SAE Aerospace
An SAE International Group

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 4241C

Issued JUL 1986
Revised JUL 2002
Reaffirmed APR 2007

Superseding AMS 4241B

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

(Composition similar to UNS A43570)

RATIONALE

This document has been reaffirmed to comply with the SAE 5-year Review policy.

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 structural aircraft components (See 8.3) requiring DAS quality control, but usage is not limited to such applications.

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.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
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SAE WEB ADDRESS: **http://www.sae.org**

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 canceled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or www.sae.org.

AMS 2360	Room Temperature Tensile Properties of Castings
AMS 2694	Repair Welding of Aerospace Castings
AMS 2771	Heat Treatment of Aluminum Alloy Castings
MAM 2771	Heat Treatment of Aluminum Alloy Castings (Metric)
AMS 2804	Identification, Castings
AMS 4246	Aluminum Alloy Welding Wire, 7.0Si - 0.52Mg
AMS-STD-2175	Classification and Inspection of Castings
ARP1947	Dendrite Arm Spacing of Structural Aircraft Quality D357 Aluminum Alloy Castings, Determination and Acceptance of

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959 or 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 10	Brinell Hardness 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 155	Reference Radiographs for Inspection of Aluminum and Magnesium Castings
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 1251	Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by Argon Atmosphere, Point-to-Plane, Unipolar Self-Initiating Capacitor Discharge
ASTM E 1417	Liquid Penetrant Examination
ASTM E 1742	Radiographic Examination

2.3 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 in accordance with ASTM E 227, ASTM E 607, or ASTM E 1251, or by other analytical methods acceptable to purchaser (See 3.4.1).

TABLE 1 - Composition

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

3.1.1 Test results may be rounded by the “rounding off” method of ASTM E 29.

3.2 Condition:

Solution and precipitation heat treated to T6 condition.

3.3 Casting:

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 as in 3.1. Spectrochemical sample shall be prepared in accordance with ASTM E 716.

3.4.2 Integrally-Attached Coupons: Unless otherwise specified, 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 3.6.2. 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:

Shall be in accordance with AMS 2771 or MAM 2771 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. Properties in 3.6.1.1 and 3.6.1.2, as applicable (See 4.3.1.2 and 4.3.1.3), shall be the basis for acceptance of castings:

3.6.1.1 Integrally-Attached Chilled Coupon "A": Specimens as in 4.3.1.3 shall have the properties 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: Specimens as in 4.3.1.2 shall have the properties in Table 3 or Table 4:

TABLE 3 - Minimum Tensile Properties for Designated Areas of Castings

Property	Value
Tensile Strength	50.0 ksi (345 MPa)
Yield Strength at 0.2% Offset	40.0 ksi (276 MPa)
Elongation in 4D (See 3.6.1.2.2)	3%

TABLE 4 - Minimum Tensile Properties for Casting Areas Other Than Designated Areas

Property	Value
Tensile Strength	45.0 ksi (310 MPa)
Yield Strength at 0.2% Offset	36.0 ksi (248 MPa)
Elongation in 4D (See 3.6.1.2.2)	2%

3.6.1.2.1 When properties other than those of Tables 3 or 4 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.

3.6.1.2.2 Specimens cut from castings 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 Microstructure: The microstructure of the casting surface in purchaser designated areas of the casting shall not exceed the maximum permissible DAS, 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:

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 Castings shall have a surface finish in accordance with the engineering drawing and shall be well cleaned. NAS 823 may be used to specify surface finish acceptance criteria.

3.7.2 Castings shall be produced under radiographic control. This control shall consist of 100% radiographic inspection of castings until process control factors (See 4.4.2) have been established to ensure production of acceptable castings.

3.7.3 Radiographic inspection shall be performed on each casting in accordance with ASTM E 1742 or to a sampling plan when specified by purchaser. A “Casting Class” of AMS-STD-2175 may be selected to specify the frequency of inspection. 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. Radiographic acceptance standards shall be in accordance with Table 5, or as specified by purchaser.

TABLE 5 - Radiographic Requirements

Discontinuities	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 discontinuities in aluminum alloy castings (maximum permissible radiograph) in accordance with ASTM E 155.			

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

3.7.3.2 When two or more types of discontinuities are present and the predominating discontinuity 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 of the maximum size 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 ASTM E 1417, 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 peened, plugged, impregnated, or welded unless authorized by purchaser.

3.7.5.1 When authorized by purchaser, welding with AMS 4246 alloy filler metal in accordance with AMS 2694 or other welding program approved by purchaser may 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 the performance of all required tests. All testing shall be performed at facilities acceptable to purchaser. 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: 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 heat treat lot as applicable under 4.3.

4.2.2 Periodic Tests: Microstructure (3.6.2) is a periodic test 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 reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.

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 specimens cut from castings in accordance with 3.6.1.2.2 shall be performed as follows:

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.

4.3.1.2.3 For determining conformance to the requirements of 3.6.1.2, 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 the selected casting or castings and shall conform to Table 4.

4.3.1.3 Determine tensile properties of one integrally-attached tensile specimen in accordance with 3.4.2.1.1 from each casting.

4.3.1.4 Each casting for radiographic inspection in accordance with 3.7.3, unless a sampling plan is specified by purchaser.

4.3.1.5 Each casting for fluorescent penetrant inspection in accordance with 3.7.4, unless a sampling plan is specified by purchaser.

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 in accordance with 3.6.2 shall be specified by purchaser at time of preproduction approval.

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

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.

4.4.2.1 Control factors for producing castings include, but are not limited to, the following. Supplier's procedures shall identify tolerances, ranges, and/or control limits, as applicable.

Type of melting furnace and furnace atmosphere
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
- Straightening procedure and method(s) of dimensional inspection

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

4.4.2.1.1 Any of the 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.