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400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

AMS 4149B G-01-07

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Superseding AMS 4149A

ALUMINUM ALLOY FORGINGS
5.6Zn - 2.5Mg - 1.6Cu - 0.23Cr [7175-T74 (formerly T736)]
Solution and Precipitation Heat Treated

UNS A97175

1. SCOPE:

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

1.2 Application: Primarily for parts requiring a combination of good 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 Aerospace Material Specifications shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

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

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods
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 2375 - Control of Forgings Requiring First Article Approval
AMS 2645 - Fluorescent Penetrant Inspection
AMS 2808 - Identification, Forgings

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM B594 - Ultrasonic Inspection of Aluminum-Alloy Products for Aerospace Applications
ASTM B660 - Packaging/Packing of Aluminum and Magnesium Products

2.3 U.S. Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

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, Ø determined in accordance with AMS 2355 or MAM 2355:

	min	max
Zinc	5.1	6.1
Magnesium	2.1	2.9
Copper	1.2	2.0
Chromium	0.18	0.28
Iron	--	0.20
Silicon	--	0.15
Manganese	--	0.10
Titanium	--	0.10
Other Impurities, each	--	0.05
Other Impurities, total	--	0.15
Aluminum	remainder	

3.2 Condition: Solution and precipitation heat treated (See 8.2); furnace Ø surveys and calibration of temperature controllers and recorders shall be in accordance with MIL-H-6088.

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

3.3.1 Tensile Properties: Shall be as follows:

3.3.1.1 Die Forgings:

3.3.1.1.1 With Grain Flow: Specimens, machined from forgings 6 in. (150 mm) and under in nominal thickness at time of heat treatment or from prolongations on such forgings, with the axis of specimen in the area of the gage length varying not more than 15 deg from parallel to the 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 2 in. or 4D %, min
Up to 3, incl	76,000	66,000	7
Over 3 to 4, incl	73,000	63,000	7
Over 4 to 5, incl	70,000	61,000	7
Over 5 to 6, incl	68,000	58,000	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 50 mm or 4D %, min
Up to 75, incl	525	455	7
Over 75 to 100, incl	505	435	7
Over 100 to 125, incl	485	420	7
Over 125 to 150, incl	470	400	7

3.3.1.1.2 Across Grain Flow: Specimens, machined from forgings 6 in. (150 mm) and under in nominal thickness at time of heat treatment or from prolongations on such forgings, with the axis of specimen in the area of gage length varying not more than 15 deg from perpendicular to the forging flow lines, shall have the properties shown in Table II. If configuration of the forging or prolongation cannot accommodate the transverse specimen described, acceptance of the forging shall be based on testing as in 3.3.1.1.3.

TABLE II

Nominal Thickness At Time Of Heat Treatment Inches	Tensile Strength psi, min	Yield Strength at 0.2% Offset psi, min	Elongation in 2 in. or 4D %, min
Up to 3, incl	71,000	62,000	4
Over 3 to 4, incl	70,000	60,000	4
Over 4 to 5, incl	68,000	58,000	4
Over 5 to 6, incl	65,000	55,000	4

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 50 mm or 4D %, min
Up to 75, incl	490	425	4
Over 75 to 100, incl	485	415	4
Over 100 to 125, incl	470	400	4
Over 125 to 150, incl	450	380	4

3.3.1.1.2.1 Elongation requirements shall not apply to specimens having a gage length diameter less than 0.250 in. (6.25 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 1/8 in. (3 mm) of the trimmed flash line.

3.3.1.1.3 At Angle to Grain Flow: Specimens, machined from forgings 6 in. (150 mm) and under in nominal thickness at time of heat treatment or from prolongations on such forgings, with the axis of specimen in the area of gage length varying more than 15 deg from parallel and also more than 15 deg from perpendicular to the forging flow line, shall have the properties shown in Table II. Such test results shall be identified as neither longitudinal nor transverse tensile test results.

3.3.1.2 Hand Forgings: Specimens, machined from forgings having an essentially square or rectangular cross section, shall have the properties shown in Table III provided that the as-forged section thickness does not exceed 6 in. (150 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 2 in. or 4D %, min
Up to 2, incl	Longitudinal	73,000	63,000	9
	Long Trans.	71,000	60,000	5
Over 2 to 3, incl	Longitudinal	73,000	63,000	9
	Long Trans.	71,000	60,000	5
	Short Trans.	69,000	60,000	4
Over 3 to 4, incl	Longitudinal	71,000	61,000	9
	Long Trans.	70,000	58,000	5
	Short Trans.	68,000	57,000	4

TABLE III (Continued)

Nominal Thickness At Time Of Heat Treatment Inches	Specimen Orientation	Tensile Strength psi, min	Yield Strength at 0.2% Offset psi, min	Elongation in 2 in. or 4D %, min
Over 4 to 5, incl	Longitudinal	68,000	57,000	8
	Long Trans.	67,000	56,000	5
	Short Trans.	66,000	55,000	4
Over 5 to 6, incl	Longitudinal	65,000	54,000	8
	Long Trans.	64,000	52,000	5
	Short Trans.	63,000	52,000	4

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 50 mm or 4D %, min
Up to 50, incl	Longitudinal	505	435	9
	Long Trans.	490	415	5
Over 50 to 75, incl	Longitudinal	505	435	9
	Long Trans.	490	415	5
	Short Trans.	475	415	4
Over 75 to 100, incl	Longitudinal	490	420	9
	Long Trans.	485	400	5
	Short Trans.	470	395	4
Over 100 to 125, incl	Longitudinal	470	395	8
	Long Trans.	460	385	5
	Short Trans.	455	380	4
Over 125 to 150, incl	Longitudinal	450	370	8
	Long Trans.	440	360	5
	Short Trans.	435	360	4

3.3.1.3 Special Purpose Forgings: Tensile property requirements for specimens cut from special purpose forgings or from forgings beyond the size and configuration limits of 3.3.1.1 and 3.3.1.2 shall be as specified on the drawing or as agreed upon by purchaser and vendor.

3.3.2 Hardness: Should be as follows but forgings shall not be rejected on the basis of hardness if the applicable tensile property requirements are met:

3.3.2.1 Die Forgings and Hand Forgings Up to 3 In. (75 mm), Incl, in Nominal Thickness: Not lower than 135 HB/10/500 or 140 HB/10/1000.

3.3.2.2 Die Forgings and Hand Forgings Over 3 In. (75 mm) in Nominal Thickness: As agreed upon by purchaser and vendor.

3.3.3 Stress-Corrosion Resistance: If electrical conductivity (3.3.3.1) and
Ø tensile properties (3.3.1) meet specified requirements, forgings have acceptable stress-corrosion cracking resistance.

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

3.3.3.1.1 If the conductivity is 38.0 - 39.9 IACS (22.0 - 23.1 MS/m), incl, if the tensile properties meet specified requirements, and if the yield strength does not exceed the specified minimum by more than 11,900 psi (80 MPa), forgings are acceptable.

3.3.3.1.2 If the conductivity is below 40.0 IACS (23.2 MS/m) and the yield
Ø strength exceeds the specified minimum value by more than 11,900 psi (80 MPa), forgings shall be given additional precipitation heat treatment and retested to determine conformance to 3.3.1 and 3.3.3.1.

3.3.3.1.3 If the conductivity is below 38.0% IACS (22.0 MS/m), forgings are not acceptable and shall be reprocessed regardless of property level.

3.3.3.2 Specimens, cut from forgings 0.750 in. (18.75 mm) and over in nominal thickness shall show no evidence of stress-corrosion cracking when stressed in the short-transverse direction (perpendicular to grain flow) to 35,000 psi (240 MPa) for forgings 3 in. (75 mm) and under in nominal thickness and to 50% of the specified minimum yield strength for the principal test direction (longitudinal for die forgings or long-transverse for hand forgings) for forgings over 3 in. (75 mm) in nominal thickness.

3.3.4 Fracture-Toughness: When specified, die forgings having nominal thickness
Ø of 1.50 - 6.00 in. (37.5 - 150.0 mm), incl, and hand forgings 2.60 - 6.00 in. (65 - 150 mm) in nominal thickness shall meet the following values of K_{Ic}. The required test directions shall be specified by purchaser.

Test Direction	K_{Ic}, min, psi$\sqrt{in.}$	K_{Ic}, min, MPa$\sqrt{m}$
Die Forgings		
L-T	27,000	29.7
T-L	21,000	23.1
S-L	21,000	23.1
Hand Forgings		
L-T	30,000	33.0
T-L	25,000	27.5
S-L	21,000	23.1

3.3.5 Grain Flow: Except in area of die forgings which contain flash line end grain, grain flow shall follow the general contour of the forgings, showing no evidence of re-entrant flow.

3.4 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.

3.4.1 Die forgings shall be subjected to a caustic etch followed by visual 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.

3.4.2 When specified, forgings shall be subjected to ultrasonic inspection in accordance with ASTM B594 and shall meet the following requirements of that specification:

3.4.2.1 Die forgings 0.500 to 4.000 in. (12.50 to 100.00 mm), incl, in nominal thickness and weighing not over 300 lb (135 kg) shall meet Class B.

3.4.2.2 Hand forgings 1.000 to 6.000 in. (25.00 to 150.00 mm), incl, in nominal thickness and weighing not more than 600 lb (270 kg) shall meet Class A.

3.4.2.3 Acceptance criteria for forgings exceeding the limits of 3.4.2.1 or 3.4.2.2 shall be as agreed upon by purchaser and vendor.

3.4.3 When specified, forgings shall be subjected to fluorescent penetrant inspection in accordance with AMS 2645. Standards for acceptance shall be as agreed upon by purchaser and vendor.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of forgings shall supply all samples for vendor's tests 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 sample and to perform any confirmatory testing deemed necessary to ensure that the forgings conform to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests to determine conformance to requirements for composition (3.1), tensile properties (3.3.1), hardness (3.3.2), stress-corrosion resistance (3.3.3.1), surface visual examination (3.4.1), and, when specified, fracture-toughness (3.3.4), ultrasonic inspection (3.4.2), and fluorescent penetrant inspection (3.4.3) are classified as acceptance tests and shall be performed on each lot.

4.2.2 Periodic Tests: Tests of forgings to determine conformance to requirements for stress-corrosion resistance (3.3.3.2) and grain flow (3.3.5) are classified as periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.