



Standard Specification for Anodes, Sacrificial Zinc Alloy¹

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1. Scope

1.1 This specification covers the requirements for zinc anodes in the form of slabs, plates, discs, and rods for corrosion protection (cathodic protection) of metals and alloys.

1.2 The anodes are primarily intended to reduce corrosion of surface ship and submarine hulls, steel and aluminum equipment and structures, sea chests, sonar domes, and the seawater side of condensers and other heat exchangers.

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

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

2.2 *ASTM Standards*:²

[A36/A36M Specification for Carbon Structural Steel](#)

[B21/B21M Specification for Naval Brass Rod, Bar, and Shapes](#)

¹ This specification is under the jurisdiction of ASTM Committee F25 on Ships and Marine Technology and is the direct responsibility of Subcommittee F25.07 on General Requirements.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[B103/B103M Specification for Phosphor Bronze Plate, Sheet, Strip, and Rolled Bar](#)

[D3951 Practice for Commercial Packaging](#)

[E290 Test Methods for Bend Testing of Material for Ductility](#)

[E536 Test Methods for Chemical Analysis of Zinc and Zinc Alloys](#)

2.3 *Military Standards*:³

[MIL-STD-129 Marking for Shipment and Storage](#)

[MIL-STD-1186 Cushioning, Anchoring, Bracing, Blocking, and Waterproofing; With Appropriate Test Methods](#)

2.4 *Military Specification*:³

[MIL-P-15011 Pallets Material Handling, Wood Post Construction, 4-Way Entry](#)

2.5 *Federal Specifications*:³

[PPP-B-601 Boxes, Wood, Cleated Plywood](#)

[PPP-B-621 Boxes, Wood, Nailed and Lock-Corner](#)

[PPP-B-636 Boxes, Shipping, Fiberboard](#)

2.6 *ASME Standard*:⁴

[B1.20.1 Pipe Threads, General Purpose, Inch](#)

2.7 *ASQ Standard*:⁵

[ASQ/ANSI Z1.4 Sampling Procedures and Tables for Inspection by Attributes](#)

3. Classification

3.1 The anodes shall be of the following classes and types, as specified (see 4.1.2):

3.1.1 *Class 1*—Cast-in cores:

3.1.1.1 *Type ZHS*—Zinc, hull slab, steel straps, 23 lb and 42 lb (10 kg and 19 kg) sizes.

3.1.1.2 *Type ZHB*—Zinc, hull slab, brass straps, 23 lb (10 kg) size.

3.1.1.3 *Type ZHC*—Zinc, hull slab, core strap, 23 lb and 42 lb (10 kg and 19 kg) sizes.

3.1.1.4 *Type ZSS*—Zinc, submarine slab, steel strap, 12 lb and 24 lb (5 kg and 11 kg) sizes.

³ Available from DLA Document Services, Building 4/D, 700 Robbins Ave., Philadelphia, PA 19111-5094, <http://quicksearch.dla.mil>.

⁴ Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, <http://www.asme.org>.

⁵ Available from American Society for Quality (ASQ), 600 N. Plankinton Ave., Milwaukee, WI 53203, <http://www.asq.org>.

3.1.1.5 Type ZTS—Zinc, teardrop shape, steel strap, 5 lb (2 kg) size.

3.1.1.6 Type ZEP—Zinc, heat exchanger or fair water disc, (pipe core or pipe bushing core):

Style A square slab, 9 lb (4 kg) size

Style B circular slab, various sizes

Style C semicircular slab, 23 lb (10 kg) size

3.1.1.7 Type ZBP—Zinc, bar, pipe core, 8 lb (4 kg) size.

3.1.1.8 Type ZDM—Zinc, segmented disc, machine formed interlocking core, various sizes.

3.1.2 Class 2—Plain, no cores;

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

3.1.2.2 Type ZPN—Zinc, plate, no core, rolled.

3.2 The letter designations of types of anodes have the following meanings:

3.2.1 The first letter designates anode metal:

Z zinc

3.2.2 The second letter designates the shape or general use:

- H hull slab
- S submarine slab
- T teardrop shape
- E heat exchanger slab
- R rod, cylindrical
- P plate
- B bar, square
- D disc, segmented

3.2.3 The third letter designates the core:

- B brass straps
- S steel straps
- C core strap
- P pipe core
- M machine formed interlocking core
- N no core

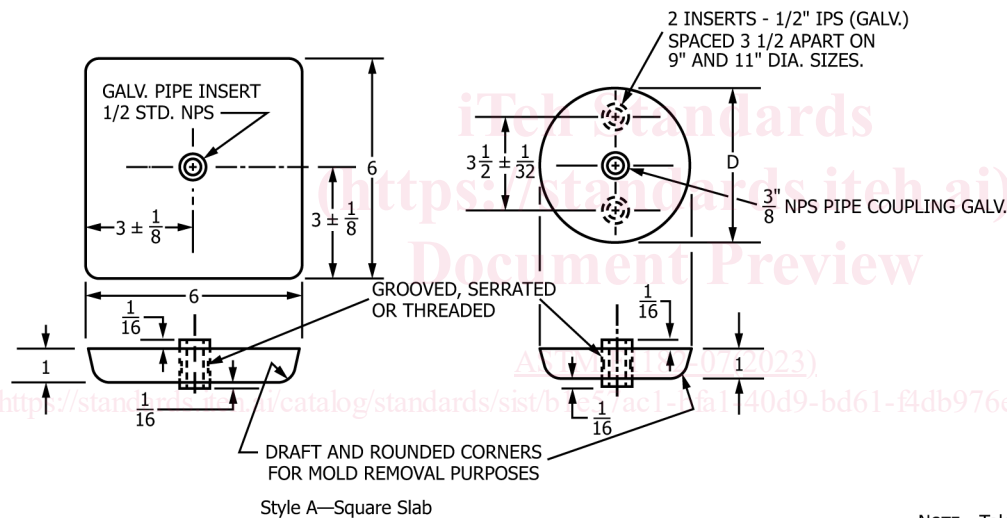
4. Ordering Information

4.1 Orders for material under this specification shall include the following information:

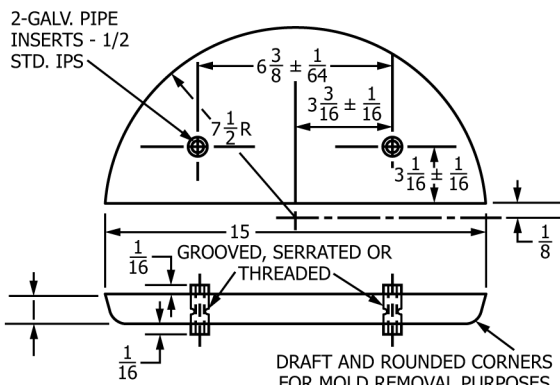
4.1.1 ASTM designation and year of issue,

4.1.2 Class and type (see 3.1),

4.1.3 Style of Type ZEP, if required (see 3.1.1.6 and Fig. 1),



Style A—Square Slab



Style C—Semicircular Slab

NOTE 1—1 in. = 25.4 mm.

NOTE 2—1 lb. = 0.45 kg.

NOTE 3—Approximate weight for Style A is 9 lb; approximate weight for Style C is 23 lb.

NOTE 4—All dimensions are in inches.

NOTE—Tolerance for center $\pm 1/8$ in.

Diameter, D, in., $\pm 1/8$ in.	Approximate Weight, lb	Surface Area, in. ²
11	24	130
9	16	92
6	7.1	47
5	4.9	36
4	3.19	26
3	1.78	16
2	0.79	9

Style B—Circular Slab

FIG. 1 ZEP Heat Exchanger Slab

- 4.1.4 Diameter of Type ZEP, Style B, if required (see Fig. 1),
 - 4.1.5 For Type ZDM, whether straight or tapered thread support plug head is required (see 5.1.4.2),
 - 4.1.6 Diameter of Type ZDM, if required (see Fig. 2),
 - 4.1.7 Length, width, and thickness of Type ZHS, if required (see Fig. 3 and Fig. 4),
 - 4.1.8 Whether Type ZHC is for surface ship or submarine usage, if required (see Figs. 5-8),
 - 4.1.9 Pipe or bolt diameter of Type ZRN, if required (see Fig. 9),
 - 4.1.10 Thickness of Type ZPN, if required (see 9.2.1),
 - 4.1.11 Quantity required (see 4.2),
 - 4.1.12 Quality assurance certification, if required (see 15.1), and
 - 4.1.13 Optional requirements, if any (see S1 through S3).
- 4.2 The order for anodes should specify the exact number of anodes required (see 4.1.11). Acquisition of anodes by weight is not practical and is not recommended.

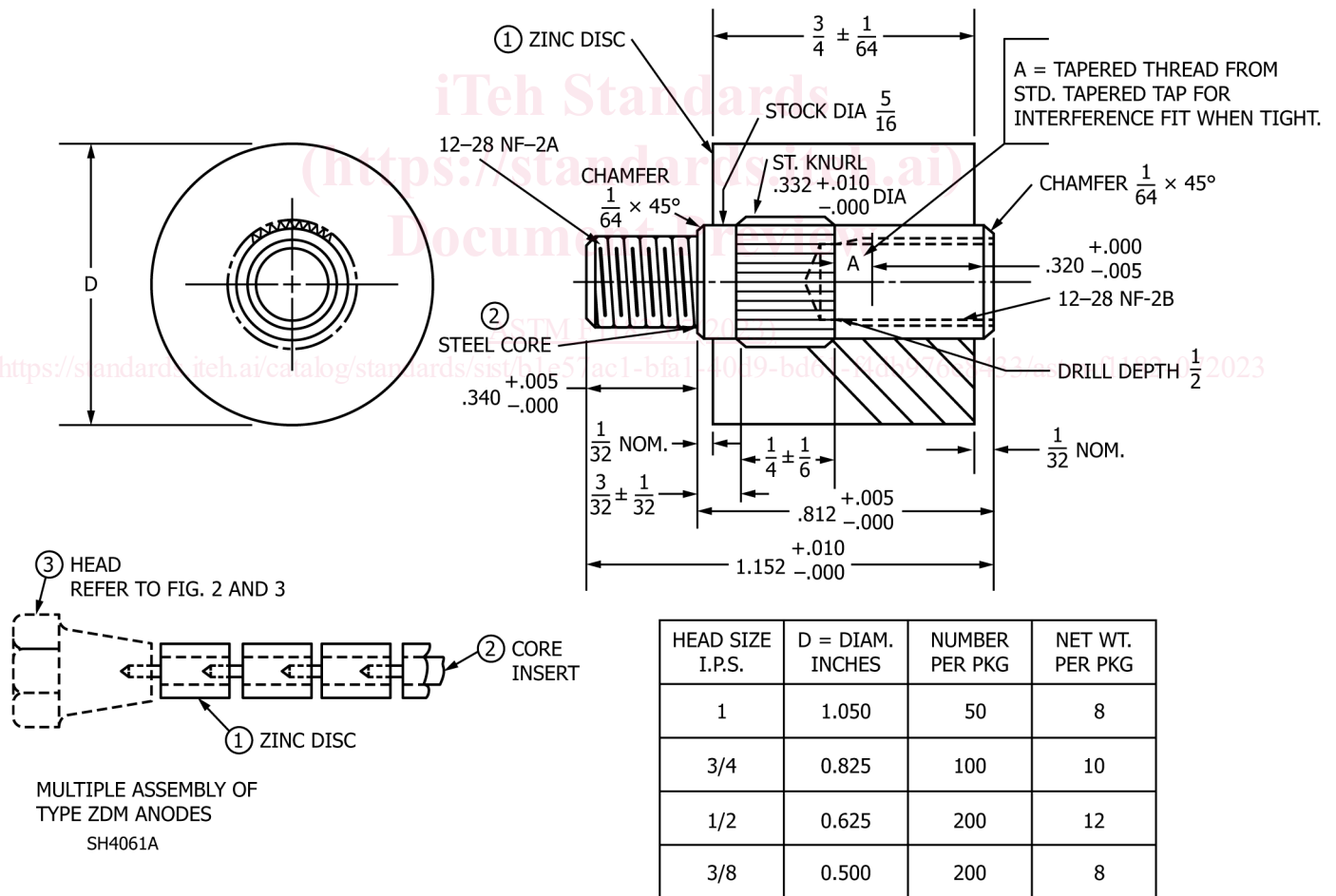
4.3 When material is ordered in the form of slabs, bars, discs, or rods, these terms refer merely to the general form and dimensions of the material and do not have any technical significance as to the methods of manufacture.

5. Materials and Manufacture

5.1 *Materials:*

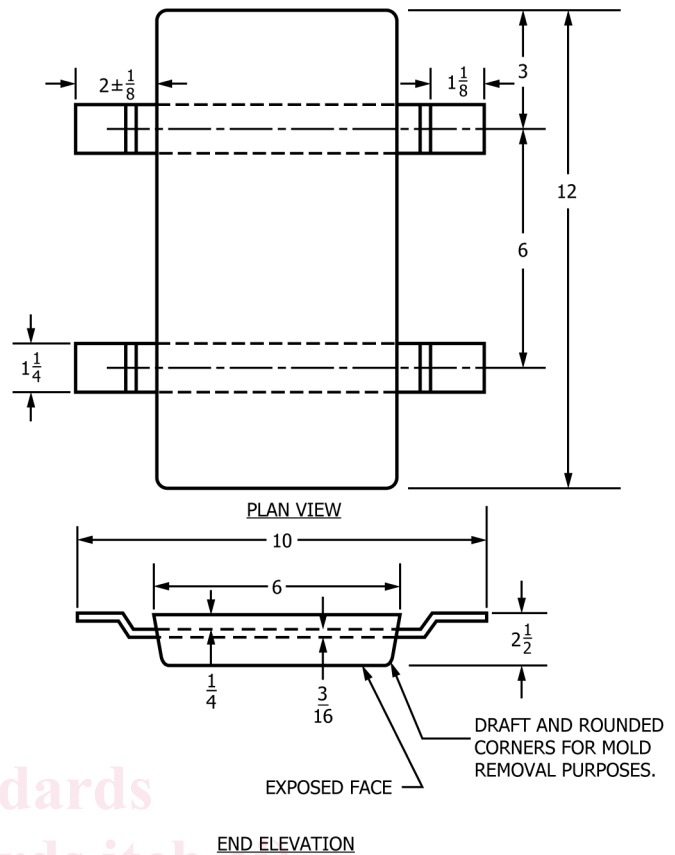
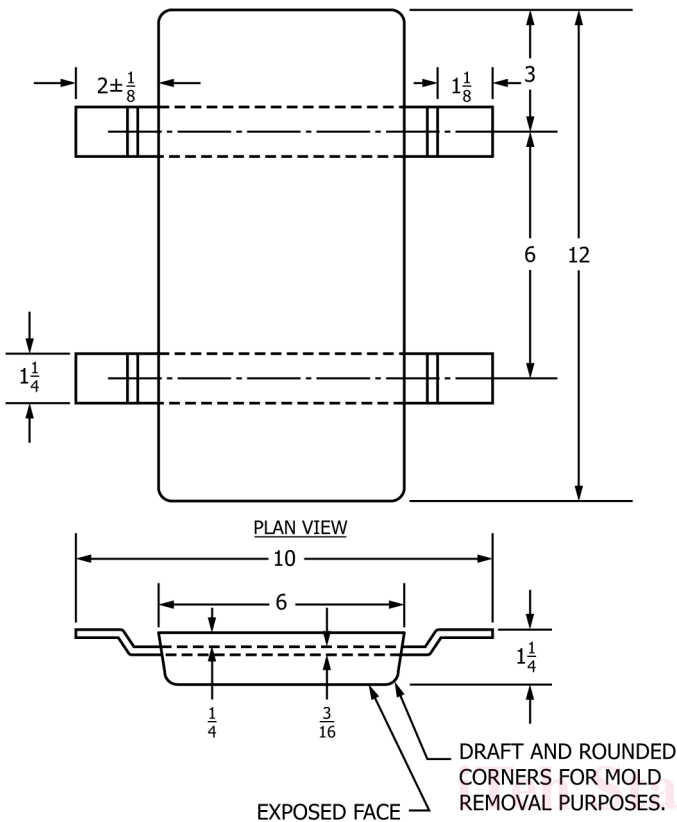
5.1.1 Types ZHS, ZHC, ZSS, and ZTS anodes shall have steel strap cores in accordance with Specification A36/A36M. The steel shall be coated with zinc, either by the hot-dip or electrodeposition method, to a minimum of 0.0005 in. (0.013 mm).

5.1.2 Type ZHB anodes shall have brass strap cores in accordance with alloy 482 of Specification B21/B21M or phosphor bronze straps in accordance with C51000 of Specification B103/B103M. The brass or bronze straps shall be coated with zinc to a minimum thickness of 0.0005 in. (0.013 mm). Lack of adhesion of the zinc coating at bend or



NOTE 1—All dimensions are in inches.
 NOTE 2—1 in. = 25.4 mm.

FIG. 2 Zinc, Segmented Disc, Machine-Formed Interlocking Core, Type ZDM



NOTE 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.
 NOTE 2—Tolerance $\pm 1/8$ in.
 NOTE 3—1 in. = 25.4 mm.
 NOTE 4—Minimum weight 21.5 lb (9.7 kg).

FIG. 3 Zinc Hull Slab (Steel Straps), Type ZHS-23; Zinc Hull Slab (Brass Straps), Type ZHB

NOTE 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 anode.
 NOTE 2—Tolerance $\pm 1/8$ in.
 NOTE 3—1 in. = 25.4 mm.
 NOTE 4—Minimum weight 41 lb (18.6 kg).

FIG. 4 Zinc Hull Slab (Steel Straps), Type ZHS-42

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.

5.1.2.1 The maximum copper content in the zinc, as specified in Table 1, may be increased to 0.020 % for Type ZHB anodes.

5.1.3 Types ZEP and ZBP anodes shall have core inserts made from zinc coated steel pipe or pipe couplings. The minimum thickness of the coating shall be as specified in 5.1.1.

5.1.4 Type ZDM anodes shall have machine formed interlocking cores in accordance with commercial grade mild or leaded steel. The cores shall be flash coated with zinc, tin, or aluminum before assembly within the anodes.

5.1.4.1 This core 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.

5.2 *Manufacture:*

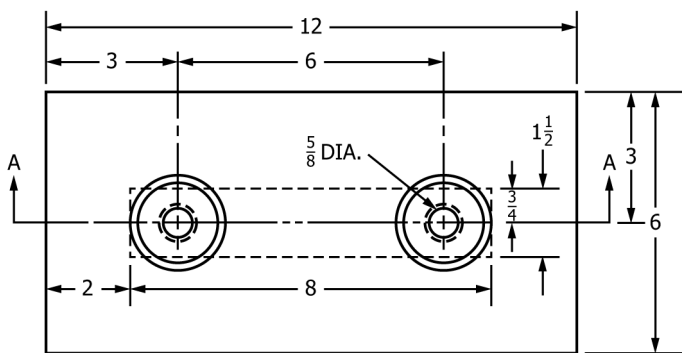
5.2.1 All anodes covered under this specification shall be manufactured by any process suitable to the contracting agency

provided they meet the mechanical properties and other requirements of this specification.

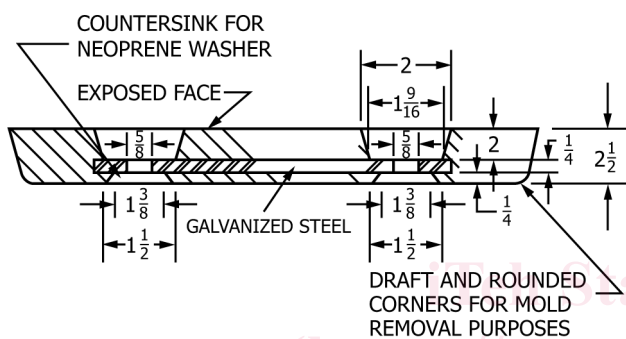
5.2.2 For Types ZHS, ZHB, ZHC, ZSS, and ZTS anodes, open or closed molds may be used. Cores and straps shall be positioned so that they are embedded $1/4$ in., $+1/8$ in., or $-1/16$ in. (6 mm, +3 mm, or -2 mm) as shown on Figs. 3-5, Fig. 7, and Fig. 10 and Fig. 11, which may be measured from either surface of the anode as applicable, except Fig. 11 (bottom), which shall be embedded $3/8$ in., $+1/8$ in., or $-1/16$ in. (10 mm, +3 mm, or -2 mm).

5.2.2.1 Type ZHC anodes designated as shown on Fig. 6 and Fig. 8 are intended for use with rubber washers for submarine application. The countersink for the rubber washer may be cast or machined. The anode shall be manufactured so that the countersink is centered on the core hole and the rubber washer fits snugly between the hull and anode core to prevent anode movement or vibration.

5.2.2.2 Type ZSS, ZHS, ZHB, and ZTS anodes 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.



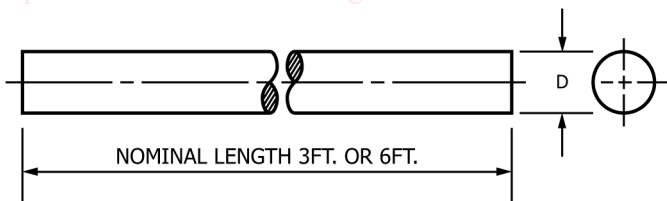
PLAN VIEW



SECTION A-A

- NOTE 1—All dimensions are in inches.
- NOTE 2—Tolerance $\pm 1/8$ in.
- NOTE 3—1 in. = 25.4 mm.
- NOTE 4—Minimum weight 39 lb (18 kg).

FIG. 8 Zinc Hull Slab (Core Strap), Type ZHC-42, Submarine Application



Nominal Diameter, D, in.	Iron Pipe Size, in.	Approximate Weight per Foot, lb (kg)
0.405	1/8	0.39 (0.17)
0.540	1/4	0.70 (0.31)
0.675	3/8	1.11 (0.50)
0.840	1/2	1.68 (0.76)
1.050	3/4	2.52 (1.13)
1.315	1	4.12 (1.85)

FIG. 9 Zinc, Rod (No Core), Type ZRN

disc type anodes unless at least 1/8 in. (3 mm) of sound metal covers the entire strap of core area.

10.2 Types ZDM and ZRN anodes shall be smooth on their curved surfaces.

10.3 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.

10.4 The coatings specified in 5.1.1 shall be adherent and free from flaking. The coating shall adhere tenaciously to the surface of the base metal. When the coating is cut or pried into, such as with a stout knife applied with considerable pressure in a manner tending to remove a portion of the coating, it shall only be possible to remove small particles of the coating by paring or whittling, and it shall not be possible to peel any portion of the coating so as to expose the steel. Lack of adhesion of the zinc coating at bends or absence of zinc coating at cut edges shall not be cause for rejection of fabricated anodes.

11. Sampling

11.1 For the purposes 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.

11.2 Select a random sample of anodes from each lot in accordance with ASQ/ANSI Z1.4 at Inspection Level II for the examination specified in 14.1. In terms of defects per 100 units, the acceptable quality level (AQL) shall be 4.0 for total defects.

11.3 From each lot specified in 11.1, select two anodes at random of Types ZHS, ZHB, ZHC, ZSS, ZTS, ZEP, and ZBP and five anode discs of Type ZDM for the core bond tests specified in 13.1.1 or 13.1.2.

11.3.1 In cases in which one of the two anodes specified in 13.1.1 or 13.1.2 fails to pass the bond test, select four additional anodes for retest at the request of the manufacturer.

11.4 Select at random from the lot at least five each of both Type ZRN and ZPN anodes for the sampling for the physical testing described in 13.2.

11.5 The sampling for the chemical analysis described in 13.3 shall consist of anodes being selected at random in accordance with 11.3, except that sufficient number of Type ZDM anodes shall be selected to comply with 12.1.5.

11.6 Discard sample anodes, except the remaining lengths of Type ZRN anodes, and do not include them in the delivery of material after the core bond tests specified in 13.1.1 and 13.1.2 are performed. Perform sampling for chemical analysis specified in 11.5 before discarding the anodes.

12. Specimen Preparation

12.1 From each anode selected for chemical analysis in accordance with 11.5, take one 2 oz (0.06 kg) sample by drilling or machining the material at the locations specified in 12.1.1 – 12.1.6, 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 anode, which shall be discarded.