

UNS A96061

ALUMINUM ALLOY FORGINGS
1.0Mg - 0.60Si - 0.28Cu - 0.20Cr (6061-T6)
Solution and Precipitation Heat Treated

1. SCOPE:

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

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 Aerospace Material Specifications (AMS) 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 2201 - Tolerances, Aluminum and Aluminum Alloy Bar, Rod, Wire, and Forging Stock, Rolled or Drawn

AMS 2350 - Standards and Test Methods

AMS 2375 - Control of Forgings Requiring First Article Approval

AMS 2630 - Ultrasonic Inspection

AMS 2645 - Fluorescent Penetrant Inspection

AMS 2808 - Identification, Forgings

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

ASTM B557 - Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products

ASTM E10 - Brinell Hardness of Metallic Materials

ASTM E34 - Chemical Analysis of Aluminum and Aluminum Alloys

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

2.3.1 Federal Standards:

Federal Test Method Standard No. 151 - Metals; Test Methods

2.3.2 Military Specifications:

MIL-H-6088 - Heat Treatment of Aluminum Alloys

2.3.3 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 by wet chemical methods in accordance with ASTM E34, by spectrographic methods in accordance with Federal Test Method Standard No. 151, Method 112, or by other analytical methods approved by purchaser:

	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 and Rolled 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:

3.3.1 Die Forgings and Rolled Rings:

3.3.1.1 Tensile Properties: Shall be as follows, determined in accordance with ASTM B557:

3.3.1.1.1 Test Specimens: Specimens, machined from separately-forged coupons or from forging stock representing the forgings and, in either case, heat treated with the forgings or machined from prolongations on heat treated forgings, shall have the following properties:

Tensile Strength, min	38,000 psi (260 MPa)
Yield Strength at 0.2% Offset, min	35,000 psi (240 MPa)
Elongation in 4D, min	10%

3.3.1.1.2 Forgings, With Grain Flow: Specimens, machined from forgings not over 4 in. (100 mm) in nominal thickness with the axis of specimen in the area of gage length varying not more than 15 deg from parallel to the forging flow lines, shall have properties as specified in 3.3.1.1.1 except that elongation may be as low as 7%.

3.3.1.1.3 Forgings, Across Grain Flow: Specimens, machined from forgings not over 4 in. (100 mm) in nominal thickness with the axis of specimen in the area of gage length varying not more than 15 deg from perpendicular to the forging flow lines, shall have properties as specified in 3.3.1.1.1 except that elongation may be as low as 5%.

3.3.1.1.4 Rings, Tangential: Specimens, machined from rings not over 2.50 in. (62.5 mm) in nominal thickness with axis of specimen tangential to ring OD (axis parallel to direction of rolling), shall have properties as specified in 3.3.1.1.1.

3.3.1.1.5 Rings, Axial: Specimens, machined from rings not over 2.50 in. (62.5 mm) in nominal thickness with axis of specimen parallel to axis of the ring (axis transverse to direction of rolling), shall have properties as specified in 3.3.1.1.1 except that elongation may be as low as 8%.

3.3.1.2 Hardness: Should be not lower than 80 HB/10/500 or 85 HB/10/1000, determined in accordance with ASTM E10, but the product shall not be rejected on the basis of hardness if the tensile property requirements are met.

3.3.2 Forging Stock: When a sample of stock is forged to a test coupon and heat treated in the same manner as forgings, specimens taken from the heat treated coupon shall conform to the requirements of 3.3.1.1.1 and 3.3.1.2. If specimens taken from the stock after heat treatment in the same manner as forgings conform to the requirements of 3.3.1.1.1 and 3.3.1.2, the tests shall be accepted as equivalent to tests of a forged coupon. The forging stock supplier, however, shall not be required to conduct such tests.

3.4 Quality: The product, as received by purchaser, shall be uniform in quality and condition, sound, and free from foreign materials and from internal and external imperfections detrimental to usage of the product.

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3.4.1 When specified, forgings and rolled rings shall be subjected to fluorescent penetrant inspection in accordance with AMS 2645 and/or to ultrasonic inspection in accordance with AMS 2630. Standards for acceptance shall be as agreed upon by purchaser and vendor.

3.5 Tolerances: Unless otherwise specified, tolerances for forging stock shall conform to all applicable requirements of AMS 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. 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 the following requirements are classified as acceptance tests and shall be performed on each lot:

4.2.1.1 Composition (3.1) of the product.

4.2.1.2 Tensile properties (3.3.1.1) of each lot of forgings and rings.

4.2.1.3 Tolerances (3.5) of forging stock.

4.2.2 Periodic Tests: Tests of forgings and rings to determine conformance to requirements for hardness (3.3.1.2) and of forging stock to determine ability to develop required properties (3.3.2) are classified as 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: Tests of forgings to determine conformance to all applicable technical requirements of this specification when AMS 2375 is specified are classified as preproduction tests and shall be performed on the first-article shipment of a forging to a purchaser, when a change in material and/or processing requires reapproval as in 4.4, and when purchaser deems confirmatory testing to be required.

4.2.3.1 For direct U.S. Military procurement, substantiating test data and, when requested, preproduction test material 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 as follows; a lot shall be all forgings or rings of the same part number, size, or nominal cross-section and configuration heat treated in the same batch-furnace load or in a continuous furnace consecutively during an 8-hr period.
- 4.3.1 Composition: At least one sample shall be taken by the producer from each
∅ group of ingots poured simultaneously from the same source of molten metal. Complete ingot analysis records shall be available to the purchaser at the producer's facility.
- 4.3.1.1 Unless compliance with 4.3.1 is established, an analysis shall be made for each 6000 lb (2700 kg) or less of material comprising the lot except that not more than one analysis shall be required per piece.
- 4.3.2 Tensile Properties:
- 4.3.2.1 Forgings: At least one separately-forged coupon or one forging prolongation heat treated with each lot of forgings.
- 4.3.2.1.1 In lieu of a prolongation or separately-forged coupon, not less than
∅ one tensile specimen with the grain flow and one tensile specimen across the grain flow from locations designated on the drawing from a forging representing each lot.
- 4.3.2.2 Rolled Rings: At least two tensile specimens, one specimen taken tangential to the ring OD and the other parallel to the axis of the ring, from a ring or ring prolongation representing the lot.
- 4.4 Approval: When specified, approval and control of forgings shall be in accordance with AMS 2375.
- 4.5 Reports:
- 4.5.1 The vendor of forgings or rings shall furnish with each shipment three copies of a report stating that the chemical composition conforms to the requirements of this specification and showing the results of tests on
∅ each lot to determine conformance to the other acceptance test requirements and, when performed, to the periodic test requirements, and stating that the forgings conform to the other technical requirements of this specification. This report shall include the purchase order number, AMS 4127E, size or part number, and quantity.
- 4.5.2 The vendor of forging stock shall furnish with each shipment three copies of a report stating that the chemical composition of the stock conforms to the requirements of this specification. This report shall include the purchase order number, AMS 4127E, size, and quantity.