SAE Aerospace
An SAE International Group

AEROSPACE MATERIAL SPECIFICATION

SAE AMS4429 REV. A

Issued 2004-12
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Superseding AMS4429

Magnesium Alloy Castings, Sand
2.8Nd - 1.4Gd - 0.4Zn - 0.6Zr (EV31A - T6)
Solution and Precipitation Heat Treated
(Composition similar to UNS M12310)

RATIONALE

AMS4429A revises Composition (3.1), Sampling for Chemical Analysis (4.3.1), and is a Five Year Review and Update of this specification.

1. SCOPE

1.1 Form

This specification covers a magnesium alloy in the form of sand castings.

1.2 Application

These castings have been used typically for parts requiring a combination of light weight, high yield strength up to 400 °F (204 °C), and relatively high corrosion resistance, 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.

AMS2360 Room Temperature Tensile Properties of Castings

AMS2475 Protective Treatments, Magnesium Alloys

AMS2694 In-Process Welding of Castings

AMS2750 Pyrometry

AMS2804 Identification, Castings

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/AMS4429A

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 117 Standard Practice for Operating Salt Spray (Fog) Apparatus

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 953 Sampling Magnesium and Magnesium Alloys for Spectrochemical Analysis

ASTM B 954 Analysis of Magnesium and Magnesium Alloys by Atomic Emission Spectrometry

ASTM B 660 Packaging/Packing of Aluminum and Magnesium Products

ASTM E 155 Reference Radiographs for Inspection of Aluminum and Magnesium Castings

ASTM E 1417 Liquid Penetrant Testing

ASTM E 1742 Radiographic Examination

3. TECHNICAL REQUIREMENTS

3.1 Composition

Shall conform to the percentages by weight shown in Table 1, determined by by spectrochemical methods in accordance with ASTM B 954, or by other analytical methods acceptable to purchaser.

TABLE 1- COMPOSITION

Element	min	max
Neodymium	2.6	3.1
Gadolinium	1.0	1.7
Zinc	0.20	0.50
Zirconium	0.4	1.0
Other Rare Earths (3.1.1)	--	0.4
Silver	--	0.05
Copper	--	0.01
Iron	--	0.010
Nickel	--	0.0020
Other Elements, each (3.1.2)	--	0.01
Magnesium	remainder	

3.1.1 Other rare earths shall principally be the total of cerium, lanthanum, and praseodymium. The supplier shall analyze for the presence of these three elements when determining acceptance but the presence of additional rare earth elements shall not be cause for rejection provided the total remains less than 0.4%.

3.1.2 Determination not required for routine acceptance.

3.2 Condition

Solution and precipitation heat treated to the T6 temper.

3.3 Casting

Castings shall be produced from metal conforming to 3.1. Metal remelted from previously analyzed ingot may be poured directly into castings. Furnace or ladle additions of grain-refining elements or alloys shall be added to the melt. Molten metal taken from alloying furnaces, with or without additions of foundry operating scrap (gates, sprues, risers, and rejected castings), shall not be poured into castings unless first converted to ingot, analyzed, and remelted or unless the composition of a sample taken after the last addition to the melt conforms to 3.1.

3.3.1 A melt shall be the metal withdrawn from a batch-furnace charge of 2000 pounds (907 kg) or less as melted for pouring castings or, when permitted by purchaser, a melt shall be 4000 pounds (1814 kg) or less of metal withdrawn from one continuous furnace in not more than eight consecutive hours.

3.3.2 A lot shall be all castings poured from a single melt in not more than eight consecutive hours and solution and precipitation heat treated in the same heat treat batch.

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 and shall be of any suitable size, shape, or form.

3.4.2 Tensile Specimens

Shall be cast with each lot of castings, shall be of standard proportions conforming to ASTM B 557 or ASTM B 557M with 0.500 inch (12.70 mm) diameter at the reduced parallel gage section, and shall be cast to size in molds made with the regular foundry mix of sand without using chills. Metal for the specimens shall be part of the melt which is used for the castings and shall be subjected to the same grain refining or alloying treatment given the metal for the castings. The temperature of the metal during pouring of the specimens shall be not lower than that during pouring of the castings.

3.4.3 Integrally-Cast Coupons for Corrosion Specimens

When salt spray (fog) corrosion properties are to be determined using integrally-cast coupons (See 3.6.2), specimens shall be approximately 3 inches (75 mm) square by 0.25 inch (6.0 mm) thick.

One or more integrally-cast coupons should remain on castings where possible until just prior to protective treatment specified in 5.2. If it is necessary to remove integrally-cast coupons prior to protective treatments (pickle), coupons shall accompany castings through any further processing such as, but not limited to, heat treatment, blasting, and etching.

3.5 Heat Treatment

Castings and representative tensile specimens shall be heated to the proper temperature, not exceeding 980 °F (527 °C), held at heat for the proper time for solution treatment, quenched as required, and reheated to a temperature between 390 to 410 °F (199 to 210 °C) and held at heat for the proper time for precipitation heat treatment to meet the requirements of 3.6. At least one set of tensile specimens 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 3 hours. Pyrometry shall be in accordance with AMS2750.

3.6 Properties

Castings and representative separately-cast tensile specimens produced in accordance with 3.4.2 shall conform to the following requirements:

3.6.1 Tensile Properties

Conformance to the requirements of 3.6.1.1.1 shall be used as the basis for acceptance of castings except when purchaser specifies that the requirements of 3.6.1.1.2 apply:

3.6.1.1 At Room Temperature

Shall be as shown in 3.6.1.1.1 or 3.6.1.1.2 determined in accordance with ASTM B 557 or ASTM B 557M:

3.6.1.1.1 Separately Cast Specimens

Shall meet the requirements of Table 2.

TABLE 2 - MINIMUM TENSILE PROPERTIES

Property	Value
Tensile Strength, minimum	36.0 ksi (248 MPa)
Yield Strength at 0.2% Offset, minimum	21.0 ksi (145 MPa)
Elongation in 4D, minimum	2.0%

3.6.1.1.2 Specimens Cut from Castings and Integrally-Cast Coupons

Specimens as in 4.3.4 shall meet the requirements of Table 3.

TABLE 3 - MINIMUM TENSILE PROPERTIES

Property	Value
Tensile Strength, minimum	36.0 ksi (248 MPa)
Yield Strength at 0.2% Offset, minimum	21.0 ksi (145 MPa)
Elongation in 4D, minimum	2.0%

3.6.1.2 When properties other than those specified in Table 3 are required, tensile specimens as in 4.3.4 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 AMS2360.

3.6.2 Corrosion Resistance

Shall not be greater than 0.090 inch (2.29 mm) per year for integrally-cast specimens or, when specified, specimens cut from castings, determined in accordance with 3.6.2.1.

3.6.2.1 Corrosion rate shall be determined in accordance with ASTM B 117 except that, prior to exposure, specimens shall be accurately weighed to within ±0.01 gram (W_1). Specimens shall be exposed to the salt spray for not less than 120 hours. Following exposure, specimens shall be rinsed with tap water and cleaned of adherent corrosion product by immersing in a hot [190 °F] [88 °C] 20% chromic acid plus 1% silver nitrate solution for 1 to 2 minutes. Cleaned specimens shall be rinsed in hot water, dried in a stream of hot air, and reweighed (W_2). The measured weight loss (WL) shall be calculated ($W_1 - W_2$) and used for calculating corrosion rate, using the following equations:

$$\text{CR (mcd)} = \frac{\text{WL}}{\text{SA} \times \text{EP}}$$

$$\text{CR [mils (0.001 inch) per year]} = \frac{\text{CR (mcd)}}{\text{D}} \times 143.7 \qquad \text{(Eq. 1)}$$

where:

WL = Measured weight loss in mg

SA = Total surface area of specimen in cm^2

EP = Exposure time in days

D = Density, 1.82 $gram/cm^3$

mcd = mg/cm^2 per day

3.7 Quality

3.7.1 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.

3.7.1.1 Castings shall have smooth surfaces and shall be sufficiently cleaned to permit fluorescent penetrant inspection.

3.7.1.2 Castings cleaned by blasting shall be etched in a sulfuric or sulfuric-nitric acid solution to remove not less than 0.002 inch (0.05 mm) of metal before protective treatment as in 5.2.

3.7.2 Castings shall be produced under radiographic control. This control shall consist of radiographic examination of castings in accordance with ASTM E 1742, or other radiographic procedures acceptable to purchaser, until proper foundry technique, which will produce castings free from harmful internal imperfections, is established for each part number and of production castings as necessary to ensure maintenance of satisfactory quality.

3.7.3 When specified, castings shall be subjected to fluorescent penetrant inspection in accordance with ASTM E 1417.

3.7.4 Radiographic, fluorescent penetrant, and other quality standards shall be as agreed upon by purchaser and vendor. ASTM E 155 may be used to define radiographic acceptance standards.

3.7.5 Castings shall not be reworked by peening, plugging, welding, or other methods without written permission from purchaser.

3.7.5.1 When permitted in writing by purchaser, defects in castings may be removed and the castings reworked by welding in accordance with AMS2694. When authorized, rework welding shall be done before heat treatment.

3.7.6 Castings shall not be impregnated, chemically treated, or coated to prevent leakage unless specified or allowed by written permission of purchaser, designating the method to 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 product conforms 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 at room temperature (3.6.1.1), and quality (3.7) are acceptance tests and shall be performed to represent each melt or lot as applicable.

4.2.2 Periodic Tests

Corrosion resistance (3.6.3) 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 classified as preproduction tests and shall be performed prior to or 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 from each melt for conformance to ASTM B 953 and 3.1.

4.3.2 One separately-cast tensile specimen in accordance with 3.4.2 from each lot except when purchaser requires properties of specimens cut from castings or from integrally-cast coupons. Tensile properties of separately-cast specimens need not be determined when tensile properties of specimens cut from castings or from integrally-cast coupons are determined.

4.3.3 Two preproduction castings in accordance with 4.4.1 of each part number.

4.3.4 Except as permitted by 4.3.4.1, one or more castings from each lot when tensile properties are required from specimens cut from castings. Specimens shall conform to ASTM B 557 or ASTM B 557M and shall be either 0.500 inch (12.7 mm) diameter at the reduced parallel gage section, subsize specimens proportional to the standard, or standard sheet-type specimens. For determining conformance to the requirements of 3.6.1.2, if specimen locations are not shown on the drawing, not less than four tensile specimens, two from the thickest section and two from the thinnest section, shall be cut from a casting or castings from each lot.

4.3.5 Two integrally-cast coupons for corrosion resistance testing when required. Location of such coupons shall be as agreed upon by purchaser and vendor.

4.3.5.1 When permitted by purchaser, tensile specimens conforming to ASTM B 557 or ASTM B 557M excised from integrally-cast coupons may be used in lieu of separately-cast specimens (4.3.2) or specimens cut from a casting or castings (4.3.4). Size, number, and location of integrally-cast coupons shall be as specified by purchaser.

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, tests specimens, sample castings, or both. Production castings incorporating the revised operations shall not be shipped prior to receipt of reapproval.