AEROSPACE MATERIAL SPECIFICATION

AMS4312	REV. D

Issued 1977-01
Revised 2008-07
Reaffirmed 2013-12

Superseding AMS4312C

Aluminum Alloy, Rolled or Forged Rings
1.0Mg - 0.60Si - 0.28Cu - 0.20Cr (6061-T651, 6061-T652)
Solution Heat Treated, Mechanically Stress Relieved, and Precipitation Heat Treated
(Composition similar to UNS A96061)

RATIONALE

AMS4312D has been reaffirmed to comply with the SAE five-year review policy.

1. SCOPE

1.1 Form

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

1.2 Application

These rings have been used typically for structural applications requiring material with moderate strength and excellent resistance to stress-corrosion cracking and where good stability is required during machining, but usage is not limited to such applications. Alloy is further characterized by excellent fusion weldability.

1.3 Classification

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

Type 1 Stress relieved by stretching (6061T651)
Type 2 Stress relieved by compression (6061T652)

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)**
Tel: +1 724-776-4970 (outside USA)
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SAE WEB ADDRESS: **http://www.sae.org**

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AMS4312D

2.1 SAE Publications

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

AMS2355	Quality Assurance Sampling and Testing of Aluminum Alloys and Magnesium Alloys, Wrought Products, Except Forging Stock, and Rolled, Forged, or Flash Welded Rings
AMS2772	Heat Treatment of Aluminum Alloy Raw Materials

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 B 594	Ultrasonic Inspection of Aluminum-Alloy Wrought Products for Aerospace Applications
ASTM B 660	Packaging/Packing of Aluminum and Magnesium Products
ASTM B 666/B 666M	Identification Marking of Aluminum Products

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	0.8
Iron	--	0.7
Copper	0.15	0.40
Manganese	--	0.15
Magnesium	0.8	1.2
Chromium	0.04	0.35
Zinc	--	0.25
Titanium	--	0.15
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.

3.2.1 Type 1

Solution heat treated, stress relieved by stretching to produce a permanent set of 11/2 to 5%, and precipitation heat treated to the T651 temper.

3.2.2 Type 2

Solution heat treated, stress relieved by compression to produce a permanent set of 11/2 to 5%, and precipitation heat treated to the T652 temper. 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 on the mill produced size.

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 2. Tensile tests are not required in any direction from which a specimen at least 2.375 inches (60.32 mm) in length cannot be obtained.

TABLE 2A - MINIMUM TENSILE PROPERTIES, INCH/POUND UNITS

Nominal Thickness at Time of Heat Treatment Inches (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 4, incl	Tangential	38.0	35.0	10
	Axial	38.0	35.0	8
	Radial	37.0	33.0	5
Over 4 to 8, incl	Tangential	37.0	34.0	8
	Axial	37.0	34.0	6
	Radial	35.0	32.0	4

TABLE 2B - MINIMUM TENSILE PROPERTIES, SI UNITS

Nominal Thickness at Time of Heat Treatment mm (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 102, incl	Tangential	262	241	10
	Axial	262	241	8
	Radial	255	228	5
Over 102 to 203, incl	Tangential	255	234	8
	Axial	255	234	6
	Radial	241	221	4

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

3.3.1.2.2 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 under 0.250 inch (6.35 mm), 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 Hardness

Shall be not lower than 80 HB/10/500 or 85 HB/10/1000, but the rings shall not be rejected on the basis of hardness if the applicable tensile property requirements are met (See 4.3.3).

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 B 594 and shall meet Class A acceptance limits of that publication.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The vendor of rings shall supply all samples for vendor'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 specified requirements.

4.2 Classification of Tests

4.2.1 Acceptance Tests

All technical requirements are acceptance tests and except for composition, shall be performed on each lot.

4.3 Sampling and Testing

Shall be in accordance with AMS2355 and the following: A lot shall be all rings of the same size solution heat treated in the same batch furnace load or consecutively in a continuous furnace during an eight-hour period and precipitation heat treated as a unit.

4.3.1 Composition

One or more samples 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 purchaser at 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, 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, not less than one-half of each ring segment obtained as in 4.3.2, or one-half of each prolongation tested, shall be submitted to 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 also be tested for tensile properties.