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400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

AMS 4229C

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Superseding AMS 4229B

ALUMINUM ALLOY CASTINGS, HIGH STRENGTH
4.5Cu - 0.70Ag - 0.30Mn - 0.25Mg - 0.25Ti (A201.0-T7)
Solution Heat Treated and Overaged

UNS A02010

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: Primarily for components requiring a combination of high strength and moderate ductility at both room and elevated temperatures.

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 Specification:

AMS 2360 - Room 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 2750 - Pyrometry
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 34 - Chemical Analysis of Aluminum and Aluminum Alloys
ASTM E 155 - Reference Radiographs for Inspection of Aluminum and Magnesium Castings
ASTM G 44 - Alternate Immersion Stress Corrosion Testing in 3.5% Sodium Chloride Solution

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	4.0	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	

3.2 Condition: Solution heat treated and overaged.

3.3 Casting: Castings shall be produced in lots from metal conforming to 3.1. 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. The type of mold for castings is not restricted.

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

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

3.4.1 Chemical Analysis Specimens: Shall be cast from each melt and shall be of any suitable size and shape. Ø

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 representative of the practice used for castings. 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 Heat Treatment: No specific heat treating instructions are specified but castings and representative tensile specimens, when required, shall be solution heat treated and overaged 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. 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. Pyrometry shall be in accordance with AMS 2750. Ø

3.5.1 For thin-wall, rapidly-solidified castings, solution heat treat by heating to 940° - 960°F (504° - 516°C), holding at heat for 2 hours ± 0.25, raising temperature to 980° - 990°F (527° - 532°C), holding at heat for 8 hours ± 0.25, and quenching and overage by heating to 370°F ± 10 (188°C ± 6) and holding at heat for 5 hours ± 0.25.

3.5.2 For slowly-solidified, heavy-walled castings [e.g., sand castings having 3/4 - 2 inch (19 - 51 mm) wall], solution heat treat by heating to 900° - 920°F (482° - 493°C), holding at heat for 2 hours ± 0.25, raising temperature to 940° - 960°F (504° - 516°C), holding at heat for 2 hours ± 0.25, raising temperature to 980° - 990°F (527° - 532°C), holding at heat for 12 hours ± 0.25, and quenching and overage by heating to 370°F ± 10 (188°C ± 6) and holding at heat for 5 hours ± 0.25.

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 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:

Tensile Strength, minimum	60,000 psi (414 MPa)
Yield Strength at 0.2% Offset, minimum	50,000 psi (345 MPa)
Elongation in 4D, minimum	3%

3.6.1.1.2 Casting Areas Other than Designated Areas:

Tensile Strength, minimum	56,000 psi (386 MPa)
Yield Strength at 0.2% Offset, minimum	48,000 psi (331 MPa)
Elongation in 4D, minimum	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 AMS 2360.

3.6.1.2 Separately-Cast Specimens:

Tensile Strength, minimum	60,000 psi (414 MPa)
Yield Strength at 0.2% Offset, minimum	50,000 psi (345 MPa)
Elongation in 4D, minimum	3%

3.6.2 Hardness of Castings: Castings, except at sprue and riser locations, should have hardness of 110 - 145 HB/10/500 or 115 - 150 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 3.6.1.1.1 are met.

3.6.3 Stress-Corrosion Resistance: Specimens as in 4.3.5 shall show no evidence of stress-corrosion cracking when tested by alternate immersion in accordance with ASTM G 44 at a stress of 75% of the specified minimum yield strength.

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 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 reworked by peening, plugging, welding, or other methods without written permission from purchaser.

3.7.5.1 Ø When permitted in writing by purchaser, imperfections in castings may be 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 samples for vendor's tests and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.5. 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: Tests for 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), hardness (3.6.2), and quality (3.7) are acceptance tests and shall be performed to represent each melt or lot of castings as applicable.

4.2.1.1 Ø Tensile properties of separately-cast specimens shall be determined only when specified by purchaser or when not feasible to obtain specimens cut from castings. Tensile properties of specimens cut from castings need not be determined when tensile properties of separately-cast specimens are determined.

4.2.2 Periodic Tests: Tests for stress-corrosion resistance (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 Ø preproduction tests and shall be performed prior to or on the first-article shipment of a casting to a purchaser, when a change in ingredients and/or processing requires reapproval as in 4.4, 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; the number Ø of specimens to be sampled shall be the minimum number of specimens tested:

4.3.1 At least one chemical analysis specimen in accordance with 3.4.1 from each Ø melt, a casting from each lot, or both.

4.3.2 Two 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 lot except when purchaser specifies use of separately-cast specimens. 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. If specimen locations are not shown on the drawing, not less than four specimens, two from the thickest section and two from the thinnest section, shall be cut from a casting or castings from each lot.

4.3.4 Three tensile specimens in accordance with 3.4.2 from each lot when purchaser specifies use of separately-cast specimens.

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 gage section. If tensile specimens are not cut from castings but are separately-cast, stress-corrosion specimens may be taken from the separately-cast 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 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, sample castings, test specimens, or both. Production castings incorporating the revised operations shall not be shipped prior to receipt of reapproval.