SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS4417 REV. B

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Superseding AMS4417A

Castings, Sand, Magnesium Alloy 1.5Ag - 2.1Di - 0.08Cu - 0.70Zr (EQ21 - T6) Solution and Precipitation Heat Treated

(Composition similar to UNS M18330)

RATIONALE

AMS4417B revises standards for chemical analysis (3.1), condition (3.2) and sampling for chemical analysis (4.3.1), … 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 requiring retention of yield strength up to 400 °F (204 °C), 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

AMS2361 Elevated Temperature Tensile Properties of Castings

AMS2768 Heat Treatment of Magnesium Alloy Castings

AMS2475 Protective Treatments, Magnesium Alloys

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http://www.sae.org/technical/standards/AMS4417B

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 557M Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products (Metric)

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 REOUIREMENTS

3.1 Composition

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

TABLE 1 - COMPOSITION

Element	min	max
Didymium (Total Rare Earths) (3.1.1)	1.75	2.5
Silver	1.3	1.7
Zirconium	0.40	1.0
Copper	0.05	0.10
Nickel	--	0.01
Other Elements, total	--	0.30
Magnesium	remainder	

3.1.1 Didymium consists of neodymium (not less than 70% of the total) plus praseodymium, along with lesser amounts of other rare earth elements. Vendor shall analyze and report neodymium and praesodymium in order to determine composition for routine acceptance. When analyzed, the total of all rare earth elements shall not exceed 2.5%.

3.2 Condition

Solution and precipitation heat treated in accordance with AMS2768.

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3.3 Casting

Castings shall be produced in lots 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 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 and shape.

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. If the metal for castings is given any treatment, such as fluxing or cooling and reheating, the metal for the specimens shall be a portion of the metal so treated and, during such treatment, shall be heated to the same maximum temperature and held for approximately the same time as the molten metal for the castings. 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, integrally-cast coupons, and separately-cast tensile specimens shall be heated to a temperature not exceeding 975 °F (524 °C) and held at heat for the proper time for solution heat treatment and quenched as required, reheated to a temperature between 380 to 400 °F (193 to 204 °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 3 hours. Pyrometry shall be in accordance with AMS2750.

3.6 Properties

Castings, integrally-cast coupons, and separately-cast tensile specimens produced in accordance with 3.4.2 and heat treated in accordance with 3.5 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 follows, determined in accordance with ASTM B 557 or ASTM B 557M:

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3.6.1.1.1 Separately-Cast Specimens as in 3.4.2 shall have the properties shown in Table 2:

TABLE 2 - MINIMUM TENSILE PROPERTIES OF SEPARATELY-CAST SPECIMENS

Property	Value
Tensile Strength	34.0 ksi (234 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 or from Integrally-Cast Coupons

3.6.1.1.2.1 The average tensile properties of specimens cut from thick and thin sections of a casting or castings or from integrally-cast coupons as in 4.3.5 shall be as shown in Table 3:

TABLE 3 - TENSILE PROPERTY AVERAGE FOR SPECIMENS CUT FROM CASTING OR FROM INTEGRALLY-CAST COUPONS

Property	Minimum Value
Tensile Strength	32.0 ksi (221 MPa)
Yield Strength at 0.2% Offset	23.0 ksi (159 MPa)
Elongation in 4D	2.0%

3.6.1.1.2.2 Any specimen cut from a casting shall be not less than shown in Table 4:

TABLE 4 - MINIMUM TENSILE PROPERTIES FOR ANY SPECIMEN CUT FROM CASTING

Property	Value
Tensile Strength	28.0 ksi (193 MPa)
Yield Strength at 0.2% Offset	20.0 ksi (138 MPa)
Elongation in 4D	1.0%

3.6.1.2 At 400 °F (204 °C)

Shall be as follows, determined in accordance with ASTM E 21 on specimens heated to 400 °F ± 5 (204 °C ± 3), held at heat for not less than 10 minutes before testing, and tested at 400 °F ± 5 (204 °C ± 3):

3.6.1.2.1 Separately-Cast Specimens shall be as shown in Table 5:

TABLE 5 - MINIMUM TENSILE PROPERTIES OF SEPARATELY-CAST SPECIMENS WHEN TESTED AT 400 °F (204 °C)

Property	Value
Tensile Strength	25.0 ksi (172 MPa)
Yield Strength at 0.2% Offset	19.0 ksi (131 MPa)

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3.6.1.2.2 Specimens Cut From Castings shall be as shown in Table 6:

TABLE 6 - MINIMUM TENSILE PROPERTIES OF SPECIMENS CUT FROM CASTINGS WHEN TESTED AT 400 °F (204 °C)

Property	Value
Tensile Strength	24.0 ksi (165 MPa)
Yield Strength at 0.2% Offset	18.0 ksi (124 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 for such specimens may be designated in accordance with AMS2360, AMS2361, or both.

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, prior to nondestructive inspection, be pickled in a sulfuric or sulfuric-nitric acid solution to remove not less than 0.002 inch (0.05 mm) of metal.

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 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 acceptance 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, or welded without written permission from purchaser.

3.7.5.1 When authorized by purchaser, defects in castings may be removed and the castings reworked by welding in accordance with AMS2694.

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.

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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 400 °F (200 °C) (3.6.1.2) 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 preproduction tests and shall be performed prior to or on the first-article shipment of a casting to a purchaser, when a change in ingredients 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 At least one chemical analysis specimen in accordance with 3.4.1 and with ASTM B 953 from each melt and/or a casting from each lot.

4.3.2 One separately-cast tensile specimens 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 specified in 4.3.5, one or more castings from each lot when properties of specimens cut from castings are required. Specimens shall conform to ASTM B 557 or ASTM B 557M 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 3.6.1.3, 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.

4.3.5 When permitted by purchaser, test bars cast integrally with the casting may be tested in lieu of testing the casting itself, provided the casting is too small for either excising test coupons or testing of the casting as a whole, and the thickness of the test bars is equal to or greater than the thickness of the portions of the castings to which the bars are attached. Test bars shall not be removed from the casting until all heat treatments have been completed, unless the bars interfere with inspection processes or straightening whereupon they may be removed after solution heat treatment, but must accompany the associated casting during precipitation heat treatment.

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.

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