Society of Automotive Engineers, Inc.
TWO PENNSYLVANIA PLAZA, NEW YORK, N.Y. 10001

AEROSPACE MATERIAL SPECIFICATION

AMS 4425

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Revised

MAGNESIUM ALLOYS CASTINGS, SAND
5.75Zn - 2.5RE - 0.70Zr (ZE63-T6)
Solution and Precipitation Treated

1. SCOPE:

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

1.2 Application: Primarily for parts requiring a high level of mechanical properties and freedom from microporosity.

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., Two Pennsylvania Plaza, New York, New York 10001.

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods
AMS 2475 - Protective Treatments, Magnesium Base Alloys
AMS 2635 - Radiographic Inspection
AMS 2804 - Identification, Castings

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

ASTM E8 - Tension Testing of Metallic Materials
ASTM E35 - Chemical Analysis of Magnesium and Magnesium Base Alloys

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

2.3.1 Federal Standards:

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

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	5.5	6.0
Rare Earths	2.0	3.0
Zirconium, total	0.40 -	1.0
Zirconium, soluble (3.1.1)	0.40	--
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: Solution and 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 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 until 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: Tensile test specimens, and chemical analysis specimens when required, shall be cast as follows and, when requested, shall be supplied with the castings.

3.4.1 Tensile Test Specimens: Shall be cast with each lot of castings, shall be standard 0.500 in. (12.70 mm) diameter at the reduced parallel 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.

3.4.2 Chemical Analysis Specimens: When required by purchaser, shall be cast from each melt to a size and shape agreed upon by purchaser and vendor.

3.5 Heat Treatment: Castings together with representative tensile test specimens from each lot shall be solution and precipitation heat treated as follows. At least three tensile test 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.

3.5.1 Hydriding and Solution Heat Treatment:

3.5.1.1 Heat in a hydrogen atmosphere to 900 F ± 10 (482.2 C ± 5.6) and hold at heat for sufficient time to produce full hydriding of the rare earth metals and zirconium contained in the alloy and to provide solution heat treatment.

3.5.1.1.1 Suggested holding periods are given below; longer holding periods will be required for castings with heavier sections.

Section Thickness		Time at Temperature
Inch	(Millimeters)	Hours
0.25	(6.4)	10
0.50	(12.7)	24
0.75	(19.0)	72

3.5.1.2 After hydriding is complete, cool rapidly from the solution heat treatment temperature to room temperature in accordance with 3.5.1.3.1 unless the alternate cooling procedure of 3.5.1.3.2 is permitted.

3.5.1.3 Cooling:

3.5.1.3.1 After hydriding or re-solution heat treating, cool rapidly from solution heat treatment temperature to ensure that the specified mechanical properties are obtained. It is recommended that castings be water spray quenched within 30 sec of opening the furnace and that they achieve room temperature in less than two minutes.

3.5.1.3.2 As an alternate procedure, castings and test specimens may be furnace cooled at any convenient rate to any convenient temperature and then re-solution heat treated in protective atmosphere at 890 - 910 F (476.7 - 487.8 C) for not less than 2 hr and cooling as in 3.5.1.3.1.

3.5.2 Precipitation Heat Treatment: Heat to a suitable temperature, hold for sufficient time to develop the specified properties, and cool in air. Conditions which have been used satisfactorily are:

72 hr at 255 F (124 C), or
48 hr at 285 F (141 C), or
24 hr at 205 F (96 C) plus 4 hr at 355 F (179 C)

3.5.3 After heat treatment, castings shall be cleaned by pickling in a sulfuric-nitric acid solution to remove not less than 0.002 in. (0.05 mm) of metal before treatment in accordance with 5.2. Shot or grit blasting prior to degreasing or pickling is permissible.

3.6 Tensile Properties: Shall be as follows, determined in accordance with ASTM E8:

3.6.1 Separately Cast Tensile Test Specimens:

Tensile Strength, min	39,000 psi (269 MPa)
Yield Strength at 0.2% Offset, min	26,000 psi (179 MPa)
Elongation in 2 in. (50.8 mm) or 4D, min	5%

3.6.2 Specimens Cut From Castings:

3.6.2.1 When tensile properties of actual castings are determined for acceptance, the average properties of all specimens tested shall conform to the following:

Tensile Strength, min	37,000 psi (255 MPa)
Yield Strength at 0.2% Offset, min	24,000 psi (165 MPa)
Elongation in 2 in. (50.8 mm) or 4D, min	4%

3.6.2.2 Any specimen cut from a casting shall conform to the following:

Tensile Strength, min	32,000 psi (221 MPa)
Yield Strength at 0.2% Offset, min	22,000 psi (152 MPa)
Elongation in 2 in. (50.8 mm) or 4D, min	2.5%

3.6.2.3 Conformance to the requirements of 3.6.2.1 and 3.6.2.2 may be used as a basis for acceptance of castings.

3.7 Quality:

3.7.1 Castings shall be uniform in quality and condition, sound, and free from internal and external imperfections detrimental to fabrication or to performance of parts. Castings shall have smooth surfaces and shall be well cleaned.

3.7.2 Castings shall be produced under radiographic control. This 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 Radiographic and other quality standards shall be as agreed upon by purchaser and vendor.

3.7.4 Castings shall not be repaired by plugging, welding, or other methods without written permission from purchaser. When permitted in writing by purchaser, defects in castings may be removed and 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 and the weld repair area shall be suitably identified to facilitate inspection. The repair welding shall be performed prior to hydriding and solution heat treatment and nondestructive testing specified herein.

3.7.5 Castings shall not be impregnated, chemically treated, or coated to prevent leaking unless permitted in writing by the purchaser specifying 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 assure that the castings conform to the requirements of this specification.

4.2 Classification of Tests: Tests to determine conformance to all technical requirements of this specification are classified as acceptance or routine control tests.

4.3 Sampling: Shall be in accordance with the following:

4.3.1 Two chemical analysis specimens in accordance with 3.42 or a casting from each melt.

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

4.3.3 Three tensile test specimens in accordance with 3.4.1 from each lot, when requested.

4.3.4 When properties are required from specimens machined from castings, one casting from each lot. Specimens shall conform to ASTM E8 and shall be either 0.500 in. (12.70 mm) diameter at the reduced parallel gage section or subsize specimens proportional to the standard or shall be standard sheet-type specimens.

4.4 Approval:

4.4.1 Sample castings from new or reworked patterns and the casting procedure shall be approved by the purchaser before castings for production use are supplied, unless such approval be waived.