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400 Commonwealth Dr., Warrendale, PA 15096

# AEROSPACE MATERIAL SPECIFICATION

SAE MAM 4131

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Submitted for recognition as an American National Standard

## ALUMINUM ALLOY FORGINGS

5.6Zn - 2.5Mg - 1.6Cu - 0.23Cr (7075-T74)  
Solution and Precipitation Heat Treated

UNS A97075

### 1. SCOPE:

- 1.1 Form: This specification covers an aluminum alloy in the form of die forgings and hand forgings procured to metric (SI) units.
- 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

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

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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

3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall conform to the following percentages by weight, determined in accordance with 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	--	0.50
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 and precipitation heat treated in accordance with MIL-H-6088.

3.3 Properties: forgings shall conform to the following requirements, determined in accordance with 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 150 mm and under in nominal thickness at time of heat treatment or from prolongations on such forgings with axis of specimen in the area of the gage length varying not more than 15 deg from parallel to forging flow lines, shall have the properties shown in Table I provided the as-forged thickness was not more than twice the heat treated thickness.

TABLE I

Nominal Thickness at Time of Heat Treatment Millimetres	Tensile Strength MPa, min	Yield Strength at 0.2% Offset MPa, min	Elongation in 5D , min
Up to 75, incl	525	455	6
Over 75 to 100, incl	505	435	6
Over 100 to 125, incl	485	420	6
Over 125 to 150, incl	470	400	6

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

TABLE II

Nominal Thickness at Time of Heat Treatment Millimetres	Tensile Strength MPa, min	Yield Strength at 0.2% Offset MPa, min	Elongation in 5D , min
Up to 75, incl	490	425	3
Over 75 to 100, incl	485	415	3
Over 100 to 125, incl	470	400	3
Over 125 to 150, incl	450	380	3

3.3.1.1.2.1 Elongation requirements shall not apply to specimens having a gage length diameter less than 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 3 mm of the trimmed flash line.

3.3.1.1.3 At Angle to Flow Lines: Specimens, machined from forgings 150 mm and under in nominal thickness at time of heat treatment or from prolongations on such forgings with 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 forging flow lines, shall have the properties shown in Table II. Such test results shall be identified as neither longitudinal nor transverse tensile 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 thickness does not exceed 150 millimetres.

TABLE III

Nominal Thickness at Time of Heat Treatment Millimetres	Specimen Orientation	Tensile Strength MPa, min	Yield Strength at 0.2% Offset MPa, min	Elongation in 5D %, min
Up to 50, incl	Longitudinal	505	435	8
	Long-Trans.	490	415	4
Over 50 to 75, incl	Longitudinal	505	435	8
	Long-Trans.	490	415	4
	Short-Trans.	475	415	3
Over 75 to 100, incl	Longitudinal	490	420	8
	Long-Trans.	485	400	4
	Short-Trans.	470	395	3
Over 100 to 125, incl	Longitudinal	470	395	7
	Long-Trans.	460	385	4
	Short-Trans.	455	380	3
Over 125 to 150, incl	Longitudinal	450	370	7
	Long-Trans.	440	360	4
	Short-Trans.	435	360	3

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 75 mm and Under 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 75 mm in Nominal Thickness: As agreed upon by purchaser and vendor.

3.3.3 Conductivity: Shall be as follows:

3.3.3.10 If the conductivity is 23.3 MS/m (40.0% IACS (International Annealed Copper Standard)) or higher and tensile properties meet specified requirements, forgings are acceptable.

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

3.3.3.3 If the conductivity is below 23.2 MS/m (40% IACS) and the longitudinal yield strength exceeds the specified minimum value by more than 80 MPa, the forgings shall be given additional precipitation heat treatment. If, after such treatment, forgings meet the requirements of 3.3.1 and 3.3.3.1 or 3.3.3.2, the forgings are acceptable.

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

3.3.4 Stress-Corrosion Resistance: Specimens cut from forgings shall show no evidence of stress-corrosion cracking when stressed in the short-transverse direction (perpendicular to grain flow) to 240 MPa for forgings 75 mm and under in nominal thickness and to 50% of the longitudinal (parallel to grain flow) yield strength for forgings over 75 mm in nominal thickness.

3.3.5 Grain Flow: Except in areas of die forgings flash line end grain, grain flow shall follow the general contour of the forging, 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 they do not reappear on re-etching and the required section thickness can be maintained are acceptable.

3.4.2 All forgings shall be subjected to ultrasonic inspection in accordance with ~~ASTM~~ B594 and shall meet the following ultrasonic classes:

3.4.2.1 Die Forgings 12.5 to 100.0 mm, Incl, in Nominal Thickness and Weighing not Over 135 kg: Class B.

3.4.2.2 Hand Forgings 25.0 to 150.0 mm., Incl, in Nominal Thickness and Weighing not Over 270 kg: Class A.

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

3.4.3 When specified, all forgings shall be subjected to fluorescent penetrant inspection in accordance with AMS 2645. Acceptance standards 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) conductivity (3.3.3), surface visual examination (3.4.1), ultrasonic inspection (3.4.2), and, when specified, fluorescent penetrant inspection (3.4.3) are classified as acceptance tests and shall be performed on each lot.

4.2.2 Periodic Tests: Tests to determine conformance to requirements for hardness (3.3.2) and stress-corrosion resistance (3.3.4) and for grain flow of die forgings (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 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 in accordance with MAM 2355 and the following:

4.3.1 Surface Imperfections (3.4.1), Ultrasonic Inspection (3.4.2), and, When Specified, Fluorescent Penetrant Inspection (3.4.3): All forgings.

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

4.5 Reports: