AEROSPACE MATERIAL SPECIFICATION

AMS4311™	REV. F

Issued 1976-07
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Superseding AMS4311E

Aluminum Alloy, Rolled or Forged Rings
5.6Zn - 2.5Mg - 1.6Cu - 0.23Cr (7075-T7351, 7075-T7352)
Solution Heat Treated, Mechanically Stress Relieved, and Precipitation Heat Treated
(Composition similar to UNS A97075)

RATIONALE

AMS4311F revises condition (3.2), properties (3.3.1.2.4), reports (4.4) and identification (5.1.1), and results from a Five-Year Review and update of this specification.

1. SCOPE

1.1 Form

This specification covers an aluminum alloy in the form of rolled or forged rings up to 6 inches (152 mm) inclusive, in nominal thickness at the time of heat treatment, and having an OD to wall thickness ratio of 10 or greater (see 8.6).

1.2 Application

These rings have been used typically for applications requiring a combination of high strength, resistance to stress-corrosion cracking, and good stability during machining, but usage is not limited to such applications.

1.3 Classifications

Rings 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 issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
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http://standards.sae.org/AMS4311F

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AMS2355 Quality Assurance, Sampling and Testing Aluminum Alloys and Magnesium Alloy Wrought Products (Except Forging Stock), and Rolled, Forged, or Flash Welded Rings

AMS2772 Heat Treatment of Aluminum Alloy Raw Materials

ARP1917 Clarification of Terms Used in Aerospace Metals Specifications

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM B594 Ultrasonic Inspection of Aluminum-Alloy Products for Aerospace Applications

ASTM B660 Packaging/Packing of Aluminum and Magnesium Products

ASTM B666/B666M Identification of Aluminum and Magnesium Alloy Products

ASTM E10 Brinell Hardness of Metallic Materials

2.3 ANSI Accredited Publications

Copies of these documents are available online at http://webstore.ansi.org/.

ANSI H35.1/H35.1M Standard Alloy and Temper Designation System For Aluminum

3. TECHNICAL REQUIREMENTS

3.1 Composition

Shall conform to the percentages by weight shown in Table 1, determined in accordance with AMS2355.

Table 1 - Composition

Element	Min	Max
Silicon	--	0.40
Iron	--	0.50
Copper	1.2	2.0
Manganese	--	0.30
Magnesium	2.1	2.9
Chromium	0.18	0.28
Zinc	5.1	6.1
Titanium	--	0.20
Other Elements, each	--	0.05
Other 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 AMS2772 to the following tempers:

3.2.1 Type 1

Solution heat treated, stress relieved by stretching to produce a permanent set of 1 to 5%, and precipitation heat treated to the T7351 temper (see ANSI H35.1/H35.1M).

3.2.2 Type 2

Solution heat treated, stress relieved by compression to produce a permanent set of 1 to 5%, and precipitation heat treated to the T7352 temper (see ANSI H35.1/H35.1M). 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, determined in accordance with AMS2355.

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 producer.

3.3.1.2 Rings with OD to Wall Thickness Ratio of 10 or Greater

Shall be in accordance with Table 2. 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 2

Table 2A - Minimum tensile properties, inch/pound units

Nominal Thickness at Time of Heat Treatment, Inch (see 3.3.1.2.1)	Specimen Orientation (see 3.3.1.2.2)	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 4D %
Up to 3, incl	Tangential	66.0	54.0	7
	Axial	64.0	50.0	4
	Radial	61.0	50.0	3
Over 3 to 4, incl	Tangential	64.0	53.0	7
	Axial	63.0	48.0	3
	Radial	60.0	48.0	2
Over 4 to 5, incl	Tangential	62.0	51.0	7
	Axial	61.0	46.0	3
	Radial	58.0	46.0	2
Over 5 to 6, incl	Tangential	61.0	49.0	6
	Axial	59.0	44.0	3
	Radial	57.0	44.0	2

Table 2B - Minimum tensile properties, SI units

Nominal Thickness at Time of Heat Treatment, Millimeters (see 3.3.1.2.1)	Specimen Orientation (see 3.3.1.2.2)	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 4D %
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 Mechanical property requirements for product outside the thickness ranges of 1.1 shall be as agreed upon by purchaser and producer.

3.3.2 Stress-Corrosion Resistance

Specimens cut from rings shall meet the conductivity test of 3.3.2.1 and shall exhibit no evidence of stress-corrosion cracking when tested in accordance with 3.3.2.2. The test of 3.3.2.2 need not be performed on rings meeting the requirements of 3.3.2.1.1 and 3.3.2.1.2.

3.3.2.1 Conductivity

Shall be as follows, determined on the surface of the sample (see 4.3.2):

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

3.3.2.1.2 If the conductivity is between 38.0 to 39.9% IACS (22.0 to 23.1 MS/m), if the tangential tensile properties meet the specified requirements, and if the tangential yield strength does not exceed the specified minimum by more than 11.9 ksi (82 MPa), the rings are acceptable.

3.3.2.1.3 If the conductivity is between 38.0 to 39.9% IACS (22.0 to 23.1 MS/m) and the tangential yield strength exceeds the specified minimum value by more than 11.9 ksi (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 3.3.2.1.1 or 3.3.2.1.2, the rings are acceptable.

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

3.3.2.2 Stress-Corrosion Cracking Resistance

Specimens as in 4.3.3 from rings 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.

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 and shall meet the Class A acceptance limits of that specification.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The producer of rings shall supply all samples for producer's tests and shall be responsible for the performance of all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the rings conform to the specified requirements.

4.2 Classification of Tests

4.2.1 Acceptance Tests

Composition (3.1), tensile properties (3.3.1), stress-corrosion resistance (3.3.2), conductivity (3.3.2.1), and ultrasonic soundness (3.4.1) are acceptance tests and, except for composition, shall be performed on each lot.

4.2.2 Periodic Tests

Stress-corrosion cracking resistance (3.3.2.2) are periodic tests and shall be performed at a frequency selected by the producer unless frequency of testing is specified by purchaser.

4.3 Sampling and Testing

Shall be in accordance with AMS2355 and the following:

4.3.1 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 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 production rings. Solution heat treated and stress-relieved ring segments shall be included in each precipitation heat treatment furnace load.

4.3.1.1 When requested by purchaser, at least one-half of each ring segment obtained as in 4.3.1 or one-half of each ring prolongation tested shall be submitted to purchaser with the rings represented.

4.3.2 Electrical Conductivity

Shall be taken on all rings and on each of the tangential tensile specimens required in 4.3.1.