

AEROSPACE MATERIAL SPECIFICATION

SAE

AMS-4320

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Submitted for recognition as an American National Standard

ALUMINUM ALLOY FORGINGS
7.7Zn - 2.5Mg - 1.5Cu - 0.16Cr (7149-T73)
Solution and Precipitation Heat Treated

UNS A97149

1. SCOPE:

1.1 Form: This specification covers an aluminum alloy in the form of die forgings, hand forgings, and forging stock.

1.2 Application: Primarily for parts requiring high strength and resistance to stress-corrosion cracking.

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-2201 - Tolerances, Aluminum and Aluminum Alloy Bar, Rod, Wire, and Forging Stock, Rolled or Cold Finished

MAM-2201 - Tolerances, Metric, Aluminum and Aluminum Alloy Bar, Rod, Wire, and Forging Stock, Rolled, Drawn, or Cold Finished

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-2645 - Fluorescent Penetrant Inspection

AMS-2808 - Identification, Forgings

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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

3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall conform to the following percentages by weight, 0 determined in accordance with AMS-2355 or MAM-2355:

	min	max
Zinc	7.2	8.2
Magnesium	2.0	2.9
Copper	1.2	1.9
Chromium	0.10	0.22
Iron	--	0.20
Manganese	--	0.20
Silicon	--	0.15
Titanium	--	0.10
Other Impurities, each	--	0.05
Other Impurities, total	--	0.15
Aluminum	remainder	

3.2 Condition: The product shall be supplied in the following condition:

3.2.1 Die and Hand Forgings: Solution and precipitation heat treated.

3.2.2 Forging Stock: As ordered by the forging manufacturer.

3.3 Heat Treatment: Shall be as follows: furnace surveys and calibration of temperature controllers and recorders shall be in accordance with MIL-H-6088.

3.3.1 Solution Heat Treatment: Heat to 875°F ± 10 (468°C ± 6), hold at heat for not less than 60 minutes, and quench in water at 130° - 150°F (54° - 66°C).

3.3.2 Holding Period: Hold at room temperature for not less than 48 hours.

3.3.3 Precipitation Heat Treatment: Heat to 250°F ± 10 (121°C ± 6), hold at heat for 24 hours ± 1, increase temperature to 330°F ± 5 (166°C ± 3), hold at heat for 14 hours ± 0.5, and cool in air. For section thicknesses over 4 inches (102 mm), the second step may be reduced to 325°F ± 5 (163°C ± 3).

3.3.3.1 The practices for the second step of the precipitation heat treatment are recommendations; some adjustments may be necessary depending on furnace equipment, size of load, forging configuration, etc.

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

3.4.1 Forgings:

3.4.1.1 Tensile Properties: Shall be as follows:

3.4.1.1.1 Test Specimens: Shall be as follows, determined on specimens machined from separately-forged coupons representing the forgings and heat treated with the forgings or machined from prolongations on heat treated forgings:

Tensile Strength, minimum	72,000 psi (496 MPa)
Yield Strength at 0.2% Offset, minimum	62,000 psi (427 MPa)
Elongation in 4D, minimum	7%

3.4.1.1.2 Die Forgings:

3.4.1.1.2.1 With Grain Flow: Specimens, machined from forgings with axis of specimen in area of gage length varying not more than 15 degrees from parallel to forging flow lines, shall have the properties shown in Table I.

TABLE I

Nominal Thickness at Time of Heat Treatment Inches	Tensile Strength psi, min	Yield Strength at 0.2% Offset psi, min	Elongation in 4D %, min
Up to 2, incl	72,000	62,000	7
Over 2 to 4, incl	71,000	61,000	7
Over 4 to 5, incl	70,000	60,000	7

TABLE I (SI)

Nominal Thickness at Time of Heat Treatment Millimetres	Tensile Strength MPa, min	Yield Strength at 0.2% Offset MPa, min	Elongation in 4D %, min
Up to 51, incl	496	427	7
Over 51 to 102, incl	490	421	7
Over 102 to 127, incl	483	414	7

3.4.1.1.2.2 Across Grain Flow: Specimens, machined from forgings with axis of specimen in area of gage length varying not more than 15 degrees from transverse to forging flow lines, shall have the properties shown in Table II.

TABLE II

Nominal Thickness at Time of Heat Treatment Inches	Tensile Strength psi, min	Yield Strength at 0.2% Offset psi, min	Elongation in 4D %, min
Up to 1, incl	71,000	61,000	3
Over 1 to 3, incl	70,000	60,000	3
Over 3 to 4, incl	70,000	60,000	2
Over 4 to 5, incl	68,000	58,000	2

TABLE II (SI)

Nominal Thickness at Time of Heat Treatment Millimetres	Tensile Strength MPa, min	Yield Strength at 0.2% Offset MPa, min	Elongation in 4D %, min
Up to 25, incl	490	421	3
Over 25 to 76, incl	483	414	3
Over 76 to 102, incl	483	414	2
Over 102 to 127, incl	469	400	2

3.4.1.1.2.2.1 Elongation requirements do not apply to specimens having a gage-length diameter under 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.

3.4.1.1.3 Hand Forgings: Specimens, machined from forgings having an essentially square or rectangular cross-section heat treated in the indicated thickness shall have the properties shown in Table III provided as-forged section thickness does not exceed 5 inches (127 mm).

TABLE III

Nominal Thickness at Time of Heat Treatment Inches	Specimen Orientation	Tensile Strength psi, min	Yield Strength at 0.2% Offset psi, min	Elongation in 4D %, min
2 to 3, incl	Longitudinal	71,000	61,000	9
	Long-Trans.	71,000	59,000	4
	Short-Trans.	69,000	58,000	3
Over 3 to 4, incl	Longitudinal	69,000	59,000	8
	Long-Trans.	69,000	57,000	3
	Short-Trans.	67,000	56,000	2
Over 4 to 5, incl	Longitudinal	67,000	56,000	7
	Long-Trans.	67,000	56,000	3
	Short-Trans.	66,000	55,000	2

TABLE III (SI)

Nominal Thickness at Time of Heat Treatment Millimetres	Specimen Orientation	Tensile Strength MPa, min	Yield Strength at 0.2% Offset MPa, min	Elongation in 4D %, min
51 to 76, incl	Longitudinal	490	421	9
	Long-Trans.	490	407	4
	Short-Trans.	476	400	3
Over 76 to 102, incl	Longitudinal	476407		8
	Long-Trans.	476	393	3
	Short-Trans.	462386		2
Over 102 to 127, incl	Longitudinal	462386		7
	Long-Trans.	462386		3
	Short-Trans.	455	379	2

3.4.1.1.4 Special Purpose Forgings: Tensile specimens cut from special purpose forgings or from forgings beyond the site and configuration limits of 3.4.1.1.2 and 3.4.1.1.3 shall have tensile properties as specified on the drawing or as agreed upon by purchaser and vendor.

3.4.1.2 Hardness: Forgings should have hardness not lower than shown in Table IV but the forgings shall not be rejected on the basis of hardness if the tensile property requirements of 3.4.1.1.2 or 3.4.1.1.3 are met.

TABLE IV

Nominal Thickness		Hardness	
Inches	Millimetres	HB/10/500	HB/10/1000
Upto 3, incl	Up to 76, incl	135	140
Over 3 to 4, incl	Over 76 to 102, incl	125	130
Over 4 to 5, incl	Over 102 to 127, incl	119	124

3.4.1.2.1 Hardness requirements for forgings over 5 inches (127 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.

3.4.1.3 Stress-Corrosion Resistance: Specimens cut from forgings shall meet the conductivity test of 3.4.1.3.1 and shall exhibit no evidence of stress-corrosion cracking when tested in accordance with 3.4.1.3.2. The test of 3.4.1.3.2 need not be performed on forgings meeting the

3.4.1.3.1 Conductivity: Shall be as follows, determined on the surface of the sample:

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

- 3.4.1.3.1.2 If the conductivity is 38.0 - 39.9% IACS (22.0 - 23.1 MS/m), incl,
0 if the longitudinal tensile properties meet specified requirements, and if the longitudinal yield strength does not exceed the specified minimum by more than 9,900 psi (68 MPa), the forgings are acceptable.
- 3.4.1.3.1.3 If the conductivity is 38.0 - 39.9% IACS (22.0 - 23.1 MS/m), incl,
0 and longitudinal yield strength exceeds the specified minimum value by more than 9,900 psi (68 MPa), the forgings shall be given additional precipitation heat treatment. If, after such treatment, the forgings meet the requirements of 3.4.1.1 and 3.4.1.3.1.1 or 3.4.1.3.1.2, the forgings are acceptable.
- 3.4.1.3.1.4 If the conductivity is below 38.0% IACS (22.0 MS/m), the forgings
0 are not acceptable but may be reheat treated as in 3.3 to meet the specified requirements.
- 3.4.1.3.2 Stress-Corrosion Cracking Resistance: Specimens cut from forgings
0 0.750 inch (19.05 mm) and over in nominal thickness shall show no strength for the principal test direction (longitudinal for die forgings or long-transverse for hand forgings).
- 3.4.1.4 Grain Flow: Shall be as specified on the drawing or as agreed upon by
purchaser and vendor.
- 3.4.2 Forging Stock: When a sample of stock is forged to a test coupon having a
0 degree of mechanical working not greater than the forging and heat treated in the same manner as forgings, specimens taken from the heat treated coupon shall conform to the requirements of 3.4.1.1.1 and 3.4.1.2. If a test specimen taken from the stock after heat treatment in the same manner as forgings conforms to the requirements of 3.4.1.1.1 and 3.4.1.2, the test shall be accepted as equivalent to tests of a forged coupon.
- 3.5 Quality: Forgings, 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 forgings.
- 3.5.1 Die forgings shall be subjected to a caustic etch followed by visual
0 examination of the forging surfaces for defect indications such as seams, laps, bursts, and quench cracks. Surface imperfections which can be removed so that they do not reappear on re-etching and the required section thickness can be maintained are acceptable.
- 3.5.2 When specified, each forging shall be subjected to ultrasonic inspection
0 in accordance with ASTM B 594 and shall meet the following requirements of that specification:
- 3.5.2.1 Die forgings 0.500 to 4.000 inches (12.70 to 101.60 mm), incl, in
section thickness and weighing not over 300 pounds (136 kg) shall meet Class B.