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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 4241A

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Superseding AMS 4241

Aluminum Alloy Castings
7.0Si - 0.58Mg - 0.15Ti - 0.06Be (D357.0-T6)
Solution and Precipitation Heat Treated
Dendrite Arm Spacing (DAS) Controlled

UNS A43570

1. SCOPE:

1.1 Form:

This specification covers an aluminum alloy in the form of castings.

1.2 Application:

Primarily for structural aircraft components (See 8.3) requiring DAS quality control.

1.3 Safety - Hazardous Materials:

While the materials, methods, applications, and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards which may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

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 2804	Identification, Castings

QUESTIONS REGARDING THIS DOCUMENT: (724) 772-7161 FAX: (724) 776-0243
TO PLACE A DOCUMENT ORDER: (724) 776-4970 FAX: (724) 776-0790
SAE WEB ADDRESS: http://www.sae.org

2.1 (Continued):

AMS 4246	Aluminum Alloy Welding Wire, 7.0Si - 0.52Mg
ARP1947	Dendrite Arm Spacing of Structural Aircraft Quality D357 Aluminum Alloy Castings, Determination and Acceptance of

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

2.3 U.S. Government Publications:

Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-H-6088	Heat Treatment of Aluminum Alloys
MIL-STD-453	Inspection, Radiographic
MIL-STD-6866	Inspection, Liquid Penetrant

2.4 AIA Publications:

Available from National Standard 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 percentages by weight shown in Table 1, determined by wet chemical methods in accordance with ASTM E 34, by spectrochemical methods, or by other analytical methods acceptable to purchaser.

TABLE 1 - Composition

Element	min	max
Silicon	6.5	7.5
Manganese	0.55	0.6
Titanium	0.10	0.20
Beryllium	0.04	0.07
Iron	--	0.12
Manganese	--	0.10
Other Impurities, each	--	0.05
Other Impurities, total	--	0.15
Aluminum	remainder	

3.2 Condition:

Solution and precipitation heat treated to T6 condition.

3.3 Casting:

Castings shall be produced from metal conforming to 3.1.

3.3.1 A melt shall be a single homogeneous 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: At least two coupons shall be integrally-attached to each casting. The two coupons shall represent a variation of size of dendrite arm spacing (DAS). The chilled coupon exhibiting a small DAS shall be identified as coupon "A"; the unchilled coupon of large DAS shall be identified as coupon "B". These coupons shall be tested for tensile property determination specified in 3.6.1 and microstructure evaluation specified in 3.6.3. Additional coupons may be added for retest and for foundry purposes at the option of the foundry.

3.4.2.1 Location and size of integrally-attached coupons are optional with the following exceptions:

3.4.2.1.1 The coupons shall be flat and at least large enough to permit excision of a sub-size round tensile specimen of 0.250 inch (6.35 mm) diameter conforming to ASTM B 557 or ASTM B 557M with a gage length of 1 inch (25 mm).

3.4.2.1.2 The coupons shall be located in such a manner as to avoid any interference with inspection tooling.

3.4.2.2 The two coupons shall be produced with varying solidification rates to develop a minimum DAS size difference of 0.0010 inch (0.025 mm) within a tensile strength range of 47.0 to 57.0 ksi (324 to 393 MPa).

3.4.2.3 The radiographic quality of the coupons shall meet the requirements for designated areas of Table 2.

3.4.2.4 Removal and testing of integrally-attached coupons for casting acceptance shall be performed by a testing facility acceptable to purchaser.

3.4.2.5 A linear plot shall be made from ultimate tensile strength results of coupons A and B relative to DAS. This will give the needed DAS to meet the tensile requirements of 3.6.1.

3.5 Heat Treatment:

Castings and integrally-attached 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 The solution heat treat temperature shall be 1010 °F ± 10 (543 °C ± 6).

3.5.2 The quenching and precipitation heat treating procedure shall be established to develop the required casting properties.

3.6 Properties:

Castings and integrally-attached chilled coupon "A" 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 and properties in either 3.6.1.1 or 3.6.1.2 shall be used as basis for acceptance of castings:

3.6.1.1 Integrally-Attached Chilled Coupon "A": For heat treat control, tensile properties shall be as shown in Table 2.

TABLE 2 - Tensile Properties

Property	Value
Tensile Strength, minimum	51.0 ksi (352 MPa)
Yield Strength at 0.2% Offset	42.0 to 47.0 ksi (290 to 324 MPa)

3.6.1.2 Specimens Cut from Castings: Tensile properties of specimens cut from a casting or castings shall be as shown in Table 3 or Table 4:

3.6.1.2.1 Designated Casting Areas:

TABLE 3 - Minimum Tensile Properties

Property	Value
Tensile Strength	50.0 ksi (345 MPa)
Yield Strength at 0.2% Offset	40.0 ksi (276 MPa)
Elongation in 4D (See 3.6.1.2.4)	3%

3.6.1.2.2 Casting Areas Other Than Designated Areas:

TABLE 4 - Minimum Tensile Properties

Property	Value
Tensile Strength	45.0 ksi (310 MPa)
Yield Strength at 0.2% Offset	36.0 ksi (248 MPa)
Elongation in 4D (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 subsize and proportional to the standard round or sheet-type specimens defined in ASTM B 557 or ASTM B 557M. For sheet-type specimens, elongation shall be measured based on a gage length of 4.5 times cross-sectional area.

3.6.2 Hardness of Castings: Should be not lower than 90 HB/10/500, determined in accordance with ASTM E 10. 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 Microstructure: The microstructure of the casting surface in purchaser designated areas of the casting shall not exceed the maximum size coarseness, determined in accordance with ARP1947 and results from tests of coupons A and B. Castings which exhibit an unacceptable microstructure shall be held for disposition by purchaser's cognizant engineering personnel. Castings shall not be rejected, however, if the requirements of 3.6.1.2 are met.

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 the engineering drawing and NAS 823 and shall be well cleaned. NAS 823 may be used to specify surface finish acceptance criteria.

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 shall be performed on each casting in accordance with MIL-STD-453. Type 1 radiographic film shall be used, and a maximum unsharpness value of 0.003 inch (0.08 mm) and equivalent penetrameter sensitivity of 1% shall be maintained. ASTM E 155 shall be used to define radiographic acceptance standards in accordance with Table 5.

TABLE 5 - Radiographic Requirements

Defect Indications	Radiograph Reference	Designated Areas	Other Areas
Gas holes	1.1	1	2
Gas porosity (round)	1.21	1	3
Gas porosity (elongated)	1.22	1	3
Shrinkage cavity	2.1	1	2
Shrinkage porosity or sponge	2.2	1	2
Foreign material (less dense)	3.11	1	2
Foreign material (more dense)	3.12	1	2
Segregation	···	none	none
Cracks	···	none	none
Cold shuts	···	none	none
Laps	···	none	none
Maximum acceptance defects in aluminum alloy castings (maximum permissible radiograph in accordance with ASTM E 155)			

3.7.3.1 When two or more types of defects are present to an extent equal to or not significantly better than the acceptance standards for respective defects, the parts shall be rejected.

3.7.3.2 When two or more types of defects are present and the predominating defect is not better than the acceptance standard, the part shall be reviewed for disposition by the cognizant engineering personnel.

3.7.3.3 Gas holes or sand spots and inclusions allowed by Table 5 shall be cause for rejection when closer than twice their maximum dimension to an edge or extremity of a casting.

3.7.4 Each casting shall be subjected to fluorescent penetrant inspection in accordance with MIL-STD-6866, sensitivity Level 2.

3.7.4.1 Linear indications, cold shuts, cracks, and seams are not acceptable.

3.7.4.2 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 any two indications is less than twice the maximum dimension of either adjacent indication.

3.7.4.3 Any individual indication which is three times longer than it is wide shall be considered a linear indication and is not acceptable.

3.7.5 Castings shall not be reworked by peening, plugging, welding, impregnation or other methods, except as specified in 3.7.5.1.

3.7.5.1 Defects in non-critical areas of the casting may be removed and the castings reworked by welding in accordance with AMS 2694, using AMS 4246 alloy filler metal. The vendor's weld procedures shall have prior approval by purchaser.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

The vendor of castings shall be responsible for coordinating all acceptance testing of production castings at facilities acceptable to purchaser. Tensile testing of specimens excised periodically from castings and DAS determinations, when required, shall be performed at a testing facility acceptable to purchaser. 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 integrally-attached coupons (3.6.1.1), tensile properties of specimens cut from castings (3.6.1.2), and quality (3.7) are acceptance tests and shall be performed on each casting, melt, or lot as applicable under 4.3.

4.2.2 Periodic Tests: Tests for hardness (3.6.2) and microstructure (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 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 For Acceptance Tests:

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

4.3.1.2 Destructive testing of castings for evaluation of excised test specimens 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.

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.

4.3.1.3 Determine tensile properties of one integrally-attached coupon required by 3.6.1.1 from each casting.

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

4.3.2.1 When required, specific test locations on the casting and frequency of evaluating castings for surface microstructure shall be defined by purchaser at time of preproduction approval.

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 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 supplied to purchaser 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 process control factors, vendor shall submit for reapproval a statement of the proposed changes in material and/or processing, and, when requested, integrally-attached coupons and/or sample castings. 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:

Melting practice regarding control of:

Chemistry
Gas content
Melt temperature
Grain size

Molding procedure regarding:

Materials and assembly
Gating and risering systems
Solidification rate in designated areas

Heat treatment practice regarding:

Temperature and time parameters
Load density
Quenching procedure

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

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. Details of the process control shall be available for purchaser's review/audit at the foundry facility.