



Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel¹

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This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This specification covers requirements for electrodeposited zinc coatings applied to iron or steel articles to protect them from corrosion. It does not cover electrodeposited zinc-coated steel wire or sheets (see Specification A 591/A 591M for sheets).

1.2 The coatings are provided in four standard thickness classes (4.1), in the as-plated condition or with one of three types of supplementary finish (4.2).

1.3 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

- A 591/A591M Specification for Steel Sheet, Electrolytic Zinc-Coated, for Light Coating Mass Applications²
- B 117 Practice for Operating Salt Spray (Fog) Apparatus³
- B 183 Practice for Preparation of Low-Carbon Steel for Electroplating⁴
- B 201 Practice for Testing Chromate Coatings on Zinc and Cadmium Surfaces⁴
- B 242 Practice for Preparation of High-Carbon Steel for Electroplating⁴
- B 254 Practice for Preparation of and Electroplating on Stainless Steel⁴
- B 320 Practice for Preparation of Iron Castings for Electroplating⁴
- B 322 Practice for Cleaning Metals Prior to Electroplating⁴
- B 374 Terminology Relating to Electroplating⁴
- B 487 Test Method for Measurement of Metal and Oxide Coating Thicknesses by Microscopical Examination of a Cross Section⁴
- B 499 Test Method for Measurement of Coating Thick-

- nesses by the Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metals⁴
- B 504 Test Method for Measurement of Thickness of Metallic Coatings by the Coulometric Method⁴
- B 567 Test Method for Measurement of Coating Thickness by the Beta Backscatter Method⁴
- B 568 Test Method for Measurement of Coating Thickness by X-Ray Spectrometry⁴
- B 571 Test Methods for Adhesion of Metallic Coatings⁴
- B 602 Test Method for Attribute Sampling of Metallic and Inorganic Coatings⁴
- B 697 Guide for Selection of Sampling Plans for Inspection of Electrodeposited Metallic and Inorganic Coatings⁴
- B 762 Method of Variables Sampling of Metallic and Inorganic Coatings⁴
- D 2092 Guide for Treatment of Zinc-Coated (Galvanized) Steel Surfaces for Painting⁵
- F 1740 Guide for Inspection of Nylon, Polyester, or Nylon/Polyester Blend, or Both Kernmantle Rope⁶
- 2.2 *Military Standard:*
 - MIL-STD-1312 Fastener Tests, Methods (Test 12)⁷

3. Terminology

3.1 *Definitions*—Definitions of the terms used in this specification are in accordance with Terminology B 374.

4. Classification

4.1 *Thickness*—The coating shall be provided in the four thickness classes defined in Table 1.

4.2 *Finish*—The coating shall have one of the finish types defined as follows:

Type	Description
I	As-plated without supplementary treatment
II	With colored chromate conversion coatings
III	With colorless chromate conversion coatings
IV	With phosphate conversion coatings

5. Ordering Information

5.1 When ordering the electroplating of articles, the purchaser shall state the designation number, the date of issue, the

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² *Annual Book of ASTM Standards*, Vol 01.06.

³ *Annual Book of ASTM Standards*, Vol 03.02.

⁴ *Annual Book of ASTM Standards*, Vol 02.05.

⁵ *Annual Book of ASTM Standards*, Vol 06.02.

⁶ *Annual Book of ASTM Standards*, Vol 13.01.

⁷ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

TABLE 1 Thickness Classes for Coatings

Classification ^A Number and Conversion Coating Suffix	Service Condition ^{B,C}	Thickness, min μm
Fe/Zn 25	SC 4 (very severe)	25
Fe/Zn 12	SC 3 (severe)	12
Fe/Zn 8	SC 2 (moderate)	8
Fe/Zn 5	SC 1 (mild)	5

^A Iron or steel with zinc electroplate. Numeral indicates thickness in micrometres.

^B See Appendix X2.

^C Where service conditions are valid only for coatings with chromate conversion coating. Type II for SC 4 and SC 3 and Type III for SC 2 and SC 1.

class or service condition number, and the type. (See 4.1, 4.2, and 7.1).

5.2 If necessary, the purchaser shall include on his part drawings or purchase order the following:

5.2.1 Electroplating application to high strength steel, if specified (6.4),

5.2.2 Thickness, if other than specified (4.1, 7.1),

5.2.3 Location of significant surface (7.1.1, 7.1.2),

5.2.4 Luster (7.3),

5.2.5 Corrosion resistance test, if specified (9.3, 10.3),

5.2.6 Hydrogen embrittlement test, if required (9.4, 10.4),

5.2.7 Sample size for inspection, if other than specified, and

5.2.8 Supplementary requirements, if applicable (Supplementary Requirement).

6. Materials and Manufacture

6.1 The coatings shall be essentially pure zinc produced by electrodeposition.

6.2 Defects in the surface of the basis metal, such as scratches, porosity, pits, inclusions, cracks, roll marks, and die marks, may adversely affect the appearance and performance of coatings applied thereto despite the observance of the best electroplating practices. Accordingly, the electroplater's responsibility for defects in the coating resulting from such conditions shall be waived, except when he is the prime contractor supplying electroplated parts. In this event, the basis metal shall be subjected to such polishing or buffing operations as are necessary to yield deposits with the desired final luster and appearance. To minimize problems of this sort, the specifications covering the basis material on the item to be electroplated shall contain appropriate limitations to such basis metal conditions.

6.3 *Cleaning of Basis Metal*—Proper preparatory procedures and thorough cleaning of the basis metal are essential to ensure satisfactory adhesion and corrosion resistance performance of the coating. It is recommended that the following appropriate recommended practices be used: B 183, B 242, B 254, B 320, and B 322.

6.4 *High-Tensile Strength Metals*—Unless otherwise specified, high strength steels having a tensile strength greater than 1700 MPa shall not be electroplated.

6.5 *Stress Relief*—All steel parts having an ultimate tensile strength of 1000 MPa and above, and that have been machined, ground, cold formed or cold straightened, shall be heat treated at a minimum of 190°C for 3 h or more for stress relief before cleaning and electroplating.

6.6 *Hydrogen Embrittlement Relief*—All electroplated parts

having a tensile strength of 1200 MPa or higher shall be baked at a minimum of 190°C for 3 h or more within 4 h after electroplating to provide hydrogen embrittlement relief. Electroplated springs and other parts subject to flexure shall not be flexed before the hydrogen embrittlement relief treatment. The baking treatment shall be done before the application of the supplementary treatments. Baked parts shall not crack or fail by fracture when tested in accordance with 10.4.

6.7 *Reactivation Treatment*—Electroplated surfaces passivated as a result of the baking operation shall be reactivated before receiving a supplementary treatment. Surfaces intended for supplementary treatments (Types II and III) may be reactivated by immersion in a dilute acid solution. Surfaces should be activated as soon as possible following baking and should be handled carefully to avoid contamination.

6.8 *Supplementary Treatments*—The supplementary film treatment for Types II and III shall be in accordance with Practice B 201. The treatment required for conversion to Type IV shall be in accordance with Guide D 2092.

NOTE 1—The zinc surface is attacked by supplementary treatments, thereby diminishing the amount of metallic zinc present. With Classes Fe/Zn25 and Fe/Zn13, this reduction is insignificant; but it is significant with Fe/Zn8 and Fe/Zn5. Therefore, it is recommended that supplementary treatments not be applied to zinc coatings having a nominal thickness less than 5 μm .

7. Coating Requirements

7.1 *Thickness*—The thickness shall be specified in accordance with 4.1 and 5.1.

7.1.1 *Significant Surfaces*—Significant surfaces are areas where minimum thicknesses to be met shall be designated on the applicable drawing or by the provision of a suitably marked sample. Significant surfaces may be defined as those normally visible, directly or by reflection, which are essential to the appearance or serviceability of the article when assembled in normal position; or which can be the source of corrosion products that deface visible surfaces on the assembled article.

7.1.2 Surfaces on which the specified thickness of deposit cannot readily be controlled, such as threads, holes, deep recesses, bases of angles, and similar areas, are normally exempt from minimum thickness requirements, unless they are specially designated as not exempt. When such areas are designated, and thus made subject to minimum thickness requirements, the purchaser and the manufacturer shall recognize the necessity for either thicker deposits on other areas or for special racking.

NOTE 2—The dimensional tolerance of most threaded articles, such as nuts, bolts, screws, and similar fasteners with complementary threads, normally does not permit the application of a coating thickness much greater than 8.0 μm . If heavier coatings are required, allowance for the deposit build-up must be made during the manufacture of the threaded articles.

7.2 *Adhesion*—The adhesion of the coating shall be such that when examined in accordance with 10.2, the coating shall not show separation from the basis metal at the interface.

7.3 *Luster*—Unless otherwise specified by the purchaser, a bright, semi-bright, or dull luster shall be acceptable.

7.4 *Corrosion Resistance*—Zinc coatings with Types II and III treatments shall show neither corrosion products of zinc nor