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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 4223C

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Superseding AMS 4223B

Submitted for recognition as an American National Standard

(R) ALUMINUM ALLOY, CASTINGS
4.5Cu - 0.70Ag - 0.30Mn - 0.25Mg - 0.25Ti (A201 .O-T4)
Solution Heat Treated and Naturally Aged

UNS A12010

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 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 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 10	Brinell 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 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 of Aluminum and Its Alloys for Spectrochemical Analysis
ASTM G 44	Evaluating Stress Corrosion Cracking Resistance of Metals and Alloys by Alternate Immersion in 3.5% Sodium Chloride Solution

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

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

3.2 Condition:

Solution heat treated and naturally aged.

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 E 716.

3.4.2 Tensile Specimens:

3.4.2.1 Except as specified in 3.4.2.2, specimens shall be cut from castings and 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 3.6.1.1.

3.4.2.2 When specified by purchaser, in lieu of specimens cut from castings, 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 3.6.1.2.

3.5 Heat Treatment:

No specific heat treating instructions are specified, but castings and representative tensile specimens, when required, shall be solution heat treated and naturally aged in accordance with AMS 2771 or MAM 2771 to produce the properties specified in 3.6.1, 3.6.2, and 3.6.3. Recommended heat treatment is presented in 3.5.1 and 3.5.2.

3.5.1 Thin-wall, rapidly-solidified castings should be solution heat treated by heating to 940 to 960 ºF (504 to 516 ºC), holding at heat for 2 hours ± 0.25, raising temperature to 980 to 990 ºF (527 to 532 ºC), holding at heat for 8 hours ± 0.25, and quenching and naturally aged at room temperature for not less than 72 hours.

3.5.2 Heavy-wall, slowly-solidified castings, e.g., sand castings having 3/4 to 2 inches (19 to 51 mm) wall thickness, should be solution heat treated by heating to 900 to 920 ºF (482 to 493 ºC), holding at heat for 2 hours ± 0.25, raising temperature to 980 to 990 ºF (527 to 532 ºC), holding at heat for 12 hours ± 0.25, and quenching and naturally aged at room temperature for not less than 72 hours.

3.5.3 When separately-cast tensile specimens are specified, one or more set of tensile specimens shall, during solution heat treatment, be placed into a batch-type furnace with each load of castings or into a continuous furnace at intervals of not longer than three hours.

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 separately-cast tensile specimens produced in accordance with 3.4.2.2 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 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

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

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 AMS 2360.

3.6.1.2 Separately-Cast Specimens: Shall have the properties shown in Table 4.

TABLE 4 - Minimum Tensile Properties

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 Hardness of Castings: Castings, except at sprue and riser locations, should have hardness of
(R) 80 to 1 10 HB/10/500 or 85 to 115 HB/10/1000, determined in accordance with ASTM E 10. Castings shall not be rejected on the basis of hardness if sample castings of the same or lower hardness meet the tensile property requirements of 3.6.1.1.

3.6.3 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 G 44 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 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 vendors 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: Hardness (3.6.2), stress-corrosion resistance (3.6.3), and radiographic
(R) 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.

4.2.3.1 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 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.
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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 Three separately-cast tensile specimens in accordance with 3.4.2 representing each lot when purchaser specifies use of separately-cast specimens, of which one shall be tested and the other two retained for retests if necessary.

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 patterns or molds 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. Method for production of separately-cast tensile specimens shall be consistent for all material cast to this specification. Control factors for producing separately-cast tensile specimens need not be the same as those used for production of castings. 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.

4.4.2.1 Process control factors for producing castings and,when specified, separately-cast test specimens include, but are not limited to, the following. Suppliers 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 ºF (28 ºC) from the established limit is permissible
Solidification and cooling procedures
Solution heat treat and aging 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 chemical composition of each melt and the results of tests for tensile properties of specimens cut from castings from each heat treat lot or, when specified, of separately-cast specimens representing each heat treat lot. This report shall include the purchase order number, melt and heat treat lot numbers, AMS 4223C, part number, and quantity.