

AEROSPACE MATERIAL SPECIFICATION



AMS 4219E

Issued MAR 1966
Revised DEC 2001
Reaffirmed OCT 2006

Superseding AMS 4219D

Aluminum Alloy Castings
7.0Si - 0.55Mg - 0.12Ti - 0.06Be (A357.0 T61P)
Solution and Precipitation Heat Treated
(Composition similar to UNS A13570)

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 components requiring high strength, 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 (See 8.2).

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.

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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
AMS 2804	Identification, Castings
AMS-STD-2175	Casting, Classification and Inspection 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 E 29	Using Significant Digits in Test Data to Determine Conformance with Specifications
ASTM E 34	Chemical Analysis of Aluminum and Aluminum Alloys
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

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, 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	--	0.20
Copper	--	0.20
Manganese	--	0.10
Magnesium	0.40	0.7
Zinc	--	0.10
Titanium	0.04	0.20
Beryllium	0.04	0.07
Other Elements, each	--	0.05
Other Elements, 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 the T61P temper.

3.3 Castings:

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 Tensile Specimens: Shall be produced as follows:

3.4.2.1 Specimens Cut from a Casting and Specimens from Integrally Cast Coupons: Shall be removed after heat treatment, 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, standard sheet type specimens, or subsize specimens proportional to the standard as required by 3.6.1.

3.4.2.2 Separately Cast Specimens: Shall conform to ASTM B 557 or ASTM B 557M and shall be cast from each melt after the last melt additions. Specimens shall be cast in molds representing the mold used for castings. Chills are not permitted on test specimen cavity, except of the end face of the specimen when approved in accordance with 4.4.2.

3.5 Heat Treatment:

Shall be in accordance with AMS 2771 as for the T61 temper, except aging time shall not be less than 3 hours.

3.6 Properties:

Castings and representative tensile specimens produced in accordance with 3.4.2 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; 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 or 3.6.1.3 apply:

3.6.1.1 Specimens Cut From Castings: Specimens as in 4.3.3 shall have the properties shown in Table 2.

TABLE 2 - Minimum Tensile Properties

Property	Value
Tensile Strength	38.0 ksi (262 MPa)
Yield Strength at 0.2% Offset	30.0 ksi (207 MPa)
Elongation in 4D	2%

3.6.1.1.1 When properties other than those of Table 2 are required, tensile specimens as in 4.3.3 machined 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 Integrally Cast Specimens: Specimens as in 4.3.3.1 shall have the properties shown in Table 3.

TABLE 3 - Minimum Tensile Properties

Property	Value
Tensile Strength	41.0 ksi (283 MPa)
Yield Strength at 0.2% Offset	32.0 ksi (221 MPa)
Elongation in 4D	3.0%

3.6.1.3 Separately Cast Specimens: Specimens as in 4.3.3.2 shall have the properties shown in Table 3.

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 When acceptance standards are not specified, Grade C of AMS-STD-2175 shall apply.

3.7.2 Methods of inspection and frequency of inspection shall be as agreed upon by purchaser and vendor. A "Casting Class" of AMS-STD-2175 may be selected to specify the method and frequency of inspection.

3.7.3 Castings shall be produced under radiographic control. This control shall consist of 100% radiographic inspection of castings until process control factors (4.4.2) have been established to ensure production of acceptable castings. Unless otherwise specified by purchaser, continued radiographic inspection of production castings shall be performed at a frequency determined by the vendor to ensure continued maintenance of internal quality.

3.7.3.1 Radiographic inspection shall be conducted in accordance with ASTM E 1742, unless otherwise specified by purchaser.

3.7.4 When specified by purchaser, castings shall be fluorescent penetrant inspected using a method specified by purchaser, or, if not specified, a method in accordance with ASTM E 1417.

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 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. 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: Except as specified in 4.2.1.1, composition (3.1), tensile properties of specimens cut from castings (3.6.1.1) or, when specified, from integrally cast coupons (3.6.1.2) or separately cast specimens (3.6.1.3), and quality (3.7) are acceptance tests and shall be performed to represent each melt or heat treat lot as applicable.

- 4.2.1.1 Tensile properties of separately cast specimens or integrally cast coupons shall be determined when specified by purchaser or when specimens cut from castings cannot be obtained. Tensile properties of separately cast specimens or from integrally cast coupons need not be determined when tensile properties of specimens cut from castings are determined.
- 4.2.2 Periodic Tests: Radiographic inspection (3.7.3) following the establishment of process control (4.4.2) 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 One chemical analysis specimen in accordance with 3.4.1 from each melt for conformance to 3.1.
- 4.3.2 One or more preproduction castings in accordance with 4.4.1 of each part number.
- 4.3.3 Not less than two tensile specimens machined from a casting or castings from each heat treat lot except when purchaser specifies use of separately cast specimens as in 4.3.3 or integrally cast coupons as in 4.3.3.1. If the number and locations of specimens are not shown on the drawing, not less than two specimens, one from the thickest section and one from the thinnest section, shall be cut from a casting or castings from each heat treat lot.
- 4.3.3.1 When permitted by purchaser, test bars integrally cast with the castings may be tested in lieu of testing specimens cut from castings. Size, number, and location of integrally cast coupons shall be as specified on the casting drawing or as agreed upon by purchaser and vendor.
- 4.3.3.2 One separately cast tensile specimen in accordance with 3.4.2 representing each heat treat lot, except when properties of specimens machined from castings or from integrally cast coupons are required.
- 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. Vendor shall also establish control factors for producing separately cast tensile specimens, but these control factors need not be identical to those used for production of 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.

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

Type of furnace

Furnace atmosphere

Alloy additions, fluxing, deoxidation, and gas removal procedures

Gating and risering practice

Mold composition and molding practice

Core composition and fabrication method, when applicable

Metal pouring temperature

Solidification and cooling procedures

Solution heat treat and precipitation hardening cycles

Straightening procedure, when applicable

Cleaning operations

Methods of inspection

Radiographic inspection sampling plan, if used.

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.

4.5 Reports:

The vendor of castings shall furnish with each shipment a report showing the results of tests for chemical composition of each melt and the results of tests for tensile properties of specimens cut from castings or, when specified or permitted, from integrally-cast coupons from each heat treat lot, or from separately-cast test specimens representing each heat treat lot, and stating that the castings conform to the other technical requirements. This report shall include the purchase order, melt and heat treat lot numbers, AMS 4219E, part number, and quantity.

4.6 Resampling and Retesting:

If any specimen used in the above tests fails to meet the specified requirements, disposition of the castings may be based on the results of testing two additional specimens for each original nonconforming specimen. Failure of any retest specimen to meet the specified requirements shall be cause for rejection of the castings represented. Results of all tests shall be reported.