



AEROSPACE MATERIAL SPECIFICATION

AMS4229™

REV. G

Issued 1969-11
Reaffirmed 2006-04
Revised 2015-09

Superseding AMS4229F

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

AMS4229G revises heat treatment requirements (Section 3.5) as a result of a Limited Scope Ballot.

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 +1 724-776-4970 (outside USA), www.sae.org.

AMS2175	Castings, Classification and Inspection of
AMS2360	Room Temperature Tensile Properties of Castings
AMS2694	In-Process Welding of Castings

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<http://www.sae.org/technical/standards/AMS4229G>

SAE WEB ADDRESS:

AMS2771 Heat Treatment of Aluminum Alloy Castings

AMS2804 Identification Castings

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 B557	Tension Testing Wrought and Cast Aluminum- and Magnesium- Alloy Products
ASTM B557M	Tension Testing Wrought and Cast Aluminum- and Magnesium- Alloy Products (Metric)
ASTM E29	Using Significant Digits in Test Data to Determine Conformance with Specifications
ASTM E34	Chemical Analysis of Aluminum and Aluminum-Base Alloys
ASTM E607	Atomic Emission Spectrometric Analysis Aluminum Alloys by the Point-to-Plane Technique, Nitrogen Atmosphere
ASTM E716	Sampling and Sample Preparation of Aluminum and Aluminum Alloys for Determination of Chemical Composition by Spectrochemical Analysis
ASTM E1251	Analysis of Aluminum and Aluminum Alloys by Atomic Emission Spectrometry
ASTM E1417/E1417M	Liquid Penetrant Testing
ASTM E1742/E1742M	Radiographic Examination
ASTM G47	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 E34, by spectrochemical methods in accordance with ASTM E607, ASTM E1251, 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 E29.

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 E716.

3.4.2 Tensile Specimens

Unless otherwise specified, tensile specimens shall be cut from the casting for testing to determine acceptance of the castings as in 3.6.1.1. Integrally cast or separately cast specimens, as in 3.6.1.2, shall only be used when permitted by the cognizant engineering organization.

3.4.2.1 Specimens Cut from a Casting and Integrally-Cast Coupons

Shall conform to ASTM B557 or ASTM B557M 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

Separately cast specimens shall conform to ASTM B557 or ASTM B557M and shall be cast from each melt after the last melt addition for testing to determine acceptance of the castings as in 3.6.1.2. 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

Castings and representative tensile specimens shall be solution and precipitation heat treated in accordance with AMS2771, except as required by 3.5.1 and 3.5.2 to produce the properties specified by 3.6.1 and 3.6.2 (see 8.4.5 and 8.5). For specific castings, in lieu of the changes introduced by AMS4229G, it is permissible to continue using heat treating process parameters which were previously approved per 4.4. 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 Solution Heat Treatment

Unless otherwise specified in 3.5.1.1, soak at 910 °F ± 10 °F (488 °C ± 6 °C) for 2 hours ± 0.25 hour, raise temperature to 950 °F ± 10 °F (510 °C ± 6 °C) and soak for 2 hours ± 0.25 hour, raise temperature to 985 °F ± 10 °F (529 °C ± 6 °C) and soak for not less than 12 hours, and quench and age at room temperature for not less than 72 hours.

3.5.1.1 When approved by the cognizant engineering organization, soak at 950 °F ± 10 °F (510 °C ± 6 °C) for 2 hours ± 0.25 hour, raise temperature to 985 °F ± 10 °F (529 °C ± 6 °C), soak for not less than 8 hours, and quench and age at room temperature for not less than 72 hours.

3.5.2 Precipitation Heat Treatment to Overage

Soak at 370 °F ± 10 °F (188 °C ± 6 °C) for 5 hours minimum, and cool in air.

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 B557 or ASTM B557M; 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 – designated areas

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 – other areas

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, When Specified

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

Table 4 - Minimum tensile properties - specimens

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 G47 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 E1742/E1742M 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 E1417/E1417M.

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

3.7.5.1 If welding is authorized by purchaser, welding shall be performed in accordance with AMS2694 or other welding program approved by purchaser.

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 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.

4.2.2 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 cognizant engineering organization 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 or integrally cast, stress-corrosion specimens may be taken from the separately-cast specimens or integrally cast specimens, as applicable.

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 is waived by the cognizant engineering organization.
- 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. When applicable, the 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.

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.