



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 above 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	ISO/TS 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}
(Percent by Mass)

Element	Designation GMW2M-ST-S ^{Note 2}			
	CR1, HR0	CR2, CR3, HR1, HR2, HR3 ^{Note 3}	CR4	CR5 ^{Note 4}
Carbon ^{Note 5}	0.13 maximum	0.10 maximum	0.08 maximum	0.02 maximum
Manganese	0.60 maximum	0.50 maximum	0.40 maximum	0.25 maximum
Phosphorus	0.035 maximum	0.025 maximum	0.025 maximum	0.020 maximum
Sulfur	0.035 maximum	0.020 maximum	0.020 maximum	0.020 maximum
Aluminum ^{Note 4, Note 6}	Not Applicable	0.015 minimum	0.015 minimum	0.015 minimum
Nitrogen	0.008 maximum	Not Applicable	Not Applicable	Not Applicable

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

Note 2: The letter C shall be added when a minimum Carbon content of 0.015% or 0.0003% (3 ppm) Boron is required (i.e., CR3C).

Note 3: HR3 is not to be used for future designs.

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

Note 6: Total aluminum content (combined and free).

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}

Property	Unit	Designation GMW2M-ST-S				
		CR1	CR2	CR3	CR4	CR5 ^{Note 3}
Yield Strength ^{Note 4, Note 5}	MPa	140 to 280	140 to 240	140 to 210	140 to 180	110 to 160
Tensile Strength	MPa	270 to 410	270 to 370	270 to 350	270 to 330	260 minimum
Total Elongation in 50 mm ^{Note 6}	%	Not Required	34 minimum	38 minimum	40 minimum	42 minimum
Total Elongation in 80 mm ^{Note 7, Note 6}	%	28 minimum	34 minimum	38 minimum	40 minimum	42 minimum
Total Elongation in 50 mm (JIS Z 2201 No.5) ^{Note 8, Note 9, Note 6}	%	Not Required	37 minimum	41 minimum	43 minimum	45 minimum
r_m ^{Note 9}		Not Required	Not Required	1.5 minimum	1.6 minimum	1.7 minimum
r_{90} ^{Note 10}		Not Required	1.3 minimum	1.6 minimum	1.9 minimum	2.0 minimum
n value ^{Note 11}		Not Required	0.16 minimum	0.18 minimum	0.20 minimum	0.22 minimum

Note 1: Additional demands can be specified by local units.

Note 2: Parameters valid in the longitudinal and transverse directions only.

Note 3: CR5 shall not be specified with uncoated or electrogalvanized (EG) coatings.

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. When the specified nominal thickness is < 0.7 mm and > 0.5 mm the value for maximum yield stress is increased by 20 MPa. For thicknesses ≤ 0.5 mm the value is increased by 40 MPa. For aluminized coatings, this value is increased by 30 MPa.

Note 6: ZnNi, aluminized and galvaneal 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 units. For thickness ≤ 0.5 mm the minimum value is reduced by 4 units.

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 unit. 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 galvaneal 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 galvaneal 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 galvaneal coatings.

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

Property	Unit	Designation GMW2M-ST-S			
		HR0	HR1	HR2	HR3 Note 3, Note 4
Yield Strength Note 5, Note 6	MPa	240 to 350	210 to 320	180 to 290	180 to 260
Tensile Strength	MPa	310 minimum	310 to 430	270 to 400	270 to 380
Total Elongation in 50 mm Note 7	%	26 minimum	30 minimum	34 minimum	38 minimum
Total Elongation in 80 mm Note 7	%	22 minimum	26 minimum	30 minimum	34 minimum
Total Elongation in 50 mm (JIS Z 2201 No.5) Note 8, Note 7	%	Not Required	33 minimum	39 minimum	42 minimum
n value		0.12 minimum	0.14 minimum	0.16 minimum	0.18 minimum

Note 1: Additional demands can be specified by local units.

Note 2: Parameters valid in the longitudinal and transverse test directions only.

Note 3: Total Elongation in 50 mm and 80 mm reduced by 1 unit in transverse direction for hot dip coatings.

Note 4: HR3 is not to be used for future designs.

Note 5: 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 6: Maximum yield strength shall be increased by 30 MPa for product thickness 2.0 mm and below.

Note 7: 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 8: The values stated apply to product thicknesses of 2 mm to 3.2 mm.

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 requirements below 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.