

 <i>An SAE International Group</i>	AEROSPACE MATERIAL SPECIFICATION	SAE AMS4235	REV. B
		Issued 1980-04 Revised 2008-03 Reaffirmed 2013-05 Superseding AMS4235A	
Aluminum Alloy Castings 4.6Cu - 0.35Mn - 0.25Mg - 0.22Ti (A206.0-T71) Solution and Precipitation Heat Treated (Composition similar to UNS A12060)			

RATIONALE

AMS4235B has been reaffirmed to comply with the SAE five-year review policy.

1. SCOPE

1.1 Form:

This specification covers an aluminum alloy in the form of sand, permanent mold, and composite mold castings.

1.2 Application

This product has been typically used for components requiring high strength and moderate ductility at both room and elevated temperatures, but usage is not limited to such applications.

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	Castings, Classification and Inspection of
AMS2360	Room Temperature Tensile Properties of Castings
AMS2694	In-Process Welding of Castings
AMS2771	Heat Treatment of Aluminum Alloy Castings
AMS2804	Identification, Castings
AS1990	Aluminum Alloy Tempers

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be reaffirmed, revised, or cancelled. SAE invites your written comments and suggestions.

Copyright © 2013 SAE International

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of SAE.

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: <http://www.sae.org>

**SAE values your input. To provide feedback
on this Technical Report, please visit**
<http://www.sae.org/technical/standards/AMS4235B>

2.2 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	Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
ASTM E 34	Chemical Analysis of Aluminum and Aluminum Alloys
ASTM E 101	Spectroscopic Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique
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 of Aluminum and Aluminum Alloys by the Point-to-Plane Technique, Nitrogen Atmosphere
ASTM E 716	Sampling of Aluminum and its 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 Testing
ASTM E 1742	Radiographic Examination
ASTM G 44	Alternate Immersion Stress Corrosion Testing in 3.5% Sodium Chloride Solution

3. TECHNICAL REQUIREMENTS

3.1 Composition

Shall conform to the following percentages by weight as shown in Table 1, determined by wet chemical methods in accordance with ASTM E 34 or by spectrochemical methods in accordance with ASTM E 101, ASTM E 227, ASTM E 607, or ASTM E 1251, or by other analytical methods acceptable to purchaser (See 3.3.1).

TABLE 1 - COMPOSITION

Element	min	max
Silicon	--	0.05
Copper	4.2	5.0
Manganese	0.20	0.50
Magnesium	0.15	0.35
Titanium	0.15	0.30
Iron	--	0.10
Zinc	--	0.10
Nickel	--	0.05
Tin	--	0.05
Other Elements, each	--	0.05
Other Elements, total	--	0.15
Aluminum	remainder	

3.1.1 Test results may be rounded in accordance with the "rounding off" method of ASTM E 29.

3.2 Condition

Solution and precipitation heat treated to the T71 temper (see AS1990).

3.3 Castings shall be produced from metal conforming to 3.1, determined by analysis of a specimen (3.3.1) cast after the last melt addition.

Chemical analysis specimens, and tensile specimens shall be cast as follows:

3.3.1 Chemical Analysis Specimens

Shall be cast from each melt after the last melt addition and shall be tested to qualify the melt lot as in 3.1. Spectrochemical samples shall be prepared in accordance with ASTM E 716.

3.3.2 Tensile Specimens shall be produced as follows:

3.3.2.1 Specimens Cut from Castings

Shall be removed after heat treatment and machined to conform to ASTM B 557, and shall be either 0.500 inch (12.70 mm) diameter at the reduced parallel gage section, subsize specimens proportional to the standard, or standard sheet-type specimens, as required by 3.5.1.1.

3.3.2.2 Separately-Cast Specimens

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

3.4 Heat Treatment

Castings and representative tensile specimens shall be solution and precipitation heat treated in accordance with AMS2771 to produce the properties specified in 3.5.1, 3.5.2 (8.4).

3.4.1 Solution Heat Treatment

Heat to $985^{\circ}\text{F} \pm 10$ ($530^{\circ}\text{C} \pm 5$), hold at heat for not less than 8 hours, and quench.

3.4.2 Precipitation Heat Treatment

Heat to $370^{\circ}\text{F} \pm 10$ ($185^{\circ}\text{C} \pm 5$) hold at heat for 5 hours ± 0.25 , and cool in air.

3.5 Properties

Castings and representative tensile specimens produced in accordance with 3.3.2 shall conform to the following requirements (See 8.4):

3.5.1 Tensile Properties

Shall be as follows, determined in accordance with ASTM B 557; conformance to the requirements of 3.5.1.1 shall be used as basis for acceptance of castings except when purchaser specifies that the requirements of 3.5.1.2 apply. Castings with nominal wall thickness greater than 1.0 inch (25.4 mm) shall have properties as specified by the cognizant engineering organization.

3.5.1.1 Specimens Cut From Castings

The average of not less than 4, and preferably 10, specimens cut from thick and thin sections of a casting or castings shall be as follows:

3.5.1.1.1 Designated Casting Areas

Shall be as shown in Table 2:

TABLE 2 DESIGNATED CASTING AREAS

Property	Value
Tensile Strength, min	54.0 ksi (370 MPa)
Yield Strength at 0.2% Offset, min	45.0 ksi (310 MPa)
Elongation in 2 inches or 4D, min	3%

3.5.1.1.2 Casting Areas Other than Designated Areas

Shall be as shown in Table 3:

TABLE 3 CASTING AREAS OTHER THAN DESIGNATED AREAS

Property	Value
Tensile Strength, min	50.0 ksi (345 MPa)
Yield Strength at 0.2% Offset, min	40.0 ksi (275 MPa)
Elongation in 2 inches or 4D, min	15%

3.5.1.1.3 When properties other than those of 3.5.1.1.1 or 3.5.1.1.2 are required, tensile specimens as in 4.3.3 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 for such specimens may be designated in accordance with AMS2360.

3.5.1.2 Separately-Cast Specimens

Shall be as shown in Table 4:

TABLE 4 SEPARATELY-CAST SPECIMENS

Property	Value
Tensile Strength, min	50.0 ksi (345 MPa)
Yield Strength at 0.2% Offset, min	40.0 ksi (275 MPa)
Elongation in 2 inches or 4D, min	3%

3.5.2 Stress-Corrosion Resistance

Specimens as in 4.3.5, cut from castings and tested in accordance with ASTM G 44 at a stress of 75% of the specified minimum yield strength, shall meet the requirements of ASTM G 44.

3.6 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.

3.6.1 When acceptance standards are not specified, Grade C of AMS2175 shall apply.

3.6.2 Methods of inspection and frequency of inspection shall be as agreed upon by purchaser and vendor. A "Casting Class" of AMS2175 may be selected to specify the method and frequency of inspection.

3.6.3 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.

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

3.6.4 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.

3.6.5 Castings shall not be peened, plugged, impregnated, or welded unless authorized by purchaser.

3.6.5.1 When welding is authorized by purchaser, it shall be done in accordance with AMS2694 or other welding program approved by purchaser.

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

Composition (3.1), tensile properties of specimens cut from castings (3.5.1.1) or, when specified, tensile properties of separately-cast specimens (3.5.1.2), and quality (3.6) are classified as acceptance tests and shall be performed to represent each melt or lot as applicable.

4.2.2 Periodic Tests

Stress-corrosion resistance (3.5.2) and radiographic inspection (3.6.3) following the establishment of process foundry control factors (4.4.2) 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

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. Any change in material, processing, or both requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.

4.3 Sampling

Shall be in accordance with the following:

4.3.1 One chemical analysis specimen 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 four tensile specimens machined from castings from each lot except when purchaser specifies use of separately-cast specimens. If specimen locations are not shown on the drawing, not less than four specimens, two from the thickest section and two from the thinnest section, shall be cut from a casting or castings from each lot.

4.3.4 One tensile specimen in accordance with 3.3.2 representing each lot when purchaser specifies use of separately-cast specimens.

4.3.5 Specimens for stress-corrosion tests shall be tensile specimens taken from the same areas of castings as the tensile tests of specimens cut from castings. When practicable, specimens shall be not less than 0.250 inch (6.25 mm) in diameter at the reduced parallel gage section. If tensile specimens are not cut from castings but are separately cast, the stress-corrosion specimen can be taken from the separately-cast tensile specimens.

4.4 Approval

4.4.1 Sample castings from new or reworked tooling (i.e., patterns, molds, dies, etc.) 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, 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 include, but are not limited to, the following. Supplier's procedure shall identify tolerances, ranges, and/or control limits, as applicable.

Type of furnace

Furnace atmosphere

Mold composition and molding practices

Alloy additions, fluxing or deoxidation, and gas removal procedures

Gating, risering, and chilling practices

Core composition and fabrication method, when applicable

Metal pouring temperature; variation of ± 50 °F (± 30 °C) from the established limit is permissible

Solidification and cooling procedures

Solution and precipitation heat treat cycles

Cleaning operations

Methods of inspection

Radiographic inspection sampling plan, if used

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 composition of each melt and the results of tests for tensile properties of specimen cut from castings from each heat treat lot, or when specified, of separately-cast specimen representing each heat treat lot. This report shall include the purchase order number, melt and heat treat lot numbers, AMS4235B, part number, and quantity.

4.6 Resampling and Retesting

If any specimens 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 and no additional testing shall be permitted. Results of all tests shall be reported.