Society of Automotive Engineers, Inc.
TWO PENNSYLVANIA PLAZA, NEW YORK, N.Y. 10001

AEROSPACE MATERIAL SPECIFICATION

AMS 4143A
Superseding AMS 4143

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ALUMINUM ALLOY FORGINGS
6.3Cu - 0.30Mn - 0.18Zr - 0.10V - 0.06Ti (2219-T6)

1. SCOPE:

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

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 this material to be 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 Specifications (AMS) and Aerospace Recommended Practices (ARP) shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from Society of Automotive Engineers, Inc., Two Pennsylvania Plaza, New York, New York 10001.

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 - Approval and Control of Critical Forgings
AMS 2630 - Ultrasonic Inspection
AMS 2645 - Fluorescent Penetrant Inspection
AMS 2808 - Identification, Forgings

2.1.2 Aerospace Recommended Practices:

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

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 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-Base Alloys

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

2.3.1 Federal Standards:

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

Printed in U.S.A.

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 approved analytical methods:

	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.

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 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. Test specimens machined from prolongations on heat treated forgings shall meet the requirements for forgings of the same thickness at time of heat treatment.

Tensile Strength, min	58,000 psi (400 MPa)
Yield Strength at 0.2% Offset, min	38,000 psi (262 MPa)
Elongation in 2 in. (50.8 mm) or 4D, min	10%

3.3.1.1.2 Die Forgings:

3.3.1.1.2.1 With Grain Flow: Test specimens machined from forgings not over 4 in. (102 mm) in thickness, with axis of specimen in the area of the gage length within 15 deg (0.262 rad) of parallel to the forging flow lines, shall conform to the requirements of 3.3.1.1.1 except that elongation may be as low as 8%.

3.3.1.1.2.2 Across Grain Flow: Test specimens machined from forgings not over 4 in. (102 mm) in thickness, with axis specimen varying more than 15 deg (0.262 rad) from parallel to the forging flow lines, shall conform to the following requirements:

Tensile Strength, min	56,000 psi (386 MPa)
Yield Strength at 0.2% Offset, min	36,000 psi (248 MPa)
Elongation in 2 in. (50.8 mm) or 4D, min	4%

3.3.1.1.2.2.1 The elongation requirement applies only to test specimens having a gage-length diameter not less than 0.250 in. (6.35 mm).

3.3.1.1.3 Rolled Rings:

3.3.1.1.3.1 Tangential: Test specimens machined from rolled rings not over 2.5 in. (64 mm) in radial thickness with axis tangential to the ring OD (axis parallel to the direction of rolling) shall conform to the following requirements:

Tensile Strength, min	56,000 psi (386 MPa)
Yield Strength at 0.2% Offset, min	40,000 psi (276 MPa)
Elongation in 2 in. (50.8 mm) or 4D, min	6%

3.3.1.1.3.2 Axial: Test specimens machined from rolled rings not over 2.5 in. (64 mm) in radial thickness with axis parallel to the axis of the ring (axis transverse to direction of rolling) shall conform to the following requirements:

Tensile Strength, min	55,000 psi (379 MPa)
Yield Strength at 0.2% Offset, min	37,000 psi (255 MPa)
Elongation in 2 in. (50.8 mm) or 4D, min	4%

3.3.1.1.4 Hand Forgings: Test specimens machined from hand forgings not over 4 in. (102 mm) in thickness shall conform to the requirements of Table I; tests need not be made in the longitudinal direction unless specifically required by purchaser:

TABLE I

Test Direction	Tensile Strength psi, min	Yield Strength at 0.2% Offset psi, min	Elongation in 2 in. or 4D %, min
Longitudinal	58,000	40,000	6
Long Transverse	55,000	37,000	4
Short Transverse (See 3.3.1.1.4.1)	53,000	35,000	2

TABLE I (SI)

Test Direction	Tensile Strength MPa, min	Yield Strength at 0.2% Offset MPa, min	Elongation in 50.8 mm or 4D %, min
Longitudinal	400	276	6
Long Transverse	379	255	4
Short Transverse (See 3.3.1.1.4.1)	365	241	2

3.3.1.1.4.1 Properties apply for thicknesses 2.375 in. (60.32 mm) and over.

3.3.1.1.5 Other Forgings: Tensile test 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.

3.3.1.2 Hardness: Forgings and rolled rings should have hardness not lower than 110 HB/10/500 or 110 HB/14.3/1000, or not lower than 115 HB/10/1000, determined in accordance with ASTM E10, but 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, a specimen taken from the heat treated coupon shall conform to the requirements of 3.3.1.1.1. If a specimen taken from the stock after heat treatment in the same manner as forgings conforms to the requirements of 3.3.1.1.1, the test shall be accepted as equivalent to tests of a forged coupon.

3.4 Quality: The product shall be uniform in quality and condition, clean, sound, and free from foreign materials and from internal and external imperfections detrimental to fabrication or to performance of parts.

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 be in accordance with all applicable requirements of AMS 2201.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of the product shall supply all samples 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 perform such confirmatory testing as he deems necessary to assure that the product conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests of the product to determine conformance to composition (3.1) requirements, of forgings to determine conformance to tensile property (3.3.1.1) and hardness (3.3.1.2) requirements, and of forging stock to determine conformance to tolerance (3.5) requirements of this specification are classified as acceptance or routine control tests.

4.2.2 Qualification Tests: Tests of forging stock to determine capability of developing required properties (3.3.2) are classified as qualification or periodic control tests, but the vendor of forging stock shall not be required to make such tests unless otherwise agreed upon by purchaser and vendor of the stock.

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 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 Unless compliance with 4.3.1 is established, an analysis shall be made for each 6000 lb (2724 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 Die 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, tensile test specimens shall be cut from one forging representing each lot from the location designated on the drawing.

4.3.2.2 Rolled Rings: At least two tensile test 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.

4.3.2.3 Hand Forgings: At least two tensile test 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.

4.4 Approval: When specified, approval and control of critical forgings shall be in accordance with AMS 2375.