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400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

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AMS 4127G

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Superseding AMS 4127F

Submitted for recognition as an American National Standard

ALUMINUM ALLOY FORGINGS AND ROLLED OR FORGED RINGS 1.0Mg - 0.6Si - 0.28Cu - 0.20Cr (6061-T6) Solution and Precipitation Heat Treated

UNS A96061

1. SCOPE:

1.1 **Form:** This specification covers an aluminum alloy in the form of die forgings, hand forgings, forged rings, rolled rings, and stock for forgings and rings.

1.2 **Application:** Primarily for complex shaped parts requiring moderate strength and good forgeability of the material. Corrosion resistance of this alloy is superior to that of 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 SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order.

2.1 **SAE Publications:** Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

2.1.1 Aerospace Material Specifications:

AMS 2201 - Tolerances, Aluminum and Aluminum Alloy Bar, Rod, Wire, and Forging Stock, Rolled or Cold Finished

MAM 2201 - Tolerances, Metric, Aluminum and Aluminum Alloy Bar, Rod, Wire, and Forging Stock, Rolled, Drawn, or Cold Finished

AMS 2355 - Quality Assurance Sampling and Testing of Aluminum Alloys and Magnesium Alloys, Wrought Products (Except Forging Stock) and Flash Welded Rings

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 2645 - Fluorescent Penetrant Inspection

AMS 2808 - Identification, Forgings

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2.2 ASTM Publications: Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM B 594 - Ultrasonic Inspection of Aluminum-Alloy Products for Aerospace Applications

ASTM B 660 - Packaging/Packing of Aluminum and Magnesium Products

2.3 U.S. Government Publications: Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

2.3.1 Military Specifications:

MIL-H-6088 - Heat Treatment of Aluminum Alloys

3. TECHNICAL REQUIREMENTS:

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

	min	max
Magnesium	0.8	- 1.2
Silicon	0.40	- 0.8
Copper	0.15	- 0.40
Chromium	0.04	- 0.35
Iron	--	0.7
Zinc	--	0.25
Manganese	--	0.15
Titanium	--	0.15
Other Impurities, each	--	0.05
Other Impurities, total	--	0.15
Aluminum		remainder

3.2 Condition: The product shall be supplied in the following condition:

3.2.1 Die Forgings, Hand Forgings, and Rolled or Forged Rings: Solution and precipitation heat treated in accordance with MIL-H-6088.

3.2.2 Forging Stock: As ordered by the forging manufacturer.

3.3 Properties: The product shall conform to the following requirements, determined in accordance with AMS 2355 or MAM 2355:

3.3.1 Die Forgings, Hand Forgings, and Rolled or Forged Rings:

3.3.1.1 Tensile Properties: Shall be as follows:

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3.3.1.1.1 Die Forgings:

3.3.1.1.1.1 With Grain Flow: Specimens, machined from forgings not over 4 inches (102 mm) in nominal thickness at time of heat treatment with axis of specimen in area of gage length varying not more than 15 degrees from parallel to the forging flow lines, shall have the following properties:

Tensile Strength, minimum	38.0 ksi (262 MPa)
Yield Strength at 0.2% Offset, minimum	35.0 ksi (241 MPa)
Elongation in 4D, minimum	7%
in 5D, minimum	6%

3.3.1.1.1.2 Across Grain Flow: Specimens, machined from forgings not over 4 inches (102 mm) in nominal thickness at time of heat treatment with axis of specimen in area of gage length varying not more than 15 degrees from perpendicular to the forging flow lines, shall have the following properties:

Tensile Strength, minimum	38.0 ksi (262 MPa)
Yield Strength at 0.2% Offset, minimum	35.0 ksi (241 MPa)
Elongation in 4D, minimum	5%
in 5D, minimum	4%

3.3.1.1.2 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 8 inches (203 mm) and the cross-sectional area is not over 256 square inches (1652 cm²).

TABLE I

Nominal Thickness at Time of Heat Treatment Inches	Specimen Orientation	Tensile Strength ksi, min	Yield Strength at 0.2% Offset ksi, min	Elongation in 4D %, min
Up to 2, incl	Longitudinal	38.0	35.0	10
	Long-Trans.	38.0	35.0	8
Over 2 to 4, incl	Longitudinal	38.0	35.0	10
	Long-Trans.	38.0	35.0	8
	Short-Trans.	37.0	33.0	5
Over 4 to 8, incl	Longitudinal	37.0	34.0	8
	Long-Trans.	37.0	34.0	6
	Short-Trans.	35.0	32.0	4

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TABLE I (SI)

Nominal Thickness at Time of Heat Treatment Millimeters	Specimen Orientation	Tensile Strength MPa, min	Yield Strength at 0.2% Offset MPa, min	Elongation in 5D %, min
Up to 51, incl	Longitudinal	262	241	9
	Long-Trans.	262	241	7
Over 51 to 102, incl	Longitudinal	262	241	9
	Long-Trans.	262	241	7
	Short-Trans.	255	228	4
Over 102 to 203, incl	Longitudinal	255	234	7
	Long-Trans.	255	234	5
	Short Trans.	241	221	3

3.3.1.1.3 Rolled or Forged Rings: Specimens machined in the indicated orientation from rings 3.5 inches (89 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:

3.3.1.1.3.1 Tangential: Axis of specimen tangential to ring OD (axis parallel to direction of rolling):

Tensile Strength, minimum	38.0 ksi (262 MPa)
Yield Strength at 0.2% Offset, minimum	35.0 ksi (241 MPa)
Elongation in 4D, minimum	
Nominal Thickness, Inches	
Up to 2.5, incl	10%
Over 2.5 to 3.5, incl	8%
Elongation in 5D, minimum	
Nominal Thickness, Millimeters	
Up to 64, incl	9%
Over 64 to 89, incl	7%

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

Tensile Strength, minimum	38.0 ksi (262 MPa)
Yield Strength at 0.2% Offset, minimum	35.0 ksi (241 MPa)
Elongation in 4D, minimum	
Nominal Thickness, Inches	
Up to 2.5, incl	8%
Over 2.5 to 3.5, incl	6%
Elongation in 5D, minimum	
Nominal Thickness, Millimeters	
Up to 64, incl	7%
Over 64 to 89, incl	5%

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3.3.1.1.3.3 Radial: Axis of specimen parallel to radius of ring, when specified:

Tensile Strength, minimum	37.0 ksi (255 MPa)
Yield Strength at 0.2% Offset, minimum	33.0 ksi (230 MPa)
Elongation in 4D, minimum	
Nominal Thickness, Inches	
Up to 2.5, incl	5%
Over 2.5 to 3.5, incl	4%
Elongation in 5D, minimum	
Nominal Thickness, Millimeters	
Up to 64, incl	5%
Over 64 to 89, incl	4%

3.3.1.1.4 Test Specimens: Specimens machined from separately forged coupons or from stock representing the forgings or rings and, in either case, heat treated with the forgings or rings, shall have the following properties:

Tensile Strength, minimum	38.0 ksi (262 MPa)
Yield Strength at 0.2% Offset, minimum	35.0 ksi (241 MPa)
Elongation in 4D, minimum	10%
in 5D, minimum	9%

3.3.1.1.5 Special Purpose Forgings: Tensile property requirements for specimens cut from special purpose forgings or from forgings or rings beyond the size and configuration limits of 3.3.1.1.1, 3.3.1.1.2, or 3.3.1.1.3 shall be as specified on the drawing or as agreed upon by purchaser and vendor.

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

3.3.2 Stock for Forgings or Rings: When a sample of stock is forged or rolled to a test coupon having a degree of mechanical working not greater than the forging or rings and heat treated in the same manner as the forgings or rings, specimens taken from the heat treated coupon shall conform to the requirements of 3.3.1.1.4 and 3.3.1.2. If specimens taken from the stock after heat treatment in the same manner as forgings or rings conform to the requirements of 3.3.1.1.4 and 3.3.1.2, the tests shall be accepted as equivalent to tests of a forged coupon.

3.4 Quality: The product, 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 product.

3.4.1 Each die forging and, when specified, each rolled or forged ring shall be etched to produce a surface suitable for visual inspection. Surfaces shall be evaluated for defects and, if defects can be removed so they do not reappear on re-etching and if the required section thickness is maintained, the forgings and rings are acceptable.

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- 3.4.1.1 When approved by purchaser, a sampling plan may be used in lieu of etching each forging and ring.
- 3.4.2 When specified, die forgings, hand forgings, and rings shall be ultrasonically inspected in accordance with ASTM B 594 and shall meet the following requirements:
- 3.4.2.1 Die Forgings: Class B.
- 3.4.2.2 Hand Forgings and Rings: Class A.
- 3.4.3 When specified, each forging and ring shall be subjected to fluorescent penetrant inspection in accordance with AMS 2645. Standards for acceptance shall be as agreed upon by purchaser and vendor.
- 3.4.4 Grain flow of die forgings, except in areas which contain flash-line end grain, shall follow the general contour of the forging, showing no evidence of re-entrant grain flow.
- 3.5 Tolerances: Stock for forging or rings shall conform to all applicable requirements of AMS 2201 or MAM 2201.
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. 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 for the following requirements are acceptance tests and shall be performed on each lot:
- 4.2.1.1 Composition (3.1).
- 4.2.1.2 Tensile properties (3.3.1.1) of each lot.
- 4.2.1.3 Visual inspection (3.4.1) of each die forging and, when specified, each ring.
- 4.2.1.4 When specified, ultrasonic inspection (3.4.2) and/or fluorescent penetrant inspection (3.4.3) of each forging or ring.
- 4.2.1.5 Tolerances (3.5) of stock for forging or rings.