SAE Aerospace
An SAE International Group

# AEROSPACE MATERIAL SPECIFICATION

SAE AMS 4452C

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Revised FEB 2006

Superseding AMS 4452B

## Magnesium Alloy, Investment Castings
## 8.7Al - 0.70Zn - 0.22Mn (AZ91C-T6)
## Solution and Precipitation Heat Treated
(Composition similar to UNS M11914)

RATIONALE

AMS 4452C is a part of the SAE Five year review and update of this specification

1. SCOPE:

1.1 Form:

This specification covers a magnesium alloy in the form of investment castings.

1.2 Application:

These castings have been used typically for small, intricate parts requiring good strength with good ductility and weldability, 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)**
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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 2175 | Classification and Inspection of Castings |
| AMS 2360 | Room Temperature Tensile Properties of Castings |
| AMS 2475 | Protective Treatment, Magnesium Alloys |
| AMS 2694 | Repair Welding of Aerospace Castings |
| AMS 2804 | Identification, Castings |
| AMS-M-6857 | Heat Treatment of Magnesium Alloy Castings |

2.2 2.2ASTM 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 E 35 | Chemical Analysis of Magnesium and Magnesium Alloys |
| ASTM E 1417 | Liquid Penetrant Examination |
| ASTM E 1742 | Radiographic Examination |

3. TECHNICAL REQUIREMENTS:

3.1 Composition:

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 |
|---|---|---|
| Aluminum | 8.1 | 9.3 |
| Zinc | 0.40 | 1.0 |
| Manganese | 0.13 | 0.30 |
| Copper | -- | 0.10 |
| Nickel | -- | 0.01 |
| Silicon | -- | 0.30 |
| Other Elements, each (3.1.1) | -- | 0.10 |
| Other Elements, total (3.1.1) | -- | 0.30 |
| Magnesium | remainder | |

3.1.1 Determination not required for routine acceptance.

3.2 Condition:

Solution and precipitation heat treated.

3.3 Casting:

Castings shall be poured either from remelted metal from a master heat or directly from a master heat. In either case, metal for casting shall be qualified as in 3.4.

3.3.1 A master heat is refined metal of a single furnace charge or is metal blended as in 3.3.2. Gates, sprues, risers, and rejected castings shall be used only in preparation of master heats; they shall not be remelted directly, without refining, for pouring of castings. Furnace or ladle additions of grain-refining elements or alloys are permissible.

3.3.2 Metal from two or more master heats may be blended provided the composition of each master heat to be blended is within the limits of 3.1 and the total weight of metal blended does not exceed 15,000 pounds (6804 kg). When two or more master heats are blended, the resultant blend shall be considered a master heat.

3.4 Master Heat Qualification:

Each master heat shall be qualified by evaluation of chemical analysis and tensile specimens conforming to 3.4.1 and 3.4.2, respectively. A master heat may be considered conditionally qualified if vendor's test results show conformance to all applicable requirements of this specification. However, except when purchaser waives confirmatory testing, final qualification shall be based on purchaser's test results. Conditional qualification of a master heat shall not be construed as a guarantee of acceptance of castings poured therefrom.

3.4.1 Chemical Analysis Specimens: Shall be of any suitable size, shape, and form.

3.4.2 Tensile Specimens: Shall be cast from remelted metal from each master heat except that when castings are poured directly from a master heat, the specimens shall also be poured directly from the master heat. Specimens shall be of standard proportions in accordance with ASTM B 557 or ASTM B 557M with 0.250 inch (6.35 mm) diameter at the reduced parallel gage section. They shall be cast to size or shall be cast oversize and subsequently machined to 0.250 inch (6.35 mm) diameter. Center gating may be used.

3.5 Heat Treatment:

Castings and representative separately-cast tensile specimens shall be solution and precipitation heat treated in accordance with AMS-M-6857. At least one set of tensile specimens shall, during each stage of heat treatment, be placed into a batch-type furnace with each load of castings or into a continuous furnace at intervals of not longer than three hours.

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: Shall be as follows, determined in accordance with ASTM B 557 or ASTM B 557M; conformance to the requirements of 3.6.1.1 shall be used as basis for acceptance of castings except when purchaser specifies that the requirements of 3.6.1.2 apply:

3.6.1.1 Separately-Cast Specimens: Shall be as shown in Table 2.

TABLE 2 - Minimum Tensile Properties

| Property | Value |
|---|---|
| Tensile Strength | 34.0 ksi (234 MPa) |
| Yield Strength at 0.2% Offset | 16.0 ksi (110 MPa) |
| Elongation in 4D | 3% |

3.6.1.2 Specimens Cut From Castings or From Integrally-Cast Coupons: Shall be as shown in Table 3.

TABLE 3 - Minimum Tensile Properties

| Property | Value |
|---|---|
| Tensile Strength | 17.0 ksi (117 MPa) |
| Yield Strength at 0.2% Offset | 12.0 ksi ( 83 MPa) |
| Elongation in 4D | 1% |

3.6.1.2.1 When properties other than those of 3.6.1.2 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 AMS 2360.

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.

3.7.2 Castings shall be produced under radiographic control. This control shall consist of radiographic examination of castings in accordance with ASTM E 1742, or other method acceptable to purchaser, until proper foundry technique, which will produce castings free from harmful 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 Fluorescent penetrant and other quality standards shall be as established by purchaser. Unless otherwise specified, radiographic acceptance standards shall meet requirements of AMS 2175, Grade D.

3.7.5 Castings shall not be reworked by peening, plugging, welding, or other method without written permission from purchaser.

3.7.5.1 When authorized by purchaser, welding in accordance with AMS 2694 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, composition (3.1), tensile properties of separately-cast specimens (3.6.1.1), and quality (3.7) are acceptance tests and shall be performed to represent each master heat 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 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 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; a lot shall be not more than 800 pounds (363 kg) of cast metal, including gates, sprues, and risers, produced in not more than five consecutive hours from a single master heat, solution and precipitation heat treated as a single heat treatment batch, and presented for vendor's inspection at one time:

4.3.1 One chemical analysis specimen in accordance with 3.4.1 from each master heat, a casting from each lot, or both.

4.3.2 One separately-cast tensile specimen in accordance with 3.4.2 from each lot except when properties of specimens machined from castings or from integrally-cast coupons are required.

4.3.3 Two preproduction castings in accordance with 4.4.1 of each part number; one casting for dimensional evaluation and the other for property and quality evaluations as required for approval as in 4.4.1.

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 machined from castings. Specimens shall conform to ASTM B 557 or ASTM B 557M and shall be either 0.250 inch (6.35 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 3.6.1.2, if specimen locations are not shown on the drawing, not less than two tensile specimens, one from the thickest section and one from the thinnest section, shall be cut from a casting or castings representing each lot.

4.3.4.1 When permitted by purchaser, tensile specimens conforming to ASTM B 557 or ASTM B 557M 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 specified by purchaser.

4.4 Approval:

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

4.4.2 Vendor shall establish, separately for tensile specimens used for master heat qualification and for production of sample castings of each part number, parameters for the process control factors which will produce tensile specimens meeting master heat qualification requirements and acceptable castings; these shall constitute the approved casting procedure and shall be used for producing subsequent master heat qualification specimens and 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 by purchaser, 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 Control factors for producing tensile specimens and castings include, but are not limited to, the following:

Type of furnace and its capacity
Type and size of furnace charge
Time molten metal is in furnace
Furnace atmosphere
Fluxing or deoxidation procedure
Number of ladles used in pour
Mold refractory formulation
Gating practices
Mold preheat and metal pouring temperatures; variations of ±25 F (±14 C) degrees are permissible
Solidification and cooling procedures
Solution and precipitation heat treatment cycle