SAE The Engineering Society For Advancing Mobility Land Sea Air and Space®

400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

AMS 4313A

Issued 1-15-77
Revised 10-1-88

Superseding AMS 4313

ALUMINUM ALLOY RINGS, ROLLED OR FORGED
6.3Cu - 0.30Mn - 0.18Zr - 0.10V - 0.06Ti (2219-T351, 2219-T352)
Solution Heat Treated and Mechanically Stress Relieved

UNS A92219

1. SCOPE:

1.1 Form: This specification covers an aluminum alloy in the form of rolled or forged rings.

1.2 Application: Primarily for structural applications requiring good fusion weldability, a combination of good strength and resistance to stress-corrosion cracking, and where good stability is required during machining. Certain design and fabrication procedures may cause these products to become susceptible to stress-corrosion cracking; ARP823 recommends practices to minimize such conditions.

1.3 Classification: Rings covered by this specification are classified by type of mechanical stress relief as follows:

Type 1 - Stress relieved by stretching (2219-T351)
Type 2 - Stress relieved by compression (2219-T352)

1.3.1 Either type may be supplied, unless a specific type is ordered.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications 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 2350 - Standards and Test Methods
AMS 2375 - Control of Forgings Requiring First Article Approval
AMS 2770 - Heat Treatment of Aluminum and Aluminum Alloys
AMS 2808 - Identification, Forgings

2.1.2 Aerospace Recommended Practices:

ARP823 - Minimizing Stress-Corrosion Cracking in Wrought Heat Treatable Aluminum Alloy Products

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 B557M - Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products (Metric)
ASTM B594 - Ultrasonic Inspection of Aluminum-Alloy Products for Aerospace Applications
ASTM B660 - Packaging/Packing of Aluminum and Magnesium Products
ASTM E3 - Preparation of Metallographic Specimens
ASTM E10 - Brinell Hardness of Metallic Materials
ASTM E34 - Chemical Analysis of Aluminum and Aluminum Alloys
ASTM E340 - Macroetching Metals and 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 Military Specifications:

MIL-H-6088 - Heat Treatment of Aluminum Alloys

3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall conform to the following percentages by weight, Ø determined by wet chemical methods in accordance with ASTM E34, by spectrochemical methods, or by other analytical methods acceptable to 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
Residual Elements, each	–	0.05
Residual Elements, each	–	0.15
Aluminum	remainder	

3.2 Condition: Rings shall be supplied in the following condition; solution heat treatment shall be performed in accordance with MIL-H-6088:

3.2.1 Type 1: Solution heat treated and stress relieved by stretching to produce a permanent set of 1-1/2 - 5%.

3.2.2 Type 2: Solution heat treated and stress relieved by compression to produce a permanent set of 1-1/2 - 5%. During compression, primary forces shall be applied in the axial direction.

3.3 Properties: Rings shall conform to the following requirements:

3.3.1 As Solution Heat Treated and Stress Relieved:

3.3.1.1 Hardness: Should be not lower than 77 HB/10/500 or 82 HB/10/1000, Ø determined in accordance with ASTM E10, but the rings shall not be rejected on the basis of hardness if the tensile property requirements are met after precipitation heat treatment in accordance with AMS 2770.

3.3.1.2 Grain Size: When specified, shall be not larger than 0.030 inch (0.76 mm) in thickness, determined as follows:

3.3.1.2.1 The radial/axial cross-section shall be macroetched in accordance with ASTM E340 for examination at not greater than 10X magnification to select an area representing the largest grain size for metallographic examination. The metallographic specimen thus selected shall be prepared in accordance with ASTM E3. Grain size shall be determined by counting the grains in the radial direction across the microscopic field at approximately 100X magnification, dividing the diameter of the field of view by the number of grains, and dividing the result by the actual magnification used.

3.3.2 After Precipitation Heat Treatment: Shall be as follows on rings precipitation heat treated in accordance with AMS 2270:

3.3.2.1 Tensile Properties:

3.3.2.1.1 Rings With OD to Wall Thickness Ratio Less Than 10: Shall be as agreed upon by purchaser and vendor.

3.3.2.1.2 Rings With OD to Wall Thickness Ratio of 10 or Greater: Shall be as specified in Table I, determined in accordance with ASTM B557. Tensile tests are not required in any direction from which a specimen at least 2.375 inches (60.32 mm) in lentgh cannot be obtained.

TABLE I

Nominal Thickness at Time of Heat Treatment Inches (See 3.3.2.1.2.1)	Specimen Orientation (See 3.3.2.1.2.2)	Tensile Strength psi, minimum	Yield Strength at 0.2% Offset psi, minimum	Elongation in 4D %, minimum
Up to 3, incl	Tangential	60,000	48,000	6
	Axial	60,000	46,000	4
	Radial	58,000	44,000	3
Over 3 to 4, incl	Tangential	58,000	46,000	6
	Axial	58,000	44,000	4
	Radial	56,000	42,000	3
Over 4 to 5, incl	Tangential	56,000	44,000	5
	Axial	56,000	42,000	3
	Radial	54,000	40,000	2
Over 5 to 6, incl	Tangential	54,000	42,000	5
	Axial	54,000	40,000	3
	Radial	52,000	40,000	2

TABLE I (SI)

Nominal Thickness at Time of Heat Treatment Millimetres (See 3.3.2.1.2.1)	Specimen Orientation (See 3.3.2.1.2.2)	Tensile Strength MPa, minimum	Yield Strength at 0.2% Offset MPa, minimum	Elongation in 4D %, minimum
Up to 76, incl	Tangential	414	331	6
	Axial	414	317	4
	Radial	400	303	3
Over 76 to 102, incl	Tangential	400	317	6
	Axial	400	303	4
	Radial	386	290	3
Over 102 to 127, incl	Tangential	386	303	5
	Axial	386	290	3
	Radial	372	276	2
Over 127 to 152, incl	Tangential	372	290	5
	Axial	372	276	3
	Radial	359	276	2

3.3.2.1.2.1 Thickness shall be the smaller of the wall thickness (one-half the difference between nominal OD and nominal ID) and height (axial) dimensions.

3.3.2.1.2.2 Tangential requirements apply to specimens machined with axis of specimen tangential to the ring OD (parallel to the direction of rolling). Axial requirements apply to specimens machined with axis of specimen parallel to the ring axis (long transverse to the direction of rolling). Radial requirements apply to specimens machined with axis of specimen parallel to the radius of the ring (short transverse to the directon of rolling). All specimens shall be machined from the core of the ring.

3.3.2.1.2.3 Ø Elongation requirements do not apply to test specimens having a gage-length diameter less than 0.250 inch (6.35 mm), or located in immediate proximity to an abrupt change in section thickness, or located so that any part of the specimen gage length is located within 0.125 inch (3.18 mm) of the trimmed flash line.

3.3.2.1.2.4 Ø Tensile property requirements for rings with nominal thickness at time of heat treatment over 6 inches (152 mm) shall be as agreed upon by purchaser and vendor.

3.3.2.2 Ø Hardness: Should be not lower than 115 HB/10/500, or 120 HB/10/1000, determined in accordance with ASTM E10, but the rings shall not be rejected on the basis of hardness if the applicable tensile property requirements are met.

3.4 Quality: Rings, 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 rings.

3.4.1 Each ring shall be ultrasonically inspected in accordance with ASTM B594 Ø and shall meet the Class A acceptance limits of that specification.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of rings shall supply all samples Ø 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 rings conform to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests to determine conformance to all technical Ø requirements of this specification are classified as acceptance tests and shall be performed on lot.

4.2.2 Preproduction Tests: Tests of rings to determine conformance to all Ø 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 ring 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.

4.2.2.1 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, contracting officer, or request for procurement.

4.3 Sampling: Shall be as follows; a lot shall be all rings of the same size solution heat treatment in the same batch-furnace load or consecutively in a continuous furnace during an eight-hour period.

4.3.1 Composition: At least one sample shall be taken by the producer from each Ø 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 4000 pounds (1814 kg) or less of alloy comprising the lot except that not more than one analysis shall be required per piece.

4.3.2 Tensile Properties: Except when testing in one or more direction is not required by 3.3.2.1.2, test specimens in the tangential, axial, and radial directions shall be taken from a ring, ring prolongation, or ring segment representing the lot. When ring segments are used for testing, the segments shall be cut from a ring after solution heat treatment and stress-relief. Ring segments shall be included in each precipitation heat treatment furnace load.

4.3.2.1 When requested by purchaser, at least one-half of each ring segment obtained as in 4.3.2 or one-half of each ring prolongation tested shall be submitted to the purchaser with the rings represented.

4.3.3 Hardness:

4.3.3.1 As Solution Heat Treated: Each ring. If hardness of any ring indicates that tensile properties may be low after subsequent precipitation heat treatment, the ring having the lowest hardness shall be precipitation heat treated and tested for tensile properties.

4.3.3.2 After Precipitation Heat Treatment: Each ring, ring prolongation, or ring segment precipitation heat treated for testing for tensile properties.

4.3.4 Quality: Each ring.

4.3.5 Grain Size: Not less than one radial/axial specimen from a ring, ring prolongation, or ring segment representing the lot, when specified.

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

4.5 Reports:

4.5.1 The vendor of rings shall furnish with each shipment a report stating that the chemical composition conforms to the requirements specified and showing the results of tests on each lot to determine conformance to the other technical requirements of this specification. This report shall include the purchase order number, lot number, AMS 4313A, size or part number, and quantity.

4.5.2 The vendor of finished or semi-finished parts shall furnish with each shipment a report showing the purchase order number, AMS 4313A, contractor or other direct supplier of rings, part number, and quantity. When rings for making parts are produced or purchased by the parts vendor, that vendor shall inspect each lot of rings to determine conformance to the requirements of this specification and shall include in the report either a statement that the rings conform or copies of laboratory reports showing the results of tests to determine conformance.