



AEROSPACE MATERIAL SPECIFICATION

AMS-A-21180™**REV. C**

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Superseding AMS-A-21180B

Aluminum-Alloy Castings, High Strength

RATIONALE

AMS-A-21180C stabilizes this document because it contains mature technology that is not expected to change and thus no further revisions are anticipated.

STABILIZED NOTICE

AMS-A-21180C has been declared "STABILIZED" by the SAE AMS D Nonferrous Alloys Committee. This document was stabilized because this document contains mature technology that is not expected to change and thus no further revisions are anticipated. Previously this document was non-current. The last technical update of this document occurred in August, 2011. Users of this document should refer to the cognizant engineering organization for disposition of any issues with reports/certifications to this specification; including exceptions listed on the certification.

NOTE: In many cases, the purchaser may represent a sub tier supplier and not the cognizant engineering organization. Users are alerted to typographical errors in the headings of the elongation column in Tables 3 and 4, where the square root symbol has been replaced, respectively, by a "?" and a □.

AMS Committee D recommends that the following similar, but not identical, specifications may be considered for future procurement. This listing does not constitute authority to substitute these specifications for the "STABILIZED" specification.

A201-T7

AMS4229 - Aluminum Alloy Castings, High Strength 4.5Cu - 0.70Ag - 0.30Mn - 0.25Mg - 0.25Ti (A201.0-T7) Solution Heat Treated and Overaged

AMS4242 - Aluminum Alloy Castings, 4.7Cu - 0.60Ag - 0.35Mn - 0.25Mg - 0.25Ti (B201.0-T7) Solution Heat Treated and Overaged

C355-T6

AMS4215 - Aluminum Alloy, Castings 5.0Si - 1.2Cu - 0.50Mg (C355.0-T6) Solution and Precipitation Heat Treated

A356-T6

AMS4218 - Aluminum Alloy Castings 7.0Si - 0.35Mg (A356.0-T6P) (Formerly T61P Temper) Solution and Precipitation Heat Treated

A357-T6

AMS4219 - Aluminum Alloy Castings 7.0Si - 0.55Mg - 0.12Ti - 0.06Be (A357.0 T61P) Solution and Precipitation Heat Treated

AMS4289 - Aluminum Alloy Castings 7.0Si - 0.55Mg - 0.12Ti (F357.0-T6) Solution Heat Treated (Beryllium-Free A357-T6)

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D357-T6

- AMS4241 - Aluminum Alloy Castings 7.0Si - 0.58Mg - 0.15Ti - 0.06Be (D357.0-T6) Solution and Precipitation Heat Treated Dendrite Arm Spacing (DAS) Controlled
- AMS4249 - Aluminum Alloy Castings 7.0Si - 0.58Mg - 0.15Ti - 0.06Be (D357.0-T6) Solution and Precipitation Heat Treated Requiring Fatigue and Fracture Toughness Testing
- AMS4288 - Aluminum Alloy Castings 7.0Si - 0.58Mg - 0.15Ti (E357.0-T6) Solution and Precipitation Heat Treated (Beryllium-Free D357-T6)

1. SCOPE

1.1 Scope

This specification covers the requirements for six alloy compositions, four inspection classes, four radiographic quality grades and six classes of mechanical properties of high strength aluminum-alloy castings.

1.2 Classification

Aluminum-alloy castings shall be furnished in the following compositions, grades and classes, as specified (See 6.3.1):

1.2.1 Composition

The chemical composition of the castings shall conform to Table 1, which consists of alloys A201.0, 354.0, C355.0, A356.0, A357.0 and 359.0. Unified Numbering System (UNS) for these alloys are: A12010, A03540, A33550, A13560, A13570 and A03590 respectively.

1.2.2 Inspection Class

Castings shall be classified with respect to criticality of application as defined by AMS2175, and each casting drawing shall specify the class required for the application (See 6.3.1).

1.2.3 Radiographic Grade

The radiographic inspection quality grades shall be as follows (See Table 2):

Grade	Description
A	A highly stressed casting or area of a casting for critical application.
B	A premium grade of casting for critical applications or specified area of a casting with low margins of safety.
C	A high quality grade of casting for general applications or area of a casting with average margin of safety.
D	An area of a casting subjected to only low stresses in a non-critical application.

1.2.4 Mechanical Property Class

The mechanical property class of each casting or area of a casting shall be as specified in Table 3 and 4, as applicable, unless mechanical property requirements are specified on the engineering drawing. Classes are identified as Class 1, 2, or 3 (for designated areas) or 10, 11, or 12 (for any area), as applicable, for the alloy specified.

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

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AMS2175	Classification and Inspection of Castings
AMS2644	Penetrant Inspection Material
AMS2771	Heat Treatment of Aluminum Alloy Castings
AMS3025	Polyalkylene Glycol Heat Treat Quenchant

2.2 AIA Publications

Available from Aerospace Industries Association, 1000 Wilson Boulevard, Suite 1700, Arlington, VA 22209-3901, Tel: 703-358-1000, www.aia-aerospace.org.

NAS 410	Certification and Qualification of NonDestructive Test Personnel
NAS 823	Cast Surface Comparison Standard

2.3 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM B 557	Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products
ASTM B 660	Packaging/Packing of Aluminum and Magnesium Products
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 88	Sampling Nonferrous Metals and Alloys in Cast Form for Determination of Chemical Composition
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	Atomic Emission Spectrometric Analysis Aluminum Alloys by the Point to Plane Technique Nitrogen Atmosphere
ASTM E 716	Sampling and Sample Preparation of Aluminum and Aluminum Alloys for Determination of Chemical Composition by Spectrochemical Analysis
ASTM E 1251	Analysis of Aluminum and Aluminum Alloys by Atomic Emission Spectrometry
ASTM E 1417	Liquid Penetrant Testing
ASTM E 1742	Radiographic Examination

2.4 U.S. Government Publications

Available from the Document Automation and Production Service (DAPS), Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6257, <http://assist.daps.dla.mil/quicksearch/>.

MIL-STD-129 Marking for Shipment and Storage

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

MIL-STD-1916 DoD Preferred Methods for Acceptance of Product

2.5 ANSI/ASQ Publications

Available from ASQ Distribution Center, 5131 S. Third Street, Milwaukee, WI 53207-6028, www.asq.org.

ANSI/ASQ Z1.4 Sampling Procedures and Tables for Inspection by Attributes

2.6 Order of Precedence

In the event of a conflict between the text of this specification and the references cited herein, the text of this specification shall take precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 First Article

Sample castings shall be subjected to first article inspection, unless such inspection has been waived (See 3.2.1.1, 4.3, 6.3.1, and 6.4).

3.2 Foundry Practice

3.2.1 Process Control Approval

3.2.1.1 Foundry Control Approval

Production of a given casting shall not begin until the foundry control is approved. If temporary gating was used, castings shall be made with the gating installed. The following shall be recorded where applicable: molten metal holding temperature, pouring temperature, degassing procedure, grain refining and modification procedures, chill and insulation sizes and locations, gating techniques and procedures, filtering techniques, and risering techniques, procedures and locations.

Approval of foundry control shall be based on the results of first article inspection, unless such inspection has been waived (See 3.1). Where there is no waiver of first article inspection, the foundry shall be required to use the same casting practice and heat-treating procedure for the production castings as for the approved first article castings. If necessary to make any change in production procedures (See 3.2.2), the foundry shall notify the purchaser of the proposed change prior to the first shipment of castings. The foundry shall submit a sample production casting produced by the changed procedure for inspection for process approval (See 6.3.1).

3.2.1.2 Surface Roughness Control Approval

Where surface roughness is specified on a drawing of a given casting or elsewhere in the acquisition documents (See 6.3.1), production of this casting shall not begin until control of surface roughness is approved. Such control may be established by any method of mold preparation or subsequent surface finishing appropriate for the purpose, unless the method is expressly forbidden in the acquisition documents. The purchaser shall be notified of the intended method for surface roughness control. Approval of surface roughness control shall be based on the results of first article inspection, unless such inspection has been waived (See 3.1). Where there is no waiver of first article inspection, the foundry shall use the same surface roughness control method for the production castings as for the approved first article castings. Where first article inspection has been waived, the foundry shall be required to use a surface roughness control method acceptable to the purchaser. If it is necessary to make any change in surface roughness control, the purchaser shall be notified of the proposed change prior to the first shipment of production castings. The foundry shall submit a sample production casting using the changed procedure for inspection for process approval (See 6.3.1).

3.2.1.3 Order of Establishment of Controls

When surface roughness is specified (See 6.3.1), approval of foundry control shall be obtained prior to approval of surface roughness control. When first article inspection for foundry control has not been waived, first article castings shall be submitted for approval without finished surfaces, if surface finishing is to be performed subsequent to casting.

3.2.2 Changes in Foundry Practice

A sample production casting, new first article, shall be submitted for approval whenever one or more of the changes listed below occur(s). The purchaser may waive this requirement after review of the change(s).

- a. When a new pattern or permanent mold is made.
- b. For each new pattern or cavity in multiple tooling.
- c. When a duplicate pattern or mold is made.
- d. When any change is made in gates, runner system, risers or chills.
- e. When any change in the "as cast" shape is made.
- f. When strength requirements are raised.
- g. When an old pattern is transferred to a new vendor, or a new facility.
- h. When another alloy is used.
- i. When melting or processing techniques are changed.
- j. When an existing pattern is re-rigged or remounted.
- k. When mold systems are changed.

3.3 Composition

3.3.1 Chemical Composition of Castings

The chemical composition of castings shall be as specified in Table 1.

3.3.2 Chemical Analysis

Analysis shall routinely be made only for the elements specifically mentioned in Table 1. If however, the presence of other elements is suspected or indicated in the course of routine analysis, further analysis shall be made to determine conformance to the limits specified for other elements.

3.4 Radiographic and Surface Requirements

3.4.1 Process Control Castings (First Article Foundry Control)

3.4.1.1 Radiographic Soundness, Mechanical Property and Surface Roughness Control

Prior to production of a given castings, radiographic, mechanical property and, when specified (See 6.3.1), surface roughness controls shall be established. Sample castings (See 4.3.1) shall be examined by radiographic methods aided by sectioning and etching to determine the presence of internal defects. In addition, the full-size casting or tension test specimens machined from castings or cast-on coupons (where permitted) shall be tested for conformance to the required mechanical properties. The full-size casting, either as-cast or surface-finished, shall be tested for roughness, when roughness requirements are specified on the casting drawing or other acquisition documents. In order for foundry control to be acceptable, each location of a casting must exhibit soundness, surface roughness, and tensile properties conforming to those specified for that location on the drawing or other acquisition document. When acceptable foundry practices have been established, the production method shall not be changed (See 3.2.2) without demonstrating to the satisfaction of the purchaser that the change does not adversely affect the quality of the casting.

3.4.1.1.1 Radiographic Inspection

The casting shall be radiographically inspected for acceptability of the casting process in relation to the soundness requirements of 3.4.1.1.2. Inspection procedures shall conform to 4.5.2.

3.4.1.1.2 Soundness

Unless otherwise specified in the contract or order, the severity of the discontinuities shall not be greater than that shown in Table 2 for the applicable quality standard specified. Discontinuities revealed by the radiograph of the casting shall be matched to the comparable ASTM E 155 reference radiograph for a particular discontinuity. The matching reference radiograph indicates the relative severity of the discontinuity, and that number shall be equal to or less than the number in Table 2. Where "none" appears in Table 2, none of the applicable discontinuities shall be permissible in the castings.

3.4.1.1.3 Mechanical Properties

Once conformance to Table 2 is established, conforming castings shall exhibit mechanical properties meeting the applicable requirements of Tables 3 and 4 or as specified in the casting drawing, when tested in accordance with 4.5.4. Specimens for the tension test shall represent as a minimum those locations subjected to high stresses, or identified as critical, and other locations (See 4.4.2.4.2) containing the most severe discontinuities within specified standards. From the latter locations specimens shall be removed when requested by the purchaser (See 6.3.1). Castings which do not meet or exceed the specified soundness criteria and mechanical properties shall be cause for disapproval of foundry control.

3.4.1.1.3.1 Mechanical Properties of Large Castings

Where the casting is large (over 100 pounds poured weight), specimen blanks shall be removed in accordance with 4.4.2.4.4. Specimens shall be tested for compliance with Tables 3 and 4, or as specified on casting drawing, as applicable. All specimens made from excised blanks or gates, or from integrally cast test bars shall exhibit properties representative of the properties of locations within the casting adjacent to those locations from which blanks for these specimens were removed.

3.4.1.1.4 Surface Quality

Foundry control castings shall not contain cracks, cold shuts, or foreign material in excess of that allowed by the applicable radiographic quality grade specified, when inspected in accordance with 4.5.2. When specified (See 6.3.1), surface roughness in any location shall not exceed the maximum specified for that location.

3.4.1.1.5 Electrical Conductivity

When applicable, the foundry control casting shall meet the requirement of 3.4.4.

3.4.2 Production Castings

3.4.2.1 Radiographic Requirements

After the foundry practices of 3.2 have been established, castings shall be radiographically inspected as specified in 4.5.2. Acceptance shall be by comparison with the applicable standard set of radiographs contained in ASTM E 155 or with other standards approved by the purchaser (See 6.7). Radiographic indications shall be identified in terms of the discontinuities listed in Table 2. Acceptance shall be made in accordance with the grade specified on the engineering drawing (See 1.2.3).

3.4.2.2 Radiographic Acceptability

Unless otherwise specified (See 6.3.1), radiographic acceptability shall comply with Table 2. Radiographic acceptability is indicated by the applicable reference ASTM E 155 radiograph which is acceptable for the specified grade, or such acceptability is indicated by the applicable radiograph in an alternate standard set (See 6.7). To be acceptable as to the specified grade, a casting must be acceptable for all discontinuities listed in Table 2 relative to that grade. Nonconformance with the applicable standard for any single defect shall make a casting unacceptable. Unacceptable shrinkage, porosity or sponge in alloy A201.0 may assume a radiographic appearance similar to mottling, and when this condition is suspected, metallographic examination is required.

3.4.3 Mechanical Properties

The mechanical properties of test specimens, taken as specified in 4.4.2.4, shall conform to the applicable requirements of Tables 3 and 4 or as specified on the drawing. The strength requirement of the casting tested in full-size shall be as specified in the drawing for the part concerned or in other purchase information.

3.4.4 Electrical Conductivity

The electrical conductivity of Alloy A201.0 in the -T7 temper shall be 31.0 percent or greater, International Annealed Copper Standard (IACS). For other tempers and alloys, electrical conductivity testing requirements shall be as specified in the acquisition documents.

3.4.5 Surface Roughness

When specified, maximum surface roughness in any area of a casting shall be that specified in drawings of the casting or in other acquisition documents, and shall be expressed in terms of comparator numbers on as-cast surfaces and in terms of height ratings on machined or ground surfaces including gate and riser areas. Surfaces other than as-cast shall not have a roughness exceeding that of an as cast surface. Comparison standards used for measuring surface roughness shall be as specified in the acquisition documents (See 6.3.1).