



400 Commonwealth Dr., Warrendale, PA 15096

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

AMS 4242

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ALUMINUM ALLOY CASTINGS, SAND COMPOSITE
4.7Cu - 0.60Ag - 0.35Mn - 0.25Mg - 0.25Ti (B201.0-T7)
Solution Heat Treated and Overaged
Aircraft Structural Quality

UNS A02010

1. SCOPE:

- 1.1 Form: This specification covers an aluminum alloy in the form of sand composite molded castings.
- 1.2 Application: Primarily for structural aircraft components.
- 1.3 Alloy B201.0 has restricted composition within the limits of alloy A201.0.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

- 2.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods
AMS 2360 - Room Temperature Tensile Properties of Castings
AMS 2804 - Identification, Castings

- 2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM B557 - Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products
ASTM E18 - Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials
ASTM E34 - Chemical Analysis of Aluminum and Aluminum Alloys

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2.2 (Continued):

ASTM E155 - Reference Radiographs for Inspection of Aluminum and Magnesium Castings

ASTM G44 - Alternate Immersion Stress Corrosion Testing in 3.5% Sodium Chloride Solution

2.3 U.S. Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.3.1 Military Specifications:

MIL-H-6088 - Heat Treatment of Aluminum Alloys

MIL-I-6866 - Inspection, Penetrant Method of

MIL-I-25135 - Inspection Materials, Penetrant

2.3.2 Military Standards:

MIL-STD-410 - Nondestructive Testing Personnel Qualification and Certification (Eddy Current, Liquid Penetrant, Magnetic Particle, Radiographic and Ultrasonic)

MIL-STD-453 - Inspection, Radiographic

MIL-STD-649 - Aluminum and Magnesium Products, Preparation for Shipment and Storage

MIL-STD-1537 - Electrical Conductivity Test for Measurement of Heat Treatment of Aluminum Alloys, Eddy Current Method

2.4 AIA Publications: Available from National Standards Association, Inc., 1321 14th Street, N.W., Washington, DC 20005.

NAS 823 - Cast Surface Comparison Standard

3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall conform to the following percentages by weight, determined by wet chemical methods in accordance with ASTM E34 or by spectrographic or other analytical methods approved by purchaser:

	min	max
Copper	4.5	5.0
Silver	0.40	0.8
Manganese	0.20	0.50
Magnesium	0.20	0.30
Titanium	0.15	0.35
Iron	--	0.05
Silicon	--	0.05
Other Impurities, each	--	0.05
Other Impurities, total	--	0.15
Aluminum	remainder	

3.2 Condition: Solution and precipitation heat treated (overaged).

3.3 Casting: Castings shall be produced from metal conforming to 3.1.

3.3.1 A melt shall be a single homogenous batch of molten metal on which all processing has been completed and the temperature has been adjusted ready for pouring castings.

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

3.4 Test Specimens:

3.4.1 Chemical Analysis Specimens: Shall be cast from each melt.

3.4.2 Integrally-Attached Coupons: Each casting shall have at least two integrally-attached coupons. One coupon shall be left attached and used only in the event that reheat treatment is necessary.

3.5 Heat Treatment: Castings and integrally-attached test coupons shall be solution and precipitation heat treated in accordance with MIL-H-6088 except as specified in 3.5.1 and 3.5.2.

3.5.1 All castings and integrally-attached coupons shall be solution heat treated and overaged in such a manner as to ensure conformance to the requirements of 3.6. A step solution treatment of 945° - 965°F (505° - 520°C) for not less than 2 hr then raised to 970° - 990°F (520° - 530°C) for not less than 14 hr is recommended. Precipitation heat treatment at 365° - 375°F (185° - 190°C) for not less than 5 hr is required.

3.5.2 The integrally-attached coupons shall remain attached to the casting until removed by a test facility approved by purchaser.

3.6 Properties: Castings and integrally-attached test coupons shall conform to the following requirements:

3.6.1 Tensile Properties: Shall be as follows, determined in accordance with ASTM B557 and shall be used as basis for acceptance of castings:

3.6.1.1 Integrally-Attached Coupons:

Tensile Strength, min	62,000 psi (425 MPa)
Yield Strength at 0.2% Offset, min	55,000 psi (380 MPa)
Elongation in 4D, min	5%

3.6.1.2 Specimens Cut from Castings: Tensile properties of specimens cut from a casting or castings shall be as follows:

3.6.1.2.1 Designated Casting Areas:

Tensile Strength, min	60,000 psi (415 MPa)
Yield Strength at 0.2% Offset, min	50,000 psi (345 MPa)
Elongation in 4D, min (See 3.6.1.2.4)	3%

3.6.1.2.2 Casting Areas Other Than Designated Areas:

Tensile Strength, min	56,000 psi (385 MPa)
Yield Strength at 0.2% Offset, min	48,000 psi (330 MPa)
Elongation in 4D, min (See 3.6.1.2.4)	2%

3.6.1.2.3 When properties other than those of 3.6.1.2.1 or 3.6.1.2.2 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.

3.6.1.2.4 Excised specimens shall be proportional to the standard round or sheet type specimens defined in ASTM B557. For sheet type specimens, elongation shall be measured based on 4.5 cross-sectional area.

3.6.2 Hardness of Castings: Should be not lower than 70 HRB, determined in accordance with ASTM E18, but castings shall not be rejected on the basis of hardness if the tensile property requirements of 3.6.1.2 are met.

3.6.3 Electrical Conductivity: Casting shall exhibit a minimum electrical conductivity of 31% IACS (International Annealed Copper Standard) (18 MS/m), determined by the procedure of MIL-STD-1537.

3.6.4 Stress-Corrosion Resistance: A specimen as in 4.3.5, cut from the designated area of the casting or from an attached coupon shall show no evidence of stress-corrosion cracking when tested for 30 days in accordance with ASTM G44 at a stress of 37,500 psi (260 MPa).

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 a surface finish in accordance with engineering drawing and NAS 823 and shall be well cleaned.

3.7.2 Castings shall be produced under foundry control. This control shall consist of preproduction examination of castings until proper foundry technique and controls are established which will produce castings that will meet the drawing quality and dimensional requirements.

3.7.3 Radiographic inspection of each casting shall be performed in accordance with MIL-STD-453. In addition, Type I radiographic film shall be used, and a maximum unsharpness value of 0.003 in. (0.08 mm) and flaw sensitivity of 1% shall be maintained. ASTM E155 shall be used to define radiographic acceptance standards in accordance with Table I.

3.7.4 Each casting shall be subjected to fluorescent penetrant inspection in accordance with MIL-I-6866.

- 3.7.4.1 The fluorescent penetrant shall have a sensitivity level equivalent to group V of MIL-I-25135.
- 3.7.4.2 Personnel conducting the testing shall be qualified and certified in accordance with MIL-STD-410.
- 3.7.4.3 Linear indications, cold shuts, cracks, and seams are not acceptable.
- 3.7.4.4 Surface porosity is not acceptable if the individual pores are closer than twice their maximum dimension to an edge or extremity of the casting or the pores form a linear indication; i.e., three or more are in a line and the distance between each indication is less than twice the maximum dimension of either adjacent indication.
- 3.7.4.5 Any individual indication which is five times longer than it is wide shall be considered a linear indication and is not acceptable.
- 3.7.5 Castings shall not be repaired by peening, plugging, welding, or other methods except as defined in 3.7.5.1.
- 3.7.5.1 Defects in non-critical areas of the casting may be removed and the castings repaired by welding in accordance with AMS 2694. The vendor's weld procedures shall have prior approval by purchaser.
- 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 be responsible for obtaining all required tests at purchaser's approved facilities. Removal and testing of tensile specimens from castings in accordance with 3.6.1.2 shall be performed at a facility that is approved by purchaser and foundry and independent of the foundry. 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 to determine conformance to requirements for composition (3.1), tensile properties of integrally-attached coupons (3.6.1.1), tensile properties of specimens cut from castings (3.6.1.2), electrical conductivity (3.6.3), and quality (3.7) are classified as acceptance tests and shall be performed on each casting, melt, or lot as applicable.
 - 4.2.2 Periodic Tests: Tests to determine conformance to requirements for hardness (3.6.2) and stress-corrosion resistance (3.6.4) are classified as 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 to determine conformance to all technical requirements of this specification are classified as 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, processing, or both 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, the contracting officer, or the request for procurement.

4.3 Sampling: Shall be in accordance with the following:

4.3.1 For Acceptance Tests:

4.3.1.1 One chemical analysis specimen in accordance with 3.4.1 from each melt.

4.3.1.2 The destructive testing of castings for the evaluation of excised tensile specimen shall occur at the following frequency:

4.3.1.2.1 First 30 Castings Received: One casting from each 10 production castings shall be selected for destructive testing in accordance with the requirements of 3.6.1.2.

4.3.1.2.2 Castings Received Thereafter: If no failure occurs in 4.3.1.2.1, one casting from each 25 production castings consecutively received thereafter. If a failure occurs, the test frequency reverts to one from each 10 production castings from the next 30 castings received.

4.3.1.2.3 Excised tensile specimens shall be either subsize specimens proportional to the standard round or standard sheet type specimens defined in ASTM B557.

4.3.1.3 An integrally-attached coupon from each casting for tensile testing.

4.3.1.4 Each casting for radiographic and fluorescent penetrant inspection.

4.3.1.5 An integrally-attached coupon from each casting for electrical conductivity testing.

4.3.2 For Periodic Tests and Preproduction Tests: As agreed upon by purchaser and vendor and the following:

4.3.2.1 Specimens for stress-corrosion tests shall be round specimens, not less than 0.250 in. (6.25 mm) in diameter in the reduced section. Whenever practicable, specimens shall be taken from the designated areas of the casting as shown on the engineering drawing. Specimens from integrally-attached coupons are acceptable if size of the casting does not permit excision of a 0.250 in. (6.25 mm) diameter specimen.

4.4 Approval:

4.4.1 Sample castings from new or reworked patterns shall be approved by purchaser before castings for production use are supplied, unless such approval be waived by purchaser.

4.4.1.1 Two preproduction castings of each part number shall be furnished to the purchaser. One casting shall have been dimensionally inspected by the vendor and the results shall be forwarded with the casting for approval. The second casting shall be for metallurgical evaluation. All vendor test results obtained to substantiate the metallurgical quality of the casting shall be included.

4.4.2 Vendor shall document the 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 material, processing, or both and, when requested, integrally-attached coupons, sample castings, or both. Production castings incorporating the revised operations shall not be shipped prior to receipt of written reapproval.

4.4.2.1 Control factors for producing castings include, but are not limited to, the following:

4.4.2.1.1 Melting practice regarding control of:

- Chemistry
- Gas content
- Grain size
- Melt temperature

4.4.2.1.2 Molding procedure regarding:

- Materials and assembly
- Gating and risering systems

4.4.2.1.3 Heat treatment practice regarding:

- Temperature and time parameters
- Load density
- Quenching procedure

4.4.2.1.4 Shop traveler describing the sequence of processing, inspection, and testing.

4.4.2.1.5 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:

- 4.5.1 The vendor of castings shall furnish with each shipment a report showing the results of tests for chemical composition of each melt, tensile properties of attached specimens representing each casting and of specimens cut from casting, if applicable, and penetrant and radiographic inspection of each casting by serial number. This report shall include the purchase order number, AMS 4242, lot number, part number, and quantity.
- 4.5.2 The vendor of finished or semi-finished parts shall furnish with each shipment a report showing the purchase order number, AMS 4242, contractor or other direct supplier of castings, part number, and quantity. When castings for making parts are produced or purchased by the parts vendor, that vendor shall inspect each lot of castings to determine conformance to the requirements of this specification and shall include in the report either a statement that the castings conform or copies of laboratory reports showing the results of tests to determine conformance.

4.6 Resampling and Retesting:

4.6.1 Attached Coupons:

- 4.6.1.1 Retesting of the integrally-attached coupon is permitted when an isolated flaw is evident on the fracture face of the broken tensile specimen.
- 4.6.1.2 Testing is required of an integrally-attached coupon after reheat treatment. The replacement specimen shall be taken from the second coupon which has remained integrally attached to the casting through the reheat treat process.

4.6.2 Tensile Specimens Excised From Castings:

- 4.6.2.1 Replacement of tensile specimens shall be allowed in accordance with ASTM B557 for poor machining, incorrect test procedure, malfunction of test equipment, or fracture location.
- 4.6.2.2 Retesting of a tensile specimen excised from the castings is permitted only when the fracture face indicates an isolated gas hole or piece of foreign material. Retesting shall be permitted by testing two adjacent specimens. Should it not be possible to obtain adjacent specimens, or if a replacement specimen also fails, two additional castings shall be tested. Failure of a tensile specimen in a second casting shall be cause to consider the lot of castings suspect and the purchaser contacted for material review action. All castings shipped and in process since the last acceptable tensile test of a casting shall be reviewed for disposition.
- 4.6.2.3 All retest tensile specimens shall be located to represent as nearly as possible the quality of the metal of the original test. Isolated flaws that are discernable by production radiography may be avoided.