



Standard Specification for Zinc Alloy Thermo-Diffusion Coatings (TDC) on Steel Fasteners, Hardware, and Other Products¹

This standard is issued under the fixed designation A1059/A1059M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers the general requirements for protective zinc coatings (hereinafter referred to as the coatings) to be applied by the thermo-diffusion coating (TDC) method, to various products made of carbon steel, including low and high tensile parts as well as of wrought iron, sintered iron steel-powder and various steel and stainless alloys. TDC is carried out by immersing the parts in a zinc alloy powder at elevated temperature for a period of time, causing a metallurgical diffusion process of zinc and iron. Further processing may be added, such as, passivation, topcoat application, paint application, etc.

1.2 This specification is applicable to orders in either inch-pound units (as A1059) or in SI units (as A1059M). Inch-pound units and SI units are not necessarily exact equivalents. Within the text of this specification and where appropriate, SI units are shown in brackets. Each system shall be used independently of the other without combining values in any way. In the case of orders in SI units, all testing and inspection shall be done using the metric equivalent of the test or inspection method as appropriate. In the case of orders in inch-pound units, such shall be stated to the applicator when the order is placed.

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*:²
[A90/A90M Test Method for Weight \[Mass\] of Coating on](#)

¹ This specification is under the jurisdiction of ASTM Committee A05 on Metallic-Coated Iron and Steel Products and is the direct responsibility of Subcommittee A05.13 on Structural Shapes and Hardware Specifications.

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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.

- [Iron and Steel Articles with Zinc or Zinc-Alloy Coatings](#)
- [A385 Practice for Providing High-Quality Zinc Coatings \(Hot-Dip\)](#)
- [A700 Practices for Packaging, Marking, and Loading Methods for Steel Products for Shipment](#)
- [A902 Terminology Relating to Metallic Coated Steel Products](#)
- [B487 Test Method for Measurement of Metal and Oxide Coating Thickness by Microscopical Examination of Cross Section](#)
- [D521 Test Methods for Chemical Analysis of Zinc Dust \(Metallic Zinc Powder\)](#)
- [D6386 Practice for Preparation of Zinc \(Hot-Dip Galvanized\) Coated Iron and Steel Product and Hardware Surfaces for Painting](#)
- [E376 Practice for Measuring Coating Thickness by Magnetic-Field or Eddy-Current \(Electromagnetic\) Testing Methods](#)
- [F1789 Terminology for F16 Mechanical Fasteners](#)
- [F2329 Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners](#)
- [F2674 Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners \[Metric\] \(Withdrawn 2011\)³](#)

3. Terminology

3.1 The following terms and definitions are specific to this specification. Terminology [A902](#) contains other terms and definitions relating to metallic-coated steel products. Terminology [F1789](#) contains other terms and definitions relating to mechanical fasteners.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *thermo-diffusion coating*—a process where the steel product is heated in close contact with zinc powder or zinc mixture.

3.2.2 *thermo-diffusion coating*—a coating made by thermo-diffusion coating process, consisting of zinc/iron alloys.

³ The last approved version of this historical standard is referenced on www.astm.org.

3.2.3 *zinc powder*—the coating material used to provide corrosion protection to steel.

3.2.4 *zinc mixture*—a combination of zinc powder and other metallic materials to be used as a coating material in the TDC process.

4. Ordering Information

4.1 Orders for coatings provided under this specification shall include the following:

4.1.1 Quantity (number of pieces to be coated) and total weight.

4.1.2 Description (type and size of products) and weight.

4.1.3 ASTM specification designation and year of issue.

4.1.4 Material identification (see 5.1) and surface condition or contamination.

4.1.5 Sampling plan, if different from Section 8.

4.1.6 Special test requirements, if different from Section 9 (see 9.1).

4.1.7 Special requirements (special stacking, heavier coating weight, etc.).

4.1.8 Tagging or piece identification method.

4.2 *Additional Information*—Additional information may be required in certain circumstances. In these cases the purchaser will furnish the applicator with the following additional information:

4.2.1 Any likely effects on the metallurgical properties of the base material caused by processing temperatures of up to 1092°F [500°C].

4.2.2 Determination of areas considered as significant surfaces. This should be done by drawings or by providing samples with suitable markings.

4.2.3 Any critical thickness tolerances, such as when bolts and nuts are used. This should be done on the product's drawing or on the purchase order.

4.2.4 Any special pre-treatment requirements or the existence of other materials, lubricants, stripping materials, pre-existing corrosion, etc.

4.2.5 Whether quality certificate is required or not.

5. Materials and Manufacture

5.1 Requirements to design of the products to be coated with zinc are detailed in Practice A385. The following provisions are necessary to produce a high quality coating.

5.1.1 The products to be coated with zinc include parts and assemblies of various sizes: presswork, forged, cast, machined products (nuts, washers, bolts, nails, chains, small round billets, blanks for plumbing fixtures, etc.). When coating is applied to long-length parts (pipes, rods), the appropriate production equipment is required.

5.1.2 The products shall have neither pockets nor closed cavities. All cavities shall be available for applying the coating of diffusion mixture. Should it be impossible to apply the coating to individual portions of surface of the article, the documents shall specify if the coating is allowed to be absent in these cavities.

5.1.3 The fasteners to be coated with zinc shall meet the requirements of standards in force, for the fasteners, and accompanied with certificates from manufacturers.

5.1.4 The products (parts) containing soft solder or resins can not be coated with zinc.

5.1.5 *For Fasteners*—The maximum deviations of threads prior to application of the coating shall comply with the standards for threads. An additional gap for the coating for external and internal threads separately or for both threads at the same time, is to be provided, if the coating with increased thickness is to be applied. Requirements for fasteners to be thermal diffusion coated with zinc are found in Specifications F2329 and F2674.

5.2 Requirements for material and surface of substrate:

5.2.1 This is applied to products of standard-quality carbon steel, high-quality structural carbon and low-carbon steel, as well as low-alloyed steel, stainless steels, pig iron and copper.

5.2.2 The following defects are not allowed on the surfaces of the parts:

5.2.2.1 Rolled-in scale, burrs;

5.2.2.2 Separation into layers and cracks including those arising from pickling, polishing and other treatment;

5.2.2.3 Corrosion damages, pores, and holes.

5.2.3 The surfaces of cast and forged products shall be free of blow and shrink holes, slag, and flux contamination.

5.2.4 The surfaces of the parts of hot-rolled metal shall be cleaned from scale, pickling sludge, products of corrosion of the base metal, and other contamination.

5.2.5 After machining, the surfaces of the parts shall be free of visible layer of grease, emulsion, metallic chips, burrs, dust and products of corrosion, and implantation of foreign metal particles.

5.2.6 Sharp corners and edges of the products except for those required for technological reasons shall be machined to a radius of at least 0.001 in. [0.3 mm].

5.2.7 After heat treatment, the surfaces of the parts shall be free of blow holes, corrosion centers, separation into layers, and buckling.

5.2.8 Welds, soldered and brazed joints on the parts shall be scraped bright and continuous over the whole perimeter.

5.2.9 Prior to applying the coating, the surface of the part shall be degreased (chemically or thermally), cleaned by pickling or abrasive blasting.

5.2.10 The degree of cleanliness of the surface shall be in accordance with Practice D6386.

5.2.11 The term for storage of the parts with the surface prepared for coating with zinc shall not exceed 24 hours under conditions excluding the precipitation of a condensate.

5.2.12 For applying coatings, the zinc powder with humidity of not more than 1.5 % in accordance with Test Methods D521 shall be used.

6. Chemical Composition

6.1 The method described results in the formation of iron-zinc compound layers known as Gamma (Solid Zn ions inside Fe substrate), Delta ($\text{Fe}_{11}\text{Zn}_{40}$), and Zeta (FeZn_7), excluding the external Eta layer of pure free zinc.

6.2 The zinc mixture used in the thermo-diffusion coating process shall contain a mass fraction not less than 94 % of metallic zinc and total impurities (other than Zinc oxide) of not more than 2 % mass fraction.