SAE Aerospace
An SAE International Group

AEROSPACE MATERIAL SPECIFICATION

AMS 4427B

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Superseding AMS 4427A

Magnesium Alloy Castings, Sand
4.0Y - 2.3Nd - 0.7Zr (WE43B - T6)
Solution and Precipitation Heat Treated

(Composition similar to UNS M18432)

RATIONALE

AMS 4427B 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 570 °F (298 °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.

AMS 2360	Room Temperature Tensile Properties of Castings
AMS 2361	Elevated Temperature Tensile Properties of Castings
AMS 2475	Protective Treatments, Magnesium Alloys
AMS 2694	Repair Welding of Aerospace Castings
AMS 2750	Pyrometry
AMS 2804	Identification, Castings

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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 B117	Operating Salt Spray (Fog) Apparatus
ASTM B 557	Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products
ASTM B 660	Packaging/Packing of Aluminum and Magnesium Products
ASTM E 10	Brinell Hardness of Metallic Materials
ASTM E 21	Elevated Temperature Tension Tests of Metallic Materials
ASTM E 35	Chemical Analysis of Magnesium and Magnesium Alloys
ASTM E 155	Reference Radiographs for Inspection of Aluminum and Magnesium Castings
ASTM E 1417	Liquid Penetrant Inspection
ASTM E 1742	Radiographic Inspection

3. TECHNICAL REQUIREMENTS

3.1 Composition

Magnesium Alloy Castings shall conform to the percentages by weight shown in Table 1, determined by wet chemical methods in accordance with ASTM E 35, by spectrochemical methods, or by other analytical methods acceptable to purchaser.

TABLE 1 - COMPOSITION

Element	min	max
Yttrium	3.7	4.3
Neodymium	2.0	2.5
Zirconium	0.40	1.0
Other Rare Earths (3.1.1)	--	1.9
Zinc + Silver	--	0.20
Lithium	--	0.2
Manganese	--	0.03
Copper	--	0.02
Iron	--	0.010
Nickel	--	0.005
Other Elements, each (3.1.2)	--	0.01
Magnesium	remainder	

3.1.1 Other Rare Earths shall be principally Heavy Rare Earths (e.g., Gadolinium, Dysprosium, Erbium, Ytterbium) (See 8.2).

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 with 0.500 inch (12.7 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 3.6.3), specimens shall be approximately 3 inches (75 mm) square by 0.25 inch (6.0 mm) thick.

3.4.3.1 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, 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 985 °F (529 °C), held at heat for the proper time for solution treatment, quenched as required, and reheated to a temperature between 470 °F (243 °C) to 490 °F (254 °C) and held at heat for the proper time for precipitation heat treatment. 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 three hours. Pyrometry shall be in accordance with AMS 2750.

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:

3.6.1.1.1 Separately-Cast Specimens

Shall meet the requirements of Table 2.

TABLE 2 - MINIMUM TENSILE PROPERTIES

Property	Value
Tensile Strength	32.0 ksi (221 MPa)
Yield Strength at 0.2% Offset	25.0 ksi (172 MPa)
Elongation in 4D	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	31.5 ksi (217 MPa)
Yield Strength at 0.2% Offset	22.0 ksi (152 MPa)
Elongation in 4D	2.0%

3.6.1.2 At 480 °F

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 480 °F ± 5 (248 °C ± 2.8), held at heat for not less than 10 minutes before testing, and tested at 480 °F ± 5 (248 °C ± 2.8).

3.6.1.2.1 Separately-Cast Specimens

Shall be as shown in Table 4.

TABLE 4 - MINIMUM TENSILE PROPERTIES

Property	Value
Tensile Strength	27.5 ksi (190 MPa)
Yield Strength at 0.2% Offset	23.0 ksi (159 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	25.5 ksi (176 MPa)
Yield Strength at 0.2% Offset	18.5 ksi (128 MPa)

3.6.1.3 When properties other than those specified in Table 3 and Table 5 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 AMS 2360, AMS 2361, or both.

3.6.2 Corrosion Resistance

Shall not be greater than 0.075 inch (1.91 mm) per year for integrally-cast specimens or, when specified, specimens cut from castings, determined in accordance with 3.6.3.1.

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 (87 °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:

$$\text{CR (mg/cm}^2\text{per day)} = \frac{\text{WL}}{\text{SA} \times \text{EP}} \quad (1)$$

$$\text{CR [mils (0.001 inch) per year]} = \frac{\text{CR (med)}}{\text{D}} \times 143.7 \quad (2)$$

where:

WL = Measured weight loss in mg
SA = Total surface area of specimen in cm^2
EP = Exposure time in days
D = Density, 1.84 gram/cm^3

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 pickled in a sulfuric or sulfuric-nitric acid solution to remove not less than 0.002 inch 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 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.

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.

4.2.1.1 Tensile properties of specimens cut from castings 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 480 °F (248 °C) (3.6.1.2), hardness (3.6.2), and corrosion resistance (3.6.3) 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

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 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.

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 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 3.6.1.3, 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.

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

4.4 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.