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400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

AMS 4311B

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Superseding AMS 4311A

ALUMINUM ALLOY RINGS, ROLLED OR FORGED
5.6Zn - 2.5Mg - 1.6Cu - 0.23Cr (7075-T7351, 7075-T7352)
Solution Heat Treated, Mechanically Stress Relieved, and Precipitation Heat Treated
UNS A97075

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 a combination of high strength, resistance to stress-corrosion cracking, and good stability during machining.

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

Type 1 - Stress-relieved by stretching (7075-T7351)
Type 2 - Stress-relieved by compression (7075-T7352)

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 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 2808 - Identification, Forgings

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 Magensium-Alloy Products, (Metric)
ASTM B594 - Ultrasonic Inspection of Aluminum-Alloy Products for Aerospace Applications
ASTM B660 - Packaging/Packing of Aluminum and Magnesium Products
ASTM E10 - Brinell Hardness of Metallic Materials
ASTM E34 - Chemical Analysis of Aluminum and Aluminum Alloys
ASTM E1004 - Electromagnetic (Eddy-Current) Measurements of Electrical Conductivity
ASTM G47 - Determining Susceptibility to Stress-Corrosion Cracking of High-Strength Aluminum Alloy Products

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

2.3.2 Military Standards:

MIL-STD-1537 - Electrical Conductivity Test for Measurement of Heat Treatment of Aluminum Alloy, Eddy Current Method

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
Zinc	5.1	6.1
Magnesium	2.1	2.9
Copper	1.2	2.0
Chromium	0.18	0.28
Iron	--	0.50
Silicon	--	0.40
Manganese	--	0.30
Titanium	--	0.20
Residual Elements, each	--	0.05
Residual Elements, total	--	0.15
Aluminum	remainder	

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

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

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

3.3 Properties: Rings shall conform to the following requirements:

3.3.1 Tensile Properties:

3.3.1.1 Rings with OD to Wall Thickness Ratio Less than 10: Shall be as agreed upon by purchaser and vendor.

3.3.1.2 Rings with OD to Wall Thickness Ratio of 10 or Greater: Shall be in accordance with Table I, determined in accordance with ASTM B557 or ASTM B557M. Tensile tests are not required in any direction from which a specimen at least 2.50 inches (63.5 mm) in length cannot be obtained.

TABLE I

Nominal Thickness at Time of Heat Treatment Inches (See 3.3.1.2.1)	Specimen Orientation (See 3.3.1.2.2)	Tensile Strength psi, minimum	Yield Strength at 0.2% Offset psi, minimum	Elongation in 4D %, minimum
Up to 3, incl	Tangential	66,000	54,000	7
	Axial	64,000	50,000	4
	Radial	61,000	50,000	3
Over 3 to 4, incl	Tangential	64,000	53,000	7
	Axial	63,000	48,000	3
	Radial	60,000	48,000	2
Over 4 to 5, incl	Tangential	62,000	51,000	7
	Axial	61,000	46,000	3
	Radial	58,000	46,000	2
Over 5 to 6, incl	Tangential	61,000	49,000	6
	Axial	59,000	44,000	3
	Radial	57,000	44,000	2

TABLE I (SI)

Nominal Thickness at Time of Heat Treatment Millimetres (See 3.3.1.2.1)	Specimen Orientation (See 3.3.1.2.2)	Tensile Strength MPa, minimum	Yield Strength at 0.2% Offset MPa, minimum	Elongation in 4D %, minimum
Up to 76, incl	Tangential	455	372	7
	Axial	441	345	4
	Radial	421	345	3
Over 76 to 102, incl	Tangential	441	365	7
	Axial	434	331	3
	Radial	414	331	2
Over 102 to 127, incl	Tangential	427	352	7
	Axial	421	317	3
	Radial	400	317	2
Over 127 to 152, incl	Tangential	421	338	6
	Axial	407	303	3
	Radial	393	303	2

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

3.3.1.2.2 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 direction of rolling). All specimens shall be machined from the core of the ring.

3.3.1.2.3 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.

3.3.1.2.4 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 Hardness: Should be not lower than 130 HB/10/500 or 135 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.

3.3.2.1 Hardness requirements for rings over 5 inches (127 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.

3.3.3 Stress-Corrosion Resistance: Specimens cut from rings shall meet the Ø conductivity test of 3.3.3.1 and shall exhibit no evidence of stress-corrosion cracking when tested in accordance with 3.3.3.2. The test of 3.3.3.2 need not be performed on rings meeting the requirements of 3.3.3.1.1 and 3.3.3.1.2.

3.3.3.1 Conductivity: Shall be as follows, determined on the surface of the Ø sample in accordance with ASTM E1004 using equipment calibrated in accordance with MIL-STD-1537:

3.3.3.1.1 If the conductivity is 40.0% IACS (International Annealed Copper Ø Standard) (23.2 MS/m) or higher and tangential tensile properties meet specified requirements, the rings are acceptable.

3.3.3.1.2 If the conductivity is 38.0% - 39.9% IACS (22.0 - 23.1 MS/m), incl, if Ø the tangential tensile properties meet the specified requirements, and if the tangential yield strength does not exceed the specified minimum by more than 11,900 psi (82 MPa), the rings are acceptable.

3.3.3.1.3 If the conductivity is between 38.0 - 39.9% IACS (22.0 - 23.1 MS/m) Ø and the tangential yield strength exceeds the specified minimum value by more than 11,900 psi (82 MPa), the rings shall be given additional precipitation heat treatment. If, after such treatment, the rings meet the requirements of 3.3.1 and 3.3.3.1.1 and 3.3.3.1.2, the rings are acceptable.

3.3.3.1.4 If the conductivity is below 38.0% IACS (22.0 MS/m), the rings are not Ø acceptable but may be re-heat treated or given additional precipitation heat treatment to meet the specified requirements.

3.3.3.2 Stress-Corrosion Cracking Resistance: Specimens as in 4.3.5 from rings Ø 0.750 inch (19.05 mm) and over in least dimension, shall show no evidence of stress-corrosion cracking when stressed to 75% of the specified minimum tangential yield strength with axis of loading parallel to the axial direction of the ring. Test shall be conducted in accordance with ASTM G47.

3.3.4 Grain Flow: Shall be as specified on the drawing or as agreed upon by purchaser and vendor.

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 requirements for composition (3.1), tensile properties (3.3.1), hardness (3.3.2), stress-corrosion resistance (3.3.3), and ultrasonic soundness (3.4.1) are classified as acceptance tests and shall be performed on each lot.

4.2.2 Periodic Tests: Tests to determine conformance to requirements for stress-corrosion cracking resistance (3.3.3.2) and grain flow (3.3.4) 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 to determine conformance to all 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.

4.2.3.1 For direct U.S. Military procurement, substantiating test data and, when requested, preproduction rings 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 Ø solution heat treated in the same batch furnace load or consecutively in a continuous furnace in an eight-hour period and solution and precipitation heat treated as a unit:

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. 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 directions is not required by 3.3.1, tensile 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 which has been solution heat treated and stress-relieved with the production rings. Solution heat treated and stress-relieved 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: Each ring. If hardness of any ring indicates low tensile properties, the ring having the lowest hardness shall be tested for tensile properties.

4.3.4 Electrical Conductivity: Shall be taken on all rings and on each of the tangential tensile specimens required in 4.3.2.

4.3.5 Stress-Corrosion Cracking Resistance: Samples shall be taken from a ring or ring prolongation. Specimens shall be not smaller than a 0.750 inch (19.05 mm) cube.

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 rings shall furnish with each shipment a report stating that Ø the chemical composition conforms to the requirements of this specification and showing the results of tests on each lot to determine conformance to the other acceptance test requirements and, when performed, to the periodic test requirements. This report shall include the purchase order number, lot number, AMS 4311B, 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 4311B, 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.