SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

AMS 4225D

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Superseding AMS 4225C

Aluminum Alloy, Heat-Resistant, Castings
5.0Cu - 1.5Ni - 0.25Mn - 0.25Sb - 0.25Co - 0.20Ti - 0.20Zr (203.0-T6)
Solution Heat Treated and Precipitation Heat Treated

(Composition similar to UNS A02030)

RATIONALE

AMS 4225D 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 moderate strength and good stability up to 600 °F (316 °C) with resistance to stress-corrosion cracking, 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.

AMS 2360	Room Temperature Tensile Properties of Castings
AMS 2361	Elevated Temperature Tensile Properties of Castings
AMS 2694	Repair Welding of Aerospace Castings
AMS 2771	Heat Treatment of Aluminum Alloy Castings
AMS 2804	Identification, Castings
AMS 2175	Casting, Classification and Inspection of

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: custsvc@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

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 21	Elevated Temperature Tension Tests of Metallic Materials
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 101	Spectrographic Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique
ASTM E 139	Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials
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 Aluminum and Aluminum Alloys for Spectrochemical Analysis
ASTM E 1417	Standard Standard Practice for Liquid Penetrant Examination Document Number
ASTM E 1742	Standard Practice for Radiographic Examination

2.3 U.S. Government Publications

Available from the Document Automation and Production Service (DAPS), Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6257, http://assist.daps.dla.mil/quicksearch/.

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	4.5	5.5
Nickel	1.3	1.8
Manganese	0.20	0.30
Antimony	0.10	0.40
Cobalt	0.10	0.40
Titanium	0.15	0.25
Zirconium	0.10	0.30
Antimony + Cobalt	--	0.6
Titanium + Zirconium	--	0.50
Iron	--	0.30
Silicon	--	0.20
Zinc	--	0.10
Other Elements, each	--	0.05
Other Elements, total	--	0.30
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 precipitation heat treated.

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 Unless specimens cut from a casting are specified by purchaser, 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.

3.4.2.2 When purchaser specifies specimens cut from a casting or from integrally-cast coupons, such specimens shall be removed after heat treatment, shall be 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.

3.5 Heat Treatment

Shall be in accordance with AMS 2771 and the following: castings 1.0 inch (25 mm) and under in nominal wall thickness and 50 pounds (23 kg) and under in weight and representative tensile specimens shall be solution heat treated and stabilized as in 3.5.1 and 3.5.2. Unless specimens cut from a casting are specified, one or more sets of separately-cast tensile specimens shall, during each stage of heat treatment, be put into a batch-type furnace with each load of castings or into a continuous furnace at intervals not longer than three hours.

3.5.1 Solution Heat Treatment

Heat to 1010 °F ± 10 (543 °C ± 6), hold at heat for not less than five hours, and quench in boiling water. When permitted by purchaser, castings and tensile specimens may be quenched from the solution heat treating temperature into oil maintained at approximately 170 °F (77 °C). Cold water or other quenchant may be used when permitted by purchaser.

3.5.2 Precipitation Heat Treatment

Heat to 425 °F ± 10 (218 °C ± 6), hold at heat for not less than 16 hours, and cool in air.

3.6 Properties

Castings, 1.0 inch (25 mm) and under in nominal wall thickness and 50 pounds (23 kg) and under in weight, and representative tensile specimens produced in accordance with 3.4.2 shall conform to the following requirements:

3.6.1 Tensile Properties

3.6.1.1 At Room Temperature

Shall be as follows, determined in accordance with ASTM B 557 or ASTM B 557M; conformance to the requirements of 3.6.1.1.1 shall be used as basis for acceptance of castings except when purchaser specifies that requirements of 3.6.1.1.2 apply:

3.6.1.1.1 Separately-Cast Specimens

Shall be as shown in Table 2.

TABLE 2 - MINIMUM TENSILE PROPERTIES

Property	Value
Tensile Strength	32.0 ksi (221 MPa)
Yield Strength at 0.2% Offset	24.0 ksi (165 MPa)
Elongation in 2 inches or 4D	1.5%

3.6.1.1.2 Specimens Cut From a Casting

3.6.1.1.2.1 Designated Casting Areas

Shall be as shown in Table 3.

TABLE 3 - MINIMUM TENSILE PROPERTIES

Property	Value
Tensile Strength	32.0 ksi (221 MPa)
Yield Strength at 0.2% Offset	24.0 ksi (165 MPa)
Elongation in 2 Inches or 4D	1.5%

3.6.1.1.2.2 Areas Other Than Designated Areas or Integrally Cast

Shall be as shown in Table 4.

TABLE 4 - MINIMUM TENSILE PROPERTIES

Property	Value
Tensile Strength	26.0 ksi (179 MPa)
Yield Strength at 0.2% Offset	20.0 ksi (138 MPa)
Elongation in 2 Inches or 4D	0.5%

3.6.1.2 At 600 °F (316 °C)

Shall be as follows, determined in accordance with ASTM E 21 on specimens heated to 600 °F ± 5 (316 °C ± 3), held at heat for not less than 20 minutes before testing, and tested at 600 °F ± 5 (316 °C ± 3); conformance to the requirements of 3.6.1.2.1 shall be used as basis for acceptance of castings except when purchaser specifies that requirements of 3.6.1.2.2 apply.

3.6.1.2.1 Separately-Cast Specimens

Shall be as shown in Table 5.

TABLE 5 - MINIMUM TENSILE PROPERTIES

Property	Value
Tensile Strength	16.0 ksi (110 MPa)
Elongation in 2 Inches or 4D	4%

3.6.1.2.2 Specimens Cut From a Casting

3.6.1.2.2.1 Designated Areas

Shall be as shown in Table 6.

TABLE 6 - MINIMUM TENSILE PROPERTIES

Property	Value
Tensile Strength	16.0 ksi (110 MPa)
Elongation in 2 Inches or 4D	4%

3.6.1.2.2.2 Areas Other Than Designated Areas or Integrally Cast

Shall be as shown in Table 7.

TABLE 7 - MINIMUM TENSILE PROPERTIES

Property	Value
Tensile Strength	13.0 ksi (93 MPa)
Elongation in 2 Inches or 4D	1%

3.6.1.3 When tensile properties other than those of 3.6.1.1.2 or 3.6.1.2.2 are required, tensile specimens taken in locations indicated on the drawing, from a casting 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 and/or AMS 2361.

3.6.2 Stress-Rupture Properties at 600 °F (316 °C)

A tensile specimen, maintained at 600 °F ± 3 (316 °C ± 2) while a load sufficient to produce an initial axial stress of 11.0 ksi (76 MPa) or higher is applied continuously, shall not rupture in less than 24 hours. The test shall be continued to rupture without change of load. Elongation after rupture, measured at room temperature, shall be not less than 3% in 4D. Tests shall be conducted in accordance with ASTM E 139.

3.6.2.1 The test of 3.6.2 may be conducted using incremental loading. In such case, the load required to produce an initial axial stress of 11.0 ksi (76 MPa) or higher shall be used to rupture or for 24 hours, whichever occurs first. After the 24 hours and at intervals of 8 to 16 hours thereafter, the stress shall be increased in increments of up to 5.0 ksi (10 MPa). Time to rupture and elongation requirements shall be as specified in 3.6.2.

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 AMS 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 AMS 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 ASTM E1742, 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.

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 the purchaser, it should be done in accordance with AMS 2694 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

Except as specified in 4.2.1.1, composition (3.1), tensile properties of separately-cast specimens (3.6.1.1.1 and 3.6.1.2.1) or, when specified, tensile properties of specimens cut from a casting (3.6.1.1.2 and 3.6.1.2.2), 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 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

Stress-rupture properties (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

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 material and/or processing requires re-approval 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 in accordance with 3.4.1 from each melt for conformance to 3.1.

4.3.2 Three tensile specimens in accordance with 3.4.2 from each heat treat lot except when purchaser specifies use of specimens cut from a casting or integrally cast as in 4.3.4.

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

4.3.4 One or more castings from each heat treat lot when properties are required from specimens machined from a casting or integrally cast. For determining conformance to the requirements of 3.6.1.1.2 or 3.6.1.2.2, 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.