

AEROSPACE MATERIAL SPECIFICATION



AMS 4179B

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Revised JAN 1987
Reaffirmed OCT 2000

Superseding AMS 4179A

Aluminum Alloy Forgings
5.6Zn - 2.5Mg - 1.6Cu - 0.23Cr (7175-T7452)
Solution Heat Treated, Stress Relieved, and Precipitation Heat Treated

UNS A97175

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 a high level of mechanical properties and good 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 15096-0001.

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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 or Cold Finished
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 Products for Aerospace Applications

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, Preparations for Shipment and Storage

3. TECHNICAL REQUIREMENTS:

3.1 Composition:

Shall conform to the following percentages by weight, 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:

The product shall be supplied in the following condition:

3.2.1 Forgings: Solution heat treated, stress relieved by compression to produce a permanent set of 1 - 5%, and precipitation heat treated (See 8.2). Heat treatment shall be performed using furnace surveys and calibration of temperature controllers and recorders in accordance with MIL-H-6088.

3.2.2 Forging Stock: As ordered by the forging manufacturer.

3.3 Properties:

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

3.3.1 Die and Hand Forgings:

3.3.1.1 Tensile Properties: Shall be as follows:

3.3.1.1.1 Die Forgings:

- 3.3.1.1.1.1 With Grain Flow: Specimens, machined from forgings not over 3 in. (75 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 following properties:

Tensile Strength, min	73,000 psi (505 MPa)
Yield Strength at 0.2% Offset, min	63,000 psi (435 MPa)
Elongation, min	
in 4D	7%
in 5D	6%

- 3.3.1.1.1.2 Across Grain Flow: Specimens, machines from forgings not over 3 in. (75 mm) in nominal section thickness at time of heat treatment with axis of specimens in the area of the gage length varying not more than 15 deg from perpendicular to the forging flow lines, shall have the following properties:

Tensile Strength, min	68,000 psi (470 MPa)
Yield Strength at 0.2% Offset, min	55,000 psi (380 MPa)
Elongation in 4D, min	
in 4D	4%
in 5D	3%

- 3.3.1.1.1.2.1 Elongation requirements applies only to specimens having a gage-length diameter not less than 0.250 in. (6.25 mm) and cut so that the length of the specimen is in a plane parallel to the parting plane.

- 3.3.1.1.2 Hand Forgings: Specimens, machined from forgings not over 6 in. (150 mm) in nominal as-forged thickness and having an essentially rectangular or square cross-section not exceeding 156 sq in. (1000 cm²) in area and heat treated in the indicated thickness, shall have the properties specified in Table I.

TABLE I

Nominal Thickness At Time of Heat Treatment Inches	Specimen Orientation	Tensile Strength psi, min	Yield Strength at 0.2% Offset psi, min	Elongation in or 4D %, min
Up to 2, incl	Longitudinal	71,000	61,000	9
	Long.-Trans.	69,000	58,000	5
Over 2 to 3, incl	Longitudinal	71,000	61,000	9
	Long.-Trans.	69,000	58,000	5
	Short-Trans.	67,000	54,000	4
Over 3 to 4, incl	Longitudinal	68,000	57,000	9
	Long.-Trans.	67,000	55,000	5
	Short-Trans.	65,000	51,000	4
Over 4 to 5, incl	Longitudinal	65,000	54,000	8
	Long.-Trans.	64,000	52,000	5
	Short-Trans.	63,000	49,000	4
Over 5 to 6, incl	Longitudinal	63,000	51,000	8
	Long.-Trans.	61,000	49,000	5
	Short-Trans.	60,000	46,000	4

TABLE I (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 or 5D %, min
Up to 50, incl	Longitudinal	490	420	8
	Long.-Trans.	475	400	4
Over 50 to 75, incl	Longitudinal	490	420	8
	Long.-Trans.	475	400	4
	Short-Trans.	460	370	3
Over 75 to 100, incl	Longitudinal	470	395	8
	Long.-Trans.	460	380	4
	Short-Trans.	450	350	3
Over 100 to 125, incl	Longitudinal	450	370	7
	Long.-Trans.	440	360	4
	Short-Trans.	435	340	3
Over 125 to 150, incl	Longitudinal	435	350	7
	Long.-Trans.	420	340	4
	Short-Trans.	415	315	3

- 3.3.1.1.3 Special Purpose Forgings: Tensile property requirements for specimens cut from special purpose forgings or from forgings having configurations or size limitations not covered by 3.3.1.1.1 and 3.3.1.1.2 shall be as specified on the drawing or as agreed upon by purchaser and vendor.
- 3.3.1.2 Hardness: Should be not lower than 135 HB/10/500 or 140 HB/10/1000 but forgings shall not be rejected on the basis of hardness if the tensile property requirements are met.
- 3.3.1.3 Conductivity: Shall be as follows, determined on the surface of the sample:
- 3.3.1.3.1 If the conductivity is 40.0% IACS (International Annealed Copper Standard) (23.2 MS/m), or higher and tensile properties meet specified requirements, the forgings are acceptable.
- 3.3.1.3.2 If the conductivity is 38.0 - 39.9% IACS (22.0 - 23.1 MS/m), if the tensile properties meet specified properties, and if the yield strength (with grain for die forgings and long-transverse for hand forgings) does not exceed the specified minimum by more than 11,900 psi (82 MPa), the forgings are acceptable.
- 3.3.1.3.3 If the conductivity is below 40.0% IACS (23.2 MS/m) and longitudinal yield strength exceeds the specified minimum value by more than 11,900 psi (82 MPa), the forgings are suspect.
- 3.3.1.3.3.1 When forgings are suspect, they may be subjected to additional precipitation heat treatment and if they then meet the requirements of 3.3.1.3.1 or 3.3.1.3.2, they are acceptable.
- 3.3.1.4 Stress-Corrosion Resistance: Specimens as in 4.3.2.1 cut from forgings shall show no evidence of stress-corrosion cracking when stressed in the short-transverse direction at 35,000 psi (240 MPa) for die and hand forgings 3.in. (75 mm) and under in section thickness or to 50% of the specified minimum long-transverse yield strength for hand forgings over 3 in. (75 mm) in section thickness and held at constant strain.
- 3.3.1.5 Grain flow of die forgings, except in areas which contain end grain, shall follow the general contour of the forging, showing no evidence of re-entrant flow.
- 3.3.2 Forging Stock: When a sample of stock is forged to a test coupon and heat treated in the same manner as forgings, specimens taken from the heat treated coupon shall conform to the requirements of 3.3.1.1 and 3.3.1.3. If specimens taken from the stock after heat treatment in the same manner as forgings conform to the requirements of 3.3.1.1 and 3.3.1.3, the tests shall be accepted as equivalent to tests of a forged coupon.
- 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 Each hand forging, and each die forging when specified, shall be subjected to ultrasonic inspection in accordance with ASTM B594 and shall meet the following acceptance criteria:

3.4.1.1 Die Forgings: Class B.

3.4.1.2 Hand Forgings: Class A.

3.4.2 Each forging shall be free from surface defects, such as seams, laps, bursts, and quench cracks, when etched by swabbing or immersing in an aqueous solution of sodium hydroxide, thoroughly rinsing in tap 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, the forgings are acceptable. Forgings shall be thoroughly dried after each etch and rinse operation to prevent fluid entrapment.

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

3.4.3 When specified, each die forging shall be subjected to fluorescent penetrant inspection in accordance with AMS 2645. Forgings shall be free from surface defects such as seams, laps, bursts, and quench cracks.

3.5 Tolerances:

Forging stock shall conform to all applicable requirements of AMS 2201 or MAM 2201.

4. QUALITY ASSURANCE PROVISIONS:

4.1 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. 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 product conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests to determine conformance to the following requirements are classified as acceptance tests and shall be performed on each lot.

4.2.1.1 Composition (3.1) of the product.

4.2.1.2 Tensile properties (3.3.1.1), conductivity (3.3.1.3), ultrasonic soundness (3.4.1), surface evaluation (3.4.2), and, when specified, fluorescent penetrant inspection (3.4.3) of each lot of forgings.

4.2.1.3 Tolerances (3.5) of forging stock.

4.2.2 Periodic Tests: Tests to determine conformance to the following requirements are classified as periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser:

4.2.2.1 Hardness (3.3.1.2) and stress-corrosion resistance (3.3.1.4) of forgings.

4.2.2.2 Grain flow (3.3.1.5.1) of die forgings.

4.2.2.3 Ability of forging stock to develop required properties (3.3.2).

4.2.3 Preproduction Tests: Tests of forgings to determine conformance to all applicable 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 of forgings, 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 AMS 2355 or MAM 2355 and the following: a lot shall be all forgings of the same nominal cross-section and configuration heat treated in the same batch-furnace load or in 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 Sampling for fluorescent penetrant inspection, when specified, shall be as agreed upon by purchaser and vendor.

4.3.2 When a statistical sampling plan and acceptance quality level (AQL) have been agreed upon by purchaser and vendor, sampling shall be in accordance with such plan in lieu of sampling as in 4.3 and the report of 4.5.1 shall state that such plan was used.

4.4 Approval:

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