



# AEROSPACE MATERIAL SPECIFICATION

Society of Automotive Engineers, Inc.  
400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

## AMS 4439A

Superseding AMS 4439

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MAGNESIUM ALLOY CASTINGS, SAND  
4.2Zn - 1.2Ce - 0.7Zr (ZE41A-T5)  
Precipitation Heat Treated

### 1. SCOPE:

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

1.2 Application: Primarily for components having uniform, medium strength for use up to 320° F (160° C), requiring pressure tightness and good fatigue and creep characteristics, and which may require welding during fabrication.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS) shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096.

#### 2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods  
AMS 2360 - Room Temperature Tensile Properties of Castings  
AMS 2475 - Protective Treatments, Magnesium Base Alloys  
AMS 2635 - Radiographic Inspection  
AMS 2645 - Fluorescent Penetrant Inspection  
AMS 2646 - Contrast Dye Penetrant Inspection  
AMS 2804 - Identification, Castings

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM B557 - Tension Testing Wrought and Cast Aluminum and Magnesium Alloy Products  
ASTM E10 - Brinell Hardness of Metallic Materials  
ASTM E35 - Chemical Analysis of Magnesium and Magnesium Base Alloys  
ASTM E155 - Reference Radiographs for Inspection of Aluminum and Magnesium Castings, Series III

2.3 Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

#### 2.3.1 Federal Standards:

Federal Test Method Standard No. 151 - Metals; Test Methods

#### 2.3.2 Military Standards:

MIL-STD-649 - Aluminum and Magnesium Products, Preparation for Shipment and Storage

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### 3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall conform to the following percentages by weight, determined by wet chemical methods in accordance with ASTM E35, by spectrographic methods in accordance with Federal Test Method Standard No. 151, Method 112, or by other approved analytical methods:

	min	max
Zinc	3.5	5.0
Cerium (Total Rare Earths)	0.75	1.75
Zirconium, total	0.40	1.0
Zirconium, soluble (3.1.2)	0.40	--
Manganese (3.1.2)	--	0.15
Copper (3.1.2)	--	0.10
Nickel (3.1.2)	--	0.01
Other impurities, total	--	0.30
Magnesium	remainder	

3.1.1 Soluble zirconium is that portion of the zirconium which is soluble in 1:4 hydrochloric acid held below its boiling point.

3.1.2 Determination not required for routine acceptance.

3.2 Condition: Precipitation heat treated.

3.3 Casting: Castings shall be produced in lots 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 are permissible. Unless otherwise agreed upon by purchaser and vendor, 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 has been found to conform to 3.1.

3.3.1 A melt shall be the metal withdrawn from a batch furnace charge of 2000 lb (908 kg) or less as melted for pouring castings or, when permitted by purchaser, a melt shall be 4000 lb (1816 kg) or less of metal withdrawn from one continuous furnace in not more than 8 consecutive hours.

3.3.2 A lot shall consist of castings poured from a single melt in not more than 8 consecutive hours.

3.4 Cast Test Specimens: Chemical analysis specimens and tensile test 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 the size and shape agreed upon by purchaser and vendor.

3.4.2 Tensile Test Specimens: Shall be cast with each lot of castings, shall be of standard proportions conforming to ASTM B557 with 0.500 in. (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 green 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.

3.5 Heat Treatment: All castings and representative tensile test specimens shall be heated to a temperature not higher than 680° F (360° C), unless otherwise specified, for the proper time for precipitation heat treatment and cooled in air. At least one set of 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.

3.6 Properties: Castings and representative tensile test specimens produced in accordance with 3.4.2 shall conform to the following requirements:

3.6.1 Tensile Properties: Shall be as follows, determined in accordance with ASTM B557:

3.6.1.1 Separately-Cast Test Specimens:

Tensile Strength, min	29,000 psi (200 MPa)
Yield Strength at 0.2% Offset, min	19,500 psi (134 MPa)
Elongation in 2 in. (50.8 mm) or 4D, min	2.5%

3.6.1.2 Specimens Cut From Castings:

3.6.1.2.1 When tensile properties of actual castings are determined for acceptance, the average of not less than four, and preferably 10, specimens cut from thick and thin sections shall be as follows:

Tensile Strength, min	28,000 psi (193 MPa)
Yield Strength at 0.2% Offset, min	19,500 psi (134 MPa)
Elongation in 2 in. (50.8 mm) or 4D, min	2.5%

3.6.1.2.2 Any specimen cut from a casting shall meet the following:

Tensile Strength, min	26,000 psi (179 MPa)
Yield Strength at 0.2% Offset, min	17,500 psi (121 MPa)
Elongation in 2 in. (50.8 mm) or 4D, min	2.0%

3.6.1.2.2.1 Conformance to the requirements of 3.6.1.2.1 and 3.6.1.2.2 may be used as basis for acceptance of castings.

3.6.1.2.3 When properties other than those specified in 3.6.1.2.1 and 3.6.1.2.2 are specified, tensile test specimens cut from castings at locations indicated on the drawing shall have the properties indicated on the drawing for each specimen. Property requirements may be designated in accordance with AMS 2360.

3.6.2 Hardness of Castings: Except at sprue and riser locations, castings should have hardness of 65 - 80 HB/10/500, 65 - 80 HB/14.3/1000, or 70 - 85 HB/10/1000, determined in accordance with ASTM E10, but shall not be rejected on the basis of hardness if the tensile property requirements of 3.6.1.2 are met.

3.7 Quality:

3.7.1 Castings, as received by the purchaser, shall be uniform in quality and condition, sound, and free from foreign materials and from internal and external imperfections detrimental to usage of the castings. Castings shall have smooth surfaces and shall be well cleaned.

- 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 in. (0.05 mm) of metal before protective treatment.
- 3.7.2 Castings shall be produced under radiographic control, unless otherwise specified. This control shall consist of radiographic examination of castings in accordance with AMS 2635 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 subject to fluorescent penetrant inspection in accordance with AMS 2645 or to contrast dye penetrant inspection in accordance with AMS 2646.
- 3.7.4 Radiographic, fluorescent penetrant, contrast dye penetrant, and other quality standards shall be as agreed upon by purchaser and vendor. ASTM E155 may be used to define radiographic acceptance standards.
- 3.7.5 Castings shall not be repaired 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 repaired by welding provided the weld repair area has properties comparable to those of the parent metal. Repair welds shall be subjected to the same inspection procedures and acceptance standards required of the casting. Weld repair area shall be suitably marked to facilitate inspection. The repair welding shall be performed prior to any heat treatment and nondestructive testing specified herein.
- 3.7.6 Castings shall not be impregnated, chemically treated, or coated to prevent leaking, 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 and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.5. Purchaser reserves the right to perform such confirmatory testing as he deems necessary to ensure that the castings conform to the requirements of this specification.
- 4.2 Classification of Tests:
- 4.2.1 Acceptance Tests: Tests to determine conformance to composition (3.1), tensile property (3.6.1.1 or 3.6.1.2.1 and/or 3.6.1.2.2 or, when specified, 3.6.1.2.3 and hardness (3.6.2) requirements of this specification are classified as acceptance tests.
- 4.2.2 Preproduction Tests: Tests to determine conformance to all technical requirements of this specification are classified as preproduction tests.
- 4.2.2.1 For direct U.S. Military procurement, substantiating test data and, when requested, preproduction test material shall be submitted to the cognizant agency as directed by the procuring activity, the contracting officer, or the request for procurement.
- 4.3 Sampling: Shall be in accordance with the following:
- ∅ 4.3.1 Two chemical analysis specimens in accordance with 3.4.1 and/or a casting from each melt.
- ∅ 4.3.2 Three tensile test specimens 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.