



Structural Aluminum Extrusion Global Qualification Procedure

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/Material Description. This procedure defines the requirements an aluminum extrusion supplier shall meet to qualify their products and processing lines at General Motors. This procedure applies to GMW material grades as specified in GMW15665. This includes GMW grades from new suppliers or grades that have undergone a significant change in process route. Aluminum extrusion products supplied to GM production facilities must have approvals as defined in this procedure.

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

1.2 Symbols. Not applicable.

1.3 Applicability. This procedure applies to GMW material grades as specified in GMW15665 - Aluminum Extrusions for Structural Applications.

1.4 Remarks. The intent of this procedure is to create a common, global procedure for qualification of aluminum extrusion materials that are used by GM worldwide. This procedure is intended to evaluate a supplier's ability to produce and supply aluminum extrusion that meets GM's requirements. Emphasis is placed on the aluminum extrusion producer's ability to supply a uniform and consistent product. Some material characteristics and attribute data are requested for qualification purposes, even though not requirements of GMW15665. In these instances, the data is required for informational purposes.

2 References

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

2.1 External Standards/Specifications.

ASTM E101	IATF 16949	ISO 8493
ASTM E1251	ISO 6892	ISO 9513
ASTM E3061	ISO 7500-1	VDA 238-100

2.2 GM Standards/Specifications.

9982285	GMW14669	GMW16170	GMW17679
GMW3011	GMW14704	GMW16549	GMW18077
GMW3059	GMW14729	GMW16705	
GMW3335	GMW14829	GMW16889	
GMW14058	GMW15665	GMW16967	

2.3 Additional References.

- IMDS Website: <https://www.mdsystem.com/imdsHome.do>

3 Test Preparation and Evaluation

3.1 Resources.

3.1.1 Facilities.

3.1.1.1 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.

3.1.1.2 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

Additionally, 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.

3.1.2 Equipment. Not applicable.

3.1.3 Test Vehicle/Test Piece. Not applicable.

3.1.4 Test Time. Varies by test performed, see Section 4 for more details.

3.1.5 Test Required Information. Not applicable.

3.1.6 Personnel/Skills. Test technician familiar with test facilities and equipment.

3.2 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.

3.3 Conditions.

3.3.1 Environmental Conditions. Not applicable.

3.3.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

Deviations from the requirements of this standard must be agreed upon by the Qualification Champion before submission of the qualification package.

3.4 Instructions. See Section 4.

3.5 Data. Not applicable.

3.6 Safety.

This Engineering Standard may involve safety requirements for hazardous materials, the method of operations and equipment. This standard does not propose to address all the safety issues associated with its use. It is the responsibility of the user of this standard to ensure compliance with all appropriate safety and health practices. This would include any specific training that may be required. The safety and health standards include site specific rules and procedures, company rules and procedures, and Government Standards. Contact shall be made with the appropriate site Safety and Health personnel for further direction and guidance in these matters.

3.7 Documentation. 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.

Documentation requirements are detailed in 4.6.

3.7.1 Test Results. Not applicable.

3.7.2 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 aluminum extrusion supplier qualification to GMW15665. See 4.4.5 for a description for qualification.

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.

4.2 Requirements.

4.2.1 Global Qualification 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, but are not requirements of GMW15665. Global Engineering Requirements are summarized in Appendix A, Table A1.

4.2.2 Testing Requirements. Testing requirements in this procedure are determined by the aluminum extrusion able to show that their quality systems meet the intent of IATF 16949 as determined by GM Supplier Quality Engineering.

4.2.3 Qualification Requirements. Requirements for qualification are defined in this procedure, including requirements for new suppliers, new process streams, and modified process streams. Testing requirements are summarized in Appendix A, Table A1. This table define testing requirements for new suppliers, new process streams, and modified process streams.

4.3 All materials supplied to this standard must comply with GMW3059, Restricted and Reportable Substances, including the requirement to submit a full material composition disclosure to GM via the International Material Data System (IMDS).

4.4 Qualification Process.

4.4.1 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.

4.4.2 Qualification Initiation - Supplier. A currently approved aluminum producer or processor can initiate qualification by establishing a technical need. The aluminum extruder, or tier two supplier shall contact a GM Materials Engineer qualification team member to initiate qualification.

4.4.3 Qualification Champions. When an appropriate request is received by GM Materials Engineering qualification team, a materials engineer 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 extrusion supplier and GM on all aluminum extrusion 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.

4.4.4 Qualification Review Timing. The Qualification Champion will review and evaluate the test data submitted by the aluminum extrusion supplier and determine whether it is ready for review by GM Materials Engineering qualification team. Within six weeks of receiving all of the data for Global Engineering requirements, a decision will be rendered on granting approval as defined in 4.4.5.

4.4.5 Supplier Qualification. The GM Materials Engineering qualification team shall review the data submitted by the supplier. The Qualification Champion shall act as the lead in this review and work with the GM Materials Engineering qualification team to identify any discrepancies with the material in relation to the appropriate specifications and expectations. The GM Materials Engineering qualification team can issue one of the following qualification judgements:

4.4.5.1 Approval. Granted to a supplier after the Global Engineering Requirements (Appendix A, Table A1) have been met for the specified GMW15665 aluminum extrusion grade.

The outline of a Global Engineering Approval is as follows: Show conformance to Global Engineering Requirements (Appendix A, Table A1).

4.4.5.2 Rejection. The GM Materials Engineering qualification team may determine that the material does not meet specification requirements 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.

4.4.6 Required Testing. Data from the test requirements shown in Appendix A, Table A1 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.

4.5 Extrusion Trial Run Requirements.

4.5.1 Class One Extrusion Trial Run. Class one (1) extrusion trial runs shall be performed on non-standard or proprietary 6000 series alloy extruded aluminum products, all 7000 series alloy extruded aluminum products, and standard extruded aluminum products with yield strengths equal to or > 270 MPa. Extruded aluminum suppliers shall utilize production intent extrusion die to perform steady state run at rate extrusion trial runs. Supplier shall conduct a minimum of three (3) steady state extrusion trial runs during GM Integration Vehicle Engineering Release (IVER) build part production. See Figure A1 in Appendix A for Class One extrusion runs schematic diagram. Die shall be removed and set-up in extrusion press between trial run No. 1 (first trial run), trial run No. 2 (second trial run), and trial run No. 3 (third trial run). Supplier shall report any required replacement/refurbishment of extrusion dies, or change in operating parameters required during, or between runs to produce steady state pre-production extrusion trial run samples. Extrusion trial run samples shall be processed through extrusion supplier's production representative quenching, stretching and heat treatment operations. Extrusion trials runs shall be held on different days of the week. Total length of profile extruded for each extrusion trial run shall be left to the discretion of extrusion supplier. Extrusion supplier shall report length of profile extruded per unit time (i.e., meters per minute), or mass of profile extruded per unit time (i.e., kilograms per minute).

4.5.2 Class Two Extrusion Trial Run. Class two (2) extrusion trial runs shall be performed on standard 6000 series alloy extruded aluminum products with yield strengths < 270 MPa. Extruded aluminum suppliers shall utilize production intent extrusion die to perform steady state run at rate extrusion trial runs. Supplier shall conduct a minimum of two (2) steady state extrusion runs during GM Integration Vehicle Engineering Release (IVER) build part production. See Figure A2 in Appendix A for Class Two extrusion trial runs schematic diagram. Die shall be removed and set-up in extrusion press between trial run No. 1 (first trial run) and trial run No. 2 (second trial run). Supplier shall report any required replacement/refurbishment of extrusion dies, or change in operating parameters required during, or between runs to produce steady state pre-production extrusion trial run samples. Extrusion trial run samples shall be processed through extrusion supplier's production representative quenching, stretching and heat treatment operations. Extrusion trials runs shall be held on different days of the week. Total length of profile extruded for each extrusion trial run shall be left to the discretion of extrusion supplier. Extrusion supplier shall report length of profile extruded per unit time (i.e., meters per minute), or mass of profile extruded per unit time (i.e., kilograms per minute).

4.5.3 Extrusion Trial Run Sample Identification. Extrusion trial runs samples shall be marked with numbers to identify trial run number and location within extrusion trial run length. The numbers one (1), two (2) and three (3) shall designate the extrusion trial run. The letters F, M and R shall identify front, middle and rear locations within an extrusion trial run, respectively. Samples taken from the front, middle and rear of extrusion trial run 1 shall be identified as 1F, 1M and 1R. Samples taken from the front, middle and rear of extrusion trial run 2 shall be identified as 2F, 2M and 2R. Samples taken from the front, middle and rear of extrusion trial run 3 shall be identified as 3F, 3M, and 3R.

4.6 Test Content.

4.6.1 Global Engineering Qualification Requirements. Global Engineering Requirements are summarized in Appendix A, Table A1.

4.6.1.1 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.mdsystem.com/imdsHome.do>. Save or print a copy of the IMDS recipient data page, including the IMDS ID number. An electronic version of the IMDS recipient data page should be included in the qualification package and should be submitted and show acceptance to GMNA VO IMDS ID No. 5751. The IMDS ID number will be used to track the submission as well as the IMDS status.

4.6.1.2 Chemical Composition Analysis. Perform chemical composition analysis using ASTM test method ASTM E101, ASTM E1251, ASTM E3061 or equivalent regional chemical composition test method. Aluminum extrusion supplier shall submit chemical composition analysis results for the specific alloy composition used to manufacture extruded aluminum profile part number, or part numbers being supplied. Chemical composition analysis shall be performed on sample from each extrusion trial run. Supplier shall provide minimum-maximum range, or maximum limit for each major aluminum extrusion alloy element.

4.6.1.3 As-received Tensile Mechanical Properties. Tests shall be performed according to GMW3335 using samples per ISO 6892 Type I (50 mm gage length) ASTM International (ASTM) type sample. Supplier shall submit 0.2% offset yield strength (in MPa), ultimate tensile strength (in MPa), and total elongation (percent in

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50 mm gage length) test results from aluminum extrusion samples after supplier production processing (i.e., straightening and heat treatment). Supplier shall report fracture location of each tensile test specimen (refer to Figure A3 in Appendix A). Tensile test specimens shall be excised parallel to the extrusion direction. Samples shall be taken from front, middle and rear of each extrusion trial run. Tensile test specimens shall be machined by water jet cutting. For square or rectangular hollow and semi-hollow aluminum extrusions, test specimens shall be excised from at least four (4) external walls. Wall thicknesses shall be reported for hollow or semi-hollow aluminum extrusion mechanical property test results. Supplier shall test one (1) sample for flat, round and solid profiles. Aluminum extrusion samples shall represent a typical solution heat treatment (if applicable) and typical artificial aging, of shipment lot for the part number or part numbers being supplied. Supplier shall provide two dimensional schematic diagram showing extrusion profile tensile test specimen excision locations. Refer to Figure A4 in Appendix A for example of tensile test specimen excision locations schematic diagram.

4.6.1.4 Stress-Strain Curves. Supplier shall submit digitized engineering stress-engineering strain and true stress-true strain curves from each as-received tensile mechanical property test. Data shall be submitted in Excel format.

4.6.1.5 GM Assembly Plant/Supplier Simulated E-coat Bake Mechanical Properties. Minimum yield strength and minimum ultimate tensile strength values shall be determined using Weibull B1C50 statistical analysis of at least of fifteen (15) tensile test specimens subjected to simulated vehicle assembly plant E-coat bake oven exposure, or tier two supplier E-coat bake oven exposure. Thermocouple attached to a tensile test specimen and a digital temperature meter shall be used to verify exposure temperature. Refer to GMW16705 Appendix A for Weibull B1C50 statistical analysis.

4.6.1.6 As-received Bend Testing. Perform 3-point bend testing per VDA 238-100 on all outer walls of the extrusion. Perform bend tests along the longitudinal, diagonal (45 degrees), and transverse bending lines. Figure A5 in Appendix A displays a schematic taken from VDA 238-100 showing the longitudinal and transverse bend test sample orientations. Test a minimum of three samples for each test direction and per wall. Calculate and report the minimum measured bend angles, as well as the minimum bend angle normalized to a 3 mm thickness. Report the average minimum bend angle (normalized to 3 mm) for each outer wall.. Include and plot all force-displacement curves from testing.

4.6.1.7 Metallographic Examination. Supplier shall submit photomicrographs from a typical hollow or semi-hollow aluminum extrusion external wall. Supplier shall submit longitudinal and transverse cross section 100x magnification photomicrographs showing grain structure at the exterior surface, mid-thickness, and interior surface of a hollow aluminum extrusion external wall. Supplier shall also submit longitudinal and transverse photomicrographs showing size and distribution of intermetallic constituents at 100x magnification. Metallography shall be performed on extrusion samples from middle of each extrusion trial run. Extrusion samples shall represent production processing (i.e., straightening and heat treatment).

4.6.1.8 Longitudinal Weld Seam Location Diagram. Hollow aluminum extrusion suppliers shall submit a schematic diagram of extruded profile cross section showing longitudinal weld seam locations and cell (i.e., cavity). Supplier shall also identify cell (i.e., hollow cavity) for longitudinal weld seam integrity test on schematic diagram. Refer to Figure A6 in Appendix A for example of longitudinal weld seam location and test cell schematic diagram.

4.6.1.9 Longitudinal Weld Seam Integrity Test. Supplier shall perform flare/drift testing on hollow aluminum extrusion samples by applying constant axial load until fracture, or buckling occurs. Supplier shall report maximum applied load (in Newtons). If fracture occurs, supplier shall report location (along longitudinal weld seam, or away from longitudinal weld seam). Refer to Figure A7 in Appendix A for schematic diagram showing longitudinal weld seam evaluation by flare/drift test method. Supplier shall flare/drift test aluminum extrusion samples from front, middle and of each extrusion trial run. Supplier shall perform flare/drift testing on all extruded profile cells, or hollows. Supplier shall submit flare/draft tested samples to GM materials engineer.

4.6.1.10 Dimensional Measurements. Supplier shall perform two dimensional (2-D) measurements (i.e., thickness, width, height, radii, length) and three dimensional (3-D) measurements (i.e., straightness, flatness, twist) on front, middle and rear samples taken from each extrusion trial run. Supplier and GM Supplier Quality Engineer (SQE) shall agree on 2-D and 3-D measurement locations. If not performed by internally, extrusion supplier shall report 3-D measurement source. GM SQE may request extrusion trial run samples to confirm 2-D and 3-D measurements.

4.6.1.11 Metal Surface Preparation. Aluminum extrusions produced from extrusion trial runs shall meet GMW17679, "Metal Surface Preparation" requirements.