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AEROSPACE MATERIAL SPECIFICATION

AMS 4147B
Superseding AMS 4147A

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ALUMINUM ALLOY FORGINGS
5.6Zn - 2.5Mg - 1.6Cu - 0.23Cr(7075-T7352)
Solution Heat Treated, Stress Relieved by Compression, and Overaged

UNS A97075

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, and where good stability is required during machining.

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 2375 - Control of Forgings Requiring First Article Approval
AMS 2808 - Identification, Forgings

REAFFIRMED

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

ASTM B342 - Electrical Conductivity by Use of Eddy Currents
ASTM B557 - Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products
ASTM B594 - Ultrasonic Inspection of Aluminum-Alloy Products for Aerospace Applications
ASTM E10 - Brinell Hardness of Metallic Materials
ASTM E34 - Chemical Analysis of Aluminum and Aluminum Alloys
ASTM G47 - Determining Susceptibility to Stress-Corrosion Cracking of High-Strength Aluminum Alloy 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

2.3.2 Military Standards:

MIL-STD-649 - Aluminum and Magnesium Products, Preparation for Shipment and Storage
MIL-STD-1537 - Electrical Conductivity Test for Measurement of Heat Treatment of Aluminum Alloys, Eddy Current Method

3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall conform to the following percentages by weight, determined by wet chemical methods in accordance with ASTM E34 or by spectrographic or other analytical methods approved by purchaser:

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	min	max
Zinc	5.1	6.1
Magnesium	2.1	2.9
Copper	1.2	2.0
Chromium	0.18	0.28
Iron	--	0.50
Silicon	--	0.40
Manganese	--	0.30
Titanium	--	0.20
Other Impurities, each	--	0.05
Other Impurities, total	--	0.15
Aluminum	remainder	

3.2 Condition: Solution heat treated, stress relieved by compression to produce a permanent set of not less than 1% nor more than 5% and overaged. The direction and method of compression shall be as agreed upon by purchaser and vendor. Heat treatments shall be performed in accordance with MIL-H-6088.

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3.3 Properties: Forgings shall conform to the following requirements:

3.3.1 Tensile Properties: Shall be as follows, determined in accordance with ASTM B557:

3.3.1.1 Die Forgings:

3.3.1.1.1 With Grain Flow: Specimens, machined from forgings not over 4 in. (100 mm) in nominal thickness at time of heat treatment, with axis of specimen in the area of 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 4D %, min
Up to 3, incl	66,000	56,000	7
Over 3 to 4, incl	64,000	53,000	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 %, min	
			in 4D	in 5D
Up to 75, incl	455	385	7	6
Over 75 to 100, incl	440	365	7	6

3.3.1.1.2 Across Grain Flow: Specimens, machined from forgings not over 4 in. (100 mm) in nominal section thickness at time of heat treatment with axis of specimens as close to short-transverse direction as possible, shall have the properties shown in Table II except as specified in 3.3.1.1.2.1.

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 3, incl	62,000	51,000	3
Over 3 to 4, incl	61,000	49,000	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 %, min	
			in 4D	in 5D
Up to 75, incl	425	350	3	2
Over 75 to 100, incl	420	340	2	1

3.3.1.1.2.1 The 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 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.

3.3.1.2 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 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 4D %, min
Up to 3, incl	Longitudinal	66,000	54,000	7
	Long-Trans.	64,000	52,000	4
	Short-Trans.	61,000	50,000	3
Over 3 to 4, incl	Longitudinal	64,000	53,000	7
	Long-Trans.	63,000	50,000	3
	Short-Trans.	60,000	48,000	2
Over 4 to 5, incl	Longitudinal	62,000	51,000	7
	Long-Trans.	61,000	48,000	3
	Short-Trans.	58,000	46,000	2
Over 5 to 6, incl	Longitudinal	61,000	49,000	6
	Long-Trans.	59,000	46,000	3
	Short-Trans.	57,000	44,000	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 %, min in 4D	Elongation %, min in 5D
Up to 75, incl	Longitudinal	455	370	7	6
	Long-Trans.	440	360	4	3
	Short-Trans.	420	345	3	2
Over 75 to 100, incl	Longitudinal	440	365	7	6
	Long-Trans.	435	345	3	2
	Short-Trans.	415	330	2	1
Over 100 to 125, incl	Longitudinal	425	350	7	6
	Long-Trans.	420	330	3	2
	Short-Trans.	400	315	2	1
OVer 125 to 150, incl	Longitudinal	420	340	6	5
	Long-Trans.	405	315	3	2
	Short-Trans.	395	305	2	1

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, determined in accordance with ASTM E10, 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) in Nominal Thickness:
ø Not lower than 125 HB/10/500 or 130 HB/10/1000.

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

3.3.3 Conductivity: Shall be as follows, determined in accordance with
ø ASTM B342 using equipment calibrated in accordance with MIL-STD-1537 on the surface of the sample:

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

3.3.3.2 If the conductivity is 38.0 - 39.9% IACS, incl, if the tensile properties meet specified requirements, and if the longitudinal yield strength does not exceed the specified minimum by more than 11,900 psi (82 MPa), the forgings are acceptable.

3.3.3.3 If the conductivity is below 40.0% IACS and the longitudinal yield strength exceeds the specified minimum value by more than 11,900 psi (82 MPa), the forgings shall be given additional overaging. If, after such treatment, the forgings meet the requirements of 3.3.1 and 3.3.3, the forgings are acceptable.

3.3.3.4 If the conductivity is below 38.0% IACS, the forgings are not acceptable and shall be reprocessed, regardless of property level.

3.3.4 Stress-Corrosion Resistance: Specimens as in 4.3.2.1 cut from forgings shall meet the requirements of ASTM G47 when stressed to 75% of the specified minimum yield strength for the principal test direction.

3.3.5 Grain Flow: Except in areas of die forgings which contain end grain, the grain flow shall follow the general contour of the forging, showing no evidence of reentrant 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 Each forging shall be ultrasonically inspected in accordance with ASTM B594 and shall meet the following requirements:

3.4.1.1 Die forgings 0.375 to 4.000 in. (9.50 to 100.00 mm), incl, in nominal thickness and weighing not over 300 lb (135 kg) shall meet Class B.

3.4.1.2 Hand forgings 1.000 to 8.000 in. (25.00 to 200.00 mm) in nominal thickness and weighing not more than 600 lb (270 kg) shall meet Class A.

3.4.1.3 Acceptance criteria for forgings exceeding the limits of 3.4.1.1 or 3.4.1.2 shall be as agreed upon by purchaser and vendor.

3.4.2 Each die forging shall be etched by swabbing or immersing in an aqueous solution of sodium hydroxide, thoroughly rinsing in water, followed by washing in nitric acid or chromic-sulfuric acid solution or equivalent solution which will produce a surface suitable for visual inspection. Surfaces shall be evaluated for defects and, if defects can be removed so that they do not reappear on re-etching and if the required section thickness is maintained, die forgings are acceptable.

3.4.2.1 When approved by purchaser, a sampling plan may be used in lieu of etching each die forging.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of forgings shall supply all Ø 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 Ø composition (3.1), tensile properties (3.3.1), hardness (3.3.2), conductivity (3.3.3), and ultrasonic soundness (3.4.1) are classified as acceptance tests and shall be performed on each lot.

4.2.2 Periodic Tests: Tests of forgings to determine conformance to Ø requirements for stress-corrosion resistance (3.3.4) 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.

4.2.3 Preproduction Tests: Tests to determine conformance to all technical Ø requirements of this specification when AMS 2375 is specified are classified as preproduction tests and shall be performed prior to or on the first-article shipment of a forging to a purchaser, when a change in material, processing, or both requires reapproval as in 4.4, and when purchaser deems confirmatory testing to be required.

4.2.3.1 For direct U.S. Military procurement, substantiating test data and, when requested, preproduction forgings 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 forgings of the same Ø nominal cross-section and configuration heat treated in the same batch-furnace load or quenched from a continuous furnace consecutively during an 8-hr period. Maximum lot size for forgings heat treated in a continuous furnace and charged consecutively during continuous furnace operation shall be 2000 lb (900 kg) for forgings weighing 5 lb (2.5 kg) and under and shall be 6000 lb (2700 kg) for forgings weighing over 5 lb (2.5 kg).

4.3.1 For Acceptance Tests:

4.3.1.1 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. Complete ingot analysis records shall be available to the purchaser at the producer's facility.

4.3.1.1.1 Unless compliance with 4.3.1.1 is established, an analysis shall be made for each 6000 lb (2700 kg) or less of alloy comprising the lot except that not more than one analysis shall be required per piece.

4.3.1.2 Tensile Properties:

4.3.1.2.1 Die Forgings: One forging or one forging prolongation heat treated with each lot of forgings.

4.3.1.2.1.1 In lieu of a prolongation, at least one tensile specimen with the grain flow and one tensile specimen across the grain flow shall be cut from the locations designated on the drawing from a forging representing each lot.

4.3.1.2.2 Hand Forgings: At least two 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. Specimens need not be taken in the longitudinal direction unless specifically required by purchaser.

4.3.1.3 Conductivity: Shall be the tensile specimens representing the predominant test direction.

4.3.2 For Periodic Tests and Preproduction Tests: As agreed upon by purchaser and vendor and as follows:

4.3.2.1 Stress-Corrosion Resistance: Specimens shall be taken from a forging or forging prolongation. Specimens shall be not less than 0.750 in. (19 mm) cube.

4.4 Approval: When specified, approval and control of forgings shall be in accordance with AMS 2375.

4.5 Reports:

4.5.1 The vendor of forgings shall furnish with each shipment a report stating that the chemical composition conforms to the requirements of this specification, showing the results of tests on each lot to determine conformance to the other acceptance test requirements, and stating that the forgings conform to the other technical requirements of this specification. This report shall include the purchase order number, lot number, AMS 4147B, size or part number, and quantity.

4.5.2 The vendor of finished or semi-finished parts shall furnish with each shipment a report showing the purchase order number, AMS 4147B, contractor or other direct supplier of forgings, part number, and quantity. When forgings for making parts are produced or purchased by the parts vendor, that vendor shall inspect each lot of forgings to determine conformance to the requirements of this specification and shall include in the report either a statement that the forgings conform or copies of laboratory reports showing the results of tests to determine conformance.