



**The Engineering
Resource For
Advancing Mobility®**

400 COMMONWEALTH DRIVE WARRENDALE PA 15096

**AEROSPACE
MATERIAL
SPECIFICATION**

AMS 4143B

Superseding AMS 4143A

Issued 2-15-65

Revised 7-1-84

ALUMINUM ALLOY FORGINGS
6.3Cu - 0.30Mn - 0.18Zr - 0.10V - 0.06Ti (2219-T6)
Solution and Precipitation Heat Treated

UNS A92219

1. SCOPE:

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

1.2 **Application:** Primarily for structural machined parts. May be welded in the T6 condition but properties are improved by reheat treatment after welding. Certain design and fabricating procedures may cause these products to become susceptible to stress-corrosion cracking; ARP 823 recommends practices to minimize such conditions.

2. **APPLICABLE DOCUMENTS:** The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specification and Aerospace Recommended Practices 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 Cold Finished

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

AMS 2350 - Standards and Test Methods

AMS 2375 - Control of forgings Requiring First Article Approval

AMS 2645 - Fluorescent Penetrant Inspection

AMS 2808 - Identification, forgings

2.1.2 Aerospace Recommended Practices:

ARP 823 - Minimizing Stress-Corrosion Cracking in Wrought Heat-Treatable Aluminum Alloy Products

SAE Technical Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

AMS documents are protected under United States and international copyright laws. Reproduction of these documents by any means is strictly prohibited without the written consent of the publisher.

AMS 4143B

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

ASTM E10 - Brinell Hardness of Metallic Materials

ASTM E34 - Chemical Analysis of Aluminum and Aluminum Alloys

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
Copper	5.8	- 6.8
Manganese	0.20	- 0.40
Zirconium	0.10	- 0.25
Vanadium	0.05	- 0.15
Titanium	0.02	- 0.10
Iron	--	0.30
Silicon	--	0.20
Zinc	--	0.10
Magnesium	--	0.02
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 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 Forgings:

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

3.3.1.1.1 Die Forgings:

3.3.1.1.1.1 With Grain Flow: Specimens, machined from forgings 4 in. (100 mm) and under in thickness or from prolongations on such forgings, with axis of specimen in the area of the gage length varying not more than 15 deg from parallel to the forgings flow lines, shall meet the following requirements:

Tensile Strength, min	58,000 psi (400 MPa)
Yield Strength at 0.2% Offset, min	38,000 psi (260 MPa)
Elongation in 4D, min	8%
in 5D, min	7%

3.3.1.1.1.2 Across Grain Flow: Specimens, machined from forgings 4 in. (100 mm) and under in thickness or from prolongations on such forgings, with the axis of specimen in the area of the gage length varying not more than 15 deg from perpendicular to the forging flow lines shall meet the following requirements:

Tensile Strength, min	56,000 psi (385 MPa)
Yield Strength at 0.2% Offset, min	36,000 psi (250 MPa)
Elongation in 4D, min	4%
in 5D, min	4%

3.3.1.1.1.2.1 The elongation requirement of 3.2.1.1.1.2 applies only to test specimens having a gage-length diameter not less than 0.250 in. (6.25 mm).

AMS 4143B

3.3.1.1.2 Hand Forgings: Specimens machined from forgings 4 in. (100 mm) and under in thickness shall have the properties shown in Table I; tests need not be made in the longitudinal direction unless specifically required by purchaser.

TABLE I

Specimen Orientation	Tensile Strength psi, min	Yield Strength at 0.2% Offset psi, min	Elongation in 4D %, min
Longitudinal	58,000	40,000	6
Long-Transverse	55,000	37,000	4
Short-Transverse	53,000	35,000	2

TABLE I (SI)

Specimen Orientation	Tensile Strength MPa, min	Yield Strength at 0.2% Offset MPa, min	Elongation in 5D %, min
Longitudinal	400	275	5
Long-Transverse	380	255	4
Short-Transverse	365	240	2

3.3.1.1.2.1 Short-transverse property requirements of Table I apply only to
ø thicknesses 2.375 in. (60 mm) and over.

3.3.1.1.3 Rolled Rings:

3.3.1.1.3.1 Tangential: Specimens, machined from rings 2.50 in. (62.5 mm) and under in radial thickness with axis of specimen tangential to the ring OD (axis parallel to the direction of rolling), shall meet the following requirements:

Tensile Strength, min	56,000 psi (385 MPa)
Yield Strength at 0.2% Offset, min	40,000 psi (275 MPa)
Elongation in 4D, min	6%
in 5D, min	5%

3.3.1.1.3.2 Axial: Specimens, machined from rings 2.50 in. (62.5 mm) and under \emptyset in radial thickness with axis of specimen parallel to the axis of the ring (axis transverse to direction of rolling), shall meet the following requirements.

Tensile Strength, min	55,000 psi (380 MPa)
Yield Strength at 0.2% Offset, min	37,000 psi (255 MPa)
Elongation in 4D, min	4%
in 5D, min	4%

3.3.1.1.4 Other forgings: Specimens machined from forgings or rolled rings having configurations or size limitations not covered by this specification shall conform to tensile property requirements specified on the drawing or agreed upon by purchaser and vendor.

3.3.1.1.5 Test Specimens: Test specimens machined from separately-forged coupons or from stock representing the forgings and, in either case, heat treated with the forgings shall conform to the following requirements:

Tensile Strength, min	58,000 psi (400 MPa)
Yield Strength at 0.2% Offset, min	38,000 psi (260 MPa)
Elongation in 4D, min	10%
in 5D, min	9%

3.3.1.2 Hardness: forgings and rolled rings should have hardness not lower than 110 HB/10/500 or 115 HB/10/1000, determined in accordance with ASTM E10, but shall not be rejected on the basis of hardness if the applicable tensile property requirements are met.

3.3.2 Stock for Forging or Rolled Rings: When a sample of stock is forged to a test coupon and heat treated in accordance with 3.2.1, a specimen taken from the heat treated coupon shall conform to the requirements of 3.3.1.1.5. If a specimen taken from the stock after heat treatment in accordance with 3.2.1 conforms to the requirements of 3.3.1.1.5, the test 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 shall be etched by swabbing or immersing in an aqueous solution of sodium hydroxide, thoroughly rinsing in water, followed by washing in nitric acid or chromic-sulfuric acid solution or equivalent solution which will produce a surface suitable for visual inspection. Surfaces shall be evaluated for defects and, if defects can be removed so they do not appear on re-etching and if the required section thickness is maintained, forgings are acceptable.

3.4.1.1 When approved by purchaser, a sampling plan may be used in lieu of etching each forging.

3.4.2 When specified, forgings and rolled rings shall be subjected to fluorescent penetrant inspection in accordance with AMS 2645 or to ultrasonic inspection in accordance with ASTM B594, or to both. Standards for acceptance shall be as agreed upon by purchaser and vendor.

3.5 Tolerances: Unless otherwise specified, tolerances for forging stock shall be in accordance with all applicable requirements of AMS 2201 or MAM 2201.

AMS 4143B

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 requirements for composition (3.1), tensile properties (3.3.1.1), hardness (3.3.1.2), etching of die forgings (3.4.1), and, when specified, ultrasonic and fluorescent penetrant inspections (3.4.2) are classified as acceptance tests and shall be performed on each lot.

4.2.2 Periodic Tests: Tests of stock for forging or rolled rings (3.3.2) to demonstrate ability to develop required properties 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 prior to or on the first article shipment of a forging to a purchaser, when a change in material or processing, or both, 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 of forgings, substantiating test data and, when requested, preproduction forgings 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 of the same 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 For Acceptance Tests:

4.3.1.1 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.

4.3.1.1.1 Unless compliance with 4.3.1.1 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.

4.3.1.2 Tensile Properties:

4.3.1.2.1 Die Forgings: At least one separately-forged coupon or one forging prolongation heat treated with each lot of forgings.

4.3.1.2.1.1 In lieu of a prolongation or separately forged coupon, tensile specimens shall be cut from the location designated on the drawing, from a forging representing each lot.

4.3.1.2.2 Hand Forgings: At least two tensile specimens taken from a forging or forging prolongation representing the lot. One specimen shall be in the long-transverse direction and the other in the short-transverse direction.

4.3.1.2.3 Rolled Rings: At least two tensile specimens taken from a ring or ring prolongation representing the lot. One specimen shall be tangential to the ring OD and the other parallel to the axis of the ring.

4.3.1.3 Hardness and Nondestructive Testing: As agreed upon by purchaser and vendor.

4.3.2 For Periodic Tests and Preproduction Tests: As agreed upon by purchaser and vendor.

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 rolled rings shall furnish with each shipment a report stating that the chemical composition conforms to the requirements of this specification, showing the results of tests on each lot to determine conformance to the tensile property requirements, and stating that the forgings or rolled rings conform to the other technical requirements of this specification. This report shall include the purchase order number, lot number, AMS 4143B, size or part number, and quantity.

4.5.2 The vendor of stock for forging or rolled rings shall furnish with each shipment 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 4143B, size, and quantity.