

**AEROSPACE
MATERIAL
SPECIFICATION**

MAM 4248

Issued 1-1-87

Submitted for recognition as an American National Standard

ALUMINUM ALLOY HAND FORGINGS AND RINGS

1.0Mg - 0.60Si - 0.28Cu - 0.20Cr (6061-T652)

Solution Heat Treated, Stress Relieved by Compression, and Precipitation Heat Treated
UNS A96061

1. SCOPE:

- 1.1 **Form:** This specification covers an aluminum alloy in the form of hand forgings and rolled rings procured to metric (SI) dimensions. AMS 4248 is the equivalent, specified in inch/pound units, of this MAM.
- 1.2 **Application:** Primarily for complex shaped parts requiring moderate strength and good forgeability of the alloy and where stability is required during machining. Corrosion resistance of this alloy is superior to that of aluminum alloys having copper as the principal alloying element.

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

- 2.1 **SAE Publications:** Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

- AMS 2350 - Standards and Test Methods
MAM 2355 - Quality Assurance Sampling and Testing of Aluminum Alloys and Magnesium Alloys, Wrought Products (Except Forging Stock) and Flash Welded Rings, Metric (SI) Units
AMS 2375 - Control of Forgings Requiring First Article Approval
AMS 2645 - Fluorescent Penetrant Inspection
AMS 2808 - Identification, Forgings

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

ASTM B594 - Ultrasonic Inspection of Aluminum-Alloy Products for Aerospace Applications

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

2.3.1 Military Specifications:

MIL-H-6088 - Heat Treatment of Aluminum Alloys

2.3.2 Military Standards:

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

3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall conform to the following percentages by weight, determined in accordance with MAM 2355:

	min	max
Magnesium	0.8	- 1.2
Silicon	0.40	- 0.8
Copper	0.15	- 0.40
Chromium	0.40	- 0.35
Iron	--	0.7
Zinc	--	0.25
Magnesium	--	0.15
Titanium	--	0.15
Other Impurities	--	0.05
Other Impurities	--	0.15
Aluminum	remainder	

3.2 Condition: Solution heat treated, stress relieved by compression to produce 1 to 5% permanent set, and precipitation heat treated. Heat treatments shall be performed in accordance with MIL-H-6088.

3.3 Properties: Forgings and rolled rings shall conform to the following requirements, determined in accordance with MAM 2355:

3.3.1 Tensile Properties: Shall be as follows:

- 3.3.1.1 Hand Forgings: Specimens, machined from forgings having an essentially square or rectangular cross-section heat treated in the indicated thickness, shall have the properties shown in Table I provided the as-forged thickness does not exceed 200 mm and the cross-sectional area is not over 1650 square centimetres.

TABLE I

Nominal Thickness at Time of Heat Treatment Inches	Specimen Orientation	Tensile Strength MPa, min	Yield Strength at 0.2% Offset MPa, min	Elongation in 5D %, min
Up to 50, incl	Longitudinal	260	240	9
	Long-Trans.	260	240	7
Over 50 to 100, incl	Longitudinal	260	240	9
	Long-Trans.	260	240	7
	Short-Trans.	255	230	4
Over 100 to 200, incl	Longitudinal	255	235	7
	Long-Trans.	255	235	5
	Short-Trans.	240	220	3

- 3.3.1.2 Rolled Rings: Specimens machined in the indicated orientation from rings 87.5 mm and under in nominal thickness at time of heat treatment and having an OD-to-wall thickness ratio of 10:1 or greater shall have the following properties:

- 3.3.1.2.1 Tangential: Axis of specimen tangential to the ring OD (axis parallel to the direction of rolling):

Tensile Strength, min	260 MPa
Yield Strength at 0.2% Offset, min	240 MPa
Elongation in 5D, min	
Nominal Thickness, mm	
Up to 62.5, incl	9%
Over 62.5 to 87.5, incl	7%

- 3.3.1.2.2 Axial: Axis of specimen parallel to axis of ring (axis transverse to direction of rolling):

Tensile Strength, min	260 MPa
Yield Strength at 0.2% Offset, min	240 MPa
Elongation in 5D, min	
Nominal Thickness, mm	
Up to 62.5, incl	7%
Over 62.5 to 87.5, incl	5%

- 3.3.1.3 Special Purpose Forgings: Tensile property requirements for specimens cut from special purpose forgings or from forgings or rolled rings beyond the size and configuration limits of 3.3.1.1 or 3.3.1.2 shall be as specified on the drawing or as agreed upon by purchaser and vendor.

3.3.2 Hardness: Should be not lower than 80 HB/10/500 or 85 HB/10/1000 but forgings or rolled rings shall not be rejected on the basis of hardness if the tensile property requirements are met.

3.4 Quality: Forgings and rolled rings, 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 forgings and rolled rings.

3.4.1 Forgings and rolled rings shall be subjected to a caustic etch followed by visual examination of the product surfaces for defect indications, such as seams, laps, bursts, and quench cracks. Surface imperfections which can be removed so that they do not reappear on etching and the required section thickness can be maintained are acceptable.

3.4.2 When specified all forgings and rolled rings shall be subjected to ultrasonic inspection in accordance with ASTM B594 and shall meet ultrasonic Class A.

3.4.3 When specified, forgings and rolled rings shall be subjected to fluorescent penetrant inspection in accordance with AMS 2645. Standards for acceptance shall be as agreed upon by purchaser and vendor.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of the product shall supply all samples for vendor's tests 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 sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests to determine conformance to all technical requirements of this specification are classified as acceptance tests and shall be performed on each lot.

4.2.2 Production Tests: Tests to determine conformance to all technical requirements of this specification when AMS 2375 is specified are classed as preproduction tests and shall be performed prior to or on the first-article shipment of a forging or rolled ring to a purchaser, when a change in material, processing, or both requires reapproval as in 4.4, and when purchaser deems confirmatory testing to be required.

4.2.2.1 For direct U.S. Military procurement, substantiating test data and, when requested, preproduction forgings or rolled rings 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 MAM 2355 and the following:

4.3.1 Surface Imperfections (3.4.1), Ultrasonic Inspection (3.4.2, and When Specified, Fluorescent Penetrant Inspection: All forgings and rolled rings.