

AEROSPACE MATERIAL SPECIFICATION



AMS 4229D

Issued NOV 1969
Revised MAY 2001
Reaffirmed APR 2006

Superseding AMS 4229C

(R) Aluminum Alloy Castings, High Strength
4.5Cu - 0.70Ag - 0.30Mn - 0.25Mg - 0.25Ti (A201.0-T7)
Solution Heat Treated and Overaged
(Composition similar to UNS A02010)

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:

These castings have been used typically for components requiring a combination of 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 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.

| | |
|----------|---|
| 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 |

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2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

| | |
|-------------|---|
| 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 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 the Argon Atmosphere, Point-to-Plane, Unipolar Self-Initiating Capacitor Discharge |
| ASTM E 1417 | Liquid Penetrant Examination |
| ASTM E 1742 | Radiographic Examination |
| ASTM G 47 | Determining Susceptibility to Stress Corrosion Cracking of 2XXX and 7XXX Alloy Products |

2.3 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-STD-2175 Casting, Classification and Inspection of

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 | -- | 0.05 |
| Iron | -- | 0.10 |
| Copper | 4.0 | 5.0 |
| Manganese | 0.20 | 0.40 |
| Magnesium | 0.15 | 0.35 |
| Titanium | 0.15 | 0.35 |
| Silver | 0.40 | 1.0 |
| 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 heat treated and overaged.

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

3.4.2 Tensile Specimens:

3.4.2.1 Specimens Cut from a Casting and 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, subsize specimens proportional to the standard, or standard sheet-type specimens, 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 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.

3.5 Heat Treatment:

Shall be in accordance with AMS 2771 or MAM 2771, except that solution heat treating and overaging process parameters shall be selected by the heat treat facility and documented as in 4.4.2.1. Recommended heat treatment is presented in 3.5.1 and 3.5.2. When separately-cast specimens are permitted, at least one set shall, during each stage of heat treatment, be put into a batch-type furnace with each load of castings or into a continuous furnace at intervals of not longer than three hours.

3.5.1 For thin-wall, rapidly-solidified castings, solution heat treat by heating to 940 to 960 °F (504 to 516 °C), holding at heat for two hours ± 0.25 , raising temperature to 980 to 990 °F (527 to 532 °C), holding at heat for eight hours ± 0.25 , and quenching and overage by heating to 370 °F ± 10 (188 °C ± 6) and holding at heat for 5 hours ± 0.25 .

3.5.2 For slowly-solidified, heavy-walled castings [e.g., sand castings having 3/4 to 2 inch (19 to 51 mm) wall], solution heat treat by heating to 900 to 920 °F (482 to 493 °C), holding at heat for two hours ± 0.25 , raising temperature to 940 to 960 °F (504 to 516 °C), holding at heat for two hours ± 0.25 , raising temperature to 980 to 990 °F (527 to 532 °C), holding at heat for 12 hours ± 0.25 , and quenching and overage by heating to 370 °F ± 10 (188 °C ± 6) and holding at heat for five hours ± 0.25 .

3.6 Properties:

Castings with nominal wall thickness 1.0 inch (25 mm) and under and not over 50 pounds (23 kg) in overall weight and representative tensile specimens produced in accordance with 3.4.2 shall conform to the following requirements; property requirements for castings over 1.0 inch (25 mm) in nominal wall thickness or over 50 pounds (23 kg) in overall weight shall be as agreed upon by purchaser and vendor (See 8.2):

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 apply:

3.6.1.1 Specimens Cut From Castings: Specimens as in 4.3.3 shall have the properties shown in Tables 2 and 3.

3.6.1.1.1 Designated Casting Areas:

TABLE 2 - Minimum Tensile Properties

| Property | Value |
|-------------------------------|--------------------|
| Tensile Strength | 60.0 ksi (414 MPa) |
| Yield Strength at 0.2% Offset | 50.0 ksi (345 MPa) |
| Elongation in 4D | 3% |

3.6.1.1.2 Casting Areas Other than Designated Areas:

TABLE 3 - Minimum Tensile Properties

| Property | Value |
|-------------------------------|--------------------|
| Tensile Strength | 56.0 ksi (386 MPa) |
| Yield Strength at 0.2% Offset | 48.0 ksi (331 MPa) |
| Elongation in 4D | 1.5% |

3.6.1.1.3 When properties other than those of 3.6.1.1.1 or 3.6.1.1.2 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 Separately-Cast Specimens: Specimens as in 4.3.4 shall have the properties shown in Table 4.

TABLE 4 - Minimum Tensile Properties

| Properties | Value |
|-------------------------------|--------------------|
| Tensile Strength | 60.0 ksi (414 MPa) |
| Yield Strength at 0.2% Offset | 50.0 ksi (345 MPa) |
| Elongation in 4D | 3% |

3.6.2 Stress-Corrosion Resistance: Specimens as in 4.3.5 shall show no evidence of stress corrosion cracking when tested for 30 days by alternate immersion in accordance with ASTM G 47 at a stress of 75% of the specified minimum yield strength.

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 MIL-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 MIL-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 (See 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 the 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, tensile properties of separately-cast specimens (3.6.1.2), 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 shall be determined when specified by purchaser or when specimens cut from castings cannot be obtained. Tensile properties of separately-cast specimens need not be determined when tensile properties of specimens cut from castings are determined.
- 4.2.2 Periodic Tests: Stress-corrosion resistance (3.6.2) and radiographic inspection (3.7.3) following the establishment of process control (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: Tests for 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 materials 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 four tensile specimens machined from a casting or castings from each heat treat lot except when purchaser specifies use of separately-cast specimens as in 4.3.4. 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 a casting or castings from each heat treat lot.
- 4.3.4 One or more separately-cast tensile specimen in accordance with 3.4.2 from each heat treat lot when purchaser specifies use of separately-cast specimens.
- 4.3.5 Specimens for stress-corrosion tests shall be tensile specimens (See 3.4.2) taken from the same areas of castings as for tensile tests of specimens cut from castings. Whenever practicable, specimens shall be not less than 0.250 inch (6.35 mm) diameter at the reduced gage section. If tensile specimens are not cut from castings but are separately-cast, stress-corrosion specimens may be taken from the separately-cast specimens.
- 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. 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. Method for production of separately-cast tensile specimens shall be consistent for all cast material. 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 tensile specimens and castings include, but are not limited to, the following. Supplier's procedures shall identify tolerances, ranges and/or control limits, as applicable. Control factors for separately-cast tensile specimens must generally represent, but need not be identical to, those factors used for castings:

Type of furnace

Furnace atmosphere

Alloy additions, fluxing, deoxidation, and gas removal procedures

Gating and risering practices

Mold composition and molding practice

Core composition and fabrication method, when applicable

Metal pouring temperature; variation of 50 °F (28 °C) from the established limit is permissible

Solidification and cooling procedures

Stabilization/precipitation heat treat cycle

Straightening procedure, when applicable

Cleaning operations

Methods of inspection

Radiographic inspection sampling plan, if used.

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.

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 a casting from each heat treat lot or from separately cast specimens when permitted by purchaser, and stating that the castings conform to the other technical requirements. This report shall include the purchase order number, melt and heat treat lot numbers, AMS 4229D, part number, and quantity.