



Zinc Alloy Plating

1 Scope

1.1 Material Description. This specification covers the basic requirements for barrel or rack electrodeposited zinc alloy over a ferrous substrate. Various alloy platings with supplemental treatments are covered by this specification.

This specification covers functional requirements only. Cosmetic requirements, such as brightness, shades, tint, etc., are not defined. Material approved to this specification may not meet special cosmetic/appearance requirements and must be agreed upon by the purchaser and applicator.

Table 1 lists the zinc alloy finishes covered by this specification.

1.1.1 For parts calling out this specification without a specific alloy (or to ZnNi without a Type A or Type B) but contracted and completing the Production Part Approval Process (PPAP) after January 1, 2014, the finish shall default to Type B. Parts completing PPAP or contracted with GM before 2014 may have ZnNi Type A or Type B.

1.1.2 Due to extremely low availability of applicators, do not specify ZnCo or ZnFeCo on new designs. For existing designs, consult with the responsible Design and Materials Engineers to locate sources or to re-specify the finish.

1.1.3 ZnFe finish applicators are also not widely available. Consult the responsible Materials Engineer before specifying ZnFe.

1.2 Symbols. Not applicable.

1.3 Typical Applications. Zinc alloy plating is especially suitable for small to medium ferrous parts, such as castings, stampings, clips, fasteners, and other ferrous parts, where levels of corrosion protection exceeding pure zinc are required.

1.4 Remarks.

1.4.1 Electroplating may not be suitable for all materials and applications. Each application must be reviewed with the responsible Materials Engineer before usage.

1.4.2 Use of this coating on threaded surfaces and/or bearing surfaces of joints could affect the

torque-tension relationship. It is recommended that a torque-tension study of the fastener joint be performed before releasing this finish on any new application.

1.4.3 Coefficient of friction (CoF) values in this specification are determined at ambient temperatures. New applications for this finish should be tested to confirm performance under application-specific operating conditions.

1.4.4 These finishes are suitable for temperatures from -50 °C to 120 °C and to 150 °C for ZnNi. For applications outside this temperature range, consult Materials Engineering.

1.4.5 Zinc and zinc corrosion products may cause localized embrittlement when in contact with stressed Polyamide 6 or 66. Caution must be taken when specifying these finishes on parts in contact with Polyamide 6 or 66.

1.4.6 High-strength or high-hardness steel parts are susceptible to hydrogen embrittlement. While certain precautions and post-plate de-embrittlement baking are generally effective in protecting the parts from hydrogen embrittlement, they are time sensitive and require extra care during processing. Electroplating of steel parts with hardness above 46 HRc is not recommended. See 3.9 for precautions against hydrogen embrittlement.

Table 1: Corrosion Requirements

Alloy	Weight Percent of Alloy	Minimum Hours to Red Rust
ZnCo (Zinc Cobalt)	0.5% to 1.5% Co	400
ZnFe (Zinc Iron)	0.4% to 0.8% Fe	480
ZnCoFe (Zinc Iron Cobalt)	0.3% to 0.7% Co, 0.4% to 0.8% Fe	480
ZnNi Type A (Low Zinc Nickel)	5.0% to 15.0% Ni	480
ZnNi Type B (High Zinc Nickel)	10.0% to 17.0% Ni	1000 Note 1

Note 1: ZnNi Type B is required to meet a minimum of 240 h Neutral Salt Spray (NSS) to first appearance of white corrosion.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

AIAG CQI-11	ISO 17025
ASTM F1470	SAE USCAR-5
ISO 1463	SAE USCAR-7
ISO 9227	SAE USCAR-11

2.2 GM Standards/Specifications.

GMW3059	GMW14872
GMW14729	GMW16730

2.3 Additional References.

- Approved Finishers List (available at www.gmsupplypower.com).
- GM Drawing Numbers: 11611882, 12565635.
- Part Numbers: 11516105, 11611882, 12565635.
- TMC003 Material Safety Data Sheet guidance documents (available at www.gmsupplypower.com).

3 Requirements

The parts finished to this specification shall meet the following technical requirements demonstrated by the test methods described. The appropriate tests for different situations, i.e., new chemical approval, new applicator approval, Production Part Approval Process, and regular process control testing, are described in Appendix A. Procedures and requirements for new chemical and applicator approval are described in Appendix B.

3.1 Appearance.

3.1.1 The finish shall have a uniformly bright or dull silver appearance and be tightly adherent and dry.

3.1.2 Range of color, iridescence, opaqueness, and sheen are normally not critical but shall be consistent from batch to batch.

3.1.3 A black finish can be specified on drawings for zinc nickel Type A and Type B. A GM approved black chemical system must be used when specified.

3.1.4 Colors other than black can be specified on part drawings for identification and error-proofing purposes. For this purpose, a coloring dye may be added to the passivate or topcoat in any GM approved chemical system. The acceptable color and appearance shall be agreed upon between the purchaser and applicator.

3.2 Adhesion. There shall be no blistering or flaking after exposing plated parts to $220\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ for 30 minutes ± 5 minutes and quenching in room temperature water $25\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$.

3.3 Alloy Content. The alloy content must be consistent throughout the entire electrodeposited layer. The alloy content range is specified in Table 1. The referee method for determining the alloy content is by X-ray Fluorescence (XRF) or spot-mode Energy Dispersive X-ray Spectroscopy (EDS).

3.4 Plating Thickness.

3.4.1 The plating layer thickness is defined as the metallic zinc alloy layer measured after all specified supplemental treatments are completed. However, the measurement of plating thickness does not include any subsequent topcoat. The plating layer thickness on significant surfaces shall be a minimum of 8 μm .

3.4.2 The plating thickness on bolts and screws shall be measured on the head, on a surface as close to flat as possible, and away from corners and edges. For referee purposes in cases when it is not possible to accurately measure the plating thickness on the head (e.g., the plating is mechanically damaged or it was already exposed to a corrosion test), the point of the bolt/screw or tip of an unexposed thread may be measured and compared to a reference part plated in the same process. On nuts, the plating thickness shall be measured on the spanner flats.

3.4.3 For parts other than threaded fasteners, the plating thickness requirement applies to significant surfaces as specified on engineering drawings. If the significant surfaces are not defined, all surfaces are considered significant.

3.4.4 For threaded fasteners, the maximum total thickness of the plating and topcoat is limited by the basic thread size (tolerance h or H). After plating and topcoat, parts must gauge with appropriate basic size GO thread gauge. Threads may be produced undersize/oversize to accommodate the coating provided that the finished product meets all specified mechanical properties. Where mechanical properties are not specified, undersizing/oversizing is subject to approval by the responsible Fastening Engineer and all undersizing/oversizing shall be within permissible limits as agreed upon.

3.4.5 For parts other than threaded fasteners, there is no limit on maximum total coating thickness as long as the finish meets all other requirements and does not negatively affect the function of the part.

Caution: Due to the relatively low ductility of zinc nickel, flaking may occur, especially at high current-density areas and on parts that will undergo additional forming/joining operations such as tube bending and press fits. In these applications, careful design considerations and process control shall be taken.

3.4.6 For referee purposes, the plating thickness shall be determined by microscopic examination of cross sections taken perpendicular to significant surfaces per ISO 1463. For regular production lot certification, a calibrated XRF can be used for plating thickness measurement. The measurement shall be taken after the entire finishing process is complete. The measurement method shall have good accuracy and be robust to the finish material, substrate material, part size, and geometry. In case of dispute, the supplier must be able to demonstrate a maximum deviation of 10% between its test method and the cross-sectioning measurement per ISO 1463 when measuring the same area of the same part.

Note: Plating layer thickness measurement shall be reported for each production lot.

3.5 Recess Fill Test. The total coating system shall not adversely affect the drive system (internal recess dimensions, hex size, etc.) or function of the fastener. Using a batch (minimum batch size of ten) of hexalobular internal drive pan head screws (Part Number 11611882 or equivalent), measure the recess penetration depth against drawing requirements to ensure conformance. Coat the parts in a production process and lot size. (Coating the test parts with other similarly sized parts to reach production lot size is acceptable.) Measure the recess penetration depth after coating. All measurements must meet the drawing requirement after coating. For Part Number 11611882, the maximum penetration depth for the drive recess is 0.5 mm.

3.6 Corrosion Resistance. After exposure to Neutral Salt Spray for the hours specified in Table 1, finished parts shall exhibit no white or red corrosion (depending on the exposure time and type of alloy plating) on significant surfaces. The test method and definition of significant surfaces are as follows:

3.6.1 Corrosion Test. Test finished parts per ISO 9227 (NSS) with the following additional requirements:

- The sample holder inside the test cabinet/chamber shall be constructed of material resistant to the test environment, i.e., acrylic and Polyvinyl Chloride (PVC). Also, the

sample holder material, i.e., metal and wood, shall not affect the corrosion test results.

- The orientation of the parts during test is slightly slanted to minimize accumulation of test solution on the finished surface. The placement and orientation of test parts shall be such that parts are not touching and that they are not shielding each other from the test environment.
- Test parts shall not drip on each other during the test.
- Parts to be tested shall be as close to as-shipped condition as possible. No special cleaning or treatments allowed.
- Parts shall be aged at the ambient laboratory conditions $23\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$ and relative humidity of $45\% \pm 10\%$ for at least 24 h before the test.

3.6.2 Significant surfaces for test evaluation of fasteners shall be all exposed surfaces of the fastener when installed, including, but not limited to, fastener heads, socket recess, SEMS washers, and external surfaces of nuts. Fastener threads and points are excluded unless otherwise specified on the drawing.

3.6.3 Significant surfaces on parts other than threaded fasteners shall be all surfaces. Deep recesses, such as blind holes and the interior of tubes, are excluded unless otherwise specified on the drawing.

3.6.4. Temperature Resistance. After heating the parts for 24 h at $150\text{ }^{\circ}\text{C}$ (part temperature) the corrosion-resistance requirements as specified in 3.6 shall be met.

Note: The corrosion protection performance described here is applicable to the finished product as it is packaged and leaves the applicator. After extended transportation, handling, and storage, the corrosion performance and other characteristics may deteriorate. It is up to the Tier 1 supplier to arrange the proper logistics with GM to ensure the parts meet performance when they reach GM assembly.

3.7 Cyclic Corrosion. Parts finished to this specification with ZnNi shall pass the following cyclic corrosion test:

Type A (Low ZnNi): GMW14872 EXT All, 4sp, Exposure D. After exposure, the finished parts shall exhibit a maximum of 10% red rust and a maximum of 50% white corrosion on significant surfaces as defined in 3.6.2 and 3.6.3.

Type B (High ZnNi): GMW14872 UB Method 1/2, All, 4sp, Exposure D. After exposure, the finished