



Low Carbon Sheet Steel

1 Scope

This specification covers the requirements for low carbon continuous cast steel for exposed and unexposed applications and is applicable to all low carbon steel sheet products and coated substrates. Continuously hot or cold rolled flat products shall be supplied as coils or sheet. Hot rolled flat products are usually supplied in thicknesses > 1.75 mm. These flat products are used for cold forming and for manufacturing of welded tubes. Cold rolled flat products with the appropriate surface type and surface finish are suitable for the application of surface coatings (metallic plating by melt dipping or thermal spray painting, electrolytic plating, organic coating and/or other coatings). This specification does not apply to steel for case hardening or strip applications. Additional requirements or agreements shall be specified by regional GM business units.

1.1 Material Description. The material designation is defined by the General Motors Worldwide (GMW) base metal specification number, steel product type and steel grade. The steel product type is designated by "CR" for cold rolled products, or "HR" for hot rolled products. A numeral (1, 2, 3, etc.) will designate the steel grade formability level. The steel grade will correspond to the chemical and mechanical requirements as shown in Table 1, Table 2, and Table 3. A third suffix (C) may be added after the steel grade to designate a low carbon steelmaking practice. The finish type, an alpha character, will designate the finish as E (exposed), or U (unexposed). In addition, products which are not coated shall have the word **uncoated** added to the call-out after the steel type, but before the finish designation. The preceding descriptive items are used together to form the coding system. Examples of the coding system for engineering part drawings and manufacturing engineering documents are shown in Section 8.

1.2 Symbols. Not applicable.

1.3 Applicability. Sheet metal parts consisting of low carbon steel products and coated low carbon steel substrates.

2 References

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

2.1 External Standards/Specifications.

ASTM A751	ASTM E112	IATF 16949
ASTM E45	EN 10002-1	JIS Z 2201

2.2 GM Standards/Specifications.

GMW8	GMW3335	GMW14729	GMW16066
GMW11	GMW14019	GMW14829	GMW16086
GMW3011	GMW14699	GMW14872	GMW16170
GMW3059	GMW14700	GMW15056	GMW16549
GMW3224	GMW14704	GMW15282	GMW16823

2.3 Additional References.

Cross-Reference of Replaced GM Regional Specifications. See Section 9.

3 Requirements

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 Deviation section at the end of this specification.

3.1 Requirements on Delivery.

3.1.1 Chemical Requirements.

3.1.1.1 Base Metal. Base metal composition based on product (coil, or sheet/blank) analysis determined per ASTM A751 shall conform to the requirements of Table 1. When end-product (coil/blank) test results are not available, ladle analysis may be used. Chemical composition on the end product is the referee method.

Table 1: Chemical Composition Note 1, Note 2

GMW2M-ST-S	C Note 3	Mn	P	S	Al Note 4, Note 5	N
Designation Note 6	Max. %	Max. %	Max. %	Max. %	Min. %	Max. %
CR1	0.13	0.60	0.035	0.025	0.01	0.008
CR2	0.08	0.50	0.025	0.020	0.015	0.008
CR3	0.06	0.50	0.025	0.018	0.015	0.008
CR4	0.02	0.40	0.025	0.015	0.015	0.008
CR5	0.008	0.25	0.020	0.015	0.015	0.008
HR0	0.13	0.60	0.035	0.025	0.015	0.008
HR1	0.10	0.50	0.025	0.020	0.015	0.008
HR2	0.10	0.50	0.025	0.018	0.015	0.008
HR3 Note 7	0.10	0.50	0.025	0.015	0.015	0.008

Min. = Minimum, Max. = Maximum

Note 1: Chemical Composition based on mass% product (coil, or sheet/blank) analysis.

Note 2: Certification requirement – measured value shall be included on all supplied and applicable certification documents upon material delivery.

Note 3: Hot rolled grades with C% < 0.015% must have a minimum of 0.0003% (3 ppm) Boron.

Note 4: Titanium, Niobium and other alloys (e.g., Boron) can be used in combination for fully stabilized/killed products. Stabilization alloys shall be reported.

Note 5: Total aluminum content (combined and free).

Note 6: The letter C indicates a minimum Carbon content of 0.015% or 0.0003% (3 ppm) Boron is required.

Note 7: HR3 is not to be used for future designs.

3.1.1.2 Surface Treatment. Products coated with a designated lubricant (e.g., mill oil or prelube) shall comply with GMW14019.

3.1.2 Mechanical Requirements. Products supplied to this specification shall meet the mechanical properties as specified in Tables 2 and 3. Coating adhesion tests for coated qualities shall meet the requirements as described in the appropriate coating specification GMW8, GMW11, or GMW16066 (aluminized). The mechanical test methods to be used are defined in GMW3335 using the appropriate tensile test piece required by the region. Plastic strain ratio, r-value, shall be determined at 20% strain. If the uniform elongation is lower than 20%, plastic strain values shall be determined at the maximum uniform elongation. The specific strain level shall be reported with all test results. Strain hardening exponent n and K value shall be determined at 10% to 20% strain, or 10% to end of uniform elongation when uniform elongation is < 20%. The specific strain range shall be reported with all test results. For tensile tests conducted to EN 10002-1, only transverse test samples shall be used if possible. For flat products with widths ≤ 300 mm test samples in rolling direction are allowed.

Table 2: Cold Rolled Sheet and Cold Rolled Substrate, Mechanical Properties Note 1, Note 2, Note 3

GMW2M-ST-S	Yield Strength (MPa) Note 4, Note 5		Tensile Strength (MPa)		Total Elongation in 50 mm (%) Note 6	Total Elongation in 80 mm (%) Note 6, Note 7	Total Elongation in 50 mm (%) JIS Z 2201 #5 Note 6, Note 8	r_m Note 9	r_{90} Note 10	n value Note 11
Designation	Min.	Max.	Min.	Max.	Min.	Min.	Min.	Min.	Min.	Min.
CR1	140	280	270	410	---	---	---	---	---	---
CR2	140	240	270	370	34	32	37	---	1.3	0.16
CR3	140	210	270	350	38	36	41	1.5	1.6	0.18
CR4	140	180	270	330	40	38	43	1.6	1.9	0.20
CR5 Note 11	110	165	260	---	42	40	45	1.7	2.0	0.22

Min. = Minimum, Max. = Maximum

Note 1: Additional demands can be specified by local units.**Note 2:** Parameters valid in the longitudinal and transverse directions only.**Note 3:** Certification requirement – measured value shall be included on all supplied and applicable certification documents upon material delivery.**Note 4:** If CR5 is required, it should be stated on the engineering part drawing to allow for yield strength < 140 MPa.**Note 5:** The values for yield stress are the 0.2% proof stress for products which do not present definite yield point and the lower yield stress r_{eL} for others. For aluminized coatings, this value for maximum yield stress is increased by 30 MPa.**Note 6:** ZnNi, aluminized and galvanneal coated steels: total elongation shall be reduced by 2%.**Note 7:** When the specified nominal thickness is < 0.7 mm and > 0.5 mm the minimum value for elongation is reduced by 2%. For thickness ≤ 0.5 mm the minimum value is reduced by 4%.**Note 8:** The values stated apply to product thickness > 0.8 mm. When the specified nominal thickness is > 0.6 mm and < 0.8 mm the elongation is reduced by 1%. When the specified nominal thickness is ≤ 0.6 mm, the elongation is reduced by 2%.**Note 9:** Calculation by $(r_0 + r_{90} + 2r_{45})/4$. The r_m value can be ≤ 0.2 lower for thickness > 1.4 mm and/or aluminized and galvanneal coated products.**Note 10:** The value of r_{90} only applies to products of thickness ≥ 0.5 mm. When thickness is > 2 mm and/or ZnNi, aluminized, and galvanneal coated, the value for r_{90} is reduced by 0.2.**Note 11:** The n-values can be 0.01 lower for ZnNi, aluminized, and galvanneal coatings.**Note 12:** CR5 shall not be specified with uncoated or electrogalvanized (EG) coatings.Table 3: Hot Rolled Sheet and Hot Rolled Substrate, Mechanical Properties Note 1, Note 2, Note 3

GMW2M-ST-S	Yield Strength (MPa) Note 4, Note 5		Tensile Strength (MPa)		Total Elongation in 50 mm (%) Note 6	Total Elongation in 80 mm (%) Note 6	Total Elongation in 50 mm (%) JIS Z 2201 #5 Note 6, Note 7	n value
Designation	Min.	Max.	Min.	Max.	Min.	Min.	Min.	Min.
HR0	240	350	310	---	26	22	---	0.12
HR1	210	320	310	430	30	26	33	0.14
HR2	180	290	270	400	34	30	39	0.16
HR3 Note 8, Note 9	180	260	270	380	38	34	42	0.18

Note 1: Additional demands can be specified by local units.**Note 2:** Parameters valid in the longitudinal and transverse test directions only.**Note 3:** Certification requirement – measured value shall be included on all supplied and applicable certification documents upon material delivery.**Note 4:** The yield stress values shall apply for the 0.2% proof stress, $R_{p0.2}$, if the yield stress cannot be easily recognized, the values shall be the lower yield stress, R_{eL} .**Note 5:** Maximum yield strength shall be increased by 30 MPa for product thickness 2.0 mm and below.**Note 6:** When the specified nominal thickness is < 6.3 mm and > 3.2 mm minimum value for elongation is increased by 1 unit. For thicknesses > 6.3 mm the value is increased by 2 units, < 2.0 mm and > 1.6 mm is reduced by 1 unit.**Note 7:** The values stated apply to product thicknesses of 2 mm to 3.2 mm.**Note 8:** Total Elongation in 50 mm and 80 mm reduced by 1 unit in transverse direction for hot dip coatings.**Note 9:** HR3 is not to be used for future designs.

3.1.3 Physical Requirements.

3.1.3.1 Material Thickness and Tolerance. The detailed engineering part drawing/electronic math file will specify the material thickness and tolerance. The tolerance requirements for various thicknesses and strength levels are listed in GMW3224.

3.1.3.2 Surface Requirements.

3.1.3.2.1 Surface Condition. Specific requirements for the condition for each region are detailed in GMW16823.

3.1.3.2.2 Quality. The steel shall be free from surface defects as negotiated between purchaser and supplier. For unexposed (U) surface, defects such as pores, slight indentations, small marks, minor scratches, and slight coloring, which do not affect formability or the application of surface coatings, are allowed. Exposed (E) surfaces shall be free of defects which might affect the uniform appearance of a quality paint or an electrolytic coating (ELPO, electrodeposited primer, cathodic e-coat). Certain applications require that both surfaces of the steel be of exposed (E) surface quality. A special requirement for temper rolling may be required and shall be specified with a (T) designation. Other surfaces shall conform at least to surface quality U. Detailed requirements will be issued by the responsible formability analysis organization (e.g., GMNA Manufacturing Engineering Metal Parts Specification (MPS) sheet, GM responsible manufacturing or metallurgical engineering document, etc.)

3.1.3.2.3 Pre-Treatment Compatibility/Paint Adhesion (Qualification Testing). When tested with approved phosphate systems, uncoated or 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. Steels with thin organic pre-coatings per GMW15056 are excluded from these requirements; as a pre-treatment will not be deposited. However, the additional following requirements must be met for thin film organic pre-coating qualification.

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:
 - For samples that are phosphated: rating 0 as-received and after 120 h humidity exposure per GMW14729.
 - For samples with thin film pre-treatment, requirements according to GMW16170 must be met.
- b. Pretreated (zinc phosphate or thin film) and E-coated samples must meet delamination test requirements according to GMW14704 (rating 0 or 1 after 48 h test duration).
- c. For fully painted applications on exposed (E) surfaces, the material shall also meet the requirements of the stone chip resistance test according to GMW14700, Method A (or B) and Method C, with a minimum stone impact rating of 8.
- d. Creep back resistance shall be inspected on E-coated samples. The samples shall be scribed per GMW15282 and tested according to GMW14872, EXT, All, 4 salt spray per cycle, Method 1/2, Exposure C. The creep back shall be evaluated per GMW15282 and meet the requirements stated in the following specifications:
 - GMW3011 for samples that are phosphated.
 - GMW16170 for samples with thin film pre-treatment.
 - GMW15056 for samples with thin organic pre-coating (applicable to thin film organic coating qualification only).

3.1.3.2.4 Adhesive Compatibility (Qualification Testing). Uncoated or zinc-based coated steels supplied to this specification shall be capable of being bonded with GM approved adhesives when tested according to GMW16549. Testing to this specification will evaluate bonding characteristics to the metal surface.

3.1.3.2.5 Coating Requirements. Refer to coating requirements in GMW8 for hot dipped zinc-based coatings, GMW11 for electrogalvanized coatings, GMW16066 for aluminized coatings, and GMW15056 for thin organic pre-coatings. Coating requirements include, but are not limited to, coating composition, coating mass, and coating adhesion.

3.1.3.3 Microstructure Requirements.

3.1.3.3.1 Grain Size. Grain size shall be Number (No.) 6 and finer when tested to ASTM E112 and shall be consistent throughout the thickness of the sheet.