ASTM A123/A123M

Effective 2016 - Revise Paragraph 6.2 and 6.4: **Revisions in Red**
Effective 2017 – Revise Scope, Paragraph 6.2 and 6.2.1-6.2.4: **Revisions in Blue**

1.5 Fabricated reinforcing steel bar assemblies are covered by the present specification. The batch galvanizing of separate reinforcing steel bars shall be in accordance with Specification A767/A767M and the continuous galvanizing of reinforcing bars shall be in accordance with Specification A1094/A1094M.

2.1 ASTM Standards:
[…]
A767/A767M Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
A780 Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
A902 Terminology Relating to Metallic Coated Steel Products
A1094/A1094M Specification for Continuous Hot-Dip Galvanized Steel Bars for Concrete Reinforcement

6.2 The coating shall be continuous (except as provided below), and as reasonably smooth and uniform in thickness as the weight, size, shape of the item, and necessary handling of the item during the dipping and draining operations at the galvanizing kettle will permit. Except for local excess coating thickness which would interfere with the use of the product, or make it dangerous to handle (edge tears or spikes), rejection for non-uniform coating shall be made only for plainly visible excess coating not related to design factors such as holes, joints, or special drainage problems (see Note 6). Since surface smoothness is a relative term, minor roughness that does not interfere with the intended use of the product such as particulates of dross (Fe/Zn solid particles) in the coating that appear like pimples, or roughness that is related to the as-received (un-galvanized) surface condition, steel chemistry, or steel reactivity to zinc shall not be grounds for rejection (see Note 7). Zinc skimmings (zinc oxide and zinc chloride particulates from the top surface of the zinc bath) may cling to the coating surface after the part is removed from the zinc bath. These zinc skimmings are not cause for rejection as the coating beneath these skimmings is intact and will provide the anticipated corrosion protection. Some zinc skimmings can be brushed off the surface or will be washed off in the rain or condensation that gathers on the part as it weathers in the atmosphere. Other zinc skimmings may need to be ground off the surface of the coating by the galvanizer without removing zinc to the point that the coating no longer meets the minimum thickness. Surface roughness of articles to be painted or powder coated and the smoothing of the galvanized coating before painting or powder coating shall be mutually determined by the galvanizer and the purchaser. Further preparation of galvanized coatings for painting or powder coating including cleaning, profiling and outgassing shall be in accordance with Practice D6386 for painting and Practice D7803 for powder coating and are the responsibility of the paint or powder coating applicator. Surface conditions related to deficiencies related to design, detailing, or fabrication as addressed by Practice A385 shall not be grounds for rejection. The zinc coating on threaded components of articles galvanized under this specification shall conform to that required in Specification A153/A153M. Surfaces that remain uncoated after galvanizing shall be renovated in accordance with the methods in Practice A780 unless directed by the purchaser to leave the uncoated areas untreated for subsequent renovation by the purchaser.

6.2.1 Each uncoated area subject to renovation shall be limited in size. The length and width of the uncoated area shall be allowed to exceed 1 in. [25 mm] in only one of the two dimensions. The figure below depicts the allowable size of uncoated area that can be renovated.

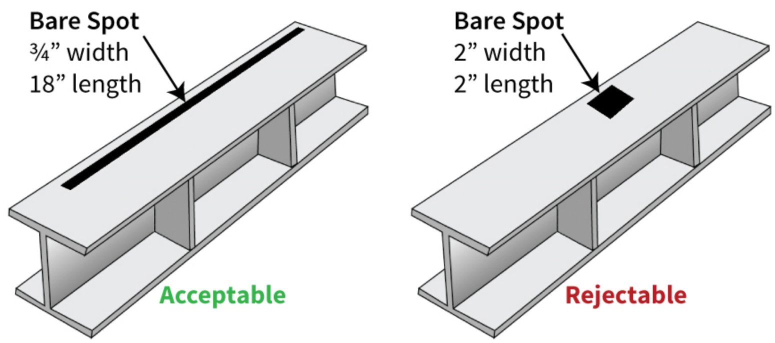


FIG. 4 Uncoated Area Subject to Renovation

6.2.2 The total of the uncoated areas subject to renovation by one of the methods in A780 on each steel article shall not exceed ½ of 1% of the accessible surface area to be hot-dip galvanized on that steel article. The total of the uncoated areas subject to renovation by one of the methods of A780 shall also not exceed 36 $in.^2$ per short ton [256 cm^2 per metric ton] of piece weight. The size of the uncoated area subject to renovation shall only be applicable at the galvanizing facility. Once the parts have left the galvanizing facility there shall be no limit on the size of the area subject to renovation.

6.2.3 The minimum thickness of the renovation in the uncoated areas for repairs using zinc metallizing or zinc solder shall be the class required by the thickness grade for the appropriate steel material category in Table 1 in accordance with the requirements of 6.1. The minimum thickness of the renovation in the uncoated areas using paints containing zinc dust shall be 3.0 mils [75 microns] and the maximum thickness of the renovation using paints containing zinc dust shall be 4.0 mils {100 microns}.

6.2.4 When uncoated areas requiring renovation exceed the criteria provided in Section 6.2.1 or 6.2.2, the part shall be rejected and may be stripped of coating and recoated, then re-inspected for uncoated areas. When uncoated areas requiring renovation are inaccessible for repair, the part shall be rejected and may be stripped of coating and recoated, then re-inspected for uncoated areas.

6.4 Upon shipment from the galvanizing facility, galvanized articles shall be free from uncoated areas, blisters, flux deposits, and gross dross inclusions. Lumps, projections, globules, or heavy deposits of zinc which will interfere with the intended use of the material will not be permitted. Surface roughness of articles to be painted or powder coated and the smoothing of the galvanized coating before painting or powder coating shall be mutually determined by the galvanizer and the purchaser. Further preparation of galvanized coatings for painting or powder coating including cleaning, profiling and outgassing shall be in accordance with Practice D6386 for painting and Practice D7803 for powder coating and are the responsibility of the paint or powder coating applicator. Plain holes of 1/2-in. [12.5-mm] diameter or more shall be clean and reasonably free from excess zinc. Marks in the zinc coating caused by tongs or other items used in handling the article during the galvanizing operation shall not be cause for rejection unless such marks have exposed the base metal and the bare metal areas exceed allowable maximums from 6.2.1 and 6.2.2. The pieces shall be handled so that after galvanizing they will not freeze together on cooling.

TABLE 1 Minimum Average Coating Thickness Grade by Material Category

Material Category	All Specimens Tested Steel Thickness Range (Measured), in. [mm]					
	<1/16 [<1.6]	≥ 1/16 to <1/8 [≥1.6 to <3.2]	≥1/8 to <3/16 [≥3.2 to< 4.8]	≥3/16 to <1/4 [≥4.8 to <6.4]	≥1/4 to< 5/8 [≥6.4 to <16.0]	≥5/8 [≥16.0]
Structural Shapes	45	65	75	75	100	100
Strip and Bar	45	65	75	75	75	100
Plate	45	65	75	75	75	100
Pipe and Tubing	45	45	75	75	75	75
Wire	35	50	60	65	80	80

Material Category	All Specimens Tested Steel Thickness Range (Measured), in. [mm]					
	<1/16 [<1.6]	≥ 1/16 to <1/8 [≥1.6 to <3.2]	≥1/8 to <3/16 [≥3.2 to< 4.8]	≥3/16 to <1/4 [≥4.8 to <6.4]	≥1/4 to< 5/8 [≥6.4 to <16.0]	≥5/8 [≥16.0]
Reinforcing Bar	...	...	...	...	100	100

ASTM A153/A153M

Effective 2016 - **Revisions in Red**

TABLE 1 Thickness or Weight [Mass] of Zinc Coating for Various Classes of Material

NOTE 1— Length of the piece, stated in Classes B-1, B-2, and B-3, refers to the finished dimension of the piece after fabrication.

Class of Material	Weight [Mass] of Zinc Coating, oz/ft^2 [g/m^2] of Surface, Minimum		Coating Thickness, mils [microns], Minimum	
	Average of Specimens Tested	Any Individual Specimen	Average of Specimens Tested	Any Individual Specimen
Class A—Castings—Malleable Iron, Steel	2.00 [610]	1.80 [550]	3.4 [86]	3.1 [79]
Class B—Rolled, pressed, and forged articles (except those which would be included under Classes C and D):				
B-1—5/8 in. [15.88 mm] and over in thickness and over 15 in. [381 mm] in length	2.00 [610]	1.80 [550]	3.4 [86]	3.1 [79]
B-2—under 5/8 in. [15.88 mm] in thickness and over 15 in. [381 mm] in length	1.50 [458]	1.25 [381]	2.6 [66]	2.1 [53]
B-3—any thickness and 15 in. [381 mm] and under in length	1.30 [397]	1.10 [336]	2.2 [56]	1.9 [48]
Class C—Fasteners over 3/8 in. [9.52 mm] in diameter and similar articles. Washers 3/16 in. and greater [4.76 and greater] in thickness	1.25 [381]	1.00 [305]	2.1 [53]	1.7 [43]
Class D—Fasteners 3/8 in. [9.52 mm] and under in diameter, rivets, nails and similar articles. Washers under 3/16 in. [4.76 mm] in thickness	1.00 [305]	0.85 [259]	1.7 [43]	1.4 [36]

5.7 High strength bolts, typically over 150,000 lb/sq. in. ultimate tensile strength, may be subject to hydrogen embrittlement. Practices to safeguard against hydrogen embrittlement are described in specification ASTM A143/A143A.

9.5 Materials that have been rejected for reasons other than embrittlement are not prohibited from being stripped, regalvanized, and resubmitted for test and inspection. They shall then conform to the requirements of this specification.

Note 1: Conformance to this specification does not guarantee "zero defects." Depending on the size and configuration of the parts (small diameter threaded parts and small washers as examples) a small amount of "fall out" may exist in an inspection lot that is not detected during a sample inspection. Issues include but are not limited to zinc build up in the threads or bonded washers. Handling of these types of issues needed to be negotiated between the purchaser and supplier.

ASTM A385/A385M

Effective 2016 – Add Paragraph 3.7: **Revisions in Red**
Effective 2017 – Revise Paragraph 3.2: **Revisions in Blue**
Effective 2020 – Addition of Fig. 9. Revise Paragraph 16.5 and 16.6. Revisions in **Green**.
Effective 2022 – Editorial, Revised 3.2, 3.5, and 3.7, Addition of 8.4, 8.5, 12.5. Revisions in **Purple**

3. Steel Selection

3.7 Steels with very low levels of silicon (less than 0.02%), and aluminum-killed steels, regularly present a challenge in developing a galvanized coating that meets the thickness requirements of ASTM A123/A123M or ASTM A153/A153M. Phosphorus (less than 0.020%) can also exhibit low coating thicknesses. For these steels, it may be difficult to meet the coating thickness requirements of ASTM A123/A123M or A153/A153M. In these cases, the galvanizer and the purchaser should agree on a plan of action. Some choices are to accept the lower coating thickness, apply a paint coating over the galvanized coating (Duplex System), blast clean the steel before hot-dip galvanizing to increase the coating thickness, over-pickle the steel in sulfuric acid to roughen the surface and increase the coating thickness, or other possible solutions.

3.2 It is known ~~that~~ the ~~exact~~ structural nature of the galvanized coating as typified by Fig. 1 cannot be guaranteed by the galvanizer and may be modified in accordance with 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. The element with the most significant effect on the galvanized coating is silicon. This element has two composition regions that can produce thick and dull coatings. The first region is silicon concentration between 0.06 % and 0.13 % and is known as the Sandelin region. The second region is silicon concentration above 0.25 %. When producing or purchasing steels to be hot-dip galvanized a good practice is to aim for steels with a silicon concentration target of <0.04 % and a maximum of 0.06 % to avoid the Sandelin region and to aim for steels with a silicon concentration target of >0.15 % to <0.22 % and a minimum of 0.13 % and a maximum of 0.25 % to avoid both the Sandelin region and the high silicon region. Recent studies have shown that even in cases where 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. The values of silicon **and phosphorus** in the mill test reports of steel can give an indication of the reactivity of the steel in the hot-dip galvanizing process but are not a guarantee. ~~The best practice is to galvanize test pieces to get a better indication of the reactivity of the steel~~. As defined in Test Methods and Practices A751, a cast or heat analysis (listed on the mill test report) represents only one sample taken from the heat and is known to vary from individual pieces, which are subject to product analysis. The product analysis normally allows greater deviation than the heat analysis, and individual parts can therefore vary more than the mill test report in chemical analysis and surface chemistry. When performing an evaluation of steel reactivity for galvanizing, the outcome of this variation can be significant, which may result in coatings different from those typified by Fig. 1. Fabrications made from recycled steel are also known to exhibit variations in surface chemistry which may differ significantly from the heat analysis. In some cases, galvanizing a test piece is helpful to obtain an indication of steel reactivity. It is crucial the test piece accurately represents the final part to be galvanized both in chemistry and thickness. It is also important that the dwell time in the galvanizing bath is similar for test pieces as that expected on the actual fabrication since the time in the bath can cause coating variations on reactive steel chemistry.

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. One method used to limit coating thickness on reactive steel chemistries is to specify blast cleaning before galvanizing. This method does not require the specification of a degree of cleanliness nor specific profile parameters; however, Commercial Blast Cleaning in accordance with SSPC-SP 6/NACE No. 3 can be used as a guide. 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. When galvanizing reactive steel chemistries in assemblies containing material thickness greater than 1 in., it is beneficial to supply the galvanizer with shop drawings before fabrication to determine if additional vent/drain holes, larger holes, or optimized hole designs can be specified relative to the handling orientation to limit coating thickness.

3.7 Steels with very low levels of silicon (less than 0.02 %) and aluminum-killed steels regularly present a challenge in developing a galvanized coating that meets the thickness requirements of Specifications A123/A123M or A153/A153M. Phosphorus (less than 0.020 %) can also exhibit low coating thicknesses. For these steels, it may be difficult to meet the coating thickness requirements of Specifications A123/A123M or A153/A153M. In these cases, the galvanizer and the purchaser should agree on a plan of action. Some choices are to accept the lower coating thickness, apply a paint coating over the galvanized coating (Duplex System), or blast clean the steel before hot-dip galvanizing to increase the coating thickness~~, over-pickle the steel in sulfuric acid~~. Blast cleaning before galvanizing is specified to roughen the~~ surface and increase the coating thickness, or other possible solutions.~~ steel surface and promote thicker galvanized coatings for low-silicon or Aluminum-killed steels, whereas blast cleaning before galvanizing is also a method used to limit coating thickness for reactive steel chemistries. The difference in outcome is due to the steel chemistry. Blast cleaning of low-silicon or Aluminum-killed steels before galvanizing does not require the specification of a degree of cleanliness nor specific profile parameters; however, Commercial Blast Cleaning in accordance with SSPC-SP 6/NACE No. 3 can be used as a guide.

8. ~~Flame~~Thermally Cut ~~Cope~~ Edges Preparation

8.4 Thermal cutting techniques, including flame, plasma, and laser cutting, result in increased steel hardness near the cut edge, changes in the diffusion properties of the steel in the heat-affected zone, and difficulties forming a uniform, smooth, and tightly adherent galvanized coating. The potential for a rough edge appearance (see Fig. 5) increases when galvanizing thermally cut edges of reactive steel chemistries or steels greater than 1⁄2 in. in thickness, or both, while a rough aesthetic may be less apparent with thinner steels or when laser and plasma cutting are specified. Rough coatings along thermally cut edges cannot be prevented by the galvanizer nor easily smoothed after galvanizing for aesthetic purposes.

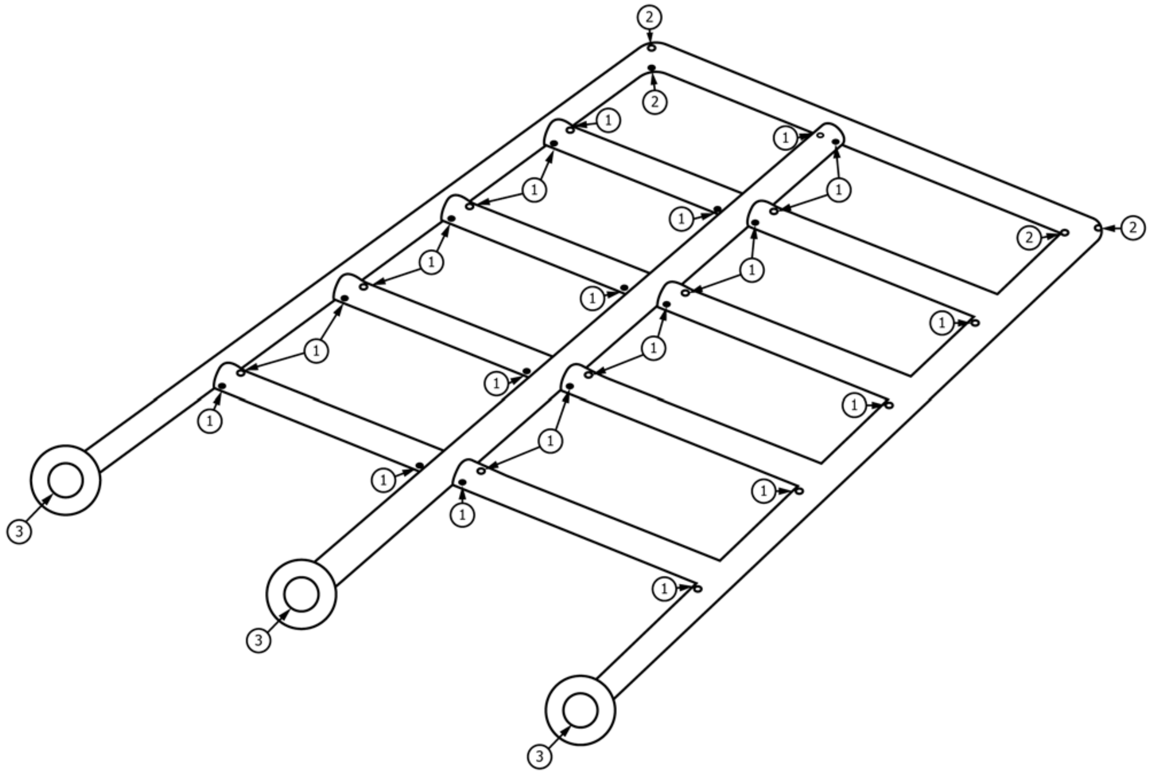
FIG. 5 Example of Hot-dip Galvanized Coating Appearance Formed Over Unprepared Flame-cut Edge on 1 in. Thick Steel

8.5 Project specifications can address the preparation of thermally cut edges for Architecturally Exposed Structural Steel (AESS), steel to be painted or powder coated after galvanizing (Duplex System), or any galvanized project with elevated aesthetic requirements. Where the additional cost to prepare cut edges can be justified, one method to achieve a higher quality galvanized finish along thermally cut edges is to grind the flat edge surface at least 1⁄16 in. into the parent material before galvanizing. Alternatively, mechanical cutting methods or water jet cutting can be considered where feasible to avoid thermal cutting techniques.

12. Design Recommendations for Providing for the Free Flow of Cleaning Solutions, Fluxes, Air, and Zinc

12.3 Air or moisture, or both, entrapped within closed fabricated pipework, such as handrail, can develop destructive pressures when heated to the galvanizing temperature. Pipe handrail shall preferably be vented full open internally, as shown in Fig. 8. In addition, there shall be one 3⁄8 in. [9.5 mm] minimum diameter external hole at each intersection to prevent any possible explosions in the event that the fabricator neglects to provide internal venting. This hole shall be located as close as possible to the weld bead joining the two steel pieces and the edge of the hole shall be not more than 0.5 in. [12 mm] from the edge of the weld bead.

Where internal venting is not possible, external vents shall be provided with one vent hole in each side of each intersection. The vent openings shall be a minimum of 3⁄8 in. [1 cm] in diameter or 25 % of the diameter of the pipe that is used, whichever is larger (see Fig. 9) and shall be located as described above. Fabricated pipework designs containing five or more horizontal components or rails (see Fig. 10) have a tendency to float within the zinc bath. To mitigate against floating, external vents shall be provided with one vent hole in each side of the internal intersections (see Fig. 10).



The above drawing illustrates desirable design features for fabrication of handrail containing five or more rails.
(1) Each vent hole shall be as close to the weld as possible with the edge of the hole less than 0.5 in [12 mm] from the edge of the weld bead, and not less than 3⁄8 in. [9.5 mm] in diameter. The two holes at each intersection shall be 180° apart and in the proper location as shown.
(2) Vent holes in end sections or in similar sections shall be at minimum 1⁄2 in. [12.7 mm] in diameter, but may be considered optional depending on lifting orientation during galvanizing or to achieve higher coating quality.
(3) Any device used for erection in the field that prevents full openings on vertical legs shall be attached after galvanizing.
Vent holes shall be visible on the outside of any pipe assembly prior to hot-dip galvanizing.

FIG. 10 Handrail—Five or More Parallel Components

12.5 Round vent/drain holes are frequently left open after galvanizing but can be plugged and smoothed flush with the surrounding coating for safety or aesthetic purposes at additional cost. It is common to use zinc or aluminum drive caps ground flush with the surrounding coating after installation. Diametral limitations or custom zinc plug molds should be discussed with the drive-cap supplier. Aluminum plugs can be specified for mild and moderately corrosive environments with minimal impact on corrosion performance. For more corrosive environments, including atmospheres close to bodies of salt water, utilize zinc plugs to avoid galvanic corrosion.

16. Galvanized Nuts, Bolts, Clearance Holes, and Tapped Holes in Galvanized Products

16.5 For bearing connections, clearance holes in hot-dip galvanized steel parts shall be standard clearance holes in accordance with the American Institute of Steel Construction (AISC) Steel Construction Manual, Section 16.2, page 20, Table 3.1. Due to the thickness of some hot-dip galvanized coatings, there may be a fit issue with galvanized bolts in standard clearance holes with galvanized coatings on the side walls of the holes. To accommodate the thickness of the galvanized coating on bolts sized less than 1 in. [M24] in nominal diameter, the clearance hole may need to be reamed to remove excess galvanized coating so that the galvanized bolt will fit in the clearance hole. The fit of the bearing connection clearance hole should be checked before the galvanized part is shipped to the job site.

16.6 For slip-critical connections, clearance holes in hot-dip galvanized parts shall be sized 1⁄8 in. [3 mm] larger than the nominal bolt diameter (db+1⁄8) [(db+3)] to accommodate the galvanized bolt without reaming. Standard clearance holes sized db+1⁄8 [(db+3)] for nominal bolt diameters 1 in. [M24] or greater do not require the use of oversized holes. When specifying nominal bolt diameters less than 1 in. [M24], clearance holes shall be oversized an additional 1⁄16 in. per AISC Steel Construction Manual, Section 16.1, Table J3.3 or additional 1 mm per Table J3.3M to achieve a hole dimension of db+1⁄8 in. [(db+3)].

ASTM A767/A767M

Effective 2019 - **Revisions in Red.**

3. Terminology

3.1 *Definition of Term Specific to This Specification:*

3.1.1 *galvanizing, n*—the process of immersing (hot-dipping) steel in molten zinc for a sufficient time to allow a metallurgical reaction between iron from the steel surface and the molten zinc.

3.1.1.1 *Discussion*— The reaction between steel and molten zinc forms zinc/iron alloy layers that bond the coating to the steel. The galvanizer may add trace amounts of certain elements (for example, aluminum, nickel, bismuth, or tin) to the zinc bath to help in the processing of certain reactive steels or to modify the appearance of the finished product. The elements are supplied to the molten coating bath, either as specified ingredients in the zinc spelter or by the addition of a master alloy containing the elements.

3.1.2 *lot, n*—all bars of one size furnished to the same steel reinforcing bar specification that have been coated within a single production shift.

6. Zinc Coating Process

[…] NOTE 3—Class 2 coatings are preferred for fabrication after galvanizing. Coatings that exceed 4.3 mils [110 µm] zinc thickness are more prone to cracking when bent to the requirements of 7.4.

7.3.2.1 When fabrication is performed after galvanizing, some cracking and flaking of the galvanized coating in the bend areas shall not be cause for rejection (Note 7).

NOTE 7—The tendency for cracking of the zinc coating increases with bar diameter, severity and rate of bending, and coating thickness.

7.4 *Class 2 Coatings*—The zinc coating shall not peel or flake off in any bend test meeting the requirements of Specifications A615, A706, or A996 [A615M, A706M, or A996M]. Refer also to Note 3.

ASTM A780

Effective 2020 - **Revisions in Red.**

A3. REPAIR USING SPRAYED ZINC (METALLIZING)

A3.3 ~~Blast clean the surface to be reconditions in accordance with SSPC SP5/NACE No. 1, white metal.~~ Where anticipated field service conditions include immersion, blast clean the surface in accordance with SSPCSP5/NACE No. 1 white metal. For less critical field exposure conditions, clean the surface to bare metal in accordance with SSPC-SP10/NACE No. 2 near white metal, as a minimum. Where abrasive blast cleaning cannot be reasonably performed, it is permissible to mechanically clean the surface in accordance with SSPC-SP11 to achieve a surface condition suitable for metalizing repair with the potential for reduced adhesion.

ASTM B6

Effective 2018 – **Revisions in Red**.

1. Scope

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.*

4. Ordering Information

4.1 See Specification B949.

6. Chemical Requirements

6.2 See Specification B949.

9. Sampling for Chemical Analysis

9.1 See Specification B949.

11. Rejection and Rehearing

11.1 See Specification B949.

12. Investigation of Claims

12.1 See Specification B949.

13. Settlement of Claims

13.1 See Specification B949.

14. Product Identification Marking and Packaging

14.1 See Specification B949.

ASTM B960

Effective 2018 – **Revisions in Red**.

1. Scope

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

4. Ordering Information

4.1 See Specification B949.

9. Sampling for Chemical Analysis

9.1 See Specification B949.

11. Rejection and Rehearing

11.1 See Specification B949.

12. Investigation of Claims

12.1 See Specification B949.

13. Settlement of Claims

13.1 See Specification B949.

14. Product Identification Marking and Packaging

14.1 See Specification B949.

ASTM D6386

Effective 2016 – **Revisions in Red.**
Effective 2022 – Revise Paragraph 5.4.1: **Revisions in Blue**

5.2 *Surface Smoothing*—Hot-dip galvanized surfaces generally are relatively smooth after galvanizing. There may be some thick/rough edges at the drip line due to excess liquid zinc run-off during the galvanizing process, or high spots in the coating due to included iron-zinc intermetallics (dross) or zinc oxide particles. These high spots and rough edges must be smoothed to avoid paint film gaps in the areas of the high spots.

5.2.1 Zinc high spots, those that would cause paint film gaps such as the metal drip line, should be removed by smoothing with hand or power tools as described in SSPC Surface Preparation Specification No. 2 or No. 3. The zinc should be removed until it is level with the surrounding area, taking care that the base coating is not removed by the smoothing methods. After smoothing, the surface shall be inspected for conformance to the required zinc thickness in accordance with Specifications A123/A123M or A153/A153M utilizing a magnetic thickness instrument in accordance with Practice E376. Any item falling below the required zinc thickness, before or after removal of any high spots, shall be repaired in accordance with Practice A780 using an appropriate method that is compatible with the paint system.

5.4.1 *Sweep Blasting*—Abrasive sweep or brush blasting in accordance with procedures described in SSPC Surface Preparation No. 16, which uses a rapid nozzle movement will roughen the galvanized surface profile. The abrasive material must be chosen with care to provide a stripping action without removing excess zinc layers, removal of up to 25 µm (1 mil) is acceptable. One of the materials that has been used successfully is aluminum/magnesium silicate. Particle size should be in the range of 200 to 500 µm (8 to 20 mils). Other materials that can be used are soft mineral sands with a Mohs hardness of five or less, organic media, such as corn cobs or walnut shells, corundum, limestone or cast zinc shot. The use of abrasive media with Mohs hardness of five or greater, or a bulk density over 200 lb/ft3 is capable of producing roughened galvanized surfaces with increased peak heights, but additional mitigations may necessary by the blaster to significantly reduce the risk of damage. Depending on the value of hardness for the abrasive medium, blasting pressure may need to be determined for the appropriate nozzle to work-piece distance, geometry of the component, and blasting medium. For some all-alloy coatings, even the relatively low-pressure blast of 0.15 to 0.25 MPa (20 to 40 psi) can be too great, causing cohesion problems. Oil contamination of the compressed air will degrade paint adhesion to sweep-blasted hot-dip galvanized surfaces, test method for determining this contamination is Test Method D4285. Care is needed in averting this type of contamination. Care must be taken to leave zinc layers intact. The purpose of sweep blasting is to deform, not remove the galvanized metal. Any area falling below the required zinc thickness, before or after sweep blasting, should be repaired in accordance with Practice A780. The procedure for this process can be found in SSPC Surface Preparation Specification No. 16. Sweep blasting of zinc should be not less than 110 m^2/h (1200 ft^2/h) using these abrasive materials. The substrate should be maintained at a temperature greater than 3 °C (5 °F) above the dew point temperature. This procedure should be completed at the same location as the paint application.

ASTM D7803

Effective 2019 – Revisions in Red.

1. Scope

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

2. Referenced Standards

2.2 *Society for Protective Coatings Specifications:*

Surface Preparation Specification No. 1 Solvent Cleaning

Surface Preparation Specification No. 2 Hand Tool Cleaning

Surface Preparation Specification No. 3 Power Tool Cleaning

Surface Preparation Specification No. WJ-1 Surface Preparation and Cleaning of Metals by Water-Jetting Prior to Recoating

Surface Preparation Specification No. WJ-2 Surface Preparation and Cleaning of Metals by Water-Jetting Prior to Recoating

Surface Preparation Specification No. WJ-3 Surface Preparation and Cleaning of Metals by Water-Jetting Prior to Recoating

Surface Preparation Specification No. WJ-4 Surface Preparation and Cleaning of Metals by Water-Jetting Prior to Recoating

Surface Preparation Specification No. 15 Commercial Tool Cleaning

Surface Preparation Specification No. 16 Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals

2.3 *NACE:*

NACE 6G186 Surface Preparation of Soluble Salt Contaminated Steel Substrates Prior to Coating

4. Significance and Use

4.1 This practice describes the methods of preparation of hot-dip galvanized surfaces prior to the application of powder coating. The key to achieving proper adhesion between powder coatings and galvanized steel is surface preparation. The surface must be entirely free from **visible** metal oxides prior to powder coating. Any metal oxides that remain on the surface of the galvanized steel can potentially retain air or moisture. Upon heating during the curing stages of the powder application, the oxides may release water vapor or air, which can expand and penetrate the powder coating, causing blisters or voids.

5. Processes for Cleaning and Preparing Hot Dipped Galvanized Iron and Steel Surfaces for Powder Coating

5.1.2 *Surface Cleaning*—Hot-dip galvanized surfaces must be clean and free of oil and grease before they are powder coated. Soluble salts shall be removed to the degree specified in the powder coating specification. Detection of soluble salts can be achieved following SSPC Guide 15. Removal of soluble salts can be achieved following NACE 6G186. Adhesion problems have been experienced with newly galvanized articles that have been water quenched or treated with chromate conversion coatings. These two post-galvanizing treatments are not recommended for galvanized articles that are to be coated. Test Method F21 can determine if contamination is on the galvanized surface prior to powder coating.

5.1.3.1 *Sweep Blasting*—Abrasive sweep or brush blasting in accordance with SSPC SP 16, which uses a rapid nozzle movement, will roughen the galvanized surface profile. The abrasive material must be chosen carefully to provide a stripping action that removes the oxide reaction products without excessive removal of the zinc. One of the materials that has been used successfully is aluminum/magnesium silicate with a particle size in the range of 200 to 500 µm (8 to 20 mils.). Other materials that can be used are soft mineral sands with a Mohs hardness of five or less, organic media, such as corn cobs or walnut shells, corundum, or limestone or steel grit (G40). Depending on the value of hardness for the abrasive medium, blasting pressure may need to be adjusted for the appropriate nozzle to work-piece distance, geometry of the component, and blasting medium. For reactive steel with all-alloy coatings which may have compromised adhesion, even the relatively low-pressure blast of 0.15 to 0.25 MPa (20 to 40 psi) can be too great, causing adhesion problems. Care must be taken to leave zinc layers intact. Oil contamination of the compressed air will degrade adhesion to sweep-blasted hot-dip galvanized surfaces (Test Method D4285). Care is needed in averting this type of contamination. The purpose of sweep blasting is to deform, not remove the galvanized metal. Any area falling below the required zinc thickness, before or after sweep blasting, shall be repaired in accordance with Practice A780. Measurement of the zinc coating thickness before and after sweep blasting shall be performed in accordance with Specification A123/A123M. Sweep blasting of zinc shall be not less than 110 m2/h (1200 ft2/h) using these abrasive materials. The substrate shall be maintained at a temperature of at least 3°C (5°F) above the dew point temperature. Following abrasive blast cleaning, surfaces shall be blown down with clean, compressed air. In some atmospheric conditions, such as high humidity, high temperature, or both, the formation of zinc oxide on the blasted surface will begin very quickly. Because newly formed zinc oxide is not visible to the naked eye, powder coating shall be applied as soon as possible after surface preparation.

5.4 *Coating Application Time*—Blow down prepared surfaces with clean, dry compressed air following surface preparation. In some atmospheric conditions, such as high humidity or high temperature, or both, the formation of zinc oxide on the freshly prepared surfaces will begin very quickly. Zinc oxide formation is not visible to the unaided eye; therefore, in any atmosphere, powder coating should be started as soon as possible and preferably within one hour after surface preparation but no later than eight hours after surface preparation.