

AEROSPACE MATERIAL SPECIFICATION

SAE AMS4212

REV. K

Issued 1940-10
Revised 2011-02

Superseding AMS4212J

Aluminum Alloy Castings
5.0Si - 1.2Cu - 0.50Mg (355.0-T6)
Solution and Precipitation Heat Treated
(Composition similar to UNS A03550)

RATIONALE

AMS4212K revises acceptance tests (4.2.1) and sampling and testing (4.3.5), and results from a Five Year Review and update of this specification.

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 and elevated temperatures, but usage is not limited to such applications.

2. APPLICABLE DOCUMENTS

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AMS2360 Room Temperature Tensile Properties of Castings

AMS2694 In-Process Welding of Castings

AMS2771 Heat Treatment of Aluminum Alloy Castings

AMS2804 Identification, Castings

AMS-STD-2175 Castings, Classification and Inspection of

AS1990 Aluminum Alloy Tempers

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<http://www.sae.org/technical/standards/AMS4212K>**

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

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 10 Brinell Hardness of Metallic Materials

ASTM E 18 Rockwell Hardness of Metallic Materials

ASTM E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

ASTM E 34 Chemical Analysis of Aluminum and Aluminum-Base Alloys

ASTM E 607 Atomic Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique, Nitrogen Atmosphere

ASTM E 716 Sampling of Aluminum and Its Alloys for Spectrochemical Analysis

ASTM E 1251 Analysis of Aluminum and Aluminum Alloys by Atomic Emission Spectrometry

ASTM E 1417 Liquid Penetrant Testing

ASTM E 1742 Radiographic Examination

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 607, ASTM E 1251, or by other analytical methods acceptable to purchaser (See 3.3.1.1).

TABLE 1 - COMPOSITION

Element	min	max
Silicon	4.5	5.5
Iron (3.1.1)	--	0.6
Copper	1.0	1.5
Manganese (3.1.1)	--	0.50
Magnesium	0.40	0.6
Chromium	--	0.25
Zinc	--	0.35
Titanium	--	0.25
Other Elements, each	--	0.05
Other Elements, total	--	0.15
Aluminum	remainder	

3.1.1 If iron content exceeds 0.45%, manganese content shall be not less than one-half of 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 to the T6 temper (See AS1990).

3.3 Cast Test Specimens

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

3.3.1.1 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.

3.3.2 Tensile Specimens

Shall be produced as follows:

3.3.2.1 Specimens Cut from a Casting and Specimens from Integrally Cast Coupons

Shall be removed after heat treatment, shall 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, standard sheet type specimens, or subsize specimens proportional to the standard.

3.3.2.2 Separately Cast Specimens

Shall conform to ASTM B 557 or ASTM B 557M and shall be cast from each melt after the last melt additions. 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. Tensile specimens shall be processed with each heat treat lot and tested for conformance to 3.5.1.

3.4 Heat Treatment

Castings and representative tensile specimens (3.3.2) shall be solution and precipitation heat treated in accordance with AMS2771 except that set temperature and soak time shall be 300 to 320 °F (149 to 160 °C) for 1 to 6 hours. Unless specimens cut from a casting or integrally-cast coupons are specified, separately-cast tensile specimens shall be put into a batch-type furnace with each load of castings or into a continuous furnace at intervals not longer than 3 hours.

3.5 Properties

Castings, integrally-cast coupons, and separately cast tensile specimens shall conform to the following requirements:

3.5.1 Tensile Properties

Shall be as follows, determined in accordance with ASTM B 557 or ASTM B 557M; conformance to the requirements of 3.5.1.1 shall be used as basis for acceptance of castings except when purchaser specifies that requirements of 3.5.1.2 or 3.5.1.3 apply:

3.5.1.1 Separately-Cast Specimens

Shall have the properties shown in Table 2.

TABLE 2 - MINIMUM TENSILE PROPERTIES

Property	Value
Tensile Strength	32.0 ksi (221 MPa)
Yield Strength at 0.2% Offset	20.0 ksi (138 MPa)
Elongation in 4D	2.0%

3.5.1.2 Specimens Cut from Castings or from Integrally-Cast Coupons

Specimens cut from castings (See 3.3.2.1) or from integrally-cast coupons, as specified, shall have the properties shown in Table 3.

TABLE 3 - MINIMUM TENSILE PROPERTIES

Property	Value
Tensile Strength	24.0 ksi (165 MPa)
Yield Strength at 0.2% Offset	15.0 ksi (103 MPa)
Elongation in 4D	0.5%

3.5.1.3 Specimens Cut from Designated Casting Areas

When specified by purchaser, specimens taken from locations indicated on the drawing, shall meet tensile property requirements specified on the drawing. Property requirements may be designated in accordance with AMS2360.

3.6 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.

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

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

3.6.3 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.

3.6.3.1 Radiographic inspection shall be conducted in accordance with ASTM E 1742, unless otherwise specified by purchaser.

3.6.4 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 ASTM E 1417.

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

3.6.5.1 When authorized by purchaser, welding in accordance with AMS2694 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

Composition (3.1), tensile properties (3.5.1) and fluorescent penetrant inspection, when specified (3.6.4) are acceptance tests and shall be performed to represent each melt or heat treat 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 (3.6.3) 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.

4.3 Sampling and Testing

Shall be in accordance with the following:

4.3.1 One chemical analysis specimen in accordance with 3.3.1 from each melt for conformance to 3.1.

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

4.3.3 Not less than two tensile specimens machined from a casting or castings (See 3.5.1.2) from each heat treat lot except when purchaser specifies use of separately cast specimens as in 4.3.3.2 or integrally cast coupons as in 4.3.3.1. If the number and locations of specimens are not shown on the drawing, not less than two specimens, one from the thickest section and one from the thinnest section, shall be cut from a casting or castings from each heat treat lot.

4.3.3.1 When permitted by purchaser, test bars integrally cast with the castings may be tested in lieu of testing specimens cut from castings. Size, number, and location of integrally cast coupons shall be as specified on the casting drawing or as agreed upon by purchaser and vendor.

4.3.3.2 One or more separately cast tensile specimen in accordance with 3.3.2.2 representing each heat treat lot, except when purchaser specifies properties of specimens machined from castings or from integrally cast coupons.

4.3.4 One or more castings from each heat treat lot when properties are required from specimens cut from a casting. For determining conformance to the requirements of 3.5.1.2, if specimen locations are not shown on the drawing, two specimens from the thickest section and two specimens from the thinnest section, shall be cut from a casting or castings from each heat treat lot.

4.3.5 When fluorescent penetrant inspection is specified (3.6.4), production castings shall be inspected at a frequency, and using acceptance criteria, defined by the purchaser.

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 control factors for producing separately cast tensile specimens, but these control factors need not be identical to those used for production of castings. 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, sample castings, test specimens, or both. Production castings incorporating the revised operations 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.

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

Melt pouring temperature

Solidification and cooling procedures

Solution heat treat and precipitation hardening cycles

Straightening procedure, when applicable

Cleaning operations

Methods of inspection

Radiographic inspection sampling plan, if used

4.4.2.1.1 Any of the above 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 composition of each melt and the results of tests for tensile properties of separately-cast specimens representing each heat treat lot, and stating that the castings conform to the other technical requirements. This report shall include the purchase order number, melt and heat treat lot numbers, AMS4212K, part number, and quantity.

4.6 Resampling and Retesting

If any specimen used in the above tests fails to meet the 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 the specified requirements shall be cause for rejection of the castings represented. Results of all tests shall be reported.