



Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip)¹

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

1. Scope

1.1 This practice indicates the precautions that should be taken to obtain high-quality hot-dip galvanized coatings.

1.2 Where experience on a specific product indicates a relaxing of any provision, the mutually acceptable change shall be a matter for agreement between the manufacturer and purchaser.

1.3 The values stated in inch-pound units are to be regarded as the standard.

2. Referenced Documents

2.1 ASTM Standards:

A 143/A 143M Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement²

A 153/A 153M Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware²

A 384 Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies²

A 563 Specification for Carbon and Alloy Steel Nuts³

3. Steel Selection

3.1 The production of a galvanized coating has as its basis the metallurgical reaction between the steel and the molten zinc, resulting in the formation of several iron-zinc compound layers, for example, gamma (not always visible microscopically), delta, and zeta in Fig. 1. In addition, a layer of the molten zinc adheres to the surface of the compound layers as the steel is withdrawn from the galvanizing bath. Upon solidification, this adherent zinc forms the eta layer.

3.2 It is known that the exact structural nature of the galvanized coating, as typified by Fig. 1, may be modified according to the exact chemical nature of the steel being galvanized. Certain elements found in steels are known to have an influence on the coating structure. The elements carbon in

excess of about 0.25 %, phosphorus in excess of 0.04 %, or manganese in excess of about 1.3 % will cause the production of coatings different from the coating typified by Fig. 1. Steels with silicon in the range 0.04 % to 0.15 % or above 0.22 % can produce galvanized coating growth rates much higher than those for steels with silicon levels below 0.04 % and between 0.15 % and 0.22 %. Recent studies have shown that even in cases where the silicon and phosphorus are individually held to desirable limits, a combined effect between them can produce a coating as shown in Fig. 2, which typically would have a mottled or dull gray appearance.

3.3 These elements manifest their structural effect as an accelerated growth of the compound layers, particularly the zeta layer, and the virtual elimination of the eta layer. Cosmetically this accelerated growth is seen as a gray matte finished coating as opposed to the usual bright and smooth appearance of galvanized coatings. Sometimes, a large surface may have adjacent areas of matte finish and bright finish leading to a mottled appearance.

3.4 There is some evidence that the coatings resulting from this accelerated growth are more brittle and less adherent than normal coatings. There is also evidence that these coatings are subject to a premature red staining in atmospheric exposure; however, this staining has been found not to be associated with corrosion of the substrate steel.

3.5 A problem with steel chemistry is not usually apparent until after an item has been galvanized. Not all combinations of silicon, phosphorus, carbon, and manganese can be galvanized successfully. When the steel chemistry is known beforehand, experienced galvanizers can in some, but not all, instances exercise limited control over the coatings as shown in Fig. 2. Also, the combination of two different steel types or thicknesses in one item may result in a nonuniform galvanizing finish. The experience of the steel supplier, designer, manufacturer, and galvanizer should determine the steel selection.

3.6 In general, galvanized coatings are specified because of their corrosion resistance, not because of their appearance. The relative corrosion resistance of the normal and abnormal coatings is, for all practical purposes, equal.

¹ This practice 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 Annual Book of ASTM Standards, Vol 01.06.

³ Annual Book of ASTM Standards, Vol 15.08.