



Protective Finishes - Zinc Phosphate Type

1 Scope

This standard covers the materials and performance requirements for zinc phosphate treatment and post-treatment. This coating is typically applied on engine and transmission components and on applications where minimum corrosion protection is required.

1.1 Material Description. This finish is composed of a zinc phosphate conversion layer, providing the substrate material with improved surface adhesion characteristics for subsequent application of lubricant, paint, adhesives, etc.

This standard also defines the requirements for various supplemental treatments with zinc phosphate as shown in Table 1. The different post-treatments are identified by different code suffixes.

1.2 Symbols. Not applicable.

1.3 Typical Applications. This coating is suitable for internally threaded parts, parts with internal drive recess, externally threaded and non-threaded ferrous parts where minimum corrosion protection and freedom from hydrogen embrittlement are required.

1.4 Remarks.

1.4.1 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.

1.4.2 Coefficient of friction 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.

1.4.3 Finishes with integrated lubricant (Codes G and H) conforming to the requirements of this specification can be used in the application range of -50 to +120 °C. For applications outside of this temperature range, consult your local Material/Fastener Engineering group.

1.4.4 Finishes with oil coatings are not recommended for usage against plastic surfaces. It is recommended that pre-applied adhesives,

sealers and nylon-type patching elements be applied before supplementary treatments (Codes A, B, G, H, W, and Y).

1.4.5 Code D (no supplemental coating) finish provides minimal corrosion protection. The Tier 1 supplier must take suitable process and logistics considerations to ensure parts do not prematurely corrode. This may include adding a rust preventative coating after phosphating. This process shall be presented during the Advanced Product Quality Planning (APQP) activities.

1.4.6 This coating process generates a small amount of hydrogen in both the acid pickling and the zinc phosphate process. This coating has high permeability, which allows for the effusion of hydrogen after coating. See 3.8 for precautions against hydrogen embrittlement.

1.4.7 This coating process exposes parts to acids and may generate surface pits on metal surfaces. Generally, the higher the material hardness, the more severe the pitting. Ensure the coating process selected is not detrimental to the function or durability of the component.

2 References

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

2.1 External Standards/Specifications.

AIAG CQI-12	ISO 16047
ISO 1463	ISO 17025
ISO 4014	SAE/USCAR-5
ISO 9227	SAE/USCAR-7

2.2 GM Standards/Specifications.

GMW3059	GMW14829
GMW14729	GMW16722

2.3 Additional References.

- Approved Finishers List file (available at www.gmsupplypower.com)
- GM P/N 11570102
- GM P/N 11611954
- GM P/N 11611987
- GM P/N 11612005

- TMC003 Material Safety Data Sheet guidance documents (available at www.gmsupplypower.com).

3 Requirements

The parts coated to this specification shall meet the following technical requirements and are 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. Procedures and requirements for new chemical and applicator approval are described in Appendix B.

3.1 Appearance.

3.1.1 The coating shall have a uniform appearance and shall be free from tears, open pores, cracks, flakes, blisters and uncoated areas.

3.1.2 Unless otherwise specified, the color of the finish shall be dark gray to black.

3.2 Dryness.

3.2.1 Parts with supplemental coating per code G and H shall be evenly coated. There shall be no visible droplets of oil or coating material on the part.

3.2.2 Parts with supplemental coating per code T shall be dry to touch. The referee method is to hold the coated part with white tissue paper while applying light hand pressure (10 N force) for 5 s. There shall be no visible staining or discoloration to the tissue paper.

3.3 Coating Weight. The minimum zinc phosphate coating weight shall be 10 g/m². The process control range for coating weight shall be ± 4 g/m². The entire control range must be above the 10 g/m² absolute minimum. Once production parts have been approved by the Production Part Approval Process (PPAP), the zinc phosphate coating material and process must remain the same. Any change will require a new PPAP. Phosphate coating weight shall be determined by either the caustic soda method or standard chromic acid method on actual parts.

3.4 Topcoat Thickness.

3.4.1 When applied to threaded products, the combined zinc phosphate and supplemental coating shall not have an adverse effect on normal installation and removal practices. At the same time, the coating thickness shall be adequate to

provide sufficient corrosion resistance as specified in Table 1.

3.4.2 The maximum thickness of coating which may be applied to threads on threaded products is limited by the basic thread size (tolerance h or H). After coating, parts must gage with appropriate basic size GO thread gages. Threads may be produced undersize/oversize (before coating) to accommodate the coating thickness, provided the finished product (after coating) meets all specified mechanical properties. Where mechanical properties are not specified, undersizing/oversizing is subject to approval by the pertinent engineer and all undersize/oversize shall be within permissible limits as agreed upon. Fastener supplier will consult with the coating applicator to determine the appropriate thread size before coating.

3.4.3 For non-threaded parts, maximum coating thickness is not defined. However, the coating thickness shall not have adverse effects on the fit, form, and function of the component.

3.4.4 For code B and Y (if code Y coating material is applicable), the maximum coating thickness under the head of bolts and screws shall not exceed 25 μ m. Supplier shall monitor the thickness per their control plan.

3.4.5 For referee purposes, the coating thickness shall be determined by microscopic examination of cross sections taken perpendicular to significant surfaces per ISO 1463.

3.5 Corrosion Resistance

3.5.1 When exposed to neutral salt spray (NSS) per ISO 9227, significant surfaces on coated parts shall show no base metal corrosion (red rust) after the minimum hours specified in Table 1. See 3.5.3 and 3.5.4 for the definition of significant surfaces.

Note: The salt spray test is only used to test the integrity of the finish for quality control. The hours to red rust in a salt spray test do not correlate to the actual service life of the part.

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 have an acceptable level of performance when they reach GM assembly.

Table 1: Corrosion Requirements

Code	Supplemental Coating	Neutral Salt Spray Hours
A	Protective Oil	24
B	Protective Paint	72
D	None	1 ^{Note 1}
G	Approved Organic topcoat/friction control oil	24
H	Approved Organic topcoat/friction control oil (High corrosion protection)	72
T	Approved dry topcoat	2
W	Protective Wax	24
Y	Other Material (as specified on drawing)	Per drawing

Note 1: Code D, 1 h salt spray requirement to be used as a referee test to verify complete phosphate coverage. This test is required for PPAP.

3.5.2 Applicator in-house NSS testing shall be performed on a regular basis to maintain statistical process control.

3.5.3 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 surface of nuts. Fastener threads and point are excluded unless otherwise specified on the drawing.

3.5.4 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 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.

3.7 Adhesion Characteristics. Adhesion requirements apply to Codes B and Y (if code Y coating material is applicable) only.

3.7.1 Parts coated to this specification shall show no evidence of blistering or other appearance changes, other than a whitish blush, after exposure to humidity testing per GMW14729 for 96 h minimum. When tape adhesion tested per GMW14829, Method B, 10 minutes after removal from humidity test there shall be a minimum of 99.0% coating retention. When removing the tape, a slight adherence of the coating is permissible since this has no influence on the corrosion resistance. In case of small fasteners where the

surface area of the part is insufficient to run the test, steel panels size 50 mm x 50 mm shall be processed with the fasteners and used for the adhesion test.

Note: This test is required for PPAP only.

3.7.2 For regular production, each coating lot shall be tested per 3.7.1, except omit the humidity exposure. If a particular part is too small for this test, a surrogate steel panel may be coated along with the same lot and used for testing.

3.8 Hydrogen Embrittlement.

3.8.1 All coated parts with surface or core hardness greater than 353 HV (35 HRC) shall be processed per SAE/USCAR-5. The referee method for detection of embrittlement shall be per SAE/USCAR-7.

3.8.2 The maximum material hardness in the drawing or relevant specification shall be used to determine if de-embrittlement treatment is required. For example, a class 10.9 fastener has a hardness range of 32 to 39 HRC. Since the maximum hardness is above 35 HRC, all parts must be treated per SAE/USCAR-5. If a part is heavily cold worked or heat treated to high strength/hardness, but it is without a specified maximum hardness limit in the drawing or specification, then the applicator shall obtain the hardness data from their customer 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.

3.9 Coefficient of Friction. For fasteners with supplemental coating to Codes G, H, and T, the coefficient of total friction shall be 0.13 ± 0.03 as tested per 3.9.1.

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