



Laser Welded Coils Fabricated from Sheet Steel

1 Scope

1.1 Material Description. This standard defines the requirements for laser welded coils used by GM or GM suppliers in the manufacture of stamped sheet steel parts in progressive die processes. It applies only to the as-supplied condition of tailored coils.

1.2 Symbols. Not applicable.

1.3 Applicability. Typical applications for these coils include typical progressive die parts benefitting from multi-gauge construction including, but are not limited to, structural cross members and longitudinal rails. In certain instances and when the business case is justified, tailored coils may be used for coil fed blanking/transfer press processes.

1.4 Remarks. Coils supplied under this standard shall be made by laser butt welding two or more hot or rolled, coated or uncoated steel coils used for subsequent progressive die or coil fed blanking/transfer press forming.

For the requirements of the component steel coils, the relevant GMW specifications apply. This specification is applicable only to steels with a tensile strength of 980 MPa maximum, but specific grade/gauge component coil combinations shall be reviewed by the tailor welded coil supplier to determine capability.

For coated blanks all requirements shall be fulfilled for hot dipped or electrogalvanized zinc coatings according to GMW8 and GMW11, respectively.

In a tailor welded coil, the coil will wind according to thicker gauge. Coil stability and prevention from tipping must be considered. In a single-welded coil, the thicker gauge shall make up a minimum of 40% of the width on a full-sized coil. Single weld coils with a thicker gauge not exceeding 40% of the width or multi-weld coils shall be reviewed by the tailor welded coil supplier to determine feasibility to ensure adequate coil balance prior to shipment to any GM or GM supplier facility. Coil design/part changes or coil size restrictions may be required to ensure adequate coil balance and to prevent tipping.

2 References

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

2.1 External Standards/Specifications.

ISO 6892-1 ISO 16949 ISO 20482

2.2 GM Standards/Specifications.

GMW2	GMW11	GMW3059	GMW3399
GMW8	GMW3032	GMW3224	GMW14019

2.3 Additional References.

- SEL 100 (Available at <http://www.stahleisen.de> → Go to Products → Bookshop)

3 Requirements

3.1 Requirements on Delivery. The tailor welded coil supplier shall utilized GM-approved/qualified steel substrates. The tailor welded coil supplier shall maintain a four (4) week inventory to avoid production disruptions due to a limited supply-base. For parts fabricated at non-GM facilities, the inventory shall be agreed upon between the supplier and purchaser.

3.1.1 Chemical Requirements. Chemical composition of the component coils shall meet the requirements of the base metal specification.

Additional demands and restrictions may be given by the central formability analysis organization.

3.1.2 Mechanical Requirements. The sheet steel of the component coils shall meet the mechanical properties specified in GMW2, GMW3032, GMW3399 or other applicable specifications (see paragraph 1.4).

3.1.3 Physical Requirements.

3.1.3.1 Quality of Laser Weld Joint. Laser welds contained in the coils shall conform to the requirements in Table A1 and in Figures A2 through A9 in Appendix A (also see SEL 100). Weld porosity shall be controlled such that formability and function of the part are not affected.

3.1.3.2 Blank Edge Preparation. The welder of the sub-coils is responsible for determining and controlling the quality of the edges to be welded. Maximum allowable burr on any edge that is not welded shall be $\leq 10\%$ metal thickness.

3.1.3.3 Material Thickness. The thickness and tolerance for the component coils shall be specified by the detailed engineering math data. For the tolerances of the single sheet thickness GMW3224 is applied.

3.1.3.4 Lubrication. The entire welded coil shall be free from corrosion products. The component shall have oil as specified in GMW14019 to provide rust protection in the coil and component blanks. However, $> 1.5 \text{ g/m}^2$ is not allowed due to processability.

3.1.3.5 Surface Quality of Laser Welded Blanks. The surface quality and the roughness of the welded coil shall be according to the relevant material specifications.

3.1.3.6 Paint Adhesion on Laser Weld Seam. The requirements for paint adhesion as described in GMW2, GMW8, GMW11, GMW3032 and GMW3399 shall be fulfilled on the weld seam.

3.1.3.7 Weld Seam Location. The location of the weld seam/s on the laser welded coil shall not deviate from the given definition by more than $\pm 1.0 \text{ mm}$ per weld seam intersected along the perpendicular distance being measured from the tailor welded coil edge. An example is given in Figure A10. Deviations of this criterion can be issued by the local business unit.

3.1.3.8 Coil Splicing. In order to facilitate multiple grade/gauge coils to be welded together, a tailor welded coil will require splicing to remove material and cross weld the tailor welded coil back together. No gap is permissible between the spliced coils for coils shipped to GM stamping plants. The transverse weld seam on a spliced coil shall be considered a defect and marked according to Section 3.1.5.2 with pierced holes and paint.

3.1.3.9 Defect Allowance.

3.1.3.9.1 GM Direct Stamping Plants. The supplier shall provide a coil defect map identifying all defect locations within the coil, which should not exceed 1% (by length) per weld seam. The total number/count of defects shall not exceed the ratio of one (1) defect per 200 m length of weld (i.e., per weld seam). Deviations to this requirement must be agreed upon between the stamping facility and tailored coil supplier and shall be documented in the purchasing contract.

3.1.3.9.2 Non-GM Stamping Facilities. The supplier shall provide a coil defect map identifying all defect locations within the coil, which should not exceed 1% (by length) per weld seam. The total number/count of defects shall be agreed upon between the stamping facility and tailored coil supplier and shall be documented in the purchasing contract.

3.1.4 Testing of Weld Seam.

3.1.4.1 Non-Destructive Testing. Each tailored coil shall be tested online (100% by online system) with appropriate and assured test procedures approved by Supplier Quality. Additional visual inspection is possible.

3.1.4.2 Destructive Testing.

3.1.4.2.1 Erichsen Cupping Test. Destructive testing of weld joints with Erichsen Cupping test is considered a best practice procedure. The cup test shall be performed according to ISO 20482. The evaluation of weld quality is performed according to pictures in Table A2, unless agreed upon by GM and the tailor welded coil supplier based on specific grade/gauge combinations. Frequency of the cup test is a minimum twice per coil, at the head and tail, prior to shipment.

3.1.4.2.2 Cross Section. Samples shall be taken 5 mm minimum from both ends of welds. Measurement shall be performed according to Appendix A, Section A2. Frequency of the cross section is minimum of once per coil setup and at the end of the coil run.

3.1.4.2.3 Tensile Tests. Tensile tests with the laser weld transverse to the load axis according to ISO 6892-1 shall be performed for initial submissions. Fracture shall be outside the weld or, depending on the grade/gauge combinations being welded, in the heat affected zone.

3.1.5 Additional Requirements.

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3.1.5.1 Coil Identification Marking for Category 1, 2, and 3 Progressive Dies (see Appendix A: Figures A11 through A13). An inkjet, with GM-approved ink, shall provide the date, time, or corresponding unique coil identification number and meter count, applied to the step side of the weld with the positioned referenced 25 mm away from the weld on the thin strip.

3.1.5.2 Defect Marking. Unless agreed upon by the coil supplier and stamping source, defects shall be marked with pierced holes and highly visible red paint on the top and bottoms surfaces of the coil in order for automated vision systems and manual inspection to properly segregate non-conforming parts. An ultraviolet (UV) pigment may be added to the paint to assist in defect detection and eliminated the requirement for pierced holes for defect identification, only with stamping plant approval. The supplier must provide a corresponding coil map showing all defect locations and length of defects within the coil. Each recorded defect length shall be determined as the linear length of paint identification, which shall include the distance between the pierced holes located within. Individual defects along the length of the coil shall not be combined for the purpose of defect counting and defect mapping. For non-GM stamping facilities, defect marking shall be agreed upon by the stamper and tailor welded coil supplier.

3.1.5.2.1 Pierced Holes. Unless otherwise authorized by the stamping facility, a hole shall be pierced at the beginning of each defect for all coils and also at the end of each defect for multi-pass welded coils. When the defect is smaller than 300 mm in length, the hole shall be pierced before the beginning of the defect and approximately 300 mm past the first hole pierced. This distance may be reduced as long as the defect is fully contained within the length of coil between the two pierced holes. Across the width, the holes shall be positioned such that the center of the pierced hole is located 100 mm from the centerline of the finished coil. The pierced holes shall have a burr height of less than 20% of the thickness of the material being pierced.

3.1.5.2.2 Paint Defect Identification. A highly visible red paint shall be used to assist in identifying defects on finished parts. The location of the paint marking is identified based on the progressive die process category below (see Appendix A, Figures A11 through A13). The width of the paint line shall be 25 mm minimum. Paint overspray shall not affect subsequent manufacturing operations such as welding, paint systems, etc.

3.1.5.2.2.1 Category 1 Progressive Dies. The paint line length must extend along the coil length to include the entire defect and the entire distance from the beginning of the first pierced holes to the end of the second pierced hole marking a defect zone.

Across the width, the paint spray shall be positioned such that the center of the paint line is located $125 \text{ mm} \pm 5 \text{ mm}$ from the centerline of the finished coil towards the seam being welded, on the top and bottom of the coil.

3.1.5.2.2.2 Category 2 Progressive Dies. The paint line length must extend along the coil length to include the entire defect and the distance from the beginning of the first pierced holes to the end of the second pierced hole marking a defect zone.

Unless agreed upon by supplier and purchaser for a two-out progressive die process (bookend parts), the paint must be applied to both sides of the centerline, and along the length of each defect. The paint spray shall be positioned such that the center of each paint line is located $125 \text{ mm} \pm 5 \text{ mm}$ from the centerline of the finished coil, on both the top and bottom of the coil.

3.1.5.2.2.3 Category 3 Progressive Dies. The paint line length must extend along the coil length to include the entire defect and the distance from the beginning of the first pierced holes to the end of the second pierced hole marking a defect zone.

Deviations to the length of paint marking and the location of the paint line with respect to the centerline, based on the progressive die part configuration, shall be agreed upon by the stamping facility and tailor welded coil supplier. The default position shall be $125 \text{ mm} \pm 5 \text{ mm}$ from the centerline of the finished coil towards the seam being welded, on the top and bottom of the coil.

3.1.5.3 Coil Size Restrictions. The minimum coil outside diameter allowed is 762 mm (30 in), and any deviations must be approved by the stamping facility manufacturing the part. The ordered coil weight is based on the specific application and the volume of a desired given production run. Any deviations to the ordered coil weight shall be approved by the stamping facility and Purchasing.

3.1.5.4 Process Control. The supplier shall develop quality process control procedures compliant with ISO 16949 demonstrating that the product will conform to all specification requirements listed in this document. This shall include a statistically-based sampling plan based upon product quality performance. The data required to be submitted for this specification for each shipment will be determined by the manufacturing location. The process shall be assured by traceability from stack label back to the batch number of steel sheet or coil.

4 Manufacturing Process.

Not applicable.

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.

5.3 Inspection and Rejection. Samples of components or materials released to a GM material specification shall be tested for conformity with the requirements of this material specification and approved by the responsible Engineering department prior to commencement of delivery of bulk supplies.

A new approval must be received for any changes, e.g., properties, manufacturing process, location of manufacture, etc. If not otherwise agreed, all testing and documentation normally required for initial release must be completed.

It is the responsibility of the supplier to inform the customer in a timely manner, without solicitation, and to include documentation of all modifications of materials and/or processes and to apply for a new release.

5.4 Material Safety Data Sheets/Safety Data Sheets (MSDS/SDS). For new product submissions, or when a change in chemical composition of an existing product has occurred, a complete copy of the Material Safety Data Sheet/Safety Data Sheet must be submitted in compliance with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS) requirements or other country-specific MSDS/SDS requirements.

5.5 All materials supplied to this standard must comply with the requirements of the International Material Data System (IMDS) and GMW3059, **Restricted and Reportable Substances**.

6 Approved Sources

Materials supplied to this specification must be approved by General Motors.

The appropriate GM Materials Engineering department(s) must confirm material as meeting the requirements of this specification. Any test data sheets of material submitted to General Motors for such confirmation (e.g., during Production Part Approval Process (PPAP)) under this material specification must list all properties and must apply corresponding test methods of this material specification.

7 Notes

7.1 Glossary.

MATSPC: Global repository of GM approved materials for corresponding GM Engineering Standards.

7.2 Acronyms, Abbreviations, and Symbols.

f	Porosity Projection Fraction
GHS	Globally Harmonized System of Classification and Labeling of Chemicals
h	Deviation in mm
HAZ	Heat Affected Zone
IMDS	International Material Data System
MSDS	Material Safety Data Sheet
PPAP	Production Part Approval Process
SDS	Safety Data Sheet
SEL	Stahl-Eisen-Lieferbedingungen
t₁	Thickness of Thicker Sheet
t₂	Thickness of Thinner Sheet
UV	Ultraviolet