SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS4442 | REV. G

Issued 1956-07
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Revised 2012-06

Superseding AMS4442F

Magnesium Alloy Sand Castings
3.2 Rare Earths - 2.5Zn - 0.70Zr (EZ33A-T5)
Precipitation Heat Treated
(Composition similar to UNS M12330)

RATIONALE

AMS4442G revises Composition (3.1) and Sampling for Chemical Analysis (4.3.1), removes the requirement for determination of soluble zirconium (Table 1, 3.1.2), and results from 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 operating up to 500 °F (260 °C), and have good pressure tightness, 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.

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/AMS4442G

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

AMS2361 Elevated Temperature Tensile Properties of Castings

AMS2475 Protective Treatments, Magnesium Alloys

AMS2694 In-Process Welding of Castings

AMS2750 Pyrometry

AMS2804 Identification, Castings

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 B 953 Sampling Magnesium and Magnesium Alloys for Spectrochemical Analysis

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

ASTM E 21 Elevated Temperature Tension Tests of Metallic Materials

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 spectrochemical methods in accordance with ASTM B 954, or by other analytical methods acceptable to purchaser.

TABLE 1 - COMPOSITION

Element	min	max
Total Rare Earths (3.1.1)	2.5	4.0
Zinc	2.0	3.1
Zirconium, total	0.40	1.0
Copper (3.1.2)	--	0.10
Nickel (3.1.2)	--	0.01
Other Elements, each	--	0.10
Other Elements, total	--	0.30
Magnesium	remainder	

3.1.1 Total Rare Earths (TRE) are principally a mixture of Cerium, Lanthanum, Neodymium and Praseodymium. The Cerium content shall not be less than 45% of TRE.

3.1.2 Determination not required for routine acceptance.

3.2 Condition

Precipitation heat treated.

3.3 Casting

Castings shall be produced from metal conforming to 3.1. 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 addition 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 precipitation heat treated in the same heat treatment batch.

3.4 Cast Test Specimens

Chemical analysis specimens and tensile specimens shall be cast as follows and, when requested, shall be supplied with the castings:

3.4.1 Chemical Analysis Specimens

Shall be cast from each melt and shall be of any suitable size, shape, and form.

3.4.2 Tensile Specimens

Shall be cast with each lot of castings, shall be of standard proportions conforming to ASTM B 557 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 that is used for the castings and shall be subjected to the same grain refining or alloying treatment given the metal for casting. The temperature of the metal during pouring of the specimens shall be not lower than that during pouring of the castings.

3.5 Heat Treatment

Castings and representative tensile specimens shall be precipitation heat treated by heating to a temperature not higher than 475 °F (246 °C), except as specified in 3.5.1, holding at the selected temperature within ±15 °F (±8 °C) for the proper time for precipitation heat treatment, and cooling in air. At least one set of tensile specimens shall 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.

3.5.1 When specified by purchaser for applications where high-temperature creep properties are not important, castings and representative tensile specimens shall be precipitation heat treated by heating to a temperature not higher than 650 °F (346 °C), holding at the selected temperature within ±15 °F (±8 °C) for not longer than 2 hours, and cooling in air.

3.6 Properties

Castings and 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.

3.6.1.1.1 Separately-Cast Specimens

TABLE 2 - MINIMUM TENSILE PROPERTIES

Property	Value
Tensile Strength	20.0 ksi (138 MPa)
Yield Strength at 0.2% Offset	14.0 ksi (96 MPa)
Elongation in 2 inches (50.8 mm) or 4D	2.0%

3.6.1.1.2 Specimens Cut From Castings or From 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	13.0 ksi (90 MPa)
Yield Strength at 0.2% Offset	11.0 ksi (76 MPa)
Elongation in 2 inches (50.8 mm) or 4D	1.5%

3.6.1.2 At 500 °F (260 °C)

Shall be as shown in 3.6.1.2.1 or 3.6.1.2.2, determined in accordance with ASTM E 21 on specimens heated to 500 °F ± 5 (260 °C ± 3), held at heat for 10 to 20 minutes before testing, and tested at 500 °F ± 5 (260 °C ± 3).

3.6.1.2.1 Separately-Cast Specimens

TABLE 4 - MINIMUM TENSILE PROPERTIES

Property	Value
Tensile Strength	13.0 ksi (90 MPa)
Yield Strength at 0.2% Offset	8.0 ksi (55 MPa)

3.6.1.2.2 Specimens Cut From Castings or From Integrally-Cast Coupons

Specimens as in 4.3.4 shall meet the requirements of Table 5.

TABLE 5 - MINIMUM TENSILE PROPERTIES

Property	Value
Tensile Strength	10.0 ksi (69 MPa)
Yield Strength at 0.2% Offset	6.0 ksi (41 MPa)

3.6.1.3 When properties other than those specified in 3.6.1.1.2 and 3.6.1.2.2 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 at room temperature may be designated in accordance with AMS2360 and at elevated temperature in accordance with AMS2361.

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

3.7.1.1 Castings cleaned by blasting shall be pickled in a sulfuric or sulfuric/nitric acid solution to remove not less than 0.002 inch (0.05 mm) of metal prior to 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 procedure 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 peened, plugged, impregnated, or welded unless authorized by purchaser.

3.7.5.1 When authorized by purchaser, welding in accordance with AMS2694 or other welding program approved by the purchaser may be used.

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 castings conform to specified requirements.

4.2 Classification of Tests

4.2.1 Acceptance Tests

Except as specified in 4.2.1.1, tests for 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.

4.2.1.1 Tensile properties of specimens cut from castings or from integrally-cast coupons shall be determined only when specified by purchaser or when separately-cast specimens are not available. 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.

4.2.2 Periodic Tests

Tensile properties at 500 °F (260 °C) (3.6.1.2) 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

Tests for all technical requirements are 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 in accordance with 3.4.1 and ASTM B 953 from each melt or a casting from each lot.

4.3.2 One separately-cast tensile specimen in accordance with 3.4.2 from each lot.

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 of specimens machined from castings are required. Specimens shall 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. For determining conformance to the requirements of 3.6.1.1.2, 3.6.1.2.2, or 3.6.1.3, 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.

4.3.4.1 When permitted by purchaser, tensile specimens conforming to ASTM B 557 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 is waived by purchaser.

4.4.2 Vendor shall establish, for production of sample castings of each part number, parameters for the process control factors that 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, 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 Process control factors include, but are not limited to, the following:

Type of furnace
Furnace atmosphere
Fluxing or oxide removal procedure
Gating and risering practices
Metal pouring temperature, variation of ±50 °F (±28 °C) from established limit is permissible
Solidification and cooling procedures
Precipitation heat treatment cycle
Cleaning operations
Methods of inspection

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 composition of at least one casting or of separately-cast specimens from each melt and for room-temperature tensile properties of separately-cast specimens representing each lot or of specimens cut from castings or from integrally-cast coupons from each lot, and stating that the castings conform to the other technical requirements. This report shall include the purchase order number, lot number, AMS4442G, part number, and quantity.