

AEROSPACE MATERIAL SPECIFICATION

SAE AMS4229

REV. E

Issued 1969-11
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Revised 2011-02

Superseding AMS4229D

Aluminum Alloy Castings, High Strength
4.5Cu - 0.70Ag - 0.30Mn - 0.25Mg - 0.25Ti (A201.0-T7)
Solution Heat Treated and Overaged
(Composition similar to UNS A02010)

RATIONALE

AMS4229E revises composition (3.1), removes the requirement that specimens be attached to castings until the completion of heat treatment (3.4.2.1, 3.5), requires property results from integral-cast coupons (3.6.1.2, 4.2.1, 4.3.4) 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 sand, permanent mold, and composite mold castings.

1.2 Application

These castings have been used typically for components requiring a combination of high strength and moderate ductility at both 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.

AMS2175	Casting, Classification and Inspection of
AMS2360	Room Temperature Tensile Properties of Castings
AMS2694	In-Process Welding of Castings
AMS2771	Heat Treatment of Aluminum Alloy Castings
AMS2804	Identification, Castings

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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 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 607	Atomic Emission Spectrometric Analysis Aluminum Alloys by the Point-to-Plane Technique, Nitrogen Atmosphere
ASTM E 716	Sampling Aluminum and Aluminum 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
ASTM G 47	Determining Susceptibility to Stress Corrosion Cracking of 2XXX and 7XXX Alloy Products

3. TECHNICAL REQUIREMENTS

3.1 Composition

Shall conform to the percentages by weight as 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 3.4.1).

TABLE 1 - COMPOSITION

Element	min	max
Silicon	--	0.05
Iron	--	0.10
Copper	4.0	5.0
Manganese	0.20	0.40
Magnesium	0.15	0.35
Titanium	0.15	0.35
Silver	0.40	1.0
Other Elements, each	--	0.03
Other Elements, total	--	0.10
Aluminum	remainder	

3.1.1 Test results may be rounded by the "rounding off" method of ASTM E 29.

3.2 Condition

Solution heat treated and overaged.

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 Specimens

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 Specimens Cut from a Casting and Integrally-Cast Coupons

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, sub-size specimens proportional to the standard, or standard sheet-type specimens, as required by 3.6.1.

3.4.2.2 Separately-Cast Specimens

Shall conform to ASTM B 557 or ASTM B 557M and shall be cast from each melt after the last melt addition. Specimens shall be cast in molds representing the mold 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.

3.5 Heat Treatment

Shall be in accordance with AMS2771, except that solution heat treating and overaging process parameters shall be selected by the heat treat facility and documented as in 4.4.2.1. Recommended heat treatment is presented in 3.5.1 and 3.5.2. When separately-cast or integral specimens are permitted, at least one set of tensile specimens shall, during each stage of heat treatment, be put into a batch-type furnace with each load of castings represented or put into a continuous furnace at intervals of not longer than 3 hours.

3.5.1 For thin-wall, rapidly-solidified castings, solution heat treat by heating to 940 to 960 °F (504 to 516 °C), holding at heat for 2 hours $\pm$ 0.25, raising temperature to 980 to 990 °F (527 to 532 °C), holding at heat for 8 hours $\pm$ 0.25, and quenching and overage by heating to 370 °F $\pm$ 10 (188 °C $\pm$ 6) and holding at heat for 5 hours $\pm$ 0.25.

3.5.2 For slowly-solidified, heavy-walled castings [e.g., sand castings having 3/4 to 2 inch (19 to 51 mm) wall], solution heat treat by heating to 900 to 920 °F (482 to 493 °C), holding at heat for 2 hours $\pm$ 0.25, raising temperature to 940 to 960 °F (504 to 516 °C), holding at heat for 2 hours $\pm$ 0.25, raising temperature to 980 to 990 °F (527 to 532 °C), holding at heat for 12 hours $\pm$ 0.25, and quenching and overage by heating to 370 °F $\pm$ 10 (188 °C $\pm$ 6) and holding at heat for 5 hours $\pm$ 0.25.

3.6 Properties

Castings with nominal wall thickness 1.0 inch (25 mm) and under and not over 50 pounds (23 kg) in overall weight and representative tensile specimens produced in accordance with 3.4.2 shall conform to the following requirements; property requirements for castings over 1.0 inch (25 mm) in nominal wall thickness or over 50 pounds (23 kg) in overall weight shall be as agreed upon by purchaser and vendor (See 8.2):

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 the requirements of 3.6.1.2 apply:

3.6.1.1 Specimens Cut From Castings

Specimens as in 4.3.3 shall have the properties shown in Tables 2 and 3.

3.6.1.1.1 Designated Casting Areas

TABLE 2 - MINIMUM TENSILE PROPERTIES

Property	Value
Tensile Strength	60.0 ksi (414 MPa)
Yield Strength at 0.2% Offset	50.0 ksi (345 MPa)
Elongation in 4D	3%

3.6.1.1.2 Casting Areas Other than Designated Areas

TABLE 3 - MINIMUM TENSILE PROPERTIES

Property	Value
Tensile Strength	56.0 ksi (386 MPa)
Yield Strength at 0.2% Offset	48.0 ksi (331 MPa)
Elongation in 4D	1.5%

3.6.1.1.3 When properties other than those of 3.6.1.1.1 or 3.6.1.1.2 are required, tensile specimens 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 AMS2360.

3.6.1.2 Separately-Cast Specimens and Integrally Cast Specimens

Specimens as in 4.3.4 shall have the properties shown in Table 4.

TABLE 4 - MINIMUM TENSILE PROPERTIES

Properties	Value
Tensile Strength	60.0 ksi (414 MPa)
Yield Strength at 0.2% Offset	50.0 ksi (345 MPa)
Elongation in 4D	3%

3.6.2 Stress-Corrosion Resistance

Specimens as in 4.3.5 shall show no evidence of stress corrosion cracking when tested for 30 days by alternate immersion in accordance with ASTM G 47 at a stress of 75% of the specified minimum yield strength.

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 AMS2175 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 AMS2175 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 (See 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 ASTM E 1742 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 ASTM E 1417.
- 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 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

Except as specified in 4.2.1.1, composition (3.1), tensile properties of specimens cut from castings (3.6.1.1) or, when specified, tensile properties of integrally-cast specimens or of separately-cast specimens (3.6.1.2), and quality (3.7) are acceptance tests and shall be performed to represent each melt or heat treat lot as applicable.

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

4.2.2 Periodic Tests

Stress-corrosion resistance (3.6.2) and radiographic inspection (3.7.3) following the establishment of process control (4.4.2) are periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.2.3 Preproduction Tests

Tests for all technical requirements are preproduction tests and shall be performed on the first-article shipment of a casting to a purchaser, when a change in materials and/ or processing requires re-approval 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 3.4.1 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 four tensile specimens machined from a casting or castings from each heat treat lot except when purchaser specifies use of separately-cast specimens as in 4.3.4. 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.
- 4.3.4 One or more separately-cast or integrally-cast tensile specimen in accordance with 3.4.2 from each heat treat lot when purchaser specifies use of separately-cast or integrally-cast specimens.
- 4.3.5 Specimens for stress-corrosion tests shall be tensile specimens (See 3.4.2) taken from the same areas of castings as for tensile tests of specimens cut from castings. Whenever practicable, specimens shall be not less than 0.250 inch (6.35 mm) diameter at the reduced gage section. If tensile specimens are not cut from castings but are separately-cast, stress-corrosion specimens may be taken from the separately-cast specimens.

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. 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 re-approval a statement of the proposed changes in processing and, when requested, test specimens, sample castings, or both. Production castings incorporating the revised operations shall not be shipped prior to receipt of re-approval.
 - 4.4.2.1 Control factors for producing tensile specimens and castings 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 (28 °C) from the established limit is permissible

Solidification and cooling procedures

Stabilization/precipitation heat treat cycle

Straightening procedure, when applicable

Cleaning operations

Methods of inspection

Radiographic inspection sampling plan, if used.