



Electrogalvanized Coatings for Sheet Steel

1 Scope

This standard covers the requirements for both one and two side pure zinc and zinc nickel alloy electrogalvanized coatings. These coatings are applied to a sheet steel substrate utilizing an electroplating process. The sheet steel substrate may be either cold or hot rolled low carbon, rephosphorized, solid solution strengthened, bake-hardenable, high strength low alloy, dual phase, complex phase, or martensitic sheet steel. Additional requirements or agreements shall be specified by regional GM Automotive Operations business units (e.g., General Motors North America (GMNA), General Motors Europe (GME), General Motors South America (GMSA), Pan Asian Automotive Technical Center (PATAC) and General Motors Korea (GMK). Coated substrates per GMW14400 are not within the scope of this specification.

1.1 Material Description. The type of coating, and its mass and finish are specified by suffixes added to the basic specification number. The first two letters EG will designate an electrogalvanized coating. The coating mass for each side is designated by a minimum value in g/m². Only coating masses shown in Table 1 should be used unless materials engineering is consulted. Other coating masses shall follow the same designation method. For one side coated coils or sheets/blanks, a zinc residue of 40 mg/m² maximum is permissible on the uncoated side. The letter G designates a pure zinc coating. The letter N designates a zinc-nickel alloy coating. The first set of digits along with the letter designation specifies the coating parameters of the unexposed side. The remaining designation specifies exposed (E), unexposed (U), or temper rolled (T) to depict surface finish.

1.2 Symbols. Not applicable.

1.3 Applicability. Sheet metal parts consisting of steel grades described by GMW2, GMW3032, or GMW3399.

1.4 Suffix Finishes.

1.4.1 Exposed (E). A finish produced by eliminating all visual spangle pattern and surface defects per 3.1.3.3, to be used for critical appearance applications.

1.4.2 Semi Exposed (Z). A spangle free finish produced by minimizing surface defects per 3.1.3.3 is used for secondary visible surfaces that do not require an exposed quality finish.

1.4.3 Unexposed (U). A minimum spangle finish used for non-critical appearance applications. See 3.1.3.3.

1.4.4 Temper Rolled (T). This surface shall have sufficient temper rolling such that Lüders lines or stretcher strain will not show when formed and painted. All other requirements are the same as U surface described above in 1.4.3.

2 References

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

2.1 External Standards/Specifications.

ISO 1460

ISO 7438

2.2 GM Standards/Specifications.

GMW2	GMW14057	GMW14829	GMW16170
GMW3011	GMW14058	GMW14872	GMW16549
GMW3032	GMW14699	GMW15056	GMW16823
GMW3059	GMW14700	GMW15200	
GMW3399	GMW14704	GMW15282	
GMW14019	GMW14729	GMW15425	

2.3 Additional References.

- GWS-5A
- TMC003 Material Safety Data Sheet guidance documents (available at www.gmsupplypower.com).

3 Requirements

3.1 Requirements on Test Delivery. The following section defines specific requirements for material on delivery, processing, performance, and other stages during life cycle. Deviations required for individual GM Business units are listed in the Deviations and shall be agreed upon between GM Purchasing and the supplier.

3.1.1 Chemical Requirements.

3.1.1.1 Coating. The coating produced in continuous electrogalvanizing lines shall consist of pure zinc or zinc-nickel alloy. Pure zinc coatings shall be 99.9% minimum pure zinc by mass. Zinc-nickel alloy coatings shall contain 9% to 13% nickel by mass. Zinc-nickel alloy coatings shall be 99.9% minimum zinc-nickel by mass. For zinc-nickel alloy coatings, nickel phase gamma shall consist of $\text{Ni}_5\text{Zn}_{21}$ structure. Pure zinc and zinc-nickel alloy coatings may contain 75 parts per million (ppm) maximum cadmium and 100 ppm maximum lead, and must conform to GMW3059. The coatings shall not contain trace elements which are detrimental to adhesive bondability, phosphateability or paintability.

3.1.1.2 Base Metal. The sheet steel base metal chemical composition shall conform to the requirements specified in GMW2, GMW3032, or GMW3399.

3.1.1.3 Surface Treatment. Products coated with a designated lubricant (e.g., mill oil or prelube) shall comply with GMW14019 and/or be approved by the local business unit. Material shall be supplied unpassivated/unchromated and any supplemental coatings shall be approved by the local GM Materials Engineering Department.

3.1.2 Mechanical Requirements.

3.1.2.1 Coating Bend Test. All bend tests shall be performed in accordance with ISO 7438. For all steels supplied according to GMW2 and GMW3032 (with 0.2% offset yield strength < 500 MPa), a Zero T (0T) bend test shall be performed. Test specimens of coated metal shall be capable of being bent through 180° in any direction without flaking of the coating on the outside of the bend only. For steels supplied to GMW3032 with 0.2% offset yield strength > 500 MPa and all GMW3399 grades, the steel must be capable of a 90° bend test in any direction with a maximum former radius (r) related to the steel thickness (t) without flaking on the outside of the bend. Refer to Appendix A for maximum bend test former radii for each grade and a diagram of the test setup. For testing of all steels, flaking of the coating within 6 mm of the edge of the bend test shall not be cause for rejection. The specimens shall not be cut < 25 mm from the coil edges of the test sheet.

3.1.2.2 Coated Base Metal. The mechanical properties of the coated material in the as-delivered condition shall conform to the requirements specified in the applicable GMW or industry standard.

3.1.3 Physical Requirements. Coating mass and finish quality shall conform to the requirements prescribed in Table 1.

Table 1: Preferred Coatings ^{Note 1}

Property	Unit	36G36G	47G00G	47G47G	50G60G	60G60G	70G70G	32N32N	32N00N
Exposed Coating Designation		E	E	E	E	E	E	E	E
Unexposed Coating Designation		U	U	U	U	U	U	U	U
Coating Mass (Triple Spot Test), U side, minimum to maximum:	g/m ²	36 to 50	47 to 61	47 to 61	50 to 70	60 to 80	70 to 90	32 to 46	32 to 46
Coating Mass (Triple Spot Test), E/U side, minimum to maximum:	g/m ²	36 to 50	0 ± 0	47 to 61	50 to 70	60 to 80	70 to 90	32 to 46	0 ± 0
Minimum Coating Mass for any Individual Spot	g/m ²	36	40	40	40	50	60	25	25
Coating Thickness (Triple Spot Test), U side, minimum to maximum ^{Note 2}	μm	5.1 to 7.0	6.6 to 8.6	6.6 to 8.6	6.6 to 9.9	8.5 to 11.3	9.9 to 12.7	4.4 to 6.3	4.4 to 6.3

Note 1: Other coating masses may be used by exception. Refer to Deviations.

Note 2: Coating thicknesses are shown for reference only, not for conformance to specification requirements.

3.1.3.1 Coating Mass. ISO 1460 shall be used for determination of coating mass of electrogalvanized coatings. Test sample size shall be 2000 mm² minimum with a preferred sample size of 3330 mm² (57.7 mm ± 0.1 mm square or 65.1 mm ± 0.1 mm in diameter). Coating mass shall be measured by triple spot test and must conform to the values in Table 1. The mass shall be the average of 3 measurements taken across the width of the strip at least 25 mm from each edge. In no case shall the lowest value of any of the three test samples fall below the minimum individual spot requirement in Table 1. Each side should be measured separately to ensure that the requirements of Table 1 are met. See Deviations section.

3.1.3.2 Coating Thickness. For conversion between coating thickness and coating mass, a density factor of 7.1 g/cm³ shall be used for pure zinc coatings and 7.3 g/cm³ for zinc-nickel alloy coatings. Coating thickness measurements may be used for routine quality control evaluations. Coating thickness shall be measured using a suitable layer thickness gauge, on-line x-ray gauge or from a specimen cut perpendicular to the panel surface. Suitable instruments for evaluation of coating thickness (e.g., eddy current, ferromagnetic, or metallurgical microscope) shall have a capability of ± 1.0 µm accuracy. When using a metallurgical microscope, standard mounting practices shall be used and thickness shall be measured at 1000x magnification. The referee method for determining coating thickness shall be coating mass, as specified in paragraph 3.1.3.1.

3.1.3.3 Coating Surface Quality. The steel shall be free from surface defects as negotiated between purchaser and supplier. For unexposed (U) surfaces, defects such as slight indentations, small marks, minor scratches, and slight coloring, which do not affect corrosion resistance, formability, or the application of surface coatings, are allowed. Exposed (E) surface shall be free of defects which might affect the uniform appearance of a quality paint or an electrolytic coating (Electrophoretic Priming Operation (ELPO), electrodeposited primer, cathodic e-coat). Temper rolling may be required and shall be specified with a (T) designation. The other surfaces shall conform at least to surface quality U. Certain applications require that both surfaces of the steel be of exposed (E) surface quality. Regulations in detail will be issued by the local business unit.

3.1.3.4 Pure Zinc Blister Susceptibility. Zinc blisters on the surface of electrogalvanized steel are not allowed. A zinc blister is a surface defect resulting from the separation of the zinc coating from the steel substrate, and is not related to other surface defects (see Appendix C). Zinc blisters are typically caused by surface contamination or the release of hydrogen from the substrate during the paint bake cycle. A surface image and cross-section is shown in Appendix C. Other surface requirements are covered in section 3.1.3.3 Coating Surface Quality. The material shall be capable of being baked at +190 °C (sample temperature) for 30 minutes without any blistering of the pure zinc plating. The zinc surface shall be visually examined for the absence of blisters using a magnification of 30x.

3.1.3.5 Surface Texture. Specific requirements for the texture for each region are detailed in GMW16823. Regulations in detail will be issued by the local business unit.

3.1.4 Additional Requirements.

3.1.4.1 Marking. If ink for marking is allowed by the local business unit, the ink shall not interfere with welding, phosphating/thin film pretreatments, transfer to the opposite side or print through during part fabrication. The ink used for marking shall be released by the purchaser. If differential coating product is specified, although it is not recommended, the heavy coated side of differentially coated product shall be identified with markings running the length of the coil at sufficient intervals to assure positive identification of the blank.

3.1.4.2 Other Requirements. Requirements such as tolerances on product shape and dimensions, inspections units, number of tests, sampling, test conditions, retests, inspection documents, packing, and handling of disputes shall be agreed upon between supplier and the local business unit.

3.2 Processing Requirements.

3.2.1 Additional Requirements.

3.2.1.1 Pre-Treatment/Paint Compatibility (Qualification Testing). When tested with approved phosphate systems, zinc-based coated steels shall be capable of achieving a high quality zinc phosphate conversion coating according to GMW3011 (crystal size and coating weight). When tested with approved thin film pre-treatments, the requirements of GMW16170 (coating weight and thickness) must be fulfilled. Outdoor exposure and proving ground tests do not have to be performed for the qualification testing of steels.

After application of production representative pre-treatment and paint, the steel shall meet the following requirements:

- a. Adhesion of the E-coat shall fulfill test requirements of the crosshatch test according to GMW14829: