



AEROSPACE MATERIAL SPECIFICATION

AMS4223™**REV. E**

Issued 1974-12
Reaffirmed 2007-04
Revised 2015-08

Superseding AMS4223D

Aluminum Alloy, Castings
4.5Cu - 0.70Ag - 0.30Mn - 0.25Mg - 0.25Ti (A201.0-T4)
Solution Heat Treated and Naturally Aged
(Composition similar to UNS A12010)

RATIONALE

AMS4223E revises heat treatment requirements (Section 3.5) as a result of Limited Scope Ballot.

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 moderate strength combined with good ductility and impact strength, but usage is not limited to such applications. Certain design and processing procedures (see 8.2) may cause these castings to become susceptible to stress-corrosion cracking.

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.

AMS2360 Room Temperature Tensile Properties of Castings

AMS2694 In-Process Welding of Castings

AMS2771 Heat Treatment of Aluminum Alloy Castings

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<http://www.sae.org/technical/standards/AMS4223E>**

AMS2804	Identification Castings
AMS2175	Casting, Classification and Inspection of
AS1990	Aluminum Alloy Tempers

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 B660	Packaging/Packing of Aluminum and Magnesium Products
ASTM E10	Brinell Hardness of Metallic Materials
ASTM E29	Using Significant Digits in Test Data to Determine Conformance with Specifications
ASTM E34	Chemical Analysis of Aluminum and Aluminum-Base Alloys
ASTM E101	Spectrographic Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique
ASTM E227	Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique
ASTM E607	Atomic Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique, Nitrogen Atmosphere
ASTM E716	Sampling of Aluminum and Its Alloys for Spectrochemical Analysis
ASTM E1251	Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by Argon Atmosphere, Point-to-Plane, Unipolar Self-Initiating Capacitor Discharge
ASTM E1417/E1417M	Liquid Penetrant Testing
ASTM E742/E1742M	Radiographic Examination
ASTM G44	Exposure of Metals and Alloys by Alternate Immersion in Neutral 3.5% Sodium Chloride Solution

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 E34, by spectrochemical methods in accordance with ASTM E101, ASTM E227, ASTM E607, or 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	5.00
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 in accordance with the “rounding off” method of ASTM E29.

3.2 Condition

Solution heat treated and naturally aged to the T4 temper (see AS1990).

3.3 Casting

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 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

Shall be produced as follows:

3.4.2.1 Specimens Cut from Castings

Shall be removed after heat treatment and machined to conform to ASTM B557 or ASTM B557M, 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 3.6.1.1.

3.4.2.2 Separately-Cast Specimens

Shall conform to ASTM B557 or ASTM B557M and 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.

3.5 Heat Treatment

3.5.1 Castings and representative tensile specimens shall be solution heat treated and naturally aged in accordance with AMS2771, except as required by 3.5.2 and 3.5.2.1, to produce the properties specified in 3.6.1 and 3.6.2 (see 8.5 and 8.6). For specific castings, in lieu of the changes introduced by AMS4223E, it is permissible to continue using heat treating process parameters which were previously approved as in 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.

3.5.2 Solution Heat Treatment

Unless otherwise specified in 3.5.2.1, soak at 910 °F $\pm$ 10 °F (488 °C $\pm$ 6 °C) for 2 hours $\pm$ 0.25 hour, raise temperature to 950 °F $\pm$ 10 °F (510 °C $\pm$ 6 °C) and soak for 2 hours $\pm$ 0.25 hour, raise temperature to 985 °F $\pm$ 10 °F (529 °C $\pm$ 6 °C) and soak for not less than 12 hours, and quench and age at room temperature for not less than 72 hours.

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

3.6 Properties

Castings with nominal wall thickness 1.0 inch (25 mm) and under and separately-cast tensile specimens produced in accordance with 3.4.2.2 shall conform to the following requirements. Castings with nominal wall thickness greater than 1.0 inch (25.4 mm) shall have properties as specified by the cognizant engineering organization.

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

3.6.1.1.1 Designated Casting Areas

Shall have the properties shown in Table 2.

Table 2 - Minimum tensile properties – Designated areas

Property	Value
Tensile Strength	50.0 ksi (345 MPa)
Yield Strength at 0.2% Offset	30.0 ksi (207 MPa)
Elongation in 4D	12%

3.6.1.1.2 Casting Areas Other Than Designated Areas

Shall have the properties shown in Table 3.

Table 3 - Minimum tensile properties – Other areas

Property	Value
Tensile Strength	35.0 ksi (241 MPa)
Yield Strength at 0.2% Offset	25.0 ksi (172 MPa)
Elongation in 4D	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 as in 4.3.3 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 for such specimens may be designated in accordance with AMS2360.

3.6.1.2 Separately-Cast Specimens

Shall have the properties shown in Table 4.

Table 4 - Minimum tensile properties - specimens

Property	Value
Tensile Strength	50.0 ksi (345 MPa)
Yield Strength at 0.2% Offset	30.0 ksi (207 MPa)
Elongation in 4D	12%

3.6.2 Stress-Corrosion Resistance

Specimens cut from castings, as in 4.3.5, shall show no evidence of stress-corrosion cracking, determined in accordance with ASTM G44 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 (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 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 of specimens cut from castings (3.6.1.1) or, when specified, tensile properties 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 factors (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

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 from each melt for conformance to 3.1.

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

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. If specimen locations are not shown on the drawing, not less than two specimens from the thickest section and not less than two specimens from the thinnest section, shall be cut from a casting or castings from each heat treat lot.

4.3.4 One separately-cast tensile specimen in accordance with 3.4.2 representing each lot when purchaser specifies use of separately-cast specimens, except when properties of specimens cut from castings are specified.

4.3.5 Specimens for stress-corrosion tests shall be tensile specimens 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 parallel gage section. If tensile specimens are not cut from castings but are separately cast, the stress-corrosion specimen can be taken from the separately-cast tensile specimens.

4.4 Approval

4.4.1 Sample castings from new or reworked tooling (i.e., patterns, molds, dies, etc.) 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 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, 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 material cast to this specification. If necessary to make any change in parameters for 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.