



Designation: A1059/A1059M – 24

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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

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, iron and steel castings, sintered iron steel-powder, and various steel and stainless alloys. TDC is a dry coating process carried out by immersing the parts in a zinc or 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *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 Recom-*

mendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

2. Referenced Documents

2.1 ASTM Standards:²

- A90/A90M Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings
- A385/A385M Practice for Providing High-Quality Zinc Coatings (Hot-Dip)
- A700 Guide 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/F2329M 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

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.

Current edition approved Nov. 1, 2024. Published November 2024. Originally approved in 2008. Last previous edition approved in 2018 as A1059/A1059M – 18. DOI: 10.1520/A1059_A1059M-24.

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

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



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 The inherent surface microroughness resulting from the thermal diffusion process makes the resulting surface well suited to receive one or more additional surface treatments, such as passivation, topcoats, or sealers to enhance features such as friction, appearance, or corrosion resistance. These are often specific to the service requirements of a given application or market.

3.3 Definitions of Terms Specific to This Standard:

3.3.1 *passivation*—chemical conversion coating formed on the surface of a newly formed thermo-diffusion coating.

3.3.2 *sealer*—thin organic or inorganic layer, typically 0.02 to 0.1 mils (0.5 to 2.0 μm) added over the thermo-diffusion coating or passivation as an additional protective layer.

3.3.3 *thermo-diffusion coating (TDC) method*—a process where the steel product is heated in close contact with zinc powder, zinc alloy powder, or other zinc mixture.

3.3.4 *thermo-diffusion coating*—a coating made by temperature induced thermo-diffusion coating method, consisting of layers of iron-zinc intermetallic compounds.

3.3.5 *topcoat*—a relatively thin, typically 0.1 to 0.4 mils (2 to 10 μm), organic or inorganic layer added to the surface of the thermo-diffusion coating for added performance, color, or appearance.

3.3.6 *zinc mixture*—a combination of zinc powder, zinc alloy powder, or other metallic materials (or combinations thereof) to be used as a coating material in the thermo-diffusion coating method.

3.3.7 *zinc powder*—the basic coating material used to provide corrosion protection layer on steel.

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 Required thermo-diffusion average coating thickness or Coating Class for the intended application (see **Table 1**).

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

4.1.6 Sampling plan, if different from Section 8.

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

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

4.1.9 Tagging or piece identification method.

4.1.10 Description of any required sealer, passivation, topcoat, or other treatment on the surface of the thermo-diffusion coating.

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 (which could include tensile or yield strength, elongation, hardness, ductility, toughness, etc.) of the base material which could be caused by the processing temperatures of up to 932 °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 heat treatment prior to thermo-diffusion treatment, such as annealing, case hardening, or tempering, including the time and temperature details.

4.2.5 Any treatment or exposure to acids, cleaners, or other processes with a pH ≤ 4.0 , particularly if there are concerns about hydrogen embrittlement in service.

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

4.2.7 Quality certification requirements.

TABLE 1 Thermo-Diffusion Coating Thickness, Resulting Dimensional Build, and Weight [Mass] of Coating for Various Coating Classes

Coating Class	Coating Thickness, mils (μm), on Surface, Average	Approximate Dimensional Growth, mils (μm), Resulting from Coating	Approximate Weight [Mass] of Coating oz/ft ² (g/m ²) of Surface, Average
75	2.95 (75)	1.83 (46)	1.71 (523)
60	2.36 (60)	1.46 (38)	1.37 (418)
50	1.97 (50)	1.27 (32)	1.14 (348)
45	1.77 (45)	1.15 (29)	1.02 (313)
40	1.57 (40)	1.02 (26)	0.91 (278)
35	1.38 (35)	0.89 (23)	0.80 (244)
30	1.18 (30)	0.77 (20)	0.68 (209)
25	0.98 (25)	0.64 (16)	0.57 (174)
20	0.79 (20)	0.55 (14)	0.46 (140)
15	0.59 (15)	0.41 (10)	0.34 (104)
12	0.47 (12)	0.33 (8.4)	0.27 (84)
10	0.39 (10)	0.28 (7)	0.23 (70)
8	0.31 (8)	0.22 (5.6)	0.18 (56)
6	0.24 (6)	0.18 (4.5)	0.14 (42)