



High Temperature, Corrosion Resistant Coating for Fasteners and Small Parts

1 Scope

This standard covers the requirements for a high temperature, corrosion resistant coating with friction control. This coating is for ferrous parts only.

1.1 Material Description. This coating is a dip-spin or spray type coating which provides corrosion protection in operating range from -50 °C to 450 °C. The coating is a baked on base coat providing corrosion protection. A lubricant-integrated topcoat or additional lubricant maintains consistent friction and is an integral part of an approved coating systems.

1.2 Symbols. Not applicable.

1.3 Typical Applications. This coating is suitable for externally threaded parts (size M6 or greater) and non-threaded ferrous parts where high levels of corrosion protection at high temperature are required. The dip-spin process is not recommended for the following:

- Bolts smaller than M6
- Parts with recessed features (such as internal drive screws)
- Loose washers of all sizes
- Internally threaded parts (nuts)

1.4 Remarks.

1.4.1 Dip-spin Coating is a Bulk Process. If parts are prone to nesting, stick together (flat washers), or easily damaged by mechanical tumbling, do not use dip-spin coating method. Alternatives include spray and dip-drain methods.

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 Polytetrafluoroethylene (PTFE) shall not be used in topcoat or lubricant for this specification due to the expected high operating temperatures.

1.4.4 This coating process does not generate hydrogen; however, pre-treatment processes, i.e.,

acid pickling, could cause hydrogen adsorption. See precautions in 3.1.1.

1.4.5 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 parts. 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.

1.4.6 Special design and process consideration must be made when applying this coating on surfaces that are part of a clamped joint. This includes the bearing surface against which the bolt underhead comes in contact. On a bolt, stud, or screw, this includes the underhead bearing surface. Excessive coating may creep resulting in loss of clamp load.

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	

2.2 GM Standards/Specifications.

9985670	GMW14700
9985809	GMW14729
9986153	GMW14829
9986333	GMW14872
GMW3059	

2.3 Additional References.

- GM Part No. 11570102
- GM Part No. 11611954
- GM Part No. 11612005 or 11611987
- TMC003 Material Safety Data Sheet guidance documents (available at www.gmsupplypower.com).

3 Requirements

3.1 Pre-treatment and Post-treatment.

3.1.1 The use of acidic cleaners is not recommended as a pre-treatment for parts heat treated or highly cold worked to the specified core or surface hardness of HRc 35 or higher. If acidic cleaning is performed in pre-treatment, process parts per SAE/USCAR-5.

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

3.2 Appearance. The coating shall have a uniform appearance and shall be free from tears, open pores, cracks, flakes, blisters and uncoated areas. The coating shall not be oily or tacky to the touch. During normal handling, practice parts shall not leave particulate residue on equipment, hands, or gloves. Unless otherwise specified, the color shall be silver or gray.

3.3 Coating Thickness.

3.3.1 The minimum coating thickness shall be 15 µm except on the threads of fasteners.

3.3.2 When applied to threaded fasteners, the coating shall not have adverse effects on normal installation and removal. Coating thickness shall be adequate to meet corrosion resistance performance requirements.

The maximum coating thickness 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. The fastener supplier will consult with the coating applicator to determine the appropriate thread size before coating.

3.3.3 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.

3.3.4 For referee purposes, the coating thickness shall be determined by microscopic examination of cross sections taken perpendicular to significant surfaces per ISO 1463. In this test, cracks, open

pores, and other discontinuities in the coating exposing the substrate is not allowed unless it is less than 100 µm in size and spaced more than 100 µm apart.

3.4 Corrosion Resistance.

3.4.1 Coated parts shall show no base metal corrosion (red rust) after 720 h of neutral salt spray (NSS) per ISO 9227. Parts undergoing this test must not go through extended heating processes outside of the regular curing process except when testing per 3.6.

Note: The salt spray test is only used to test the integrity of the finish for quality control. The hours to red rust shall not be construed as having any correlation to the actual service life of the part.

3.4.2 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 (screw-washer assembly) washers and external surface of nuts. Fastener threads and point are excluded unless otherwise specified on the drawing.

3.4.3 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.

3.5 Cyclic Corrosion. Parts coated to this specification shall be exposed to cyclic corrosion test per GMW14872, UB, All, 4s, Method 1/2, Exposure D with a thermal soak addition (Option 4) for 4 h at 350 °C. After exposure, there shall be no red rust on significant surfaces.

3.6 High Temperature Corrosion Resistance. After heating the parts for 4 h continuously at 450 °C (part temperature), the corrosion resistance requirements as specified in 3.4 and 3.5 shall be met.

3.7 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.

3.7.1 Test coated part per GMW14700, Method C. A minimum rating of 7 is required.

3.8 Adhesion Characteristics.

3.8.1 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 tested per GMW14829, Method B, 10 minutes after removal from humidity

test there shall be minimum 99.0% of coating retention after the tape adhesion test. 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 when the surface area of the part is not large enough to run the test, steel panels 50 x 50 mm shall be processed with fasteners and used for adhesion test.

3.8.2 For regular production, each coating lot shall be tested per 3.8.1, 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.

3.9 Chemical Resistance. Coated parts shall be immersed in the following underhood fluids for 24 h at 23 °C ± 2 °C. After exposure, the coating shall not blister or show any signs of softening or dulling.

- Engine oil (SAE 5W30 or equivalent)
- 50% mixture of potable water and extended life coolant (9985809)
- DOT 4 brake fluid
- Transmission fluid (9986333 or 9986153)
- Windshield washer fluid (9985670)

3.10 Friction Control. Coatings to this specification shall include lubrication for friction control. See Appendix A, Testing Requirements.

3.10.1 Coefficient of Friction Test. The coefficient of friction of threaded fasteners shall be 0.13 ± 0.03 when tested per ISO 16047 with the following additional requirements:

- For studs and bolts with non-rotating heads, or short bolts (effective length from head to first full thread ≤ 3d), a surrogate bolt (GM Part No. 11570102) can be used for friction testing. The surrogate bolt must be coated together with the production parts under the same process.
- Test washer shall be according to ISO 16047, type HL, except with surface roughness of 0.2 to 0.8 Ra and plain (uncoated) surface (reference GM Part No. 11611954). Stamped identification is not allowed on the washer surface. Test washers must be ultrasonically cleaned and degreased within 2 h prior to test.
- Test nuts shall be according to ISO 16047 with plain surface, uncoated and degreased (GM Part No. 11612005 or 11611987). Test nuts must be ultrasonically cleaned and degreased within 2 h prior to test.
- Test bolt shall be according to ISO 16047 with plain (uncoated) surface. Bolts must be ultrasonically cleaned and degreased within 2 h prior to test.

- For testing of all fasteners, the length of the protrusion of the bolt shall be two to seven thread pitches when the nut is seated against the test washer or test device. There shall be a minimum of two full threads within the clamp length after tightening.
- When testing bolt/screw-washer and nut-washer assemblies, the production part washer shall not be fixed against rotation. D_o must be based on the bolt head bearing surface outer diameter $D_{w \min}$.
- Tightening speed shall be 30 rpm ± 3 rpm.
- Do not wash or precondition the coated fastener to be tested. (This may change the frictional property of the coating and affect the test result.)

3.10.2 Requirements for Chemical Approval. Process test bolts using production equipment with regular production-loading weights and other environments. This includes pre-treatment, coating, post-treatments, and transportation.

The coefficient of friction test shall be performed by an ISO 17025 accredited laboratory.

Apply coating to M10 x 1.5 mm x 60 mm property class 10.9 hex head bolt per ISO 4014, Grade A. Thread tolerance shall be 6 h after coating. Perform test according to 3.10.1 except use the test washers GM Part No. 11611954 (steel with plain finish). The bolt is the driven part. For each washer type, the coefficient of friction ±3 sigma values based on 30 samples are required to be within the specification. See Appendix B, Chemical and Application Approval.

3.10.3. Requirements for Applicator Approval. The applicator shall perform test per 3.10.1 with only test washer GM Part No. 11611954 (steel washer with plain finish). The test bolt must be processed through the applicator using the same equipment and process handling as regular production. The coefficient of friction test shall be performed by the applicator.

3.10.4 Requirement for Production Part Approval Process (PPAP). Test production fastener according to 3.10.1, friction values for 30 samples shall be within the specification.

4 Manufacturing Process

The GM-approved process, including pre-treatment (cleaning), coating, and post-treatment shall be performed by one company in one facility. The equipment, process controls, chemicals, and location used must remain the same for regular production. This includes pre-treatment (such as