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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 4144D

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Superseding AMS 4144C

Submitted for recognition as an American National Standard

ALUMINUM ALLOY HAND FORGINGS AND ROLLED RINGS
6.3Cu - 0.30Mn - 0.18Zr - 0.10V - 0.06Ti (2219-T852)
Solution Heat Treated, Stress Relief Compressed, and Precipitation Heat Treated

UNS A92219

1. SCOPE:

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

1.2 Application: Primarily for structural parts subject to warpage during machining. May be welded in the -T852 condition but properties are improved by re-heat treatment to -T6 temper after welding.

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

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order.

2.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

2.1.1 Aerospace Material Specifications:

AMS 2355 - Quality Assurance Sampling and Testing of Aluminum Alloys and Magnesium Alloys, Wrought Products (Except Forging Stock) and Flash Welded Rings

MAM 2355 - Quality Assurance Sampling and Testing of Aluminum Alloys and Magnesium Alloys, Wrought Products (Except Forging Stock) and Flash Welded Rings, Metric (SI) Units

AMS 2808 - Identification, Forgings

2.1.2 Aerospace Recommended Practices:

ARP823 - Minimizing Stress-Corrosion Cracking in Wrought Heat-Treatable Aluminum Alloy Products

2.2 ASTM Publications: Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM B 594 - Ultrasonic Inspection of Aluminum-Alloy Products for Aerospace Applications
ASTM B 660 - Packaging/Packing of Aluminum and Magnesium Products

2.3 U.S. Government Publications: Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

2.3.1 Military Specifications:

MIL-H-6088 - Heat Treatment of Aluminum Alloys

2.3.2 Military Standards:

MIL-STD-6866 - Inspection, Liquid Penetrant

3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall conform to the following percentages by weight, Ø determined in accordance with AMS 2355 or MAM 2355:

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

3.2 Condition: Solution heat treated, stress-relieved by compressing to produce a permanent set of 1 - 5%, and precipitation heat treated. Heat treatments shall be performed in accordance with MIL-H-6088.

3.3 Properties: The product shall conform to the following requirements, determined in accordance with AMS 2355 or MAM 2355:

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 I. Tests may be waived for any test direction having a dimension less than 2 inches (51 mm). Tests need not be made in the longitudinal direction unless required by purchaser.

TABLE I

Nominal Thickness Inches	Specimen Orientation	Tensile Strength ksi, min	Yield Strength at 0.2% Offset ksi, min	Elongation in 4D %, min
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 I (SI)

Nominal Thickness Millimeters	Specimen Orientation	Tensile Strength MPa, min	Yield Strength at 0.2% Offset MPa, min	Elongation %, min in 4D	Elongation %, min 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	296	6	
	Long Trans.	379	283	4	
	Short Trans.	379	276	3	
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	

3.3.1.1.1 Tensile properties of specimens machined from forgings over 17 inches (432 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.

3.3.1.2 Rolled Rings:

3.3.1.2.1 Tangential: Specimens machined from rings 2.5 inches (63.5 mm) and under in nominal thickness with axis of specimen tangential to ring OD (axis parallel to direction of rolling) shall have the following properties:

Tensile Strength, minimum	60.0 ksi (414 MPa)
Yield Strength at 0.2% Offset, minimum	48.0 ksi (331 MPa)
Elongation in 4D, minimum	6%

3.3.1.2.2 Axial: Specimens machined from rings 2.5 inches (63.5 mm) and under in nominal radial thickness with axis of specimen parallel to axis of ring (axis transverse to direction of rolling) shall conform to the following requirements:

Tensile Strength, minimum	60.0 ksi (414 MPa)
Yield Strength at 0.2% Offset, minimum	46.0 ksi (317 MPa)
Elongation in 4D, minimum	4%

3.3.1.2.3 Tensile properties of specimens machined from rings over 2.5 inches (63.5 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.

3.3.1.3 Ø 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 re-entrant grain flow.

3.3.2 Hardness: Should be not lower than 115 HB/10/500 or 122 HB/10/1000, or equivalent, but forgings and rolled rings shall not be rejected on the basis of hardness if the tensile property requirements are met.

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 Ø When specified, forgings and rolled rings shall be subjected to a caustic etch followed by visual examination of the product surfaces for defect indications, by ultrasonic inspection in accordance with ASTM B 594, and/or by fluorescent penetrant inspection in accordance with MIL-STD-6866. Standards for acceptance shall be as agreed upon by purchaser and vendor.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Ø Responsibility for Inspection: The vendor of the product shall supply all samples for vendor's tests and shall be responsible for performing all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests for all technical requirements are acceptance tests and shall be performed on each lot.

4.3 Ø Sampling and Testing: Shall be in accordance with AMS 2355 or MAM 2355 and the following: