GM WORLDWIDE ENGINEERING STANDARDS	**Material Specification**	**GMW3359**

Non-Electrolytically Applied Zinc-Rich Coating

1 Scope

This standard covers the basic requirements for a corrosion resistant non-electrolytically applied zinc-rich coating. Besides corrosion protection, the coating also provides consistent frictional properties.

1.1 Material Description. This coating specification covers zinc flake coating with or without a top coat.

Coating Types: Three levels of corrosion protection are provided by the following types:

Type A: High corrosion resistant coating.

Type B: Medium corrosion resistant coating.

Type C: Low corrosion resistant coating.

Note: When not explicitly specified, the default coating type shall be Type A. Parts contracted and Production Part Approval Processed ("PPAPed") before January 1, 2014, that is without the coating Type (A, B, or C) specified, may continue to default to Type B.

Note: Type C coating systems may be without top coat if coefficient of friction (CoF) requirements are met. Treatment with an additional lubricant to meet CoF is permissible.

1.2 Symbols. Not applicable.

1.3 Applicability. This coating is suitable for externally and internally threaded fasteners size M6 or larger, and other ferrous parts where high level of corrosion protection and freedom from hydrogen embrittlement are required. This coating is not recommended for the following types of parts:

- Bolts and nuts of sizes < M6.
- Parts with internal drive recess and blind holes.
- Parts mating against magnesium surfaces.
- Loose washers with diameter < 14 mm.
- Parts where electrical conductivity is required.

1.4 Remarks.

1.4.1 This coating process does not generate hydrogen; however, pre-treatment processes, i.e., acid pickling could cause hydrogen adsorption. Non-electrolytically applied zinc-rich coating has high permeability which allows effusion of hydrogen during curing which might have been absorbed during acid pickling. See precautions in 3.1.1.

1.4.2 Use of this coating system on threaded surface and/or bearing surface 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 The corrosion performance is influenced by part geometry, substrate material, and application process. The coating systems approved to this specification were tested to meet all requirements using common steel fasteners. For new designs, applications, and parts with complex geometries or difficult to clean material such as castings and powder metal, extra validation testing is highly recommended.

1.4.4 This finish is suitable for service temperatures from -50 °C to +120 °C. Applications outside of this temperature range shall be reviewed with the responsible Materials Engineering organization before usage.

1.4.5 Dip-spin coating is a bulk process. If parts are prone to nesting, stick together (flat washers), or easily damaged by mechanical tumbling, dip-spin coating method is not recommended. Alternatives include spray and dip-drain methods.

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In the case of flat washers, additional handling may be required between the coating and curing step to reduce the amount of parts sticking together. Final sorting of parts stuck together will be necessary to ensure all washers have sufficient coating on both sides.

1.4.6 Shot blasting is not a preferred pre-treatment method for internally threaded parts (nuts), nut-washer and bolt-washer assemblies. If shot blasting is used, extra care shall be taken to ensure shots are not trapped in the coated parts.

1.4.7 This coating is relatively soft, and is prone to “dusting”. It is expected that equipment handling high volumes of coated parts (such as automated bolt feeders) will require regular cleaning to remove the coating dust.

1.4.8 The curing process of these coatings occurs between 200 °C to 350 °C and may temper high hardness metals. It is the responsibility of the fastener manufacturer to ensure their parts still meet mechanical and material requirements after coating.

2 References

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

2.1 External Standards/Specifications.

AIAG CQI-12	ISO 9227	ISO 17025	SAE/USCAR-7
ISO 1463	ISO 16047	SAE/USCAR-5	SAE/USCAR-11

2.2 GM Standards/Specifications.

9984094	9986153	GMW14270	GMW14829
9985670	9986333	GMW14700	GMW14872
9985809	GMW3059	GMW14729	GMW16551

2.3 Additional References.

- GM Part Number (P/N) 11502644, test washer.
- GM P/N 11515490, Electrodeposition Primer (ELPO) coated test washer.
- GM P/N 11516090, test nut.
- GM P/N 11516105, surrogate bolt.
- GM P/N 11570102, M10 heavy hex bolts.

3 Requirements

The parts coated to this specification shall meet the following technical requirements and demonstrated by the test methods described. The appropriate tests for different situations: New chemical approval, new applicator approval, Production Part Approval Process (PPAP), and regular process control testing, are described in Appendix A, Table A1. Procedures and requirements for new chemical and applicator approval are described in Appendix B.

Note: For fasteners with weight-saving indented heads, it is allowable to have up to 1% of a delivered batch to exhibit coating bubbles and flaking inside the indentation. This deviation extends to 3.2 through 3.6 for the inside of the indentation only.

3.1 Pre-treatment and Post-treatment.

3.1.1 All coated parts with surface or core hardness > 320 HV (32 HRC), and processed through an acidic or hydrogen-generating pre-treatment process shall be processed per SAE/USCAR-5. The referee method for detection of embrittlement shall be per SAE/USCAR-7.

The maximum material hardness in the drawing or relevant specification shall be used to determine if de-embrittlement treatment is required. If a part is heavily cold worked or heat treated to high strength/hardness, but is without a specified maximum hardness limit in the drawing or specification, then the part manufacturer must provide to the applicator the hardness data in order to determine if de-embrittlement treatment is required. Note that treatment is determined by the maximum measured hardness of the lot, not the average.

3.1.2 The curing temperature of the coating process shall not exceed the maximum of 400 °C. This is to reduce the risk of tempering or other softening conditions to hardened parts. For hardened parts, special consideration shall be made to ensure the mechanical properties are not detrimentally affected by the coating process.

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3.2 Appearance. The coating shall have a uniform appearance and shall be free from uncoated areas and excess coating which affect performance. The coating shall not be oily or tacky to the touch. The coating shall be completely cured and shall have good adhesion to base metal. Unless otherwise specified, the color shall be silver or gray.

Note: Due to the nature of the coating process, it is possible to have small coating buildup. Coating buildup < 1 mm thick and not in the underhead bearing area does not affect function or assembly of bolts, screws or nuts and should not be a cause for rejection. However, when present in a large number of parts (> 1% of the delivered batch), coating dust and debris becomes a concern. It is the responsibility of the coating applicator to minimize coating buildup. Coating applicators with multiple complaints for this issue may be removed from the approved supplier list.

3.3 Flexibility and Chip Resistance. The coating must withstand the normal extension, flexing and compression encountered by springs and spring clips during product assembly without evidence of flaking or loss of adhesion from the base metal. It shall withstand normal handling and storage conditions without chipping or flaking.

3.3.1 Expose coated part per GMW14700, method C. Test at room temperature. After exposure per GMW14700, expose the same parts to Neutral Salt Spray (NSS) per 3.6. Parts shall meet the corrosion performance requirements per 3.6.

3.4 Adhesion Characteristics.

3.4.1 Parts coated to this specification shall show no evidence of blistering or other appearance changes other than a whitish blush after humidity exposure per GMW14729 for 96 h. After removal from humidity exposure for at least 10 minutes, perform tape adhesion test per GMW14829. There shall be a minimum of 99.0% coating (top coat) retention. When removing the tape, a slight adherence of the coating is permissible since this has no influence on the corrosion resistance. In the case of small parts with insufficient surface area for the tape adhesion test, coat 50 mm x 50 mm steel panels with the parts and use the panels for the test.

3.4.2 For each production lot, perform tape adhesion test per GMW14829 on finished coated parts. There shall be a minimum of 99.0% coating (top coat and base coat) retention. If the production part geometry or size is not suitable for this test, surrogate parts may be coated with the production parts and used for adhesion testing.

3.5 Coating Thickness.

3.5.1 The coating thickness is defined as the combined base coat and top coat after the entire coating and curing process is completed. The phosphate pretreatment/adhesion layer is not included in the total coating thickness. The minimum coating thicknesses for the different coating types (A/B/C) are listed in Table 1.

3.5.2 The coating thickness on bolts and screws shall be measured on the head. In cases when it is not possible to accurately measure the coating thickness on the head (e.g., the coating is mechanically damaged, or it was already exposed to a corrosion test), the untouched surface of the fastener tip may be measured and compared to a reference part coated in the same process. On nuts, the coating thickness shall be measured on the spanner flats.

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

3.5.4 For threaded fasteners, the maximum coating thickness is limited by the basic thread size (tolerance h or H). After coating, parts must gage with appropriate basic size GO thread gage. The maximum allowable torque for gauging can be found in GMW16551. Threads may be produced undersize/oversize to accommodate the coating, provided that the finished fastener meets all specified mechanical properties. Where mechanical properties are not specified, undersizing/oversizing is subject to approval by the pertinent GM Fastener Engineer, and all undersizing/oversizing shall be within agreed upon limits. The fastener supplier will consult with the coating applicator to determine the appropriate thread size before coating.

3.5.5 The maximum coating thickness under the head of bolts and screws shall not exceed 25 µm.

3.5.6 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.

3.5.7 The applicator may use a non-destructive method to measure the total or base coat thickness for process quality control or lot release. However, a documented correlation with the total coating thickness, measured by microscopic test per ISO 1463, and the readings by non-destructive test, must be established for each coating type and thickness measurement equipment.

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