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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 4217G

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Superseding AMS 4217F

Submitted for recognition as an American National Standard

(R) ALUMINUM ALLOY, CASTINGS
7.0Si - 0.32Mg (356.0-T6)
Solution and Precipitation Heat Treated

UNS A03560

1. SCOPE:

1.1 Form:

This specification covers an aluminum alloy in the form of castings.

1.2 Application:

These castings have been used typically for components requiring high strength at room temperature, but usage is not limited to such applications.

2. APPLICABLE DOCUMENTS:

The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 2360	Room Temperature Tensile Properties of Castings
AMS 2694	Repair Welding of Aerospace Castings
AMS 2771	Heat Treatment of Aluminum Alloy Castings
MAM 2771	Heat Treatment of Aluminum Alloy Castings (Metric)
AMS 2804	Identification, Castings

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM B 557	Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products
ASTM B 557M	Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products (Metric)
ASTM B 660	Packaging/Packing of Aluminum and Magnesium Products
ASTM E 29	Using Significant Digits in Test Data to Determine Conformance with Specifications
ASTM E 34	Chemical Analysis of Aluminum and Aluminum-Base Alloys
ASTM E 101	Spectrographic Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique
ASTM E 227	Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique
ASTM E 607	Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique, Nitrogen Atmosphere
ASTM E 716	Sampling Aluminum and Aluminum Alloys for Spectrochemical Analysis

2.3 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-STD-453	Inspection, Radiographic
MIL-STD-2175	Casting, Classification and Inspection of
MIL-STD-6866	inspection, Liquid Penetrant

3. TECHNICAL REQUIREMENTS:

3.1 Composition:

Shall conform to the percentages by weight shown in Table 1, determined by wet chemical methods in accordance with ASTM E 34, by spectrochemical methods in accordance with ASTM E 101, ASTM E 227, or ASTM E 607, or by other analytical methods acceptable to purchaser (See 3.4.1).

TABLE 1 - Composition

Element	min	max
Silicon	6.5	7.5
Magnesium	0.20	0.45
Iron (3.1.1)	--	0.6
Manganese (3.1.1)	--	0.35
Zinc	--	0.35
Copper	--	0.25
Titanium	--	0.25
Other Impurities, each	--	0.05
Other Impurities, total	--	0.15
Aluminum	remainder	

3.1.1 If iron exceeds 0.45, manganese content shall be not less than one half the iron content.

3.1.2 Test results may be rounded in accordance with the "rounding off" method of ASTM E 29.

3.2 Condition:

Solution and precipitation heat treated.

3.3 Castings:

Castings shall be produced from metal conforming to 3.1, determined by analysis of a specimen (3.4.1) cast after the last melt addition.

3.4 Cast Test Specimens:

Chemical analysis specimens and tensile specimens shall be cast as follows:

3.4.1 Chemical Analysis Specimen: Shall be cast from each melt after the last melt addition and shall be tested to qualify the melt lot as in 3.1. Spectrochemical sample shall be prepared in accordance with ASTM E 716.

3.4.2 Tensile Specimens:

3.4.2.1 Unless specimens cut from a casting are specified by purchaser, separately-cast specimens conforming to ASTM B 557 or ASTM B 557M shall be cast from each melt after the last melt addition. Specimens shall be cast in molds representing the mold formulation used for castings. Chills are not permitted on test specimen cavity except on the end face of the specimen when approved in accordance with 4.4.2. A tensile specimen shall be processed with each heat treat lot and tested for conformance to 3.6.1.

3.4.2.2 When purchaser specifies specimens cut from a casting or from integrally-cast coupons, such specimens shall be removed after heat treatment, shall be machined to conform to ASTM B 557 or ASTM B 557M, and shall be either 0.500 inch (12.70 mm) diameter at the reduced parallel gage section, subsize specimens proportional to the standard, or standard sheet-type specimens, as required by 3.6.1.

3.5 Heat Treatment:

(R) Castings and representative tensile specimens shall be solution and precipitation heat treated in accordance with AMS 2771 or MAM 2771. Unless specimen cut from a casting or from integrally-cast coupons are specified, at least one set of separately-cast tensile specimens shall, during each stage of heat treatment, be put into a batch-type furnace with each load of castings or into a continuous furnace at intervals not longer than three hours.

3.6 Properties:

Castings and representative tensile specimens shall conform to the following requirements:

3.6.1 Tensile Properties: Shall be as follows, determined in accordance with ASTM B 557 or ASTM B 557M; conformance to the requirements of 3.6.1.1 shall be used as basis for acceptance of castings except when purchaser specifies that requirements of 3.6.1.2 apply:

3.6.1.1 Separately-Cast Specimens: Shall be as shown in Table 2.

TABLE 2 - Minimum Tensile Properties

Property	Value
Tensile Strength	30.0 ksi (207 MPa)
Yield Strength at 0.2% Offset	20.0 ksi (138 MPa)
Elongation in 4D	3.0%

3.6.1.2 Specimens Cut from a Casting or from Integrally-Cast Coupons:

3.6.1.2.1 The average of not less than four, and preferably ten, specimens shall be as shown in Table 3.

TABLE 3 - Minimum Average Tensile Properties

Property	Value
Tensile Strength	22.5 ksi (155 MPa)
Yield Strength at 0.2% Offset	15.0 ksi (103 MPa)
Elongation in 4D	0.7%

3.6.1.2.2 When properties other than those of 3.6.1.2.1 are required, tensile specimens as in 4.3.4 taken from locations indicated on the drawing, from a casting or castings chosen at random to represent the lot, shall have the properties indicated on the drawing for such specimens. Property requirements may be designated in accordance with AMS 2360.

3.7 Quality:

Castings, as received by purchaser, shall be uniform in quality and condition, sound, and free from foreign materials and from imperfections detrimental to usage of the castings.

3.7.1 When acceptance standards are not specified, Grade C of MIL-STD-2175 shall apply.

3.7.2 Methods of inspection and frequency of inspection shall be as agreed upon by purchaser and vendor. A "Casting Class" of MIL-STD-2175 may be selected to specify the method and frequency of inspection.

3.7.3 Castings shall be produced under radiographic control. This control shall consist of 100% radiographic inspection of castings until process control factors (4.4.2) have been established to ensure production of acceptable castings. Unless otherwise specified by purchaser, continued radiographic inspection of production castings shall be performed at a frequency determined by the vendor to ensure continued maintenance of internal quality.

3.7.3.1 Radiographic inspection shall be conducted in accordance with MIL-STD-453, unless otherwise specified by purchaser.

3.7.4 When specified by purchaser, castings shall be fluorescent penetrant inspected using a method specified by purchaser, or, if not specified, a method in accordance with MIL-STD-6866.

3.7.5 Castings shall not be peened, plugged, impregnated, or welded unless authorized by purchaser.

3.7.5.1 When authorized by purchaser, welding in accordance with AMS 2694 or other welding program approved by purchaser may be used.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

The vendor of castings shall supply all samples for vendor's tests and shall be responsible for the performance of all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the castings conform to specified requirements.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Except as specified in 4.2.1.1, composition (3.1), tensile properties of separately-cast specimens (3.6.1.1) or, when specified, tensile properties of specimens cut from a casting or from integrally-cast coupons (3.6.1.2.1), and quality (3.7) are acceptance tests and shall be performed to represent each melt or lot as applicable.

4.2.1.1 Tensile properties of specimens cut from a casting or from integrally-cast coupons shall be determined when specified by purchaser or when separately-cast specimens are not available. Tensile properties of separately-cast specimens need not be determined when tensile properties of specimens cut from a casting or from integrally-cast coupons are determined.

4.2.2 Periodic Tests: Radiographic inspection (3.7.3) following the establishment of process control (4.4.2) is a periodic test and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.2.3 Preproduction Tests: All technical requirements are preproduction tests and shall be performed prior to or on the first-article shipment of a casting to a purchaser when a change in material and/or processing requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.

4.2.3.1 For direct U.S. Military procurement, substantiating test data and, when requested, preproduction test material shall be submitted to the cognizant agency as directed by the procuring activity, contracting officer, or request for procurement.

4.3 Sampling and Testing:

Shall be in accordance with the following:

4.3.1 One chemical analysis specimen in accordance with 3.4.1 from each melt for conformance to 3.1.

4.3.2 Three tensile specimens in accordance with 3.4.2 from each heat treat lot.

4.3.3 One or more preproduction castings in accordance with 4.4.1 of each part number.

4.3.4 When tensile specimens cut from a casting are specified, one or more castings from each heat treat lot for determining conformance to 3.6.1.2.1. When specimen locations are not shown on the drawing, two or more specimens from the thickest section and two or more from the thinnest section shall be used.

4.3.5 When tensile specimens from integrally-cast coupons are specified, four or more tensile specimens shall be machined from each heat treat lot for determining conformance to 3.6.1.2.1.

4.4 Approval:

4.4.1 Sample castings from new or reworked patterns and the casting procedure shall be approved by purchaser before castings for production use are supplied, unless such approval be waived by purchaser.

4.4.2 Vendor shall establish, for production of sample castings of each part number, parameters for the process control factors which will produce acceptable castings; these shall constitute the approved casting procedure and shall be used for producing production castings. Vendor shall also establish a procedure for production of separately-cast tensile specimens. Method for production of separately-cast tensile specimens shall be consistent for all cast material. If necessary to make any change in parameters for the process control factors, vendor shall submit for reapproval a statement of the proposed changes in processing and, when requested, test specimens, sample castings, or both. Production castings incorporating the revised operation shall not be shipped prior to receipt of reapproval.

4.4.2.1 Control factors for producing castings and separately-cast tensile specimens include, but are not limited to, the following. Supplier's procedures shall identify tolerances, ranges, and/or control limits, as applicable. Control factors for separately-cast tensile specimens must generally represent, but need not be identical to, those factors used for castings:

Type of furnace
Furnace atmosphere
Alloy additions, fluxing, deoxidation, and gas removal procedures
Gating and risering practices
Mold composition and molding practice
Core composition and fabrication method, when applicable
Metal pouring temperature: variation of 50 °F (10 °C) from the established limit is permissible
Solidification and cooling procedures
Solution and precipitation heat treat cycles
Straightening procedure, when applicable
Cleaning operations
Methods of inspection
Radiographic inspection sampling plan, if used

4.4.2.1.1 Any of the process control factors for which parameters are considered proprietary by the vendor may be assigned a code designation. Each variation in such parameters shall be assigned a modified code designation.

4.5 Reports:

The vendor of castings shall furnish with each shipment a report showing the results of tests for chemical composition of each melt and the results of tests for tensile properties of separately-cast specimens representing each heat treat lot, or of specimens cut from a casting or from integrally-cast coupons from each heat treat lot. This report shall include the purchase order number, heat treat lot number, AMS 4217G, part number, and quantity.

4.6 Resampling and Retesting:

If any specimen used in the above tests fails to meet specified requirements, disposition of the castings may be based on the results of testing two additional specimens for each original nonconforming specimen. Failure of any retest specimen to meet specified requirements shall be cause for rejection of the castings represented. Results of all tests shall be reported.