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

AEROSPACE MATERIAL SPECIFICATION

AMS 4313

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Revised

UNS A92219

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

1. SCOPE:

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

1.2 Application: Primarily for structures requiring good fusion weldability and a combination of good strength and resistance to stress-corrosion cracking, where good stability is required during machining. Certain design and fabrication procedures may cause this material to be susceptible to stress-corrosion cracking; ARP 823 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 (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, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods
AMS 2375 - Approval and Control of Critical Forgings
AMS 2770 - Heat Treatment of Aluminum and Aluminum Alloys
AMS 2808 - Identification, Forgings

2.1.2 Aerospace Recommended Practices:

ARP 823 - 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 Magnesium Alloy Products
ASTM E3 - Preparation of Metallographic Specimens
ASTM E10 - Brinell Hardness of Metallic Materials
ASTM E34 - Chemical Analysis of Aluminum and Aluminum-Base Alloys
ASTM E340 - Machroetching Metals and Alloys

2.3 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
MIL-I-8950 - Inspection, Ultrasonic, Wrought Metals, Process for

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 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: 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, 77HB/14.3/1000, or 82 HB/10/1000, 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 in. (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 2770:

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 in. (60.32 mm) in length 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, min	Yield Strength at 0.2% Offset psi, min	Elongation in 2 in. or 4D %, min
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	Rangential	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, min	Yield Strength at 0.2% Offset MPa, min	Elongation in 50.8 mm or 4D %, min
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	Rangential	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 test requirements apply to specimens machined with axis of specimen tangential to the ring OD (parallel to the direction of rolling). Axial test requirements apply to specimens machined with axis of specimen parallel to the axis of the ring (long transverse to the direction of rolling). Radial test requirements apply to specimens machined with axis of specimen parallel to the radius of the ring (short transverse to the direction of rolling). All specimens shall be machined from the core of the ring.

3.3.2.2 Hardness: Should be not lower than 115 HB/10/500, 115 HB/14.3/1000, 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 tensile property requirements are met.

3.4 Quality: Rings, as received by the 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 rings.

3.4.1 Unless otherwise specified, each ring shall be ultrasonically inspected in accordance with MIL-I-8950 requirements 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 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 perfrom such confirmatory testing as he deems necessary to ensure that the rings conform to the requirements of this specification.

4.2 Classification of Tests: Tests to determine conformance to all technical requirements of this specification are classified as acceptance tests and preproduction tests, except that grain size (3.3.1.2) shall be determined only when specified.

4.2.1 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, the contracting officer, or the request for procurement.