



Global Qualification Process for Aluminum Sheet

1 Introduction

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. This procedure defines the requirements an aluminum producer or processor shall meet to qualify their aluminum products and processing lines at General Motors. This procedure applies to GMW material grades as specified in GMW15192. This includes GMW grades from new suppliers or grades that have undergone a significant change in process route. Aluminum sheet products supplied to GM production facilities must have Engineering and Manufacturing approvals as defined in this procedure.

Note: The release of specific parts and applications are not within the scope of this procedure.

1.2 Applicability. This procedure applies to GMW material grades as specified in GMW15192 for body and closure panel applications.

1.3 Remarks. The intent of this procedure is to create a common, global procedure for qualification of aluminum sheet materials that are used by GM worldwide. This procedure is intended to evaluate a supplier's ability to produce and supply aluminum sheet that meets GM's requirements. Emphasis is placed on the aluminum producer's ability to supply a uniform and consistent product. Some material characteristics and attribute data are requested for qualification purposes even though they are not requirements of GMW15192. In these instances, the data is required for informational purposes.

While this procedure details the requirements for initiating global qualification, additional regional requirements may be requested by the Qualification Champion. The data required to be submitted for each shipment will be determined by the regional manufacturing location.

2 References

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

2.1 External Standards/Specifications.

ASTM E34	ASTM E606	EN 573	ISO 10113
ASTM E101	ASTM E607	IATF 16949	ISO 10275
ASTM E112	ASTM E646	ISO 7500-1	
ASTM E517	ASTM E1251	ISO 9513	

2.2 GM Standards/Specifications.

GMW3011	GMW14700	GMW15282	GMW16549
GMW3059	GMW14704	GMW15287	GMW16823
GMW3335	GMW14729	GMW15288	GMW16967
GMW14019	GMW14829	GMW15421	
GMW14669	GMW15192	GMW16170	

3 Test Preparation and Evaluation

3.1 Resources.

3.1.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label. Calibration in accordance to ISO 7500-1 and ISO 9513 is required.

3.1.2 Alternatives. Alternative test facilities and equipment may also be used. However, all testing must be performed at an International Laboratory Accreditation Cooperation (ILAC) member accredited laboratory, see www.ilac.org for a list of national accreditation bodies. If the lab is not approved by a signatory of the ILAC mutual recognition agreement the laboratory must be approved for technical competence for the required testing as agreed upon by the Qualification Champion and supplier.

3.2 Test Conditions. Deviations from the requirements of this standard must be agreed upon by the Qualification Champion before submission of the qualification package. Such requirements shall be specified on component drawings, test certificates, reports, etc.

3.3 Preparation. Suppliers are required to provide any test samples to General Motors or outside testing sources as required by this procedure and any referenced tests. Additional requirements for material may be identified at the start of testing or may be necessary if tests are repeated. The Qualification Champion shall inform the supplier if any additional samples are necessary as part of a re-test.

3.4 Safety. This standard may involve hazardous materials, operations, and equipment. This standard does not propose to address all the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

3.5 Documentation. Documentation requirements are detailed in Section 7.

Samples of components or material released to this standard shall be tested for conformity with the requirements of this standard and approved by the responsible GM department prior to the start of delivery of production level components or materials.

Any change to the component or material, e.g., design, function, properties, manufacturing process and/or location of manufacture requires a new release of the product. It is the sole responsibility of the supplier to provide the customer, unsolicited, with documentation of any change or modification to the product/process, and to apply for a new release.

If not otherwise agreed to, the entire verification test shall be repeated and documented by the supplier prior to start of delivery of the modified or changed product. In some cases, a shorter test can be agreed to between the responsible GM department and the supplier.

3.6 Supplier Quality Audit. General Motors, at its discretion, may perform a supplier assessment and review of its suppliers at any time prior to or following aluminum qualification.

4 Requirements and Procedure

4.1 Summary. This procedure outlines the testing requirements for sheet metal qualification to GMW15192. The first step consists of Global Engineering Requirements. Due to GM regional manufacturing differences and requirements, the second step consists of Regional Manufacturing Requirements, which is a regional qualification that involves a separate approval in each GM region of manufacture. See 5.5 for a description of the qualification levels.

All testing must be performed at an International Laboratory Accreditation Cooperation (ILAC) member accredited laboratory, see www.ilac.org for a list of national accreditation bodies. If the lab is not approved by a signatory of the ILAC mutual recognition agreement, the laboratory must be approved for technical competence for the required testing as agreed upon by the Qualification Champion and supplier.

4.1.1 Global Engineering Requirements. Global Engineering Requirements are a set of GM Worldwide common, engineering-based requirements for all participating regions in the global qualification process. Some material characteristics and attribute data are requested for qualification purposes even though they are not requirements of GMW15192. Global Engineering Requirements are summarized in Appendix A, Tables A1, A2, and A3.

4.1.2 Regional Manufacturing Requirements. Regional Manufacturing Requirements are a set of manufacturing requirements for the target GM production region. The target region is defined as the GM region where the supplier would like to provide material. The Regional Manufacturing requirements consist of additional laboratory testing and a plant try out to evaluate the ability of this sheet aluminum to be formed, hemmed, assembled, joined, bonded, cleaned, and painted in GM manufacturing and assembly operations. Regional Manufacturing Requirements are summarized in Appendix A, Tables A4 and A5.

4.2 Testing Requirements. Testing requirements in this procedure are determined by the aluminum grade, surface quality and the qualification status of the processing line.

GM also requires that all suppliers adhere to the fundamental quality systems requirements of IATF 16949. If IATF 16949 certification is not yet complete, the supplier must show a timing plan for completion, provide a letter of conformance from the certifying organization, and must obtain a waiver from GM Supplier Quality Engineering. Suppliers choosing other approaches must be able to show that their quality systems meet the intent of IATF 16949 as determined by GM Supplier Quality Engineering.

4.3 Qualification Requirements. Requirements for qualification are defined in this procedure, including requirements for new suppliers, new process lines, and modified processes. Suppliers must also be capable of meeting the thickness tolerance requirements in GMW15192.

Testing requirements are summarized in Appendix A, Tables A1 through A5. These tables define testing requirements for new suppliers, new process lines, or modified process routes.

5 Qualification Process

5.1 Qualification Initiation - GM. The global qualification process may be initiated by Global Purchasing and Supply Chain (GPSC) through establishment of a commercial need or by GM Engineering through establishment of a technical need.

5.2 Qualification Initiation - Supplier. A currently approved aluminum producer or processor can initiate qualification by establishing a technical need. The aluminum producer or processor shall contact the Global Aluminum Sheet Team (GAST) to initiate qualification.

5.3 Qualification Champions. When an appropriate request is received by the GAST, a team member will be assigned to coordinate the qualification and will be identified as the **Qualification Champion**. The Qualification Champion will generally be located in the region that identifies the need for the qualification. The Qualification Champion will also act as the interface between the aluminum producer and GM on all aluminum technical issues during the qualification process. Qualification Champions are required to make themselves available to attend Global Purchasing and Supply Chain meetings and plant visits where technical issues and requirements are discussed.

5.4 Qualification Review Timing. The Qualification Champion will review and evaluate the test data submitted by the aluminum producer and determine whether it is ready for review by the GAST. Within six weeks of receiving all of the data for Global Engineering requirements, a decision will be rendered on granting Level 1 Approval as defined in 5.5. Within six weeks of receiving all of the data for Regional Manufacturing Requirements, a decision will be rendered on granting Level 2 Approval as defined in 5.5.

5.5 Supplier Qualification Levels. The GAST shall review the data submitted by the supplier. The Qualification Champion shall act as the lead in this review and work with the GAST to identify any discrepancies with the material in relation to the appropriate specifications and expectations. The GAST can issue one of the following qualification levels:

Level 1 Approval: Granted to a supplier after the Global Engineering Requirements (Appendix A, Tables A1, A2, and A3) have been met for the specified GMW15192 aluminum grade. The supplier may then initiate the process for qualification to the Regional Manufacturing Requirements (Appendix A, Tables A4 and A5) as described in a Level 2 Approval.

The outline of a Level 1 Approval is as follows: Show conformance to Global Engineering Requirements (Appendix A, Tables A1, A2, and A3).

Level 2 Approval: Granted to a supplier after demonstrating that the Regional Manufacturing requirements have been met in the target GM region. Once these requirements have been met, the supplier will then be approved to supply product in that region. The supplier may not supply outside of the approved region(s).

The outline of a Level 2 Approval is as follows: Level 1 Approval and show conformance to Regional Manufacturing requirements (Appendix A, Tables A4 and A5) for a selected region or regions.

Level 3 Approval: Granted to a supplier that has completed the Level 1 Approval and has Level 2 Approval in all regions. The regions requiring approval to be granted a Level 3 Approval include: GMNA, GMB, GMIO, GMH, GMK and SGM.

Outline of a Level 3 Approval is as follows: Level 1 Approval + Level 2 Approval in all regions (GMNA, GMB, GMIO, GMH, GMK and SGM).

5.5.1 Rejection. The GAST may determine that the material does not meet specification requirements (Level 1 or Level 2) and/or there is sufficient missing information to warrant rejection of the qualification. The supplier must resubmit a qualification package in order to be considered for approval.

5.6 Required Testing. Data from the test requirements shown in Appendix A, Tables A1, A2 A3, A4, and A5 and defined here must be received from the aluminum producer to satisfy the requirements of this procedure. See 4.1 for laboratory accreditation requirements. Before testing, the responsible Qualification Champion has to agree on the test plan and the test lab. Additional testing may be conducted in GM laboratories. In some instances, A/B comparison testing of a new material to an already approved material may be required.

6 Test Content

6.1 Global Engineering Requirements. Global Engineering Requirements are summarized in Appendix A, Tables A1, A2, and A3.

A material cannot be approved for use in any region until the regional manufacturing requirements have also been met (see Appendix A, Tables A4 and A5).

6.1.1 All materials supplied to this procedure must comply with the requirements of GMW3059, *Restricted and Reportable Substances for Parts*.

Compliance with the requirements of GMW3059 must be documented in the International Material Data System (IMDS). The IMDS web site address is: <https://www.mdssystem.com/imdsHome.do>.

6.1.2 Chemical Analysis of Base Aluminum. Base metal composition based on product (ingot, coil or sheet/blanks) analysis determined per ASTM E34, ASTM E101, ASTM E607, ASTM E1251 or EN 573 shall conform to the requirements in GMW15192. Chemical analysis samples should be based on statistical sampling of multiple ingots or coils. Additional demands and restrictions may be given by the GAST.

In addition, the melt specification from the qualifying mill shall be reported, including the maximum and minimum allowable for each alloy element and any residual elements.

6.1.3 Mechanical Properties. Products approved by this procedure shall be tested to and conform to the mechanical properties as specified in GMW15192. The required mechanical standards are defined in GMW3335. The appropriate tensile test sample geometry required by the target GM region will be chosen by the Qualification Champion.

Mechanical properties shall include 0.2% offset yield strength ($R_{p0.2}$), ultimate tensile strength (R_m), percentage plastic elongation at maximum force (A_g), percentage elongation after fracture (A or El), n -value, and r -value. The strain hardening exponent, n -value, shall be determined per ISO 10275 or ASTM E646 for both strain ranges indicated in GMW15192. The plastic strain ratio, r -value, shall be reported in the longitudinal 0 degrees, transverse 90 degrees, and diagonal 45 degrees directions along with the corresponding r -bar value. The r -value shall be measured per ISO 10113 or ASTM E517 at both of the strains indicated in GMW15192.

For purposes of qualification, data is to be submitted in all three test directions (longitudinal 0 degrees, transverse 90 degrees, and diagonal 45 degrees) even though GMW15192 only requires guaranteed mechanical properties in the transverse direction.

6.1.3.1 As Received Mechanical Properties.

6.1.3.1.1 Intracoil. As received mechanical properties shall be submitted from the head and tail sections of one coil, along with 5 equally spaced sections along the body of the coil. Edge, center, edge tests shall be performed in the longitudinal 0 degrees, transverse 90 degrees and diagonal 45 degrees directions for all seven (7) sampling locations, for a total of 63 tests.

6.1.3.1.2 Multicoil. As received mechanical properties shall also be submitted from the head and tail sections of ten (10) coils. Edge, center, edge tests shall be performed in the longitudinal 0 degrees, transverse 90 degrees and diagonal 45 degrees directions of all 20 sampling locations, for a total of 180 tests.

6.1.3.2 Paint Bake Properties. This section applies to age hardenable 6000 aluminum alloys intended for use after a paint bake heat treatment, with no subsequent heat treatment. For age hardenable 6000 aluminum alloys, data shall be submitted showing the change in mechanical properties following 0% and 2% strain and simulated paint bake at 185 °C for 20 minutes. Use five (5) of the ten (10) coils from 6.1.3.1.2 testing. On one coil, measure the paint bake properties at the head and tail sections, edge-center-edge, in the longitudinal 0 degrees, transverse 90 degrees and diagonal 45 degrees directions for a total of 18 tests. For the remaining 4 coils, measure the paint bake properties at the head and tail sections, center only, in the transverse 90 degrees direction for a total of 8 tests. In addition, for the 6000-S grade, use the same 4 coils and same coil locations to measure paint bake properties in the transverse 90 degrees direction using the paint bake cycle of 180 °C for 20 minutes, for information only. Other simulated paint bake times and temperatures may be requested to compare new aluminum sheet products to current production sheet products.

6.1.3.3 Aging Property Changes. For age hardenable 6000 aluminum alloys, data shall be submitted showing changes in mechanical properties due to natural aging at room temperature, between 20 °C to 25 °C. Data shall be measured from a representative coil. Changes in mechanical properties shall be collected in weekly increments for the first 3 weeks followed by monthly increments starting at 1 month and ending at 6 months after solution heat treat (SHT). Testing shall be done in the longitudinal 0 degrees, transverse 90 degrees and diagonal 45 degrees.

Using the same representative coil, data shall also be submitted showing changes in mechanical properties following natural aging at room temperature, between 20 °C and 25 °C and simulated paint bake. Changes in mechanical properties shall be collected in monthly increments starting at 1 month and ending at 6 months after solution heat treat (SHT). After natural aging at room temperature, between 20 °C and 25 °C, samples should be strained at 0% and 2% and then subjected to the simulated paint bake cycle of 185 °C for 20 minutes. Testing shall be done in the transverse 90 degrees direction.

6.1.4 Microstructure. Microstructural analysis is required in one location for longitudinal, transverse, and thickness directions at 100x, 500x and 1000x magnifications. Submit photomicrographs showing intermetallic particles (i.e., constituents, dispersoids), and grain boundaries.

Grain size shall be tested to ASTM E112 and shall be consistent throughout the thickness of the sheet.

6.1.5 Sheet Thickness Characteristics. Sheet thickness of the finished product shall be measured at the centerline and at 25, 50, 100, 150 and 200 mm from each trimmed edge, at the head and tail sections of one coil, along with 5 equally spaced sections along the body of the coil.

In addition, sheet thickness of the finished product shall be measured at the centerline and at 25, 50, 100, 150, and 200 mm from each trimmed edge, from at least ten (10) coils. These thickness measurements shall be reported along with the width of the trimmed sheet and location in the coil from which the measurements were taken.

6.1.6 Hemming Factor. For age hardenable 6000 aluminum alloys intended for exposed (E) applications, data shall be taken showing the hemming factor as defined in GMW15192. Testing shall be done as according to GMW15421. Edge, center, edge tests shall be performed in the longitudinal 0 degrees, and transverse 90 degrees directions from both the head and tail of 3 coils, for a total of 36 tests. The longitudinal and transverse directions are defined according in GMW15421.

In addition, data shall be taken showing changes in the hemming factor as defined in GMW15192 after natural aging at room temperature, between 20 °C and 25 °C. Changes in the hemming factor shall be collected in monthly increments starting at 1 month and ending at 6 months after solution heat treat (SHT). For the aged samples, edge, center, edge tests shall be formed in the longitudinal 0 degrees and transverse 90 degrees from the head and tail of one coil, for a total of 12 tests per month, or 72 total tests.

6.1.7 Roping/Paint Brush Line Evaluation. Age hardenable 6000 aluminum alloys intended for exposed (E) applications shall be free from surface irregularities commonly known as paint brush or, roping lines. These surface defects form on the surface of the sheet upon application of tensile strain perpendicular to the sheet rolling direction. A uniaxial tensile strain of 10% shall be applied to test samples from three different coils. Test samples shall be 250 mm x 35 mm, where the 35 mm dimension represents the longitudinal 0 degrees direction, and the 250 mm dimension represents the transverse 90 degrees direction. After straining, the test sample surfaces shall be stoned with a standard 320 grit stone. Test samples shall be submitted to the Qualification Champion to show proof of conformance. Appendix B, Figure B1 shows samples with and without the roping surface defect. Test strips shall have a 1 or 2 roping rating (1 = best rating, 4 = worst rating) as defined in Figure B1.

In addition, the qualification champion may require testing of larger samples, such as pie pan samples or fully stamped panels. The same Appendix B, Figure B1 rating system will be used.

6.1.8 Reduced Stretcher Strains. Reduced Stretcher Strain (RSS) alloys shall be free from surface irregularities commonly known as **stretcher strain marks** or **Lüders lines**.

Yield point elongation (YPE) shall be measured using the sample geometry defined in GMW3335. Tensile testing shall be in both the longitudinal 0 degrees and transverse 90 degrees directions on samples from three different coils.

After tensile testing, enlarge the tensile curve graphically so that the strain path between 0% and 1.5% and the full YPE domain are clearly visible. The YPE plateau is defined as the area between the first peak on the stress strain curve and the end of the plateau. Measure the YPE and express it as a percentage with two decimal places. The YPE must be < 0.60% for the alloy to be classified as a reduced stretcher strain.

© Copyright 2018 General Motors Company All Rights Reserved