



Aluminum Forgings

1 Scope

This material standard covers forgings made of Aluminum alloys used in automotive and allied industries. This specification specifies chemical composition and material properties based on test coupons excised from forged components.

1.1 Material Description. The materials are aluminum alloys of Aluminum Association (AA) 6000 series and some vendor specific alloys similar to 6000 series.

1.2 Symbols. Not applicable.

1.3 Applicability. Aluminum alloy forging applications are many in most vehicle systems. Major applications are chassis components such as control arms, links, knuckles, brackets, yokes, etc.

2 References

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

2.1 External Standards/Specifications.

ASTM B557	ASTM E10	ISO 209	ISO 6892
ASTM B918/B807	ASTM G47	ISO 6506	ISO 16455

2.2 GM Standards/Specifications.

GMW3059	GMW16704	GMW16705
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2.3 Additional References.

- Aluminum Association (AA)
- Safety and Industrial Hygiene (S&IH) Technical Standard (TS), S&IH TS 3.4-160-02

3 Requirements

3.1 Chemical Requirements.

3.1.1 Forgings furnished to this specification shall conform to the composition limits shown in Table 1.

3.1.2 To meet the mechanical property requirements, it will be necessary to restrict chemical composition ranges of specific elements and must be approved by General Motors prior to Production Part Approval Process (PPAP). Selected ranges shall become the drawing requirements.

3.1.3 Alloy designations and composition limits were obtained from Aluminum Association (AA) and ISO 209 reference standards when available. Some are vendor specifications.

3.1.4 Any chemical composition changes to GMW15657 alloy grades shall be shown on the engineering drawing.

3.2 Mechanical Requirements.

3.2.1 Tensile test specimens shall be excised from a part location specified on the engineering drawing.

3.2.2 The test specimen axis shall be oriented as parallel to major wrought direction of maximum metal flow.

3.2.3 Required tensile properties determined from heat treated forged parts are given in Table 2.

3.2.4 The engineering drawing may specify property requirements of alternate specimens that are not parallel to maximum metal flow.

3.2.5 The tension tests shall be made in accordance with test methods ISO 6892, GMW16705 and alternately ASTM B557.

3.2.6 Hardness testing shall be done in accordance with ISO 6506, GMW16705 and alternately ASTM E10.

3.2.7 A test plan shall be established upon mutual agreement between the seller and buyer, GMW16704 may be used as guidance in setting up the test plan system.

3.3 Physical Requirements. Typical physical properties associated with each alloy grade are shown in Appendix A, Table A1.

3.4 Additional Requirements.

3.4.1 Microstructural Requirements. The stronger linear fibrous structure in the die forging process helps to improve the mechanical properties. The aim is to maintain the fibrous structure as much as possible and minimize recrystallized structure.

3.4.2 Forging Requirements.

3.4.2.1 Forgings furnished shall be of uniform quality and free from surface anomalies such as seams, laps, bursts, lubricants, dust and dirt, and quench cracks, all to an extent that would be detrimental to safe handling, machinability, appearance or performance.

3.4.2.2 Cracks and crack-like anomalies are not permitted.

3.4.2.3 Any anomalies, plus surface roughness and forging cleanliness may have maximum allowable limits specified.

3.4.2.4 For any of the preceding forging requirements, a measurement system shall be agreed upon between purchaser and supplier.

3.4.3 Stress Corrosion Resistance. Stress Corrosion Cracking (SCC) is caused by sustained tensile stress under some service environments. For example:

- Corrosive environment which could result in premature failure of parts along grain boundaries.
- Varying amounts of copper in the alloy influence SCC differently.
- Alloys containing higher percentage of copper and silicon in excess of stoichiometric magnesium silicide (Mg_2Si) are relatively more prone to SCC. Short transverse direction in forging is more prone to SCC than others.
- Fine grains minimize SCC. Microstructural differences among various heat treatments in the form of size and type of precipitates at the grain boundaries could also be a factor.

Hence, alloy percentages in materials, fabricating methodologies, heat treatment methods, loading paths, etc., shall be carefully selected to minimize SCC so as to meet the durability requirements of components. Stress corrosion testing may be performed per test method ISO 16455 or ASTM G47.

3.5 All materials supplied to this standard must comply with GMW3059, **Restricted and Reportable Substances**, including the requirement to obtain a GM-approved International Material Data System (IMDS) submission.

Table 1: Chemical Composition Limits in percent (%) by Mass for Aluminum Forging Alloys
Remainder of Alloy is Aluminum

GMW Grades	Elements percent (%) by Mass				
	Silicon	Iron	Copper	Manganese	Magnesium
GMW15657M-AL-F- Mg1SiCu(6061) ^{Note 1}	0.40 to 0.80	0.70 maximum	0.15 to 0.40	0.15 maximum	0.80 to 1.20
Si1MgMn(6082)	0.70 to 1.30	0.50 maximum	0.10 maximum	0.40 to 1.00	0.60 to 1.20
Si1MgCuMn	0.85 to 0.95	0.20 maximum	0.45 to 0.55	0.45 to 0.50	0.75 to 0.85
Si1Mg1MnCu	0.95 to 1.15	0.30 maximum	0.20 to 0.50	0.40 to 0.55	0.85 to 1.10