SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS 4144 | REV. F

Issued 1965-09
Revised 2006-05
Reaffirmed 2011-09

Superseding AMS 4144E

Aluminum Alloy, Hand Forgings and Rolled Rings
6.3Cu - 0.30Mn - 0.18Zr - 0.10V - 0.06Ti (2219-T852/T851)
Solution Heat Treated, Mechanically Stress Relieved, and Precipitation Heat Treated
(Composition similar to UNS A92219)

RATIONALE

AMS 4144F is a Five Year Review and update of this specification.

1. SCOPE

1.1 Form

This specification covers an aluminum alloy in the form of hand forgings and rolled rings.

1.2 Application

These products have been used typically for structural parts subject to warpage during machining, but usage is not limited to such applications. Product may be welded in the -T852/-T851 condition but properties are improved by re-heat treatment to -T6 temper after welding.

1.2.1 Certain design and fabricating procedures and service conditions may cause these products to become susceptible to stress-corrosion cracking; ARP823 recommends practices to minimize such conditions.

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.

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.

AMS 2355	Quality Assurance Sampling and Testing, Aluminum Alloys and Magnesium Alloys, Wrought Products, Except Forging Stock, and Rolled, Forged, or Flash Welded Rings
AMS 2772	Heat Treatment of Aluminum Alloy Raw Materials
AMS 2808	Identification, Forgings
ARP823	Minimizing Stress-Corrosion Cracking in Wrought Heat-Treatable Aluminum Alloy Products
AS1990	Aluminum Alloy Tempers

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
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/AMS4144F

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 Products for Aerospace Applications
ASTM B 660	Packaging/Packing of Aluminum and Magnesium Products
ASTM E 1417	Liquid Penetrant Examination

3. TECHNICAL REQUIREMENTS

3.1 Composition

Shall conform to the percentages by weight shown in Table 1, determined in accordance with AMS 2355.

TABLE 1 - COMPOSITION

Element	min	max
Silicon	--	0.20
Iron	--	0.30
Copper	5.8	6.8
Manganese	0.20	0.40
Magnesium	--	0.02
Zinc	--	0.10
Titanium	0.02	0.10
Vanadium	0.05	0.15
Zirconium	0.10	0.25
Other Elements, each	--	0.05
Other Elements total	--	0.15
Aluminum	remainder	

3.2 Condition

Product shall be solution heat treated, mechanically stress-relieved, and precipitation heat treated to the T851 or T852 condition as applicable (See AS 1990). Heat treatments shall be performed in accordance with AMS 2772.

3.2.1 Seamless Rolled Rings

Shall be processed by either of the following procedures:

Condition 1: Stress relieve by compression to produce a permanent set of 2 to 5% (-T852)
Condition 2: Stress relieve by tension to produce a permanent set of 2 to 5% (-T851)

3.2.1.1 Seamless rolled rings shall be supplied in either Condition 1 or 2.

3.3 Properties

The product shall conform to the following requirements, determined in accordance with AMS 2355 on the mill product:

3.3.1 Tensile Properties

Shall be as follows:

3.3.1.1 Hand Forgings

Specimens machined from hand forgings 17 inches (432 mm) and under in nominal thickness shall conform to the requirements of Table 2. Tests may be waived for any test direction having a dimension under 2 inches (51 mm). Tests need not be made in the longitudinal direction unless required by purchaser.

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

Nominal Thickness Inches	Specimen Orientation	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 4D %
Up to 4, incl	Longitudinal	62.0	50.0	6
	Long Trans.	62.0	49.0	4
	Short Trans.	60.0	46.0	3
Over 4 to 6, incl	Longitudinal	58.0	44.0	6
	Long Trans.	56.0	42.0	4
	Short Trans.	56.0	41.0	3
Over 6 to 8, incl	Longitudinal	57.0	43.0	6
	Long Trans.	55.0	41.0	4
	Short Trans.	55.0	40.0	3
Over 8 to 10, incl	Longitudinal	56.0	42.0	6
	Long Trans.	54.0	41.0	3
	Short Trans.	54.0	39.0	3
Over 10 to 12, incl	Longitudinal	54.0	41.0	6
	Long Trans.	53.0	40.0	3
	Short Trans.	53.0	39.0	2
Over 12 to 14, incl	Longitudinal	53.0	40.0	6
	Long Trans.	52.0	40.0	3
	Short Trans.	52.0	38.0	2
Over 14 to 17, incl	Longitudinal	51.0	39.0	6
	Long Trans.	50.0	39.0	3
	Short Trans.	50.0	37.0	2

TABLE 2B - MINIMUM TENSILE PROPERTIES, SI UNITS

Nominal Thickness Millimeters	Specimen Orientation	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 4D %	Elongation in 5D %
Up to 102, incl	Longitudinal	427	345	6	5
	Long Trans.	427	338	4	3
	Short Trans.	414	317	3	2
Over 102 to 152, incl	Longitudinal	400	303	6	
	Long Trans.	386	290	4	
	Short Trans.	386	283	3	
					--
Over 152 to 203, incl	Longitudinal	393		6	
	Long Trans.	379	296	4	
	Short Trans.	379	283	3	
			276		--
Over 203 to 254, incl	Longitudinal	386	290	6	
	Long Trans.	372	283	3	
	Short Trans.	372	269	3	
					--
Over 254 to 305, incl	Longitudinal	372	283	6	
	Long Trans.	365	276	3	
	Short Trans.	365	269	2	
					--
Over 305 to 356, incl	Longitudinal	365	276	6	
	Long Trans.	358	276	3	
	Short Trans.	358	262	2	
					--
Over 356 to 432, incl	Longitudinal	352	269	6	
	Long Trans.	345	269	3	
	Short Trans.	345	255	2	--

3.3.1.2 Rolled Rings

Shall be as shown in Table 3 for rings in either condition -T851 or -T852.

TABLE 3A - MINIMUM TENSILE PROPERTIES, INCH/POUND UNITS

Nominal Thickness at Time of Heat Treatment Inches	Specimen Orientation	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 4D %
Up to 2.5, incl	Tangential	60.0	48.0	6
	Axial	60.0	46.0	4
	Radial	58.0	44.0	3
Over 2.5 to 4, incl	Tangential	58.0	46.0	6
	Axial	58.0	44.0	4
	Radial	56.0	42.0	3
Over 4 to 5, incl	Tangential	56.0	44.0	5
	Axial	56.0	42.0	3
	Radial	54.0	40.0	2
Over 5 to 6, incl	Tangential	54.0	42.0	5
	Axial	54.0	40.0	3
	Radial	52.0	40.0	2

TABLE 3B - MINIMUM TENSILE PROPERTIES, SI UNITS

Nominal Thickness at Time of Heat Treatment Millimeters	Specimen Orientation	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 4D %
Up to 64, incl	Tangential	414	331	6
	Axial	414	317	4
	Radial	400	303	3
Over 64 to 102, incl	Tangential	400	317	6
	Axial	400	303	4
	Radial	386	290	3
Over 102 to 127, incl	Tangential	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

3.3.1.3 Grain flow of hand forgings, except in areas which contain flash-line end grain, shall follow the general contour of the forging showing no evidence of reentrant grain flow.

3.4 Quality

The product, 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 product.

3.4.1 When specified, forgings and rolled rings shall be subjected to a caustic etch followed by visual examination of the product surfaces for indications, by ultrasonic inspection in accordance with ASTM B 594, and/or by fluorescent penetrant inspection in accordance with ASTM E 1417. Standards for acceptance shall be as agreed upon by purchaser and vendor.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The vendor of the product 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 product conforms to specified requirements.

4.2 Classification of 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 AMS 2355 and the following:

4.3.1 Tensile Properties

4.3.1.1 Hand Forgings

Two or more tensile specimens shall be taken from a forging or forging prolongation representing the lot. One specimen shall be taken in the long-transverse direction and the other in the short-transverse direction.