



AEROSPACE MATERIAL SPECIFICATION

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

AMS 4312

Issued 1-15-77
Revised

UNS A96061

ALUMINUM ALLOY RINGS, ROLLED OR FORGED
1.0Mg - 0.60Si - 0.28Cu - 0.20Cr (6061-T651, 6061-T652)
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 structural applications requiring material with moderate strength and excellent resistance to stress-corrosion cracking and where good stability is required during machining. Alloy is further characterized by excellent fusion weldability.
- 1.3 Classification: The rings covered by this specification are classified by type of mechanical stress relief as follows:

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

- 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) 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 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 E10 - Brinell Hardness of Metallic Materials
ASTM E34 - Chemical Analysis of Aluminum and Aluminum-Base 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

SAE Technical Board rules provide that: "All technical reports, including standards approval, and practices recommended, are advisory only. Their use by anyone engaged in industry or trade is entirely voluntary. There is no agreement to adhere to any SAE standard or recommended practice, and no commitment to conform to or be guided by any technical report. In formulating and approving technical reports, the Board and its Committees will not investigate or consider patents which may apply to the subject matter. Prospective users of the report are responsible for protecting themselves against liability for infringement of patents."

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
Magnesium	0.8	1.2
Silicon	0.40	0.8
Copper	0.15	0.40
Chromium	0.04	0.35
Iron	--	0.7
Zinc	--	0.25
Manganese	--	0.15
Titanium	--	0.15
Other Impurities, each	--	0.05
Other Impurities, 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 1-1/2 - 5%, and precipitation heat treated.

3.2.2 Type 2: Solution heat treated, stress relieved by compression to produce a permanent set of 1-1/2 - 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. 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 3.3.1.2.1)	Specimen Orientation (See 3.3.1.2.2)	Tensile Strength psi, min	Yield Strength at 0.2% Offset psi, min	Elongation in 2in. or 4D %, min
Up to 4, incl	Tangential	38,000	35,000	10
	Axial	38,000	35,000	8
	Radial	37,000	33,000	5
Over 4 to 8, incl	Tangential	37,000	34,000	8
	Axial	37,000	34,000	6
	Radial	35,000	32,000	4

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, min	Yield Strength at 0.2% Offset MPa, min	Elongation in 50.8 mm or 4D %, min
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 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 **Hardness:** Should be not lower than 80 HB/10/500, 80 HB/14.3/1000, or 85 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 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 perform 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.
- 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.

- 4.3 Sampling: Shall be as follows; 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 8-hr period 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.
- 4.3.1.1 Unless compliance with 4.3.1 is established, an analysis shall be made for each 4000 lb (1816 kg) or less of material 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, at least one half of each ring segment obtained as in 4.3.2, or one half of each 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 Quality: Each ring.
- 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 three copies of a report stating that 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 technical requirements of this specification. This report shall include the purchase order number, material specification number, size or part number, and quantity.
- 4.5.2 The vendor of finished or semi-finished parts shall furnish with each shipment three copies of a report showing the purchase order number, material specification number, 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 a statement that the rings conform, or shall include copies of laboratory reports showing the results of tests to determine conformance.
- 4.6 Resampling and Retesting: If any specimen used in the above tests fails to meet the specified requirements, disposition of the rings may be based on the results of testing two additional specimens for each original nonconforming specimen. Failure of any retest specimen to meet the specified requirements shall be cause for rejection of the rings represented and no additional testing shall be permitted. Results of all tests shall be reported.