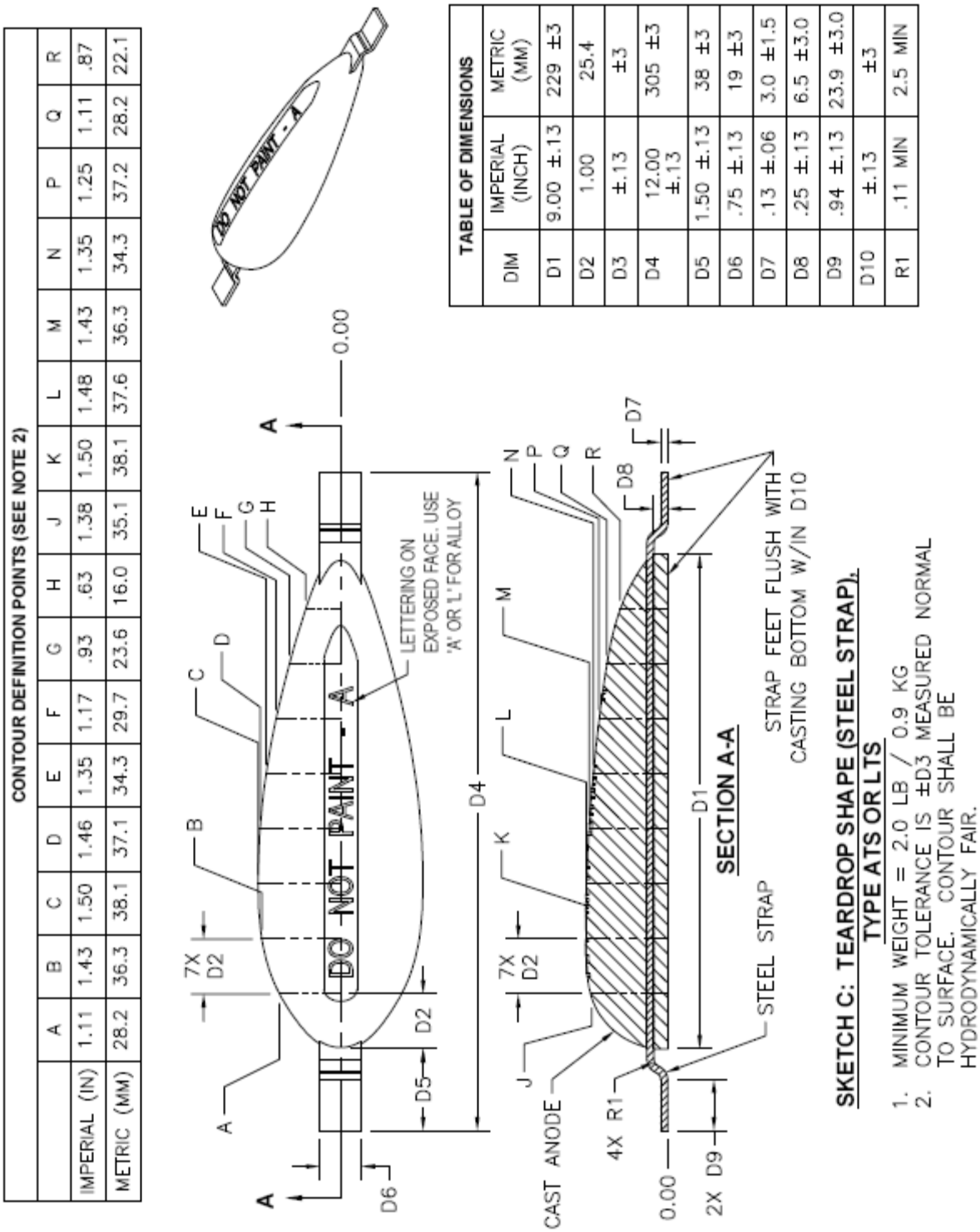
FIGURE A-8. Aluminum, submarine slab (steel strap) type ASS/LSS with elongated stud hole.

CONTOUR DEFINITION POINTS (SEE NOTE 2)

	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
IMPERIAL (IN)	1.11	1.43	1.50	1.46	1.35	1.17	.93	.63	1.38	1.50	1.48	1.43	1.35	1.25	1.11	.87
METRIC (MM)	28.2	36.3	38.1	37.1	34.3	29.7	23.6	16.0	35.1	38.1	37.6	36.3	34.3	37.2	28.2	22.1

TABLE OF DIMENSIONS

DIM	IMPERIAL (INCH)	METRIC (MM)
D1	9.00 ±.13	229 ±3
D2	1.00	25.4
D3	±.13	±3
D4	12.00 ±.13	305 ±3
D5	1.50 ±.13	38 ±3
D6	.75 ±.13	19 ±3
D7	.13 ±.06	3.0 ±1.5
D8	.25 ±.13	6.5 ±3.0
D9	.94 ±.13	23.9 ±3.0
D10	±.13	±3
R1	.11 MIN	2.5 MIN



SKETCH C: TEARDROP SHAPE (STEEL STRAP), TYPE ATS OR LTS

1. MINIMUM WEIGHT = 2.0 LB / 0.9 KG
2. CONTOUR TOLERANCE IS ±D3 MEASURED NORMAL TO SURFACE. CONTOUR SHALL BE HYDRODYNAMICALLY FAIR.

FIGURE A-9. Aluminum, teardrop (steel strap) type ATS/LTS.

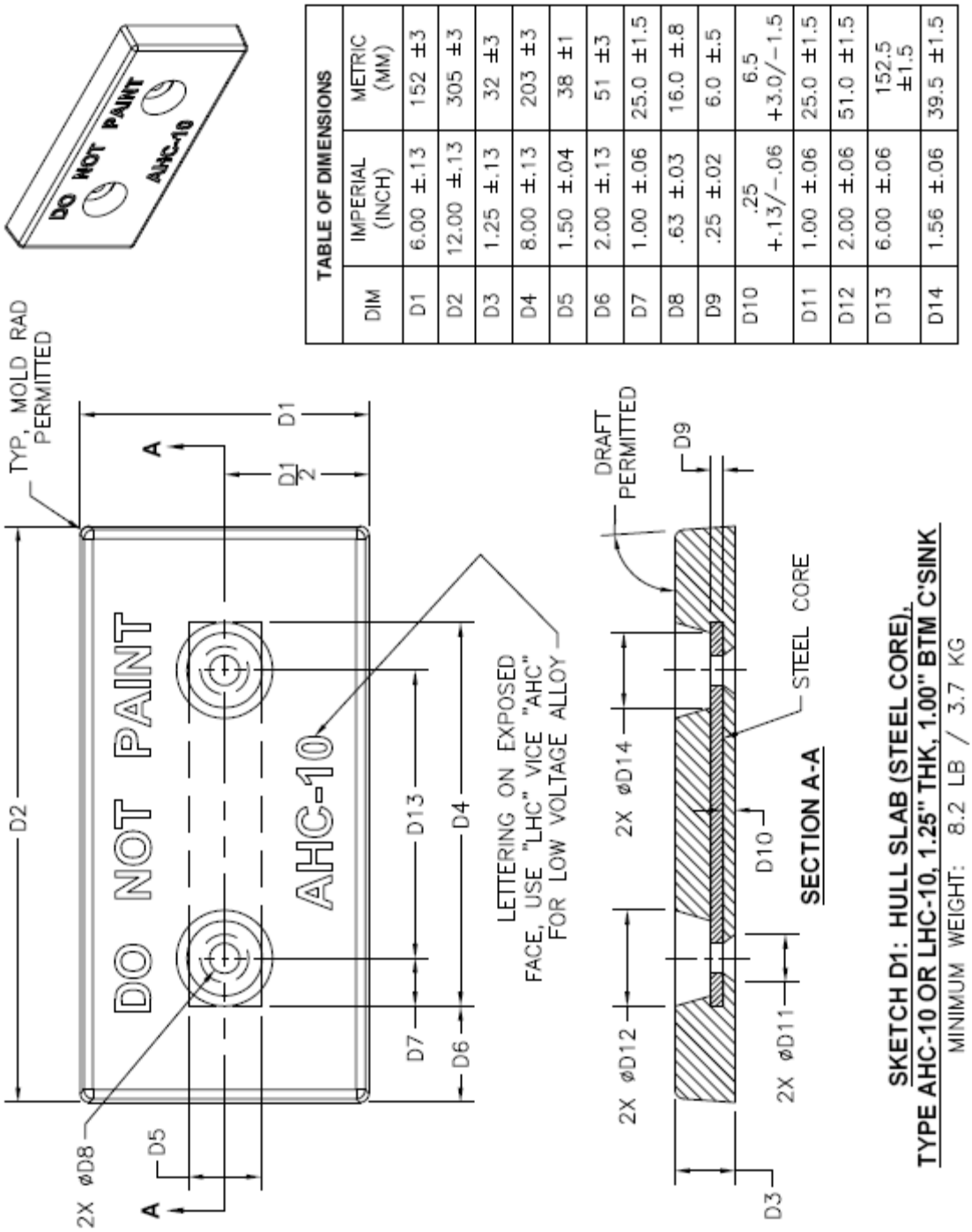


TABLE OF DIMENSIONS		
DIM	IMPERIAL (INCH)	METRIC (MM)
D1	6.00 ±.13	152 ±3
D2	12.00 ±.13	305 ±3
D3	1.25 ±.13	32 ±3
D4	8.00 ±.13	203 ±3
D5	1.50 ±.04	38 ±1
D6	2.00 ±.13	51 ±3
D7	1.00 ±.06	25.0 ±1.5
D8	.63 ±.03	16.0 ±.8
D9	.25 ±.02	6.0 ±.5
D10	.25 +.13/−.06	6.5 +3.0/−1.5
D11	1.00 ±.06	25.0 ±1.5
D12	2.00 ±.06	51.0 ±1.5
D13	6.00 ±.06	152.5 ±1.5
D14	1.56 ±.06	39.5 ±1.5

FIGURE A-10. Aluminum hull slab (steel strap), type AHC-10/LHC-10.

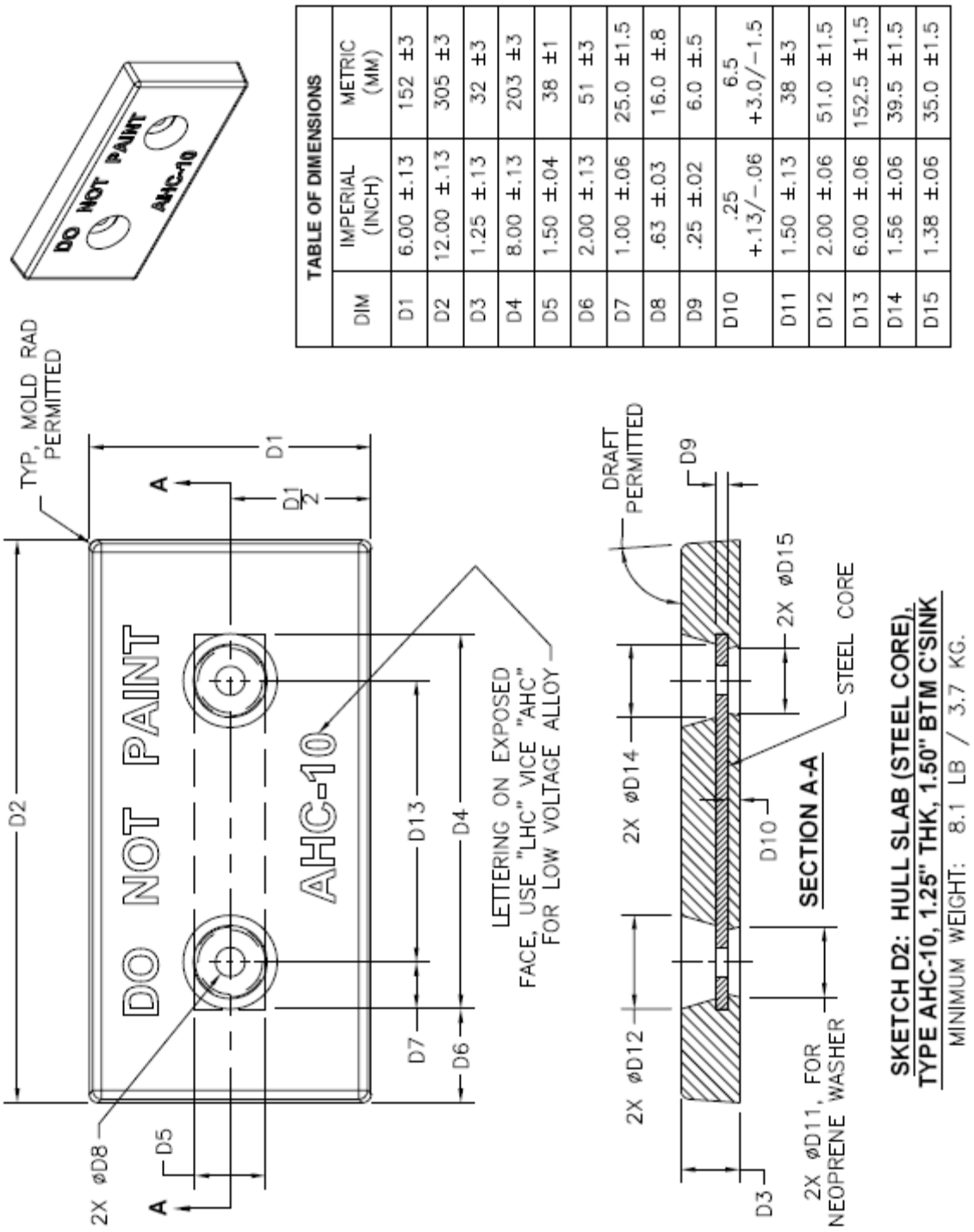


TABLE OF DIMENSIONS		
DIM	IMPERIAL (INCH)	METRIC (MM)
D1	6.00 ±.13	152 ±3
D2	12.00 ±.13	305 ±3
D3	1.25 ±.13	32 ±3
D4	8.00 ±.13	203 ±3
D5	1.50 ±.04	38 ±1
D6	2.00 ±.13	51 ±3
D7	1.00 ±.06	25.0 ±1.5
D8	.63 ±.03	16.0 ±.8
D9	.25 ±.02	6.0 ±.5
D10	.25 +.13/−.06	6.5 +3.0/−1.5
D11	1.50 ±.13	38 ±3
D12	2.00 ±.06	51.0 ±1.5
D13	6.00 ±.06	152.5 ±1.5
D14	1.56 ±.06	39.5 ±1.5
D15	1.38 ±.06	35.0 ±1.5

FIGURE A-11. Aluminum hull slab (steel core), type AHC-10/LHC-10 with countersink for neoprene washer.

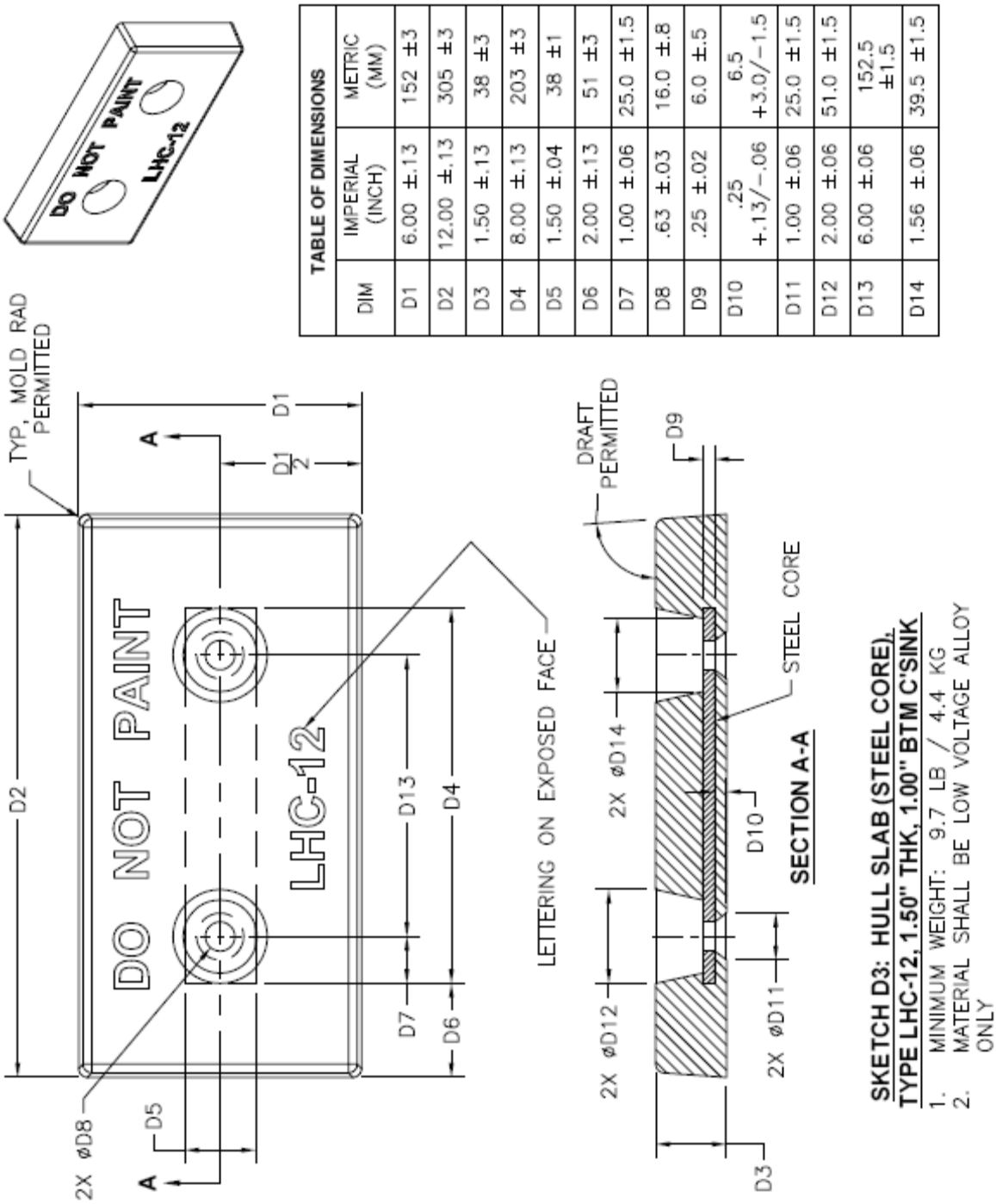


TABLE OF DIMENSIONS		
DIM	IMPERIAL (INCH)	METRIC (MM)
D1	6.00 ±.13	152 ±3
D2	12.00 ±.13	305 ±3
D3	1.50 ±.13	38 ±3
D4	8.00 ±.13	203 ±3
D5	1.50 ±.04	38 ±1
D6	2.00 ±.13	51 ±3
D7	1.00 ±.06	25.0 ±1.5
D8	.63 ±.03	16.0 ±.8
D9	.25 ±.02	6.0 ±.5
D10	.25 +.13/−.06	6.5 +3.0/−1.5
D11	1.00 ±.06	25.0 ±1.5
D12	2.00 ±.06	51.0 ±1.5
D13	6.00 ±.06	152.5 ±1.5
D14	1.56 ±.06	39.5 ±1.5

This low voltage anode shall be used in applications where equivalent ampere-hour of corresponding zinc anode (ZHC-23) is required.

FIGURE A-12. Aluminum hull slab (steel strap), type LHC-12.

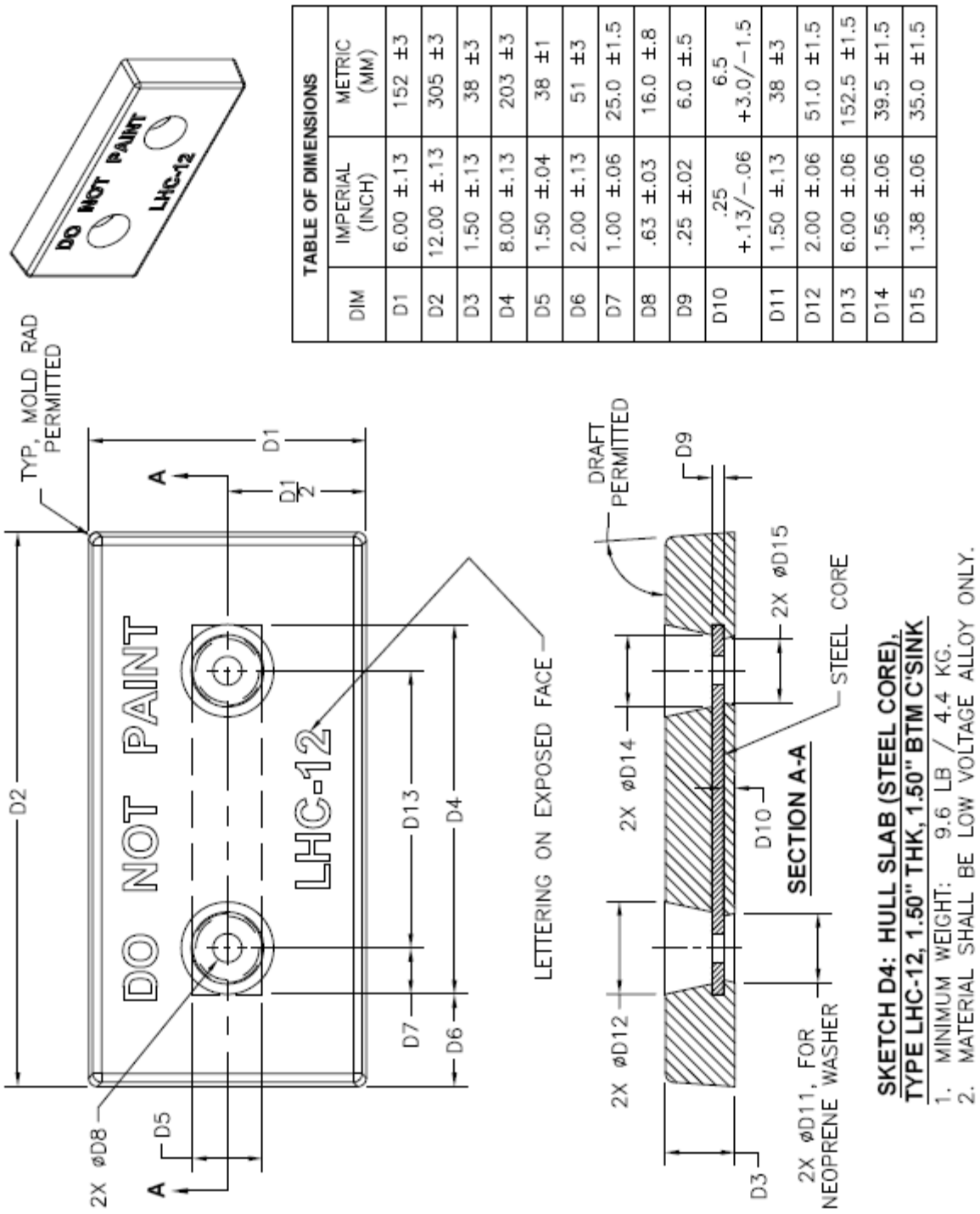


TABLE OF DIMENSIONS		
DIM	IMPERIAL (INCH)	METRIC (MM)
D1	6.00 ±.13	152 ±3
D2	12.00 ±.13	305 ±3
D3	1.50 ±.13	38 ±3
D4	8.00 ±.13	203 ±3
D5	1.50 ±.04	38 ±1
D6	2.00 ±.13	51 ±3
D7	1.00 ±.06	25.0 ±1.5
D8	.63 ±.03	16.0 ±.8
D9	.25 ±.02	6.0 ±.5
D10	.25 +.13/−.06	6.5 +3.0/−1.5
D11	1.50 ±.13	38 ±3
D12	2.00 ±.06	51.0 ±1.5
D13	6.00 ±.06	152.5 ±1.5
D14	1.56 ±.06	39.5 ±1.5
D15	1.38 ±.06	35.0 ±1.5

This low voltage anode shall be used in applications where equivalent ampere-hour of corresponding zinc anode (ZHC-23) is required.

FIGURE A-13. Aluminum hull slab (steel core), type LHC-12 with countersink for neoprene washer.

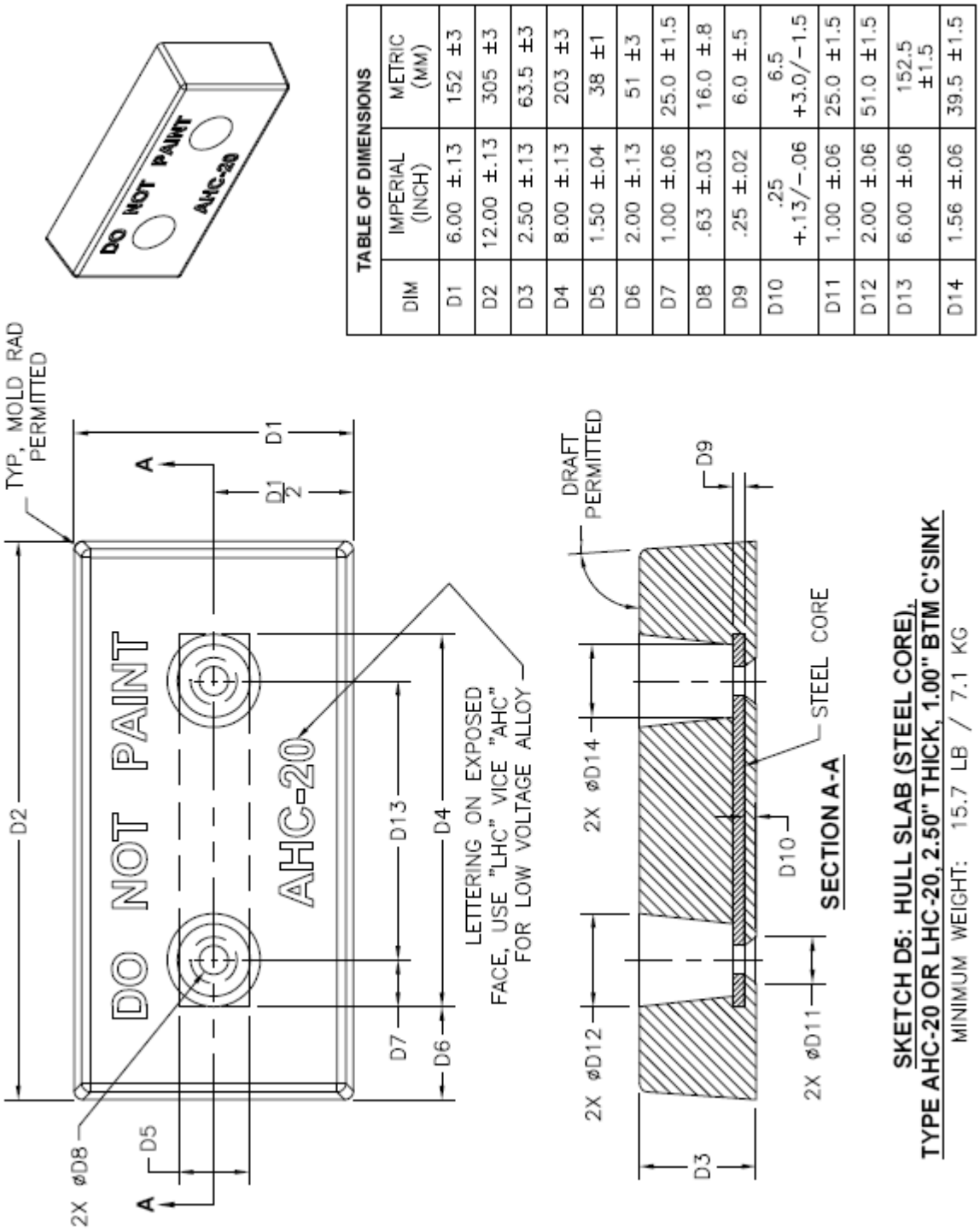


TABLE OF DIMENSIONS		
DIM	IMPERIAL (INCH)	METRIC (MM)
D1	6.00 ±.13	152 ±3
D2	12.00 ±.13	305 ±3
D3	2.50 ±.13	63.5 ±3
D4	8.00 ±.13	203 ±3
D5	1.50 ±.04	38 ±1
D6	2.00 ±.13	51 ±3
D7	1.00 ±.06	25.0 ±1.5
D8	.63 ±.03	16.0 ±.8
D9	.25 ±.02	6.0 ±.5
D10	.25 +.13/−.06	6.5 +3.0/−1.5
D11	1.00 ±.06	25.0 ±1.5
D12	2.00 ±.06	51.0 ±1.5
D13	6.00 ±.06	152.5 ±1.5
D14	1.56 ±.06	39.5 ±1.5

FIGURE A-14. Aluminum hull slab (steel core), type AHC-20/LHC-20.

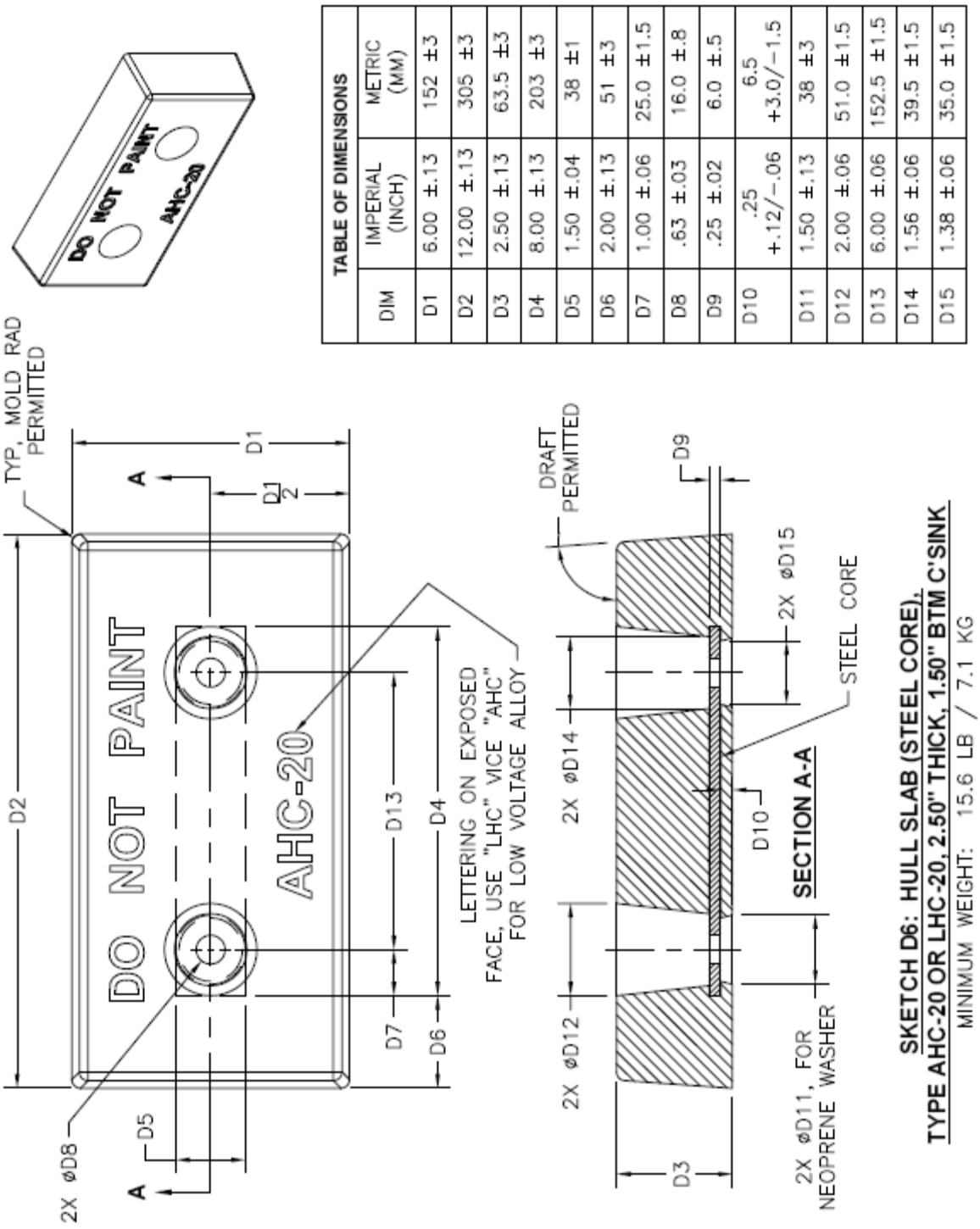


TABLE OF DIMENSIONS		
DIM	IMPERIAL (INCH)	METRIC (MM)
D1	6.00 ±.13	152 ±3
D2	12.00 ±.13	305 ±3
D3	2.50 ±.13	63.5 ±3
D4	8.00 ±.13	203 ±3
D5	1.50 ±.04	38 ±1
D6	2.00 ±.13	51 ±3
D7	1.00 ±.06	25.0 ±1.5
D8	.63 ±.03	16.0 ±.8
D9	.25 ±.02	6.0 ±.5
D10	.25 +.12/−.06	6.5 +3.0/−1.5
D11	1.50 ±.13	38 ±3
D12	2.00 ±.06	51.0 ±1.5
D13	6.00 ±.06	152.5 ±1.5
D14	1.56 ±.06	39.5 ±1.5
D15	1.38 ±.06	35.0 ±1.5

FIGURE A-15. Aluminum hull slab (steel core), type AHC-20/LHC-20 with countersink for neoprene washer.

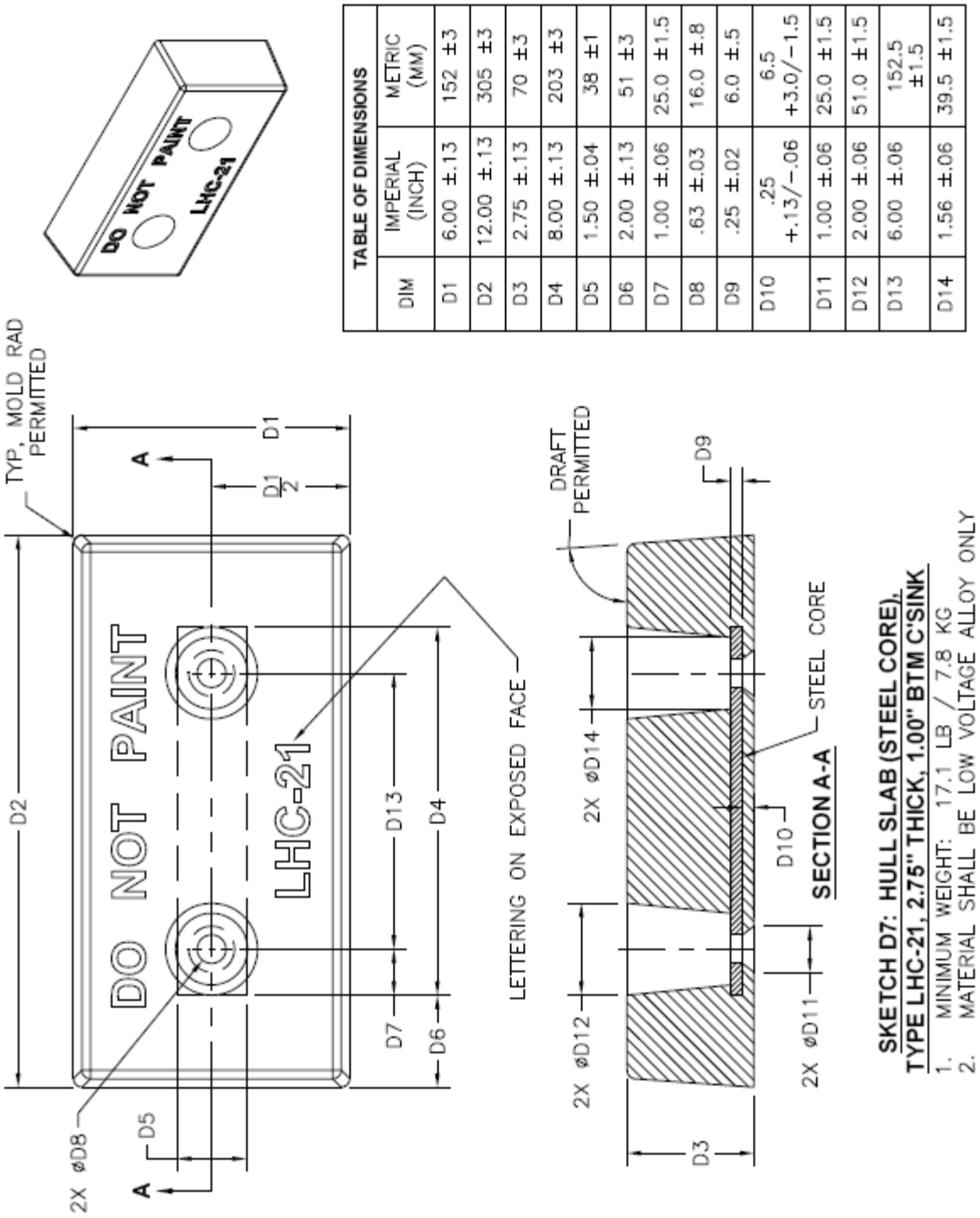


TABLE OF DIMENSIONS		
DIM	IMPERIAL (INCH)	METRIC (MM)
D1	6.00 ±.13	152 ±3
D2	12.00 ±.13	305 ±3
D3	2.75 ±.13	70 ±3
D4	8.00 ±.13	203 ±3
D5	1.50 ±.04	38 ±1
D6	2.00 ±.13	51 ±3
D7	1.00 ±.06	25.0 ±1.5
D8	.63 ±.03	16.0 ±.8
D9	.25 ±.02	6.0 ±.5
D10	.25 +.13/−.06	6.5 +3.0/−1.5
D11	1.00 ±.06	25.0 ±1.5
D12	2.00 ±.06	51.0 ±1.5
D13	6.00 ±.06	152.5 ±1.5
D14	1.56 ±.06	39.5 ±1.5

This low voltage anode shall be used in applications where equivalent ampere-hour of corresponding zinc anode (ZHC-42) is required.

FIGURE A-16. Aluminum hull slab (steel core), type LHC-21.

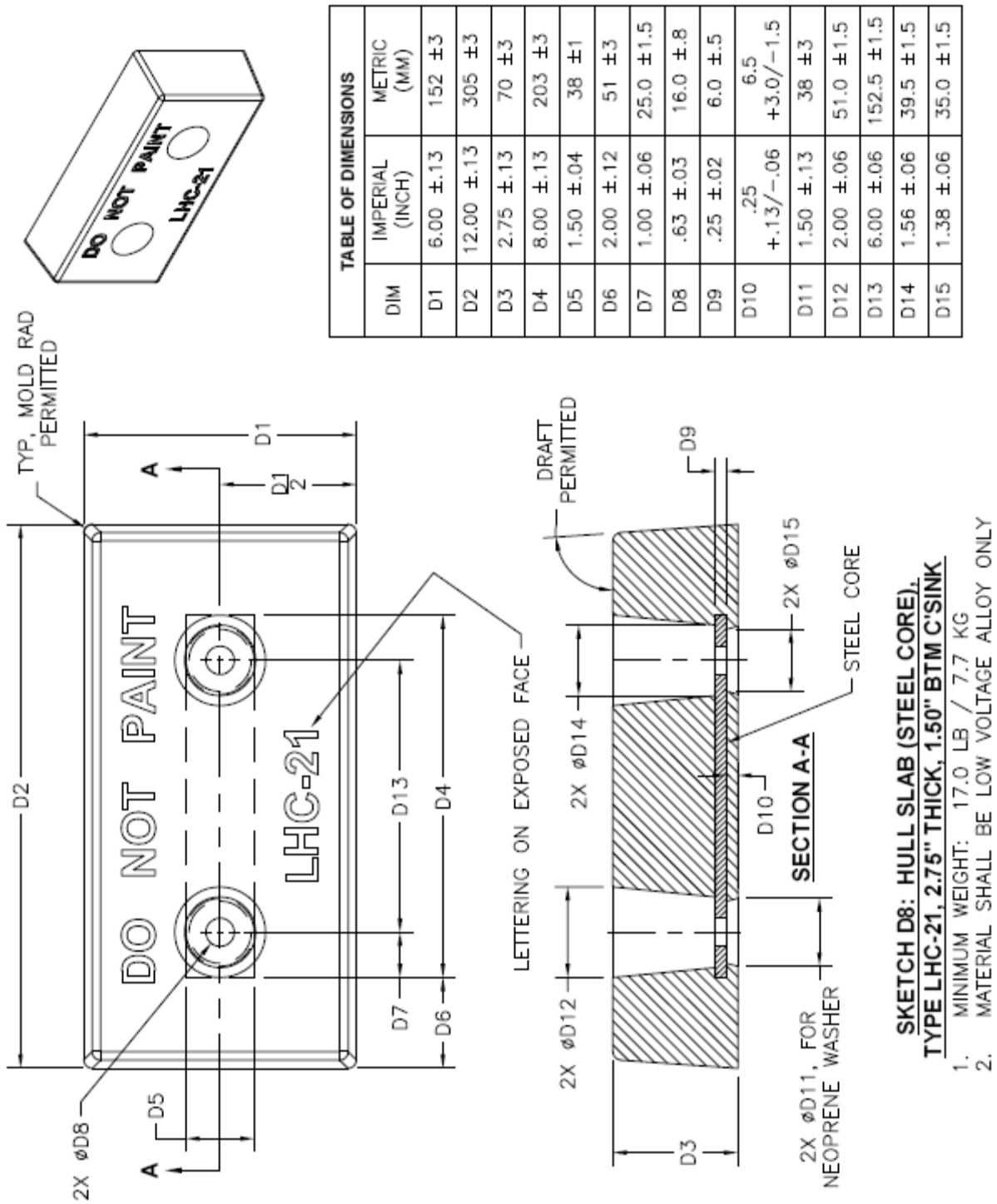


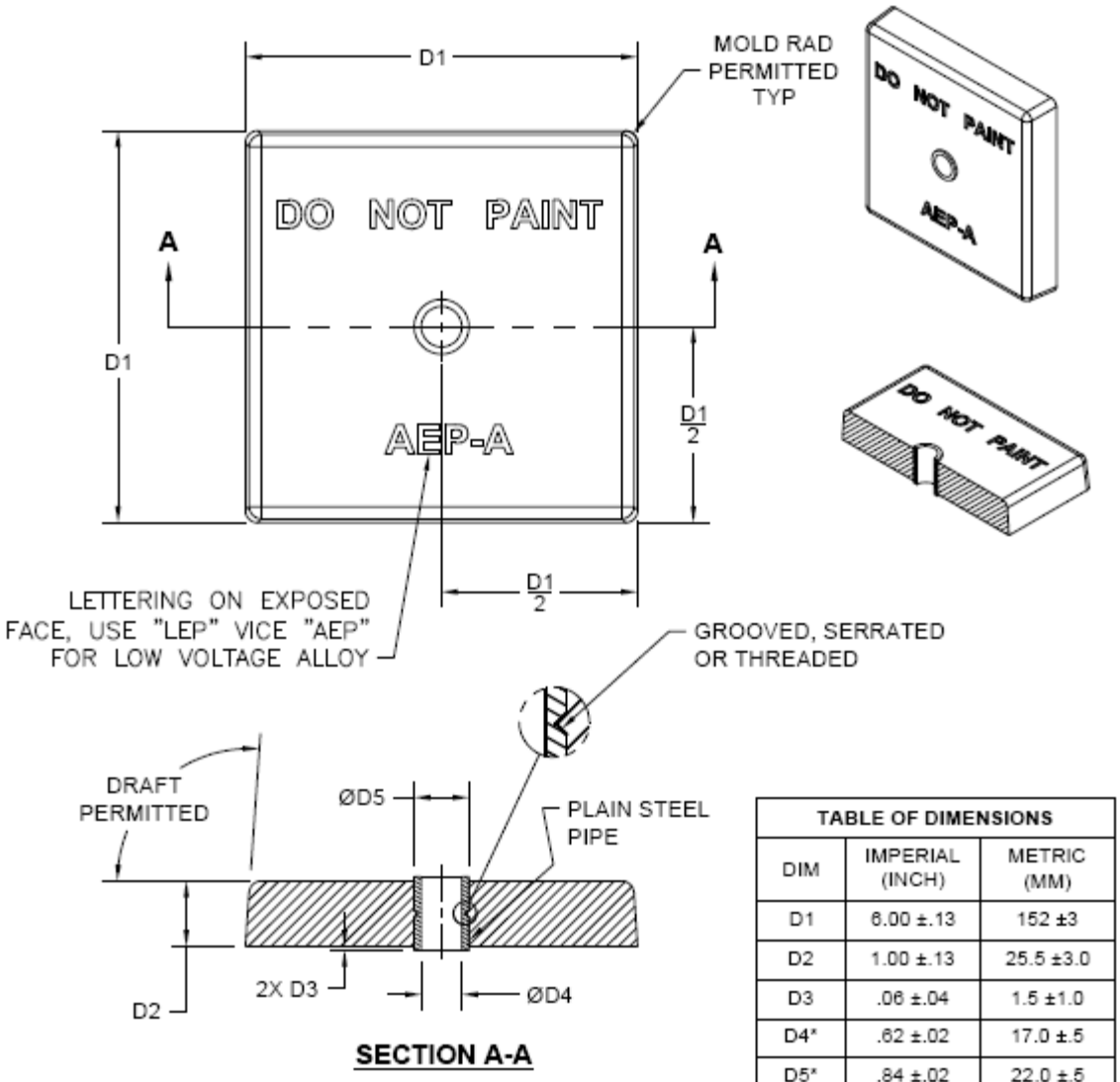
TABLE OF DIMENSIONS		
DIM	IMPERIAL (INCH)	METRIC (MM)
D1	6.00 ±.13	152 ±3
D2	12.00 ±.13	305 ±3
D3	2.75 ±.13	70 ±3
D4	8.00 ±.13	203 ±3
D5	1.50 ±.04	38 ±1
D6	2.00 ±.12	51 ±3
D7	1.00 ±.06	25.0 ±1.5
D8	.63 ±.03	16.0 ±.8
D9	.25 ±.02	6.0 ±.5
D10	.25 +.13/−.06	6.5 +3.0/−1.5
D11	1.50 ±.13	38 ±3
D12	2.00 ±.06	51.0 ±1.5
D13	6.00 ±.06	152.5 ±1.5
D14	1.56 ±.06	39.5 ±1.5
D15	1.38 ±.06	35.0 ±1.5

SKETCH D8: HULL SLAB (STEEL CORE), TYPE LHC-21, 2.75" THICK, 1.50" BTM C'SINK

1. MINIMUM WEIGHT: 17.0 LB / 7.7 KG
2. MATERIAL SHALL BE LOW VOLTAGE ALLOY ONLY

This low voltage anode shall be used in applications where equivalent ampere-hour of corresponding zinc anode (ZHC-42) is required.

FIGURE A-17. Aluminum hull slab (steel core), type LHC-21 with countersink for neoprene washer.



SECTION A-A

TABLE OF DIMENSIONS		
DIM	IMPERIAL (INCH)	METRIC (MM)
D1	6.00 ±.13	152 ±3
D2	1.00 ±.13	25.5 ±3.0
D3	.06 ±.04	1.5 ±1.0
D4*	.62 ±.02	17.0 ±.5
D5*	.84 ±.02	22.0 ±.5

* CORRESPONDS TO ASTM A53 1/2" SCHED 40 OR BS EN 10305-1 22MM STEEL PIPE SIZES.

SKETCH E1: HEAT EXCHANGER SLAB STYLE A (PIPE CORE), TYPE AEP OR LEP, 1.00" THICK

MINIMUM WEIGHT: 3.2 LB / 1.5 KG

FIGURE A-18. Aluminum, heat exchanger slab, pipe core (style A) AEP/LEP.

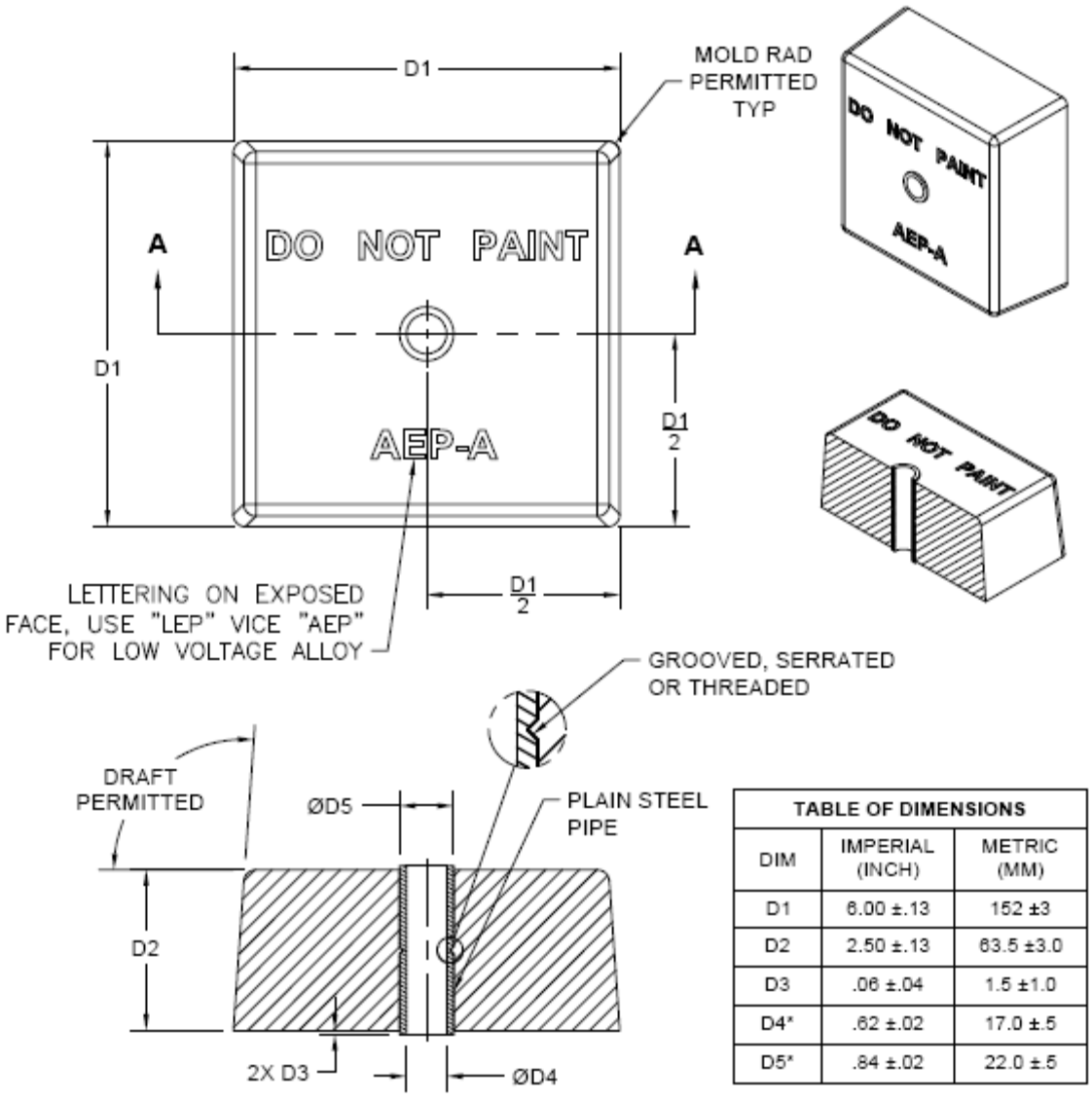


TABLE OF DIMENSIONS		
DIM	IMPERIAL (INCH)	METRIC (MM)
D1	6.00 ±.13	152 ±3
D2	2.50 ±.13	63.5 ±3.0
D3	.06 ±.04	1.5 ±1.0
D4*	.62 ±.02	17.0 ±.5
D5*	.84 ±.02	22.0 ±.5

* CORRESPONDS TO ASTM A53 1/2" SCHED 40 OR BS EN 10305-1 22MM STEEL PIPE SIZES.

SKETCH E2: HEAT EXCHANGER SLAB STYLE A (PIPE CORE), TYPE AEP OR LEP, 2.50" THICK

MINIMUM WEIGHT: 8.0 LB / 3.6 KG

FIGURE A-19. Aluminum, heat exchanger slab, pipe core (style A) AEP/LEP.

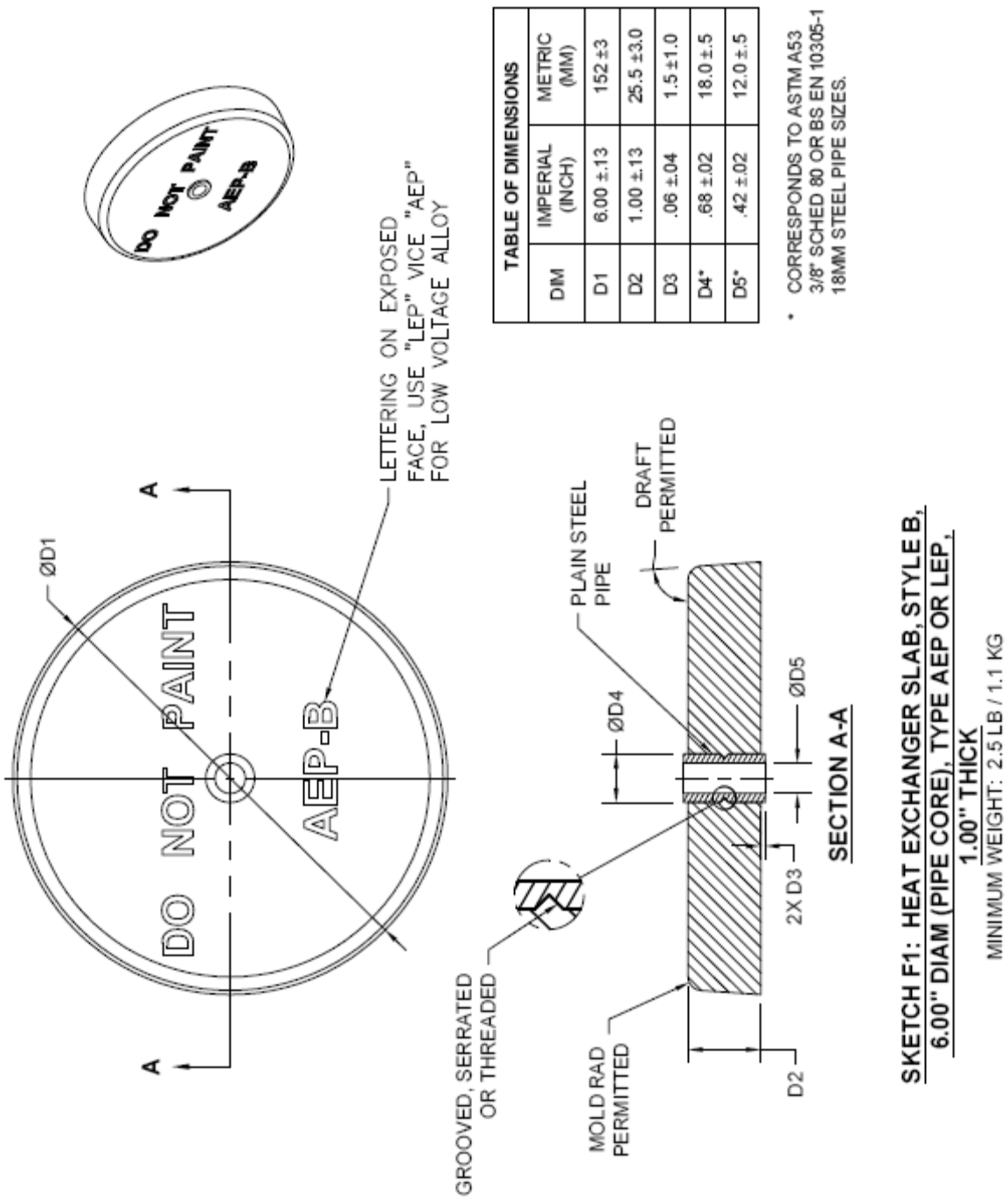


FIGURE A-20. Aluminum, heat exchanger slab, pipe core (style B) AEP/LEP.

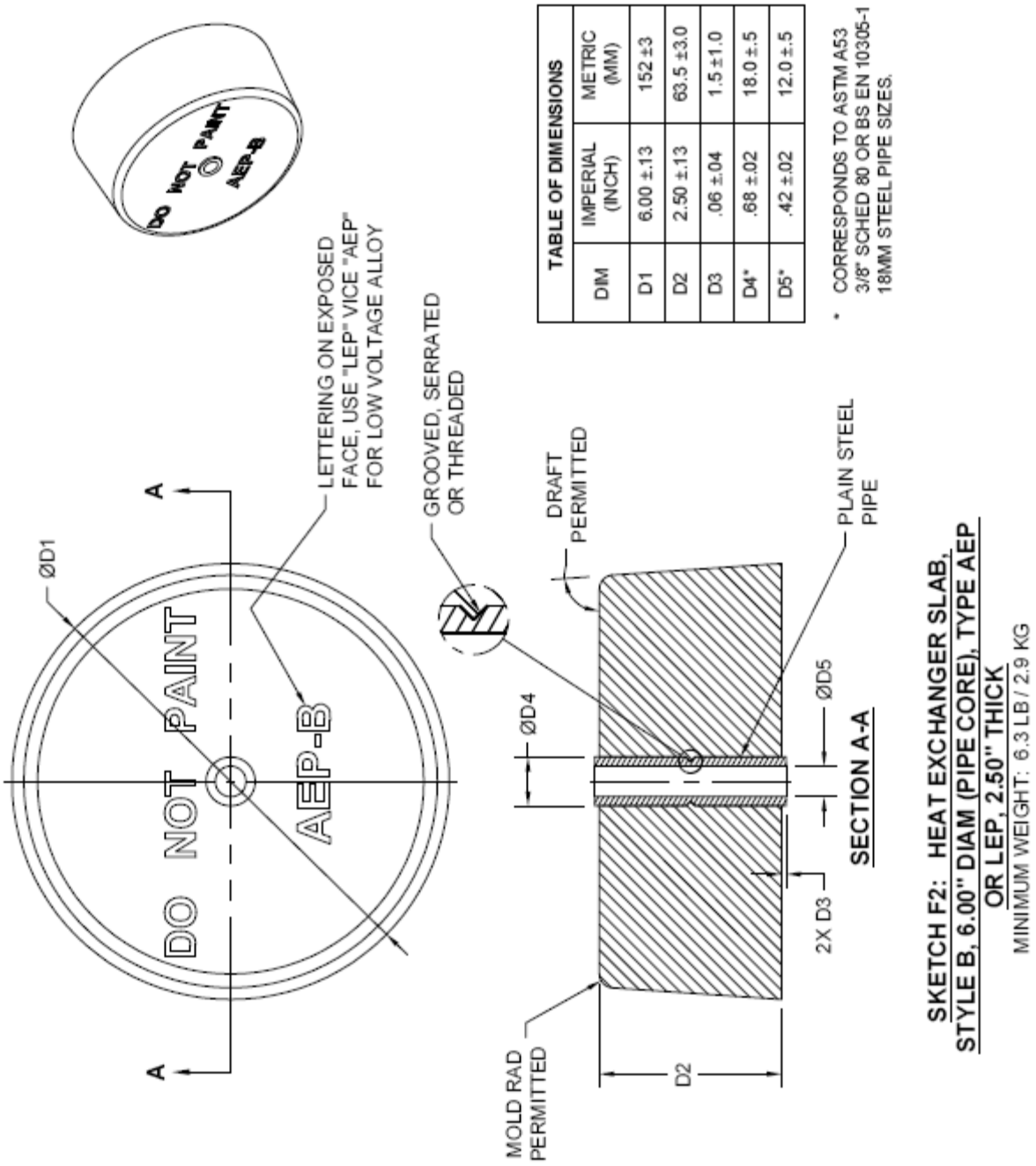


FIGURE A-21. Aluminum, heat exchanger slab, pipe core (style B) AEP/LEP.

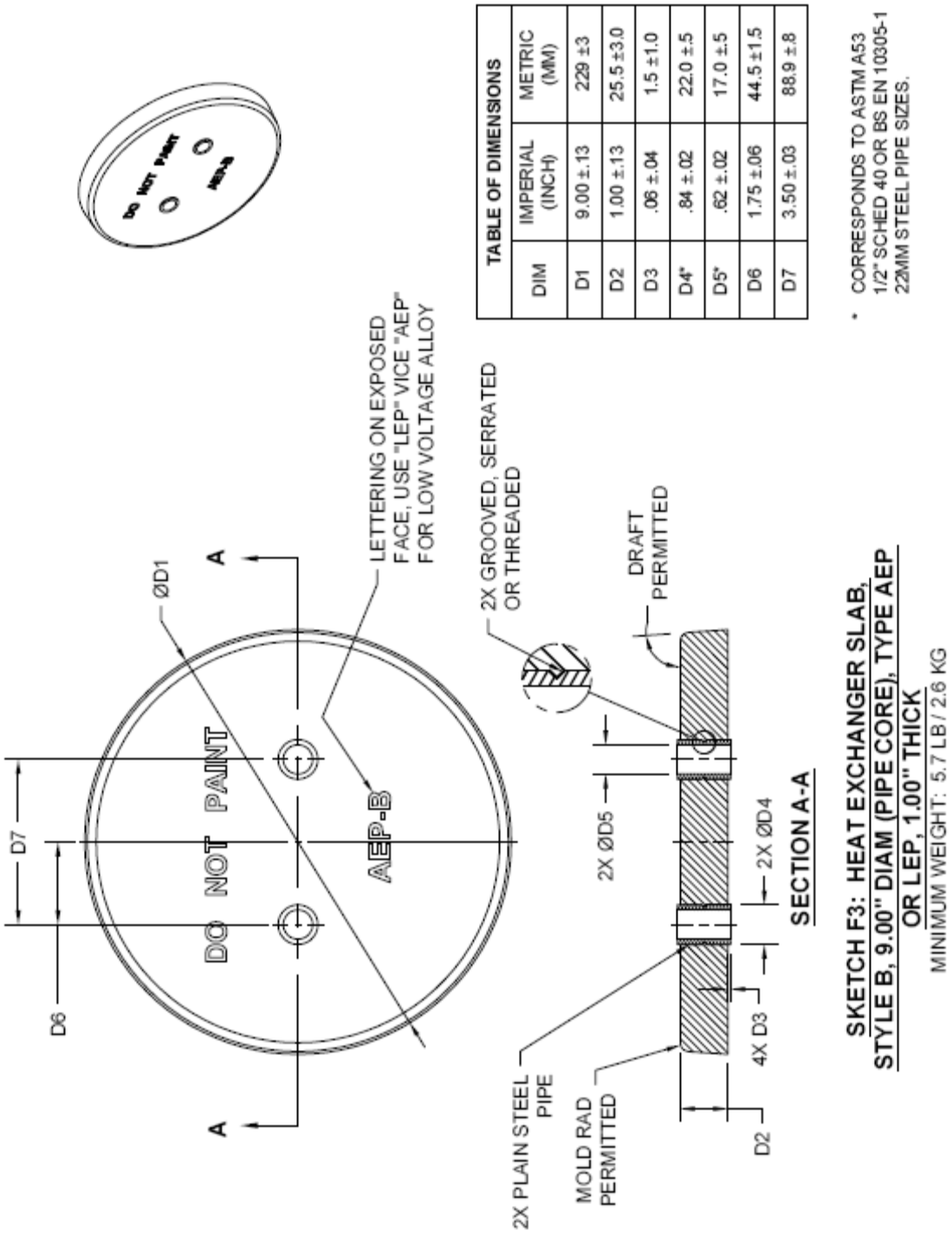


FIGURE A-22. Aluminum, heat exchanger slab, pipe core (style B) AEP/LEP.

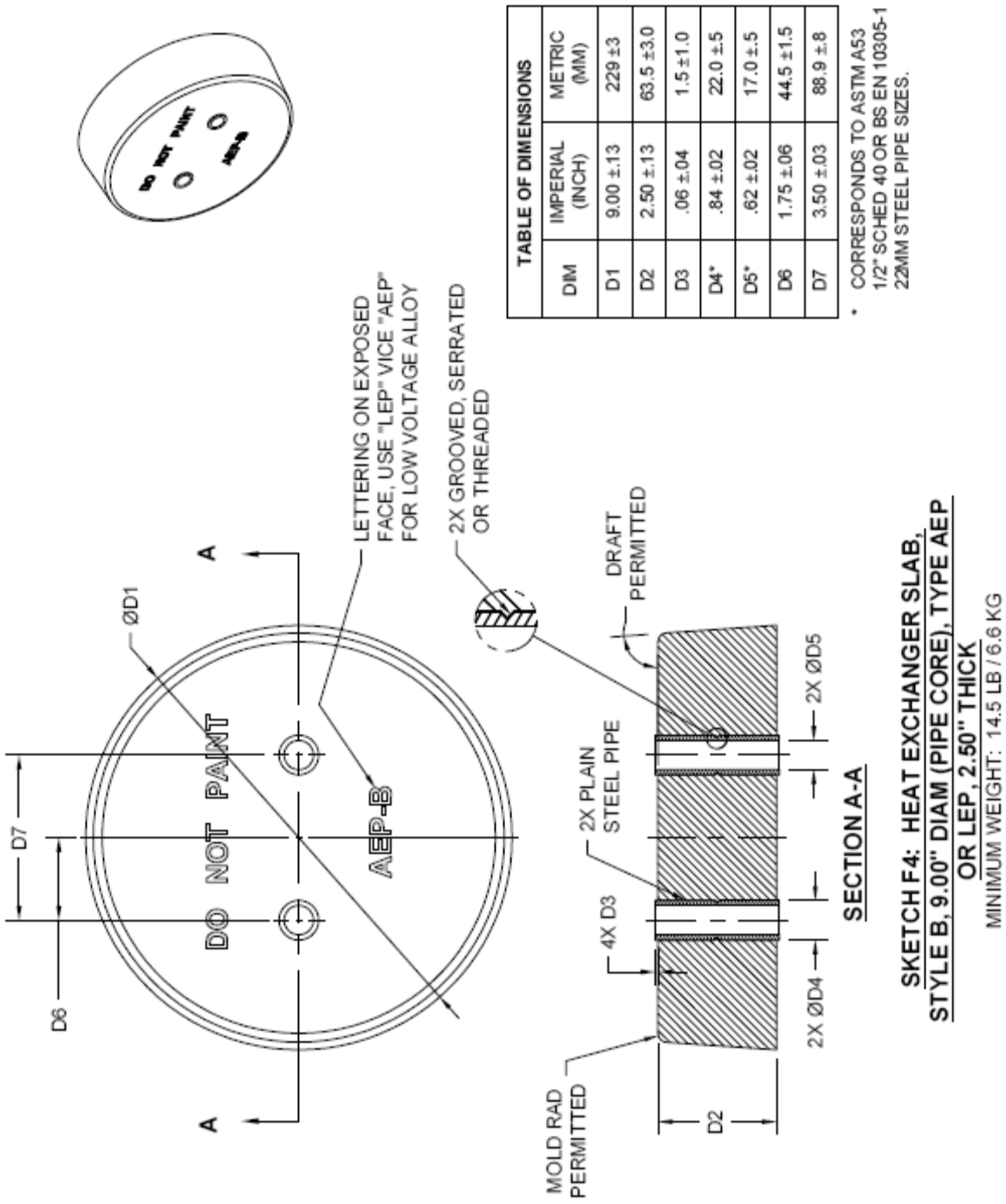


FIGURE A-23. Aluminum, heat exchanger slab, pipe core (style B) AEP/LEP.

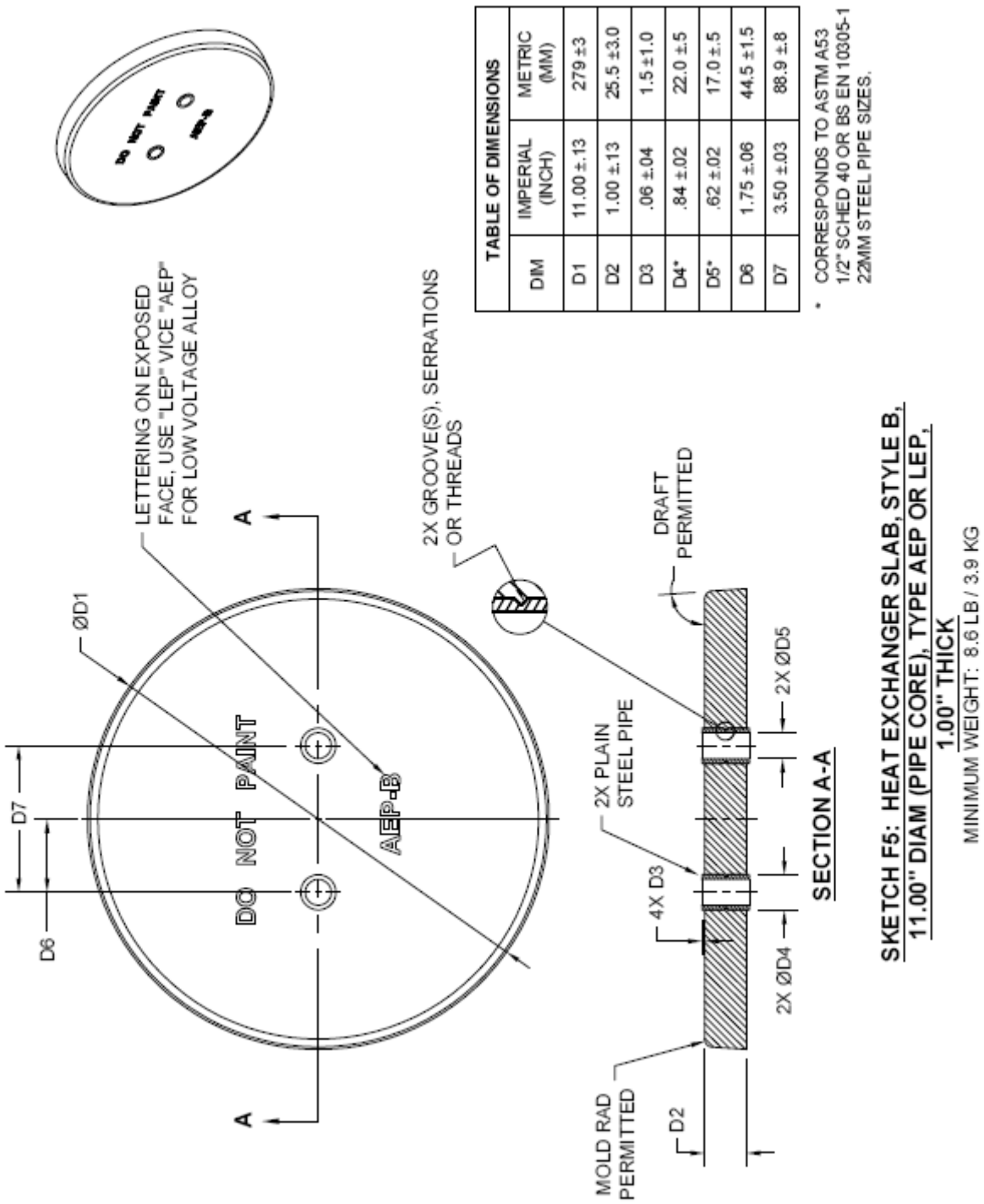


FIGURE A-24. Aluminum, heat exchanger slab, pipe core (style B) AEP/LEP.

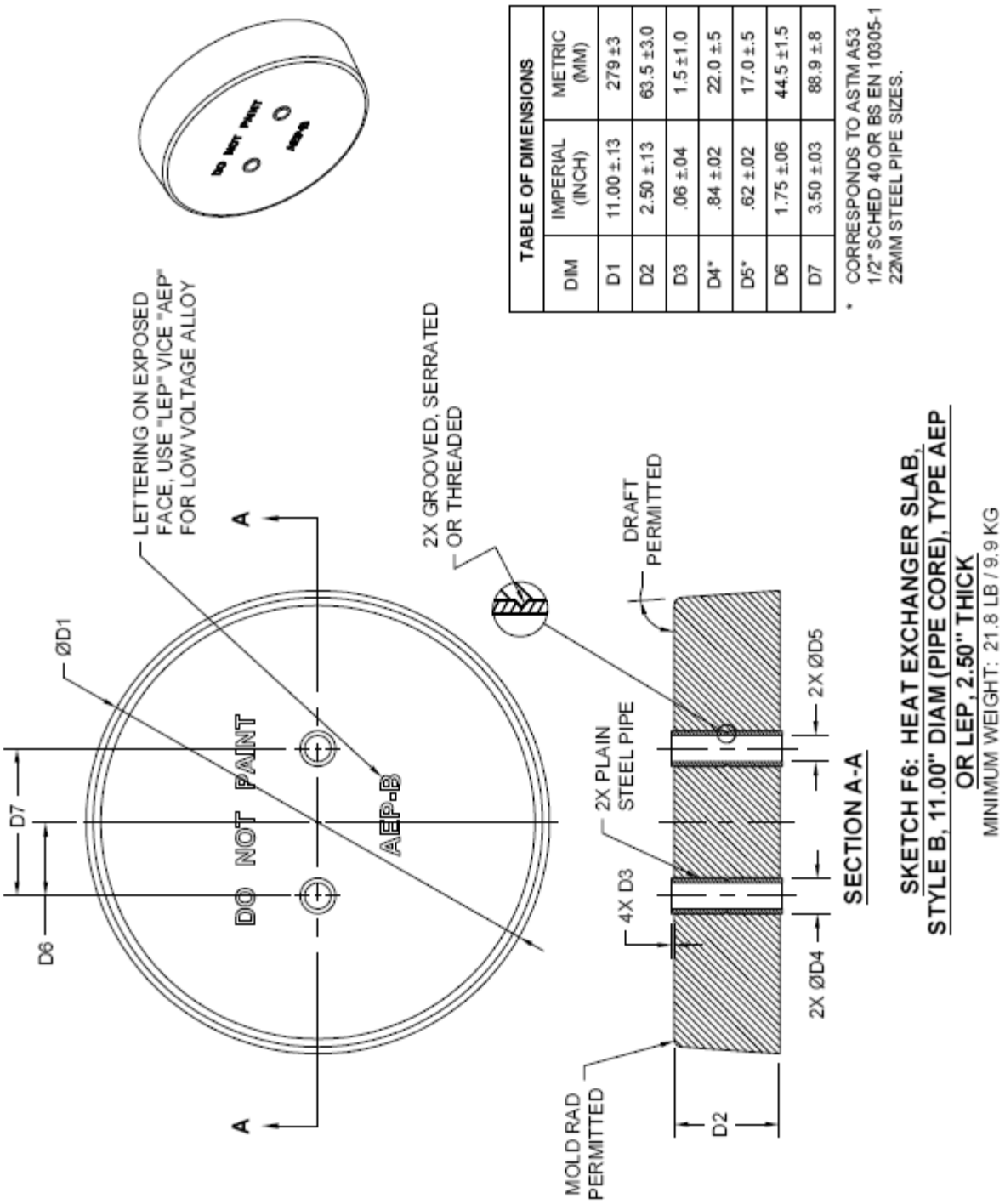


FIGURE A-25. Aluminum, heat exchanger slab, pipe core (style B) AEP/LEP.

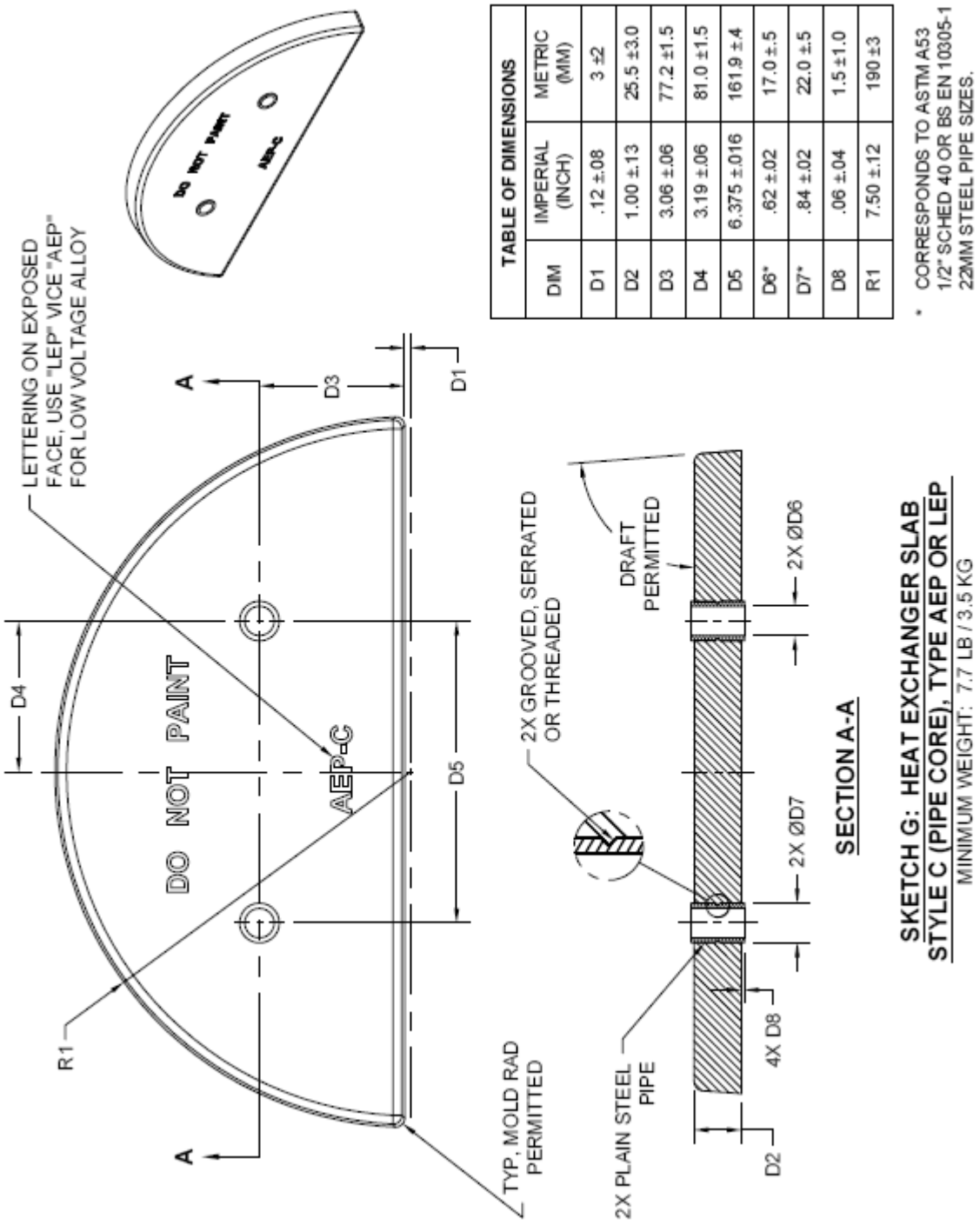


FIGURE A-26. Aluminum, heat exchanger slab, pipe core (style C) AEP/LEP.

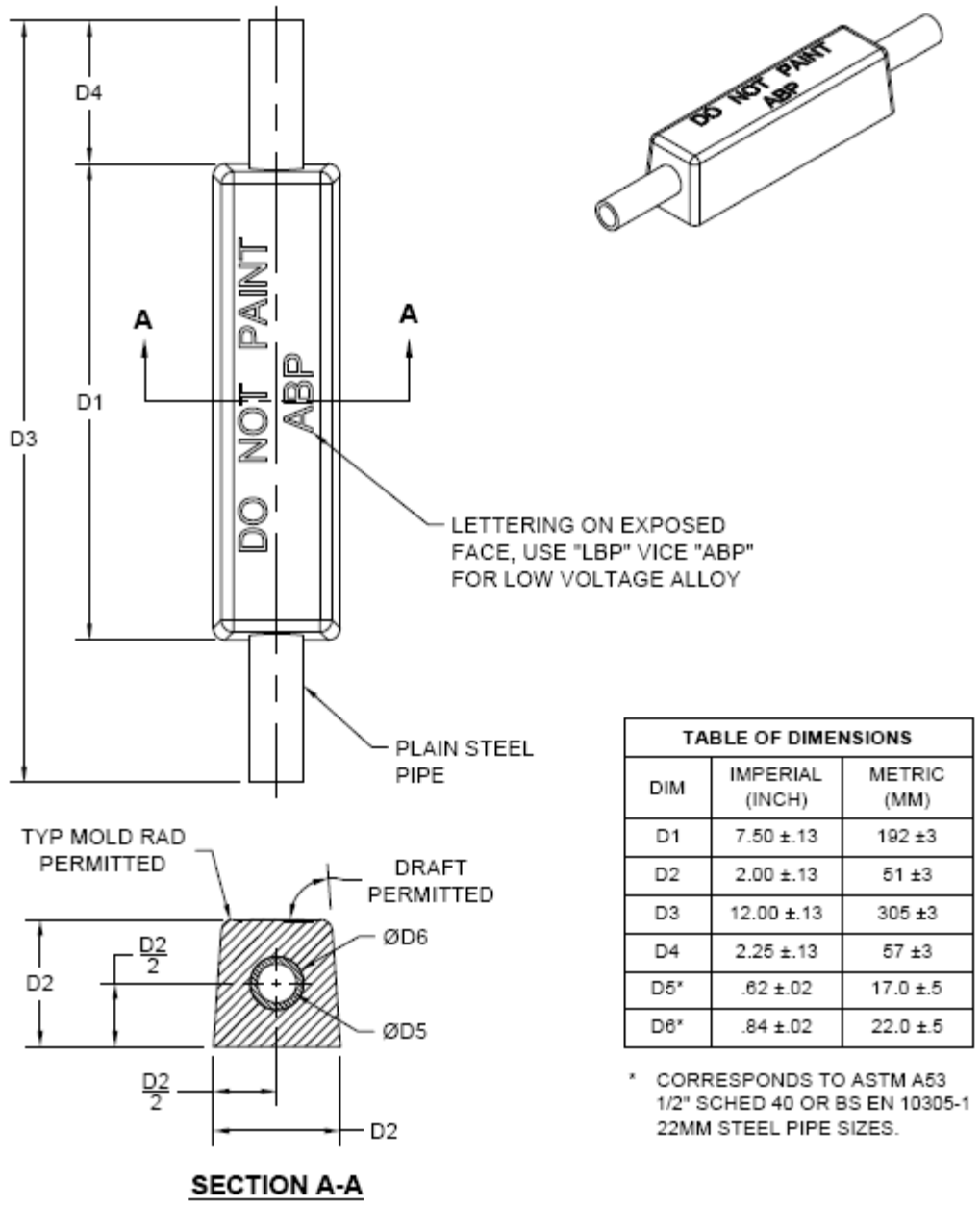


TABLE OF DIMENSIONS		
DIM	IMPERIAL (INCH)	METRIC (MM)
D1	7.50 ±.13	192 ±3
D2	2.00 ±.13	51 ±3
D3	12.00 ±.13	305 ±3
D4	2.25 ±.13	57 ±3
D5*	.62 ±.02	17.0 ±.5
D6*	.84 ±.02	22.0 ±.5

* CORRESPONDS TO ASTM A53 1/2" SCHED 40 OR BS EN 10305-1 22MM STEEL PIPE SIZES.

SKETCH H: BAR SHAPE (PIPE CORE), TYPE ABP OR LBP

MINIMUM WEIGHT: 2.9 LB / 1.3 KG

FIGURE A-27. Aluminum, bar (pipe core), type ABP/LBP.

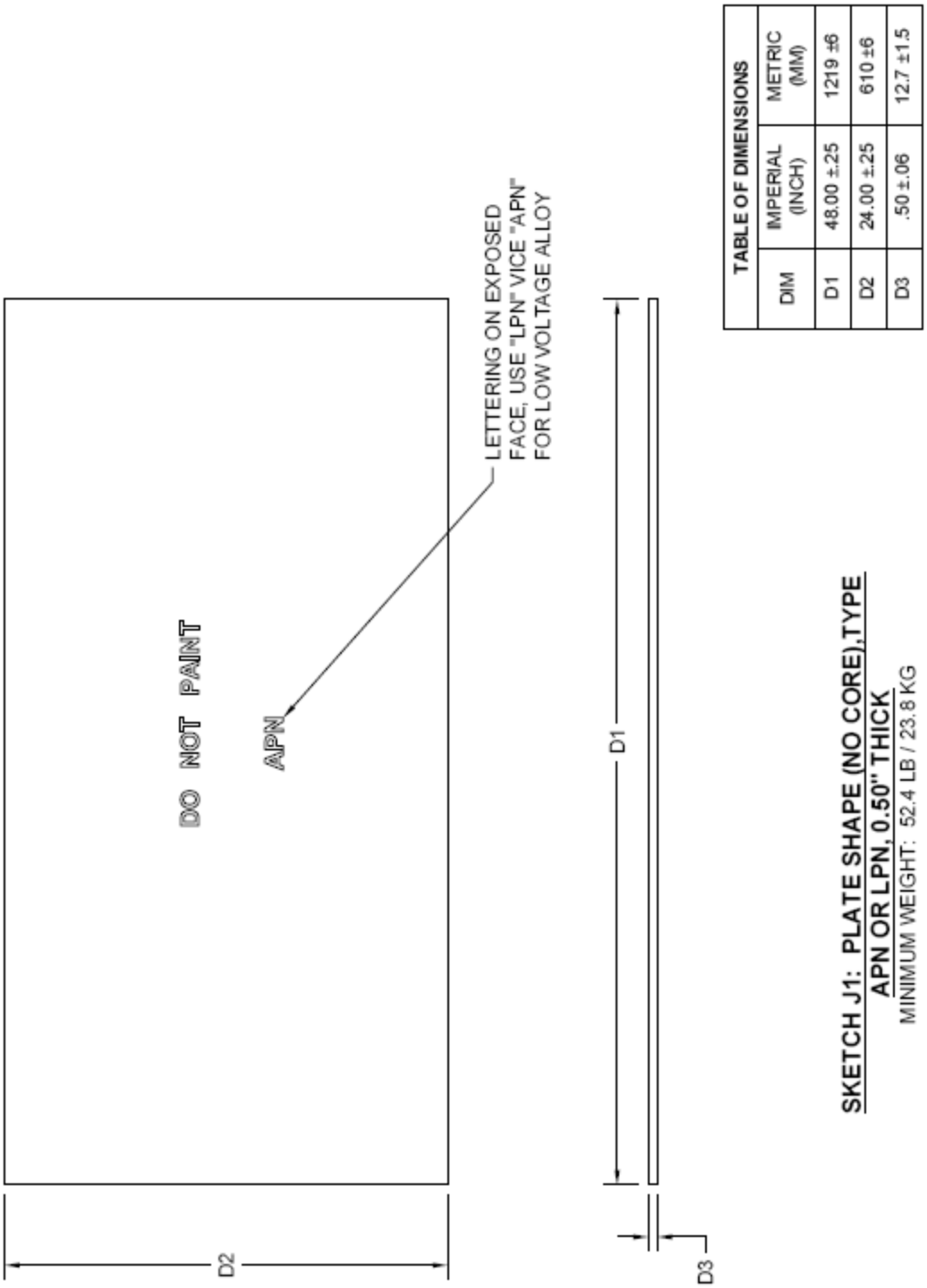


FIGURE A-28. Aluminum, plate (no core), type APN/LPN.

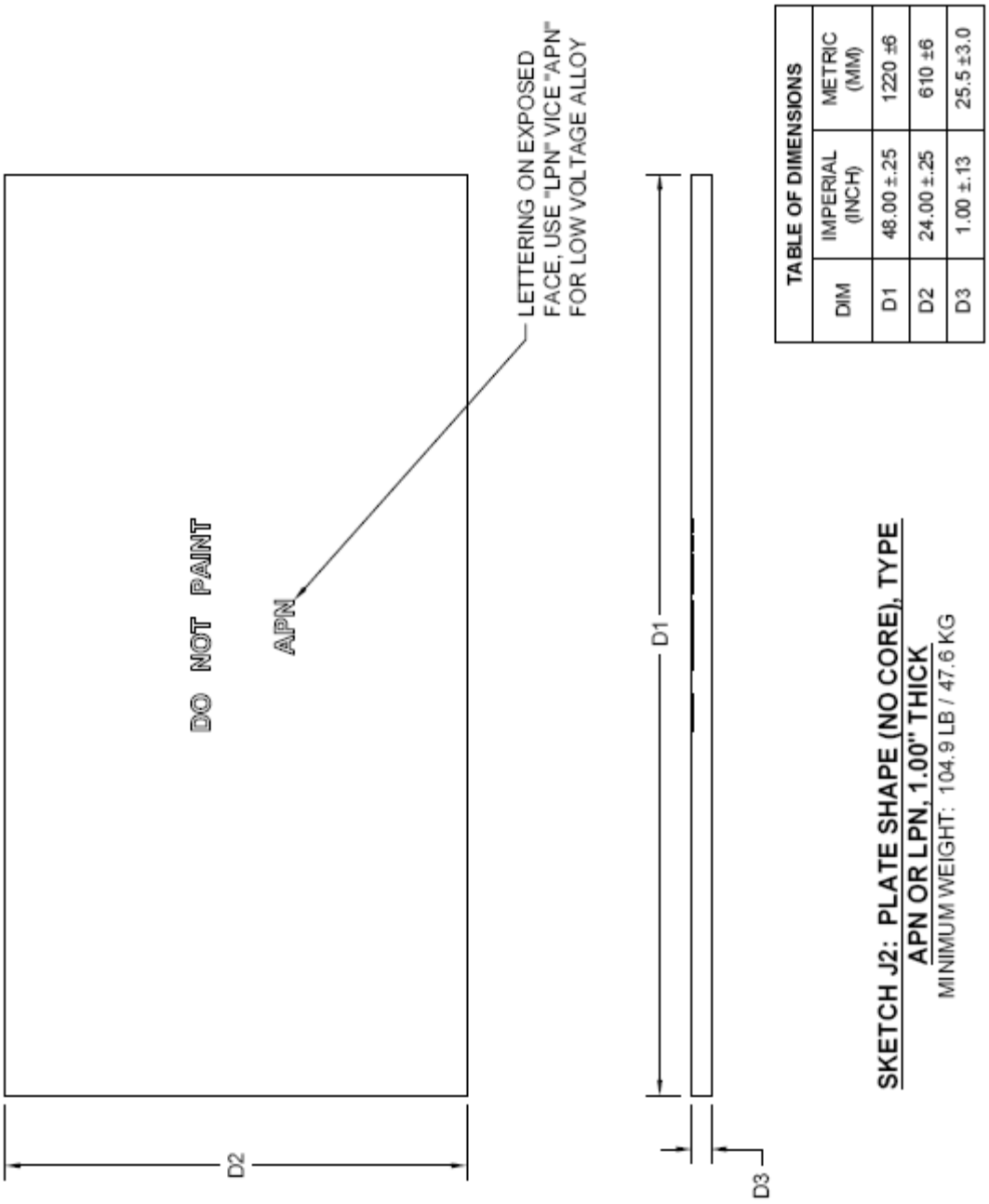


FIGURE A-29. Aluminum, plate (no core), type APN/LPN.

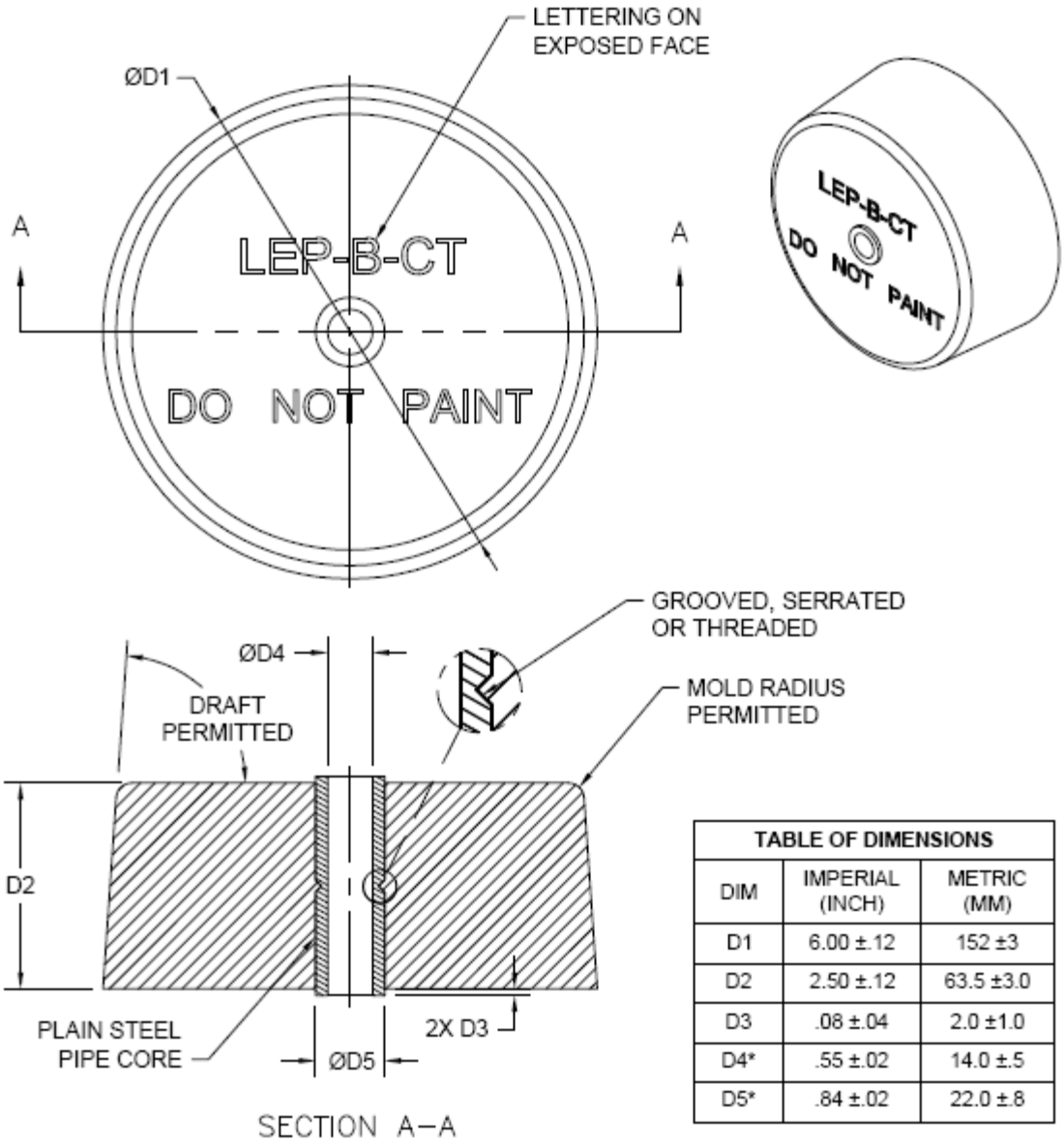


TABLE OF DIMENSIONS		
DIM	IMPERIAL (INCH)	METRIC (MM)
D1	6.00 ±.12	152 ±3
D2	2.50 ±.12	63.5 ±3.0
D3	.08 ±.04	2.0 ±1.0
D4*	.55 ±.02	14.0 ±.5
D5*	.84 ±.02	22.0 ±.8

* CORRESPONDS TO ASTM A53 1/2" SCHED 80 OR BS EN 10305-1 22MM STEEL PIPE SIZES.

SKETCH K1: FAIRWATER DISK (PIPE CORE), CLOSE TOLERANCE, TYPE LEP-B-CT
MINIMUM WEIGHT: 6.3 LB / 2.9 KG
ANODE MATERIAL MUST BE LOW VOLTAGE ALLOY

FIGURE A-30. Low voltage aluminum, close tolerance, fairwater disc (pipe core or pipe bushing core) (LEP-B-CT).

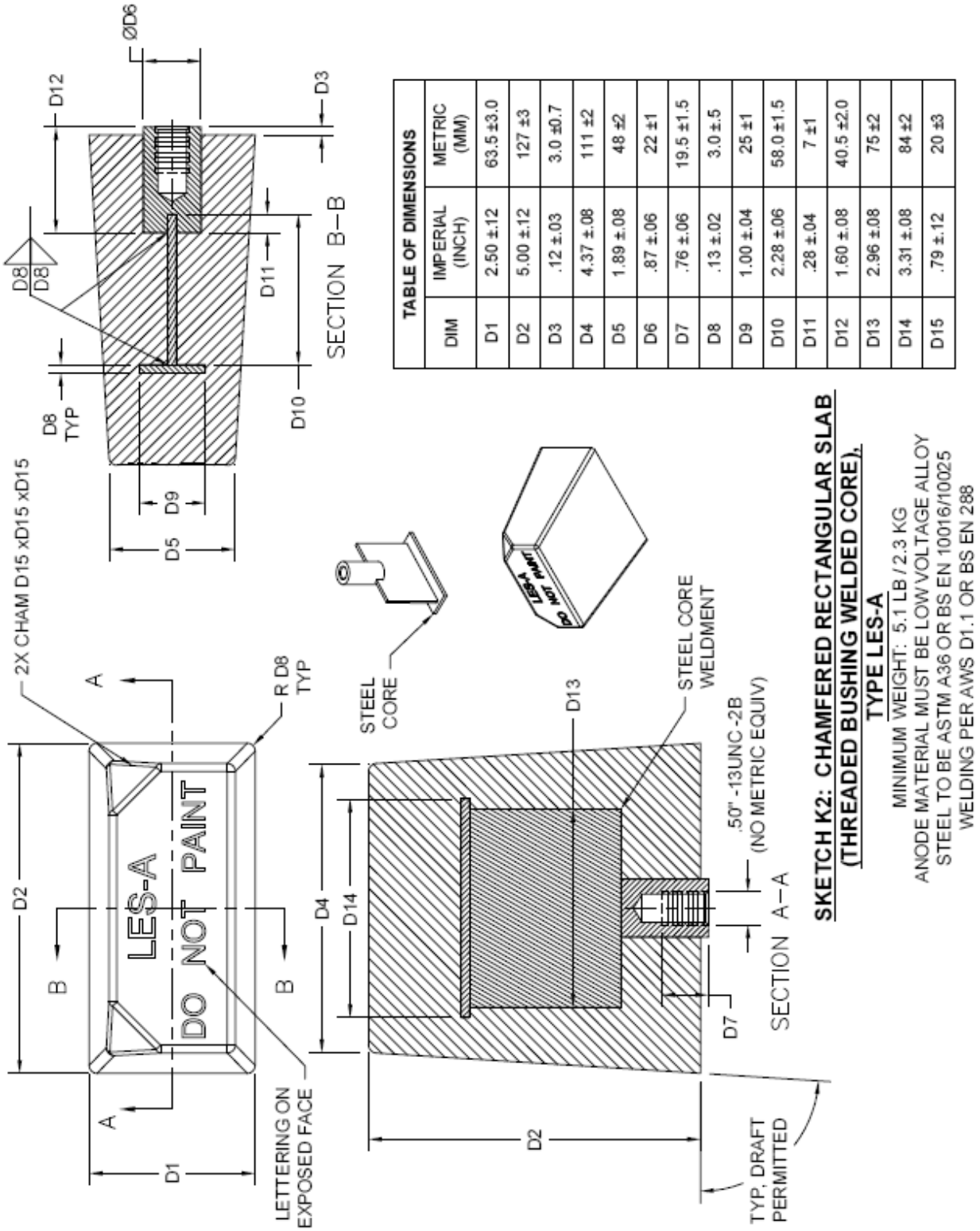


TABLE OF DIMENSIONS		
DIM	IMPERIAL (INCH)	METRIC (MM)
D1	2.50 ±.12	63.5 ±3.0
D2	5.00 ±.12	127 ±3
D3	.12 ±.03	3.0 ±0.7
D4	4.37 ±.08	111 ±2
D5	1.89 ±.08	48 ±2
D6	.87 ±.06	22 ±1
D7	.76 ±.06	19.5 ±1.5
D8	.13 ±.02	3.0 ±.5
D9	1.00 ±.04	25 ±1
D10	2.28 ±.06	58.0 ±1.5
D11	.28 ±.04	7 ±1
D12	1.60 ±.08	40.5 ±2.0
D13	2.96 ±.08	75 ±2
D14	3.31 ±.08	84 ±2
D15	.79 ±.12	20 ±3

FIGURE A-31. Aluminum, submarine disc (I-beam with welded bushing core), chamfered rectangular slab (LES-A).

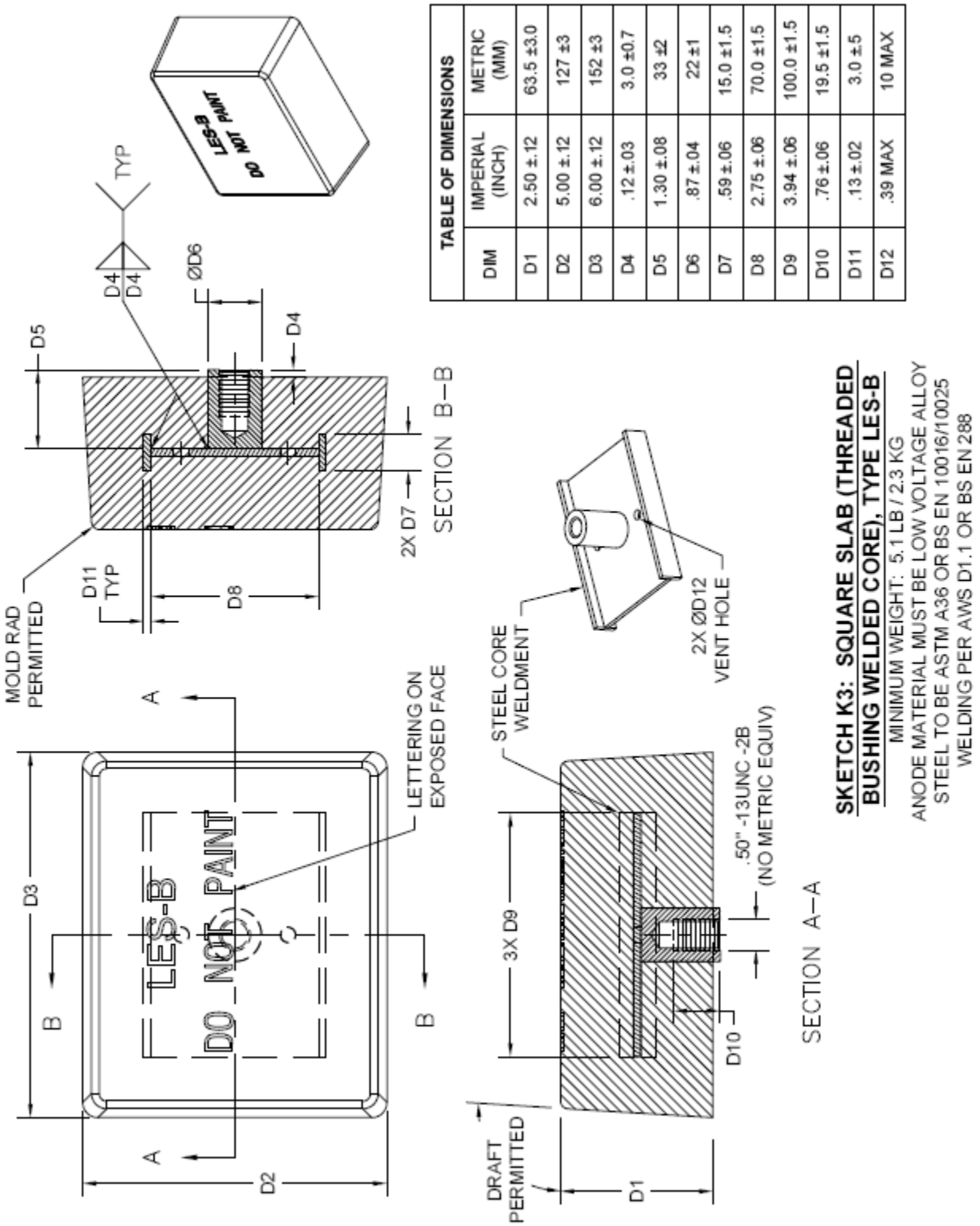


FIGURE A-32 Aluminum, submarine disc (I-beam with welded bushing core), square slab (LES-B).

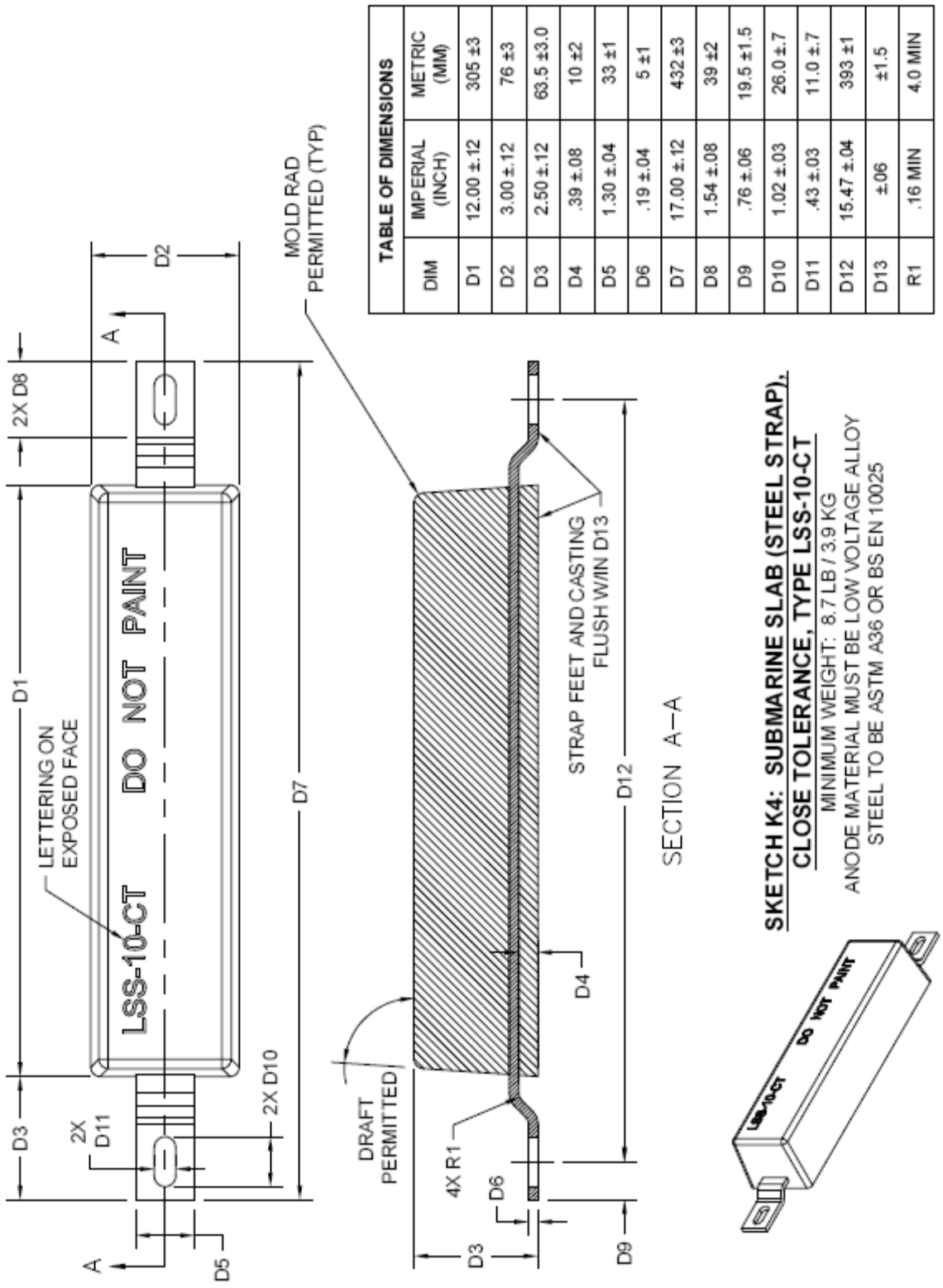


FIGURE A-33. Aluminum, close tolerance, submarine (steel strap) type LSS-10-CT.

Preparing Activity:
Navy - SH
(Project 3426-2008-002)

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