Society of Automotive Engineers, Inc.
400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

AEROSPACE MATERIAL SPECIFICATION

AMS 4144A
Superseding 4144

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UNS A92219

ALUMINUM ALLOY HAND FORGINGS AND RINGS
6.3Cu - 0.30Mn - 0.18Zr - 0.10V - 0.06Ti (2219-T852)
Solution Heat Treated, Stress Relief Compressed, and Precipitation Heat Treated

1. SCOPE:

1.1 Form: This specification covers an aluminum alloy in the form of hand forgings and rolled rings.

1.2 Application: Primarily for structural parts subject to warpage during machining. May be welded in the -T852 condition but properties are improved by re-heat treatment to -T6 temper 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., 400 Commonwealth Drive, Warrendale, Pennsylvania 15096.

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods
AMS 2375 - Approval and Control of Critical Forgings
AMS 2630 - Ultrasonic 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 of 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

2.3.2 Military Standards:

MIL-H-6088 - Heat Treatment of Aluminum Alloys

3. TECHNICAL REQUIREMENTS:

3.1 2 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: Solution heat treated, stress-relieved by compressing, and precipitation heat treated. The compressing in the solution heat treated condition shall produce a permanent set of 1 - 5%. Heat treatment shall be performed in accordance with MIL-H-6088.

3.3 Properties: The product shall conform to the following requirements:

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

3.3.1.1 Hand Forgings: Test specimens machined from hand forgings 4 in. (102 mm) and under in nominal thickness shall conform to the requirements of Table I. Tests may be waived for any test direction having less than 2 in. (51 mm) of solid metal. Tests need not be made in the longitudinal direction unless specifically required by the purchaser.

TABLE I

Specimen Orientation	Tensile Strength psi, min	Yield Strength at 0.2% Offset psi, min	Elongation in 2 in. or 4D %, min
Longitudinal	62,000	50,000	6
Long Transverse	62,000	49,000	4
Short Transverse	60,000	46,000	3

TABLE I (SI)

Specimen Orientation	Tensile Strength MPa, min	Yield Strength at 0.2% Offset MPa, min	Elongation in 50.8 mm or 4D %, min
Longitudinal	427	345	6
Long Transverse	427	338	4
Short Transverse	414	317	3

3.3.1.1.1 Tensile properties of specimens machined from forgings over 4 in. (102 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.

3.3.1.2 Rolled Rings:

3.3.1.2.1 Tangential: Test specimens machined from rings 2.5 in. (64 mm) and under in nominal thickness with axis of specimen tangential to the ring OD (axis parallel to the direction of rolling) shall conform to the following requirements:

Tensile Strength, min	60,000 psi (414 MPa)
Yield Strength at 0.2% Offset, min	48,000 psi (331 MPa)
Elongation in 2 in. (50.8 mm) or 4D, min	6%

3.3.1.2.2 Axial: Test specimens machined from rings 2.5 in. (64 mm) and under in nominal radial thickness with axis of specimen parallel to axis of ring (axis transverse to direction of rolling) shall conform to the following requirements:

Tensile Strength, min	60,000 psi (414 MPa)
Yield Strength at 0.2% Offset, min	46,000 psi (317 MPa)
Elongation in 2 in. (50.8 mm) or 4D, min	4%

3.3.1.2.3 Tensile properties of specimens machined from rings over 2.5 in. (64 mm) in nominal radial thickness shall be as agreed upon by purchaser and vendor.

3.3.2 Hardness: Forgings and rolled rings should have hardness not lower than 115 HB/10/500 or 115 HB/14.3/1000, or not lower than 122 HB/10/1000, determined in accordance with ASTM E10, but shall not be rejected on the basis of hardness if the tensile property requirements (See 4.3.2) are met.

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 a caustic etch followed by visual Ø examination of the product surfaces for defect indications and/or to ultrasonic inspection in accordance with AMS 2630. 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 and shall be responsible for performing all required tests. Results of such tests shall be reported to the Ø 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: Tests to determine conformance to all technical requirements of this Ø specification are classified as acceptance or routine control tests.

4.3 Sampling: Shall be as follows; a lot shall be all forgings or rolled rings of the same nominal Ø cross-section and configuration heat treated in the same batch furnace load or charged consecutively in not more than 8-hr continuous furnace operation.

4.3.1 Composition: At least one sample shall be taken by the producer from each group of ingots
Ø 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 Hand Forgings: At least two tensile test specimens shall be taken from a forging or forging
Ø prolongation representing the lot. One specimen shall be taken in the long transverse direction and the other in the short transverse direction.

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

Ø 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 the product shall furnish with each shipment three copies of a report stating that the product conforms to the chemical composition and showing the results of tests to determine conformance to the tensile property requirements of this specification. This report shall include
Ø the purchase order number, material specification number and its revision letter, size or part number, and quantity.

4.5.2 The vendor of finished or semi-finished parts shall furnish with each shipment three copies of a report showing the purchase order number, material specification number and its revision letter, contractor or other direct supplier of material, part number, and quantity. When material for making parts is produced or purchased by the parts vendor, that vendor shall inspect each lot of material to determine conformance to the requirements of this specification, and shall include in the report a statement that the material conforms, or shall include copies of laboratory reports showing the results of tests to determine conformance.

4.6 Resampling and Retesting: If any specimen used in the above tests fails to meet the specified
Ø requirements, disposition of the product may be based on the results of testing two additional specimens for each original nonconforming specimen. Failure of any retest specimen to meet the specified requirements shall be cause for rejection of the product represented and no additional testing shall be permitted. Results of all tests shall be reported.

5. PREPARATION FOR DELIVERY:

Ø 5.1 Identification: The product shall be identified in accordance with AMS 2808.

5.2 Packaging: The product shall be prepared for shipment in accordance with commercial practice to
Ø assure carrier acceptance and safe transportation to the point of delivery. Packaging shall conform to carrier rules and regulations applicable to the mode of transportation.

6. ACKNOWLEDGMENT: A vendor shall mention this specification number and its revision letter in all quotations and when acknowledging purchase orders.

7. REJECTIONS: Material not conforming to this specification or to authorized modifications will be subject to rejection.

8. NOTES:

8.1 Marginal Indicia: The phi (Ø) symbol is used to indicate technical changes from the previous issue of this specification.