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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 4225B

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Superseding AMS 4225A

Submitted for recognition as an American National Standard

ALUMINUM ALLOY CASTINGS, SAND, HEAT RESISTANT
5.0Cu - 1.5Ni - 0.25Mn - 0.25Sb - 0.25Co - 0.20Ti - 0.20Zr (203.0P)
Solution Heat Treated and Stabilized

UNS A02030

1. SCOPE:

1.1 Form: This specification covers an aluminum alloy in the form of sand castings.

1.2 Application: Primarily for components requiring moderate strength and good stability up to 600°F (316°C) with resistance 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.

2.1.1 Aerospace Material Specifications:

AMS 2360 - Room Temperature Tensile Properties of Castings
AMS 2361 - Elevated Temperature Tensile Properties of Castings
AMS 2635 - Radiographic Inspection
AMS 2645 - Fluorescent Penetrant Inspection
AMS 2646 - Contrast Dye Penetrant Inspection
AMS 2694 - Repair Welding of Aerospace Castings
AMS 2771 - Heat Treatment of Aluminum Alloy Castings
AMS 2804 - Identification, Castings

2.2 ASTM Publications: Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

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 21 - Elevated Temperature Tension Tests of Metallic Materials
ASTM E 34 - Chemical Analysis of Aluminum and Aluminum Alloys
ASTM E 139 - Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials
ASTM E 155 - Reference Radiographs for Inspection of Aluminum and Magnesium Castings

3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall conform to the following percentages by weight, Ø determined by wet chemical methods in accordance with ASTM E 34, by spectrochemical methods, or by other analytical methods acceptable to purchaser:

	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 Impurities, each	--	0.05
Other Impurities, total	--	0.30
Aluminum	remainder	

3.2 Condition: Solution heat treated and stabilized. Ø

3.3 Castings: Castings shall be produced in lots from metal conforming to 3.1. Ø Metal remelted from previously analyzed ingot may be poured directly into castings. Furnace or ladle additions of grain-refining elements or alloys are permissible. Molten metal taken from alloying furnaces, with or without additions of foundry operating scrap (gates, sprues, risers, and rejected castings), shall not be poured into castings unless first converted to ingot, analyzed, and remelted or unless the composition of a sample taken after the last addition to the melt conforms to 3.1.

3.3.1 A melt shall be the metal withdrawn from a batch-furnace charge of 2000 pounds (907 kg) or less as melted for pouring castings or, when permitted by purchaser, a melt shall be 4000 pounds (1814 kg) or less of metal withdrawn from one continuous furnace in not more than eight consecutive hours.

3.3.2 Ø A lot shall be all castings poured from a single melt in not more than eight consecutive hours and heat treated in the same solution and stabilization heat treatment batch.

3.4 Ø Cast Test Specimens: Chemical analysis specimens and tensile specimens shall be cast as follows and, when requested, shall be supplied with the castings:

3.4.1 Chemical Analysis Specimens: Shall be cast from each melt and shall be of any convenient size, shape, and form.

3.4.2 Tensile Specimens: Shall be cast with each lot of castings, shall be of standard proportions conforming to ASTM B 557 or ASTM B 557M with 0.500 inch (12.70 mm) diameter at the reduced parallel gage section and shall be cast to size in molds made with the regular foundry mix of sand, without using chills. Metal for the specimens shall be part of the melt which is used for the castings. If the metal for castings is given any treatment, such as fluxing or cooling and reheating, the metal for the specimens shall be a portion of the metal so treated and during such treatment, shall be heated to the same maximum temperature and held for approximately the same time as the molten metal for the castings. The temperature of the metal during pouring of the specimens shall be not lower than that during pouring of the castings.

3.5 Ø 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; solution and stabilization heat treatments for castings over 1.0 inch (25 mm) in nominal wall thickness or weighing over 50 pounds (23 kg) shall be as agreed upon by purchaser and vendor. 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 or into a continuous furnace at intervals of not longer than three hours.

3.5.1 Ø Solution Heat Treatment: Heat to 1010°F ± 10 (543°C ± 6), hold at heat for not less than 5 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 as permitted by purchaser.

3.5.2 Stabilization 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; properties of castings over 1.0 inch (25 mm) in nominal wall thickness or over 50 pounds (23 kg) in weight shall be as agreed upon by purchaser and vendor:

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 the requirements of 3.6.1.1.2 apply:

3.6.1.1.1 Separately-Cast Specimens:

Tensile Strength, minimum	32.0 ksi (221 MPa)
Yield Strength at 0.2% Offset, minimum	24.0 ksi (165 MPa)
Elongation in 4D, minimum	1.5%

3.6.1.1.2 Specimens Cut From Castings:

3.6.1.1.2.1 Designated Casting Areas:

Tensile Strength, minimum	32.0 ksi (221 MPa)
Yield Strength at 0.2% Offset, minimum	24.0 ksi (165 MPa)
Elongation in 4D, minimum	1.5%

3.6.1.1.2.2 Areas Other Than Designated Areas:

Tensile Strength, minimum	26.0 ksi (179 MPa)
Yield Strength at 0.2% Offset, minimum	20.0 ksi (138 MPa)
Elongation in 4D, minimum	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 20 - 30 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 the requirements of 3.6.1.2.2 apply.

3.6.1.2.1 Separately-Cast Specimens:

Tensile Strength, minimum	16.0 ksi (110 MPa)
Elongation in 4D, minimum	4%

3.6.1.2.2 Specimens Cut From Castings:

3.6.1.2.2.1 Designated Areas:

Tensile Strength, minimum	16.0 ksi (110 MPa)
Elongation in 4D, minimum	4%

3.6.1.2.2.2 Areas Other Than Designated Areas:

Tensile Strength, minimum	13.0 ksi (93 MPa)
Elongation in 4D, minimum	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 Hardness of Castings: Castings, except at gate and riser locations, should have hardness not lower than 70 HB/10/500 or 75 HB/10/1000, determined in accordance with ASTM E 10, but castings shall not be rejected on the basis of hardness if the tensile property requirements of 3.6.1.1.2 are met.

3.6.3 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) 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.

3.6.3.1 The test of 3.6.3 may be conducted using a load higher than required to produce an initial axial stress of 11.0 ksi (76 MPa) but load shall not be changed while test is in progress. Time to rupture and elongation requirements shall be as specified in 3.6.3.

3.6.3.2 When permitted by purchaser, the test of 3.6.3 may be conducted using incremental loading. In such case, the load required to produce an initial axial stress of 11.0 ksi (76 MPa) shall be used to rupture or for 24 hours, whichever occurs first. After the 24 hours and at intervals of 8 - 16 hours, preferably 8 - 10 hours, thereafter, the stress shall be increased in increments of 1.5 ksi (10 MPa). Time to rupture and elongation requirements shall be as specified in 3.6.3.

3.7 Quality:

3.7.1 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.

3.7.1.1 Castings shall have smooth surfaces and shall be well cleaned.

3.7.2 Castings shall be produced under radiographic control. This control shall consist of radiographic examination of castings in accordance with AMS 2635 until proper foundry technique, which will produce castings free from harmful internal imperfections, is established for each part number and of production castings as necessary to ensure maintenance of satisfactory quality.

3.7.3 When specified, castings shall be subjected to fluorescent penetrant Ø inspection in accordance with AMS 2645, to contrast dye penetrant inspection in accordance with AMS 2646, or to both.

3.7.4 Radiographic, fluorescent penetrant, contrast dye penetrant, and other quality standards shall be as agreed upon by purchaser and vendor. ASTM E 155 may be used to define radiographic acceptance standards.

3.7.5 Castings shall not be repaired by peening, plugging, welding, or other methods without written permission of purchaser.

3.7.5.1 When permitted in writing by purchaser, defects in castings may be removed and the castings reworked by welding in accordance with AMS 2694.

3.7.6 Castings shall not be impregnated, chemically treated, or coated to prevent leakage unless specified or allowed by written permission of purchaser, designating the method to be used.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of castings shall supply all Ø samples for vendor's tests and shall be responsible for performing all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the castings conform to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Except as specified in 4.2.1.1, tests for 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 castings (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 lot as applicable.

4.2.1.1 Tensile properties of specimens cut from castings shall be determined Ø only 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 castings are determined.

4.2.2 Periodic Tests: Tests for hardness (3.6.2) and stress-rupture properties (3.6.3) 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 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 At least one chemical analysis specimen in accordance with 3.4.1 from each melt, a casting from each lot, or both.

4.3.2 Three tensile specimens in accordance with 3.4.2 from each lot except when purchaser specifies use of specimens cut from castings as in 4.3.4.

4.3.3 Two preproduction castings in accordance with 4.4.1 of each part number.

4.3.4 One or more castings from each lot when properties are required from specimens machined from castings. Specimens 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, subsize specimens proportional to the standard, or standard sheet-type specimens. 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, not less than four tensile specimens, two from the thickest section and two from the thinnest section, shall be cut from a casting or castings from each lot.

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. If necessary to make any change in parameters for the process control factors, vendor shall submit for reapproval 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 reapproval.