



Electrodeposition Primer - Generic Qualification

1 Scope

This specification details the general materials performance, compatibility, and processing information requirements for international company approval of electrodeposition (ELPO) primers.

1.1 Material Description. Materials qualified to this standard shall meet the performance requirements shown in Appendix A, Table A2. Additional testing and any exceptions to the requirements detailed herein are noted in the Appendix. Suppliers must demonstrate the technology as being production capable to reduce undue risk prior to release in a production facility. Any material development issues, such as chemical or performance values that fall outside of specified ranges, must be discussed with the appropriate ELPO engineer for resolution. Material must successfully complete a production trial in a target facility prior to release for other facilities. Plant-specific tests must be performed after generic approval is received. An example of items evaluated in plant-specific testing includes GM sealers and sealing compounds.

1.2 Symbols. Not applicable.

1.3 Applicability. This specification applies to medium, high-build and Hyper-throw materials for use on vehicles and space frames. These primers are intended to provide corrosion and chip resistance and may or may not be intended for subsequent coating for appearance purposes. These coatings must perform over bare Cold Rolled Steel (CRS), Electrogalvanized (EG) coated steel, Hot Dip Galvanized coated steel (HDG), Galvannealed (Zinc-Iron Alloy (ZnFe)) and Aluminum substrates (Al).

1.4 Remarks. Not applicable.

2 References

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

2.1 External Standards/Specifications.

ASTM D1475	ASTM D3960	ASTM D4399	ASTM D2369
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2.2 GM Standards/Specifications.

GMW2	GMW14270	GMW15282	GMW17198
GMW8	GMW14700	GMW15287	GMW17199
GMW11	GMW14704	GMW15531	GMW17200
GMW3041	GMW14829	GMW16569	GMW17218
GMW3059	GMW14872	GMW16639	GMW17259
GMW8738 (ID)	GMW14873	GMW16656	GMW17405

(ID) = This is a standard that is distributed only internally within General Motors. This standard cannot be distributed outside of General Motors. Contact the GM lead engineer for any instructions.

2.3 Additional References.

- Four (4) Panel Box Test
- Fuchs Lubricant Co. RP 4107 S, <https://www.fuchs.com/us/en/>
- GM Paint Facility Process Specifications (available in Global Document Management (GDM)) (ID)
- Surface Coatings Process Control Relationships Manual (available in GDM) (ID)

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3 Requirements

3.1 Requirements on Delivery.

3.1.1 Chemical Requirements.

3.1.1.1 Volatile Organic Compounds (VOC) (ASTM D3960). The maximum allowable level of VOC is 72 g/L (0.6 lb/gal), minus water. This test is to be run at 110 °C, then repeated at 180 °C for reference.

3.1.1.2 Chemical Fingerprint. GM may conduct infrared (IR) spectrophotometry analysis of the materials supplied to this specification. Analysis may also be performed on ELPO that is removed from representative panels with film thickness and bake at target levels. The infrared spectra established for initial approval shall constitute a reference standard and shall be part of the submission package. Formulation ranges for the various resin systems, pigments, flow control agents, additives (biocides, ultraviolet (UV) stabilizers), and key manufacturing control characteristics must be provided as part of the submission package. If a product change is proposed which is outside the technology formulation limits, the responsible engineer must be notified. All ingredient ranges, key manufacturing control limits, and Certificate of Analysis ranges must pass standard gauge repeatability and reproducibility studies.

3.1.1.3 Delivery Documentation. The supplier shall be responsible for submitting a Certificate of Analysis with each batch of material arriving at a plant. This document shall be prepared and provide data in accordance with the requirements detailed in GMW17405.

3.1.2 Physical Requirements.

3.1.2.1 Product Information. The engineer responsible for technology qualification shall be contacted prior to test initiation. The following product information shall be submitted and include test results and typical ranges where applicable. For components: Volume solids (ASTM D2369); Weight solids (Weigh/Bake/Weigh method), Density (ASTM D1475). Provide resin to paste-mixed product: Feed ratio and solution conductivity (ASTM D4399).

3.1.3 Additional Requirements.

3.1.3.1 Submission Package. One (1) submission book and three (3) USB flash drive must be prepared for distribution. All test results, Key Product Characteristics (KPC), photographs and approval-related data are to be included as a permanent record of the initially approved material.

3.1.3.2 Mini-submissions. Some approvals will require mini-submissions when only minor changes are made to previously approved ELPO materials. Table A5 outlines testing requirements for a mini-submission. Tests may be added or deleted according to the nature and significance of the material modifications; these shall be determined prior to testing by the responsible engineer.

3.1.3.3 Panel Preparation. The specific number and substrate combinations to be evaluated are shown in Appendix A, Table A1. Test panels are to meet a 0.8 mm cutoff profilometer Ra roughness of 0.64 µm to 1.27 µm (25 µin to 50 µin). Initial test panel substrate roughness must be recorded prior to any coating applications.

3.1.3.4 Test Substrates. Appendix A, Table A2 outlines which substrate types are to be used and the durability requirements for each test. The required test panels must meet the designations in Table 1.

Table 1: Test Panel Designations

Type	Specification
CRS	GMW2-M-STs
EG	GMW11-M-STs
HDG	GMW8-M-STs
ZnFe	GMW8-M-STs
Al	AA611
Al	AA6016

Note: AA = Aluminum Company of America

Note: Other aluminum alloys may be requested for testing as new lightweight alloys are developed for production use.

3.1.3.5 Sample Size. Three (3) test panels are to be used for each test condition; however, the responsible engineer and the supplier may agree on a different number for specific tests prior to the initiation of generic approval work. All substrates, pre-treatments and coating layers shall be fully identified with source, product code, batch number, bake description and film build.

3.1.3.6 Bake. The bake temperature and time ranges (minimum/maximum) and targets shall be recommended by the supplier and be provided on a time/temperature graph. All test panels shall be baked in indirect or electric ovens using a typical cure of $165\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ metal temperature for 15 minutes unless otherwise specified by the responsible engineer. Additional panels may be requested using a gas-fired oven for ELPO cure and subsequent evaluation.

3.1.3.7 Conditioning. When testing is to take place over fully layered panels, the samples shall be subject to an aging period of at least 72 h at room temperature following the bake cycle.

3.1.3.8 Storage Requirements. The materials approved to this specification must be stable after storage under the following conditions:

- Resin: 180 days at $+5\text{ }^{\circ}\text{C}$ to $+35\text{ }^{\circ}\text{C}$
- Paste: 90 days at $+5\text{ }^{\circ}\text{C}$ to $+35\text{ }^{\circ}\text{C}$, as defined by the ability to pass all initial test requirements in the application facility (i.e., assembly plant)

3.2 Processing Requirements.

3.2.1 Chemical Requirements.

3.2.1.1 Bath Performance. Performance requirements for the bath are outlined in Table A4. The system being tested shall be identical to the intended production system and processing, when known. The bath should be evaluated both freshly prepared and following a 30% purge of ultrafiltrate that is replaced with deionized/reverse osmosis water. To determine bath stability, the following tests must be performed before and after 90 days of agitation: pH, conductivity, percent solvent, percent solids and Pigment to Binder ratio (P/B).

3.2.1.2 Odor. Comparative odor testing is to be performed per GMW16639. This procedure examines the odor characteristics of emissions to the air from the process bath material. Equivalent or improved odor characteristics are required for new ELPO products.

3.2.1.3 pH. An operating bath shall be in the 5.2 pH to 6.2 pH range. Paste and resin pH shall be safe for storage tanks and plant personnel.

3.2.2 Mechanical Requirements.

3.2.2.1 Settling Test with Agitation. The dirt count on a horizontal panel that has been subjected to the GMW17198 procedure using test ELPO bath shall not exceed the count on the panel subjected to control bath.

3.2.2.2 Pump Shear Test. A pump shear test must be performed per GMW17200. The test duration must be a minimum of 16 h. The weight of a 200 mesh screen (plus residuals) is to be used to filter the test ELPO. The weight of any volatiles that precipitate during the test should not exceed the weight of an approved control.

3.2.3 Physical Requirements.

3.2.3.1 Appearance. The coating on samples shall be smooth, uniform, and free of sags, craters, or other surface defects. The gloss shall be a minimum of 30, measured on a 20 degree gloss meter.

3.2.3.2 ELPO Film Smoothness.

Profilometer Ra values based on 2.5 mm cut off on properly baked ELPO must achieve the following:

- Vertical surfaces: $0.46\text{ }\mu\text{m}$ (18 μin) maximum
- Horizontal surfaces: $0.56\text{ }\mu\text{m}$ (22 μin) maximum

3.2.3.3 ELPO Film Thickness. Interior and exterior ELPO film thickness requirements are outlined in Appendix C, Figures C1 thru C3.

3.2.3.4 Throw Power. Throw power characteristics are to be assessed using a four (4)-panel box test. Panel faces A thru H must be evaluated and reported. Throw power must be equal to or better than the current production control but $\geq 9\text{ }\mu\text{m}$ on the G face for traditional and Hyper-throw ELPO materials. The A face must

target 17.5 µm for traditional ELPO, and 15 µm for Hyper-throw products. Box test details are shown in Appendix B.

3.2.3.5 Rupture Voltage; Pre-coated ZnFe Steel. Rupture characteristics must be evaluated and recorded at the following voltages: Fresh material or non-purged 150V, 200V, 250V, 275V, 300V, 325V, 350V, 375V and 400V at a bath temperature of 33 °C (92 °F), using a 5 s ramp time and a 60 s hold time. The test rating shall be based on profilometer and percent of panel ruptured and equivalent to or exceed that of the controls. Testing is to be performed per the ELPO supplier's panel coating protocol.

3.2.3.6 Edge Coverage. This testing is to be performed at the discretion of the responsible engineer. When required, test per GMW17218. Performance requirements are shown in Appendix A, Table A2.

3.2.3.7 Bake-off Loss. Test per GMW17259. The amount of applied film that is lost as a result of the curing process must not exceed that of the control at an equivalent Pigment to Binder ratio. Target bake temperatures are to be used during this evaluation.

3.3 Performance Requirements.

3.3.1 Chemical Requirements.

3.3.1.1 Accelerated Corrosion Testing. GM laboratory cosmetic corrosion testing is required. All test cycles must achieve the equivalent of 5 years cosmetic corrosion exposure minimum. Creep is to be evaluated using GMW15282, measure maximum peak to maximum peak and average. Lab testing is to be performed per GMW14872. For Aluminum substrate, laboratory testing to be performed per GMW15287, report maximum and average filament lengths are to be measured and compared to the control.

3.3.1.1.1 Road Test Options. Testing can be performed on test panels that are attached to the exterior of a vehicle on the road schedule or on full vehicles processed with the ELPO materials being qualified. The decision regarding panel or full vehicle testing shall be agreed upon by the responsible engineer and the supplier prior to initial testing. When required, a GMW8738 5-year road schedule is to be used for this option.

3.3.1.1.2 Full Durability Vehicle. Road testing can be performed at any global GM Corrosion Engineering proving ground approved to run GMW15531. A 5-year minimum equivalent road schedule per GMW8738 is to be performed when required. **Note:** If a maximum peak to maximum peak scribe on the Durability Vehicle is outside of the maximum creep requirement, additionally measure the Average Creep using the definition noted above for final compliance consideration.

3.3.1.2 Lubricant Compatibility. Compatibility testing is to be performed per GMW16656. Reference oil RP 4107 S from Fuchs is to be used.

3.3.1.3 Fume Yellowing. The degree of topcoat yellowing resulting from the cathodic Electrocoat (E-Coat), after baking, is to be determined per GMW17199. Use an electric or indirect-fired oven for this purpose. The resulting yellowing exhibited on the panel shall not exceed that of the control electrocoat. (Baseline data is to be acquired for quantitative comparison.)

3.3.1.4 Overbake and Underbake. The durability of overbaked and underbaked samples must be evaluated. All test samples are to be prepared per the requirements outlined in Table A3.

Corrosion test per GMW14872, 5 years equivalent; Gravelometer test per GMW14700; Water immersion test per GMW14704. Tape adhesion testing is required per GMW14829 before and after water immersion.

3.3.1.5 Outdoor Exposure Testing. Prior to outdoor exposure testing, initial tape adhesion per GMW14829 must be performed. Outdoor exposure testing is required per GMW14873. Results are to be observed after six (6) months (visual only) and one (1) year of exposure. Evaluate corrosion creep per GMW15282.

The responsible engineer and supplier must agree upon the specific details of this requirement prior to the initiation of testing.

3.3.1.6 Bare and Oily Steel Performance. Corrosion testing is to be performed per GM14872 on panels prepared under the following conditions:

Bare: Unphosphated panels must be prepared by wiping with acetone prior to ELPO coating.

Oily: Panels must be prepared first by acetone wiping. Panels must then have Fuchs RP 4107 S lubricant applied at 3 g/m² prior to ELPO coating.

See Appendix A, Table A1 for requirements.

3.3.2 Mechanical Requirements. Not applicable.

3.3.3 Physical Requirements.

3.3.3.1 Chip Resistance. Two (2) chip-resistance methods are to be performed. Low-temperature Method A or Method B is acceptable. Room-temperature testing per GMW14700 Method C is also required. The results must meet the specified requirements shown in Appendix A, Table A2 and be at least equivalent to the control. Room-temperature and low-temperature testing are to be performed on opposite ends of the same 100 mm x 300 mm test panels so that both conditions can be reviewed on the same samples.

3.3.3.2 Stationary Glass Bond Material Compatibility. The test matrix shall be designed by the responsible engineer and issued in the form of a test request. Test requirements are outlined in GMW16569. Performance requirements are referenced in GMW3041. The ELPO is to be evaluated as a direct bonding surface and as a primer layer.

3.3.4 Additional Requirements.

3.3.4.1 Product/Performance Relationships. The supplier shall provide detailed information on plant-related key process controls in the form of correlations between application parameters and effects. They shall include the following:

- Film build vs. voltage, immersion time, bath temperature, bath solids, minimum through maximum P/B ratio, conductivity, bake time/temperature, pH
- Corrosion vs. bake time/temperature, bath solids, P/B, ELPO thickness, catalyst level (upper, lower and one midpoint, minimum), additive level
- Tank stability vs. tank circulation, pH, P/B, bath solids, conductivity, temperature
- Yellowing vs. bake time/temperature, P/B, ELPO thickness, and any components with the potential to cause fume yellowing
- Bake time/temperature chart
- Cratering vs. bath temperature, voltage, P/B, ELPO thickness, bath solids, conductivity, flow control

3.3.4.2 Compatibility with Associated Production Material/Process. Compatibility with plant-specific materials, such as anti-chip primers and sealers, shall be evaluated prior to introduction to production facilities. If there are any plant-specific material issues that must be addressed during the approval process, the details are to be discussed and resolved between the responsible engineer and the supplier prior to the initiation of testing. Examples include:

- Polyvinyl Chloride (PVC)
- Underbody Sealer (UBS)
- Cavity wax
- Hem flange sealer
- Cockpit adhesive

3.4 All materials supplied to this standard must comply with GMW3059, **Restricted and Reportable Substances**, including the requirement to obtain a GM-approved International Material Data System (IMDS) submission.

4 Manufacturing Process

4.1 Immersion. ELPO materials are electrically applied while immersed in a bath that has the correct proportion of pigment, resin and additives to meet the application requirements.

5 Rules and Regulations

5.1 Legal Regulations. All materials must satisfy applicable laws, rules, regulations and recommendations valid in the country of usage.

5.2 Language. In the event of conflict between the English and domestic language, the English language shall take precedence.