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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 4132E

Issued JAN 1957
Revised SEP 2000
Reaffirmed APR 2006

Superseding AMS 4132D

Aluminum Alloy, Die and Hand Forgings, Rolled Rings, and Forging Stock
2.3Cu - 1.6Mg - 1.1Fe - 1.0Ni - 0.18Si - 0.07Ti (2618-T61)
Solution and Precipitation Heat Treated

UNS A92618

1. SCOPE:

1.1 Form:

This specification covers an aluminum alloy in the form of die forgings, hand forgings, rolled rings, and forging stock.

1.2 Application:

These products have been used typically for rotating parts operating in service up to 450 °F (232 °C) and other parts operating up to 600 °F (316 °C) at low stresses, but usage is not limited to such applications.

2. APPLICABLE DOCUMENTS:

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been canceled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 2355	Quality Assurance Sampling and Testing, Aluminum Alloys and Magnesium Alloys, Wrought Products, Except Forging Stock, and Rolled, Forged, or Flash Welded Rings
MAM 2355	Quality Assurance Sampling and Testing, Aluminum Alloys and Magnesium Alloys, Wrought Products, Except Forging Stock, and Rolled, Forged, or Flash Welded Rings, Metric (SI) Units
AMS 2772	Heat Treatment of Aluminum Alloy Raw Materials
AMS 2808	Identification, Forgings

QUESTIONS REGARDING THIS DOCUMENT: (724) 772-7161 FAX: (724) 776-0243
TO PLACE A DOCUMENT ORDER: (724) 776-4970 FAX: (724) 776-0790
SAE WEB ADDRESS: http://www.sae.org

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM B 594 Ultrasonic Inspection of Aluminum-Alloy Wrought Products for Aerospace Applications
ASTM B 660 Packaging/Packing of Aluminum and Magnesium Products
ASTM E 1417 Liquid Penetrant Examination

2.3 ANSI Publications:

Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

ANSI H35.2 Dimensional Tolerances for Aluminum MIll Products
ANSI H35.2M Dimensional Tolerances for Aluminum Mill Products (Metric)

3. TECHNICAL REQUIREMENTS:

3.1 Composition:

Shall conform to the percentages by weight shown in Table 1, determined in accordance with AMS 2355 or MAM 2355.

TABLE 1 - Composition

Element	min	max
Silicon	0.10	0.25
Iron	0.9	1.3
Copper	1.9	2.7
Magnesium	1.3	1.8
Zinc	--	0.10
Titanium	0.04	0.10
Nickel	0.9	1.2
Other Elements, each	--	0.05
Other Elements, total	--	0.15
Aluminum	remainder	

3.2 Condition:

The product shall be supplied in the following condition:

3.2.1 Die Forgings and Rolled Rings, and Hand Forgings 4 Inches (102 mm) and Under in Nominal Thickness: Solution and precipitation heat treated.

3.2.2 Hand Forgings Over 4 Inches (102 mm) in Nominal Thickness: As forged.

3.2.3 Forging Stock: As ordered by the forging manufacturer.

3.3 Heat Treatment:

Die forgings and rolled rings, and hand forgings 4 inches (102 mm) and under in nominal thickness shall be solution and precipitation heat treated in accordance with AMS 2772 except that the product shall be quenched in boiling water.

3.4 Properties:

The product shall conform to the following requirements, determined in accordance with AMS 2355 or MAM 2355 on the mill produced product:

3.4.1 Forgings:

3.4.1.1 Tensile Properties: Shall be as follows:

3.4.1.1.1 Die Forgings:

3.4.1.1.1.1 With Grain Flow: Specimens, machined from forgings not over 4 inches (102 mm) in nominal thickness at time of heat treatment with axis of specimen in the area of gage length varying not more than 15 degrees from parallel to the forging flow lines, shall have the properties shown in Table 2.

TABLE 2 - Minimum Tensile Properties

Property	Value
Tensile Strength	58.0 ksi (400 MPa)
Yield Strength at 0.2% Offset	48.0 ksi (331 MPa)
Elongation in 4D	4%
in 5D	3%

3.4.1.1.1.2 Across Grain Flow: Specimens, machined from forgings not over 4 inches (102 mm) in nominal thickness at time of heat treatment with axis of specimen in the area of gage length varying not more than 15 degrees from perpendicular to the forging flow lines, shall have the properties shown in Table 3.

TABLE 3 - Minimum Tensile Properties

Property	Value
Tensile Strength	55.0 ksi (379 MPa)
Yield Strength at 0.2% Offset	45.0 ksi (310 MPa)
Elongation in 4D	4%
in 5D	3%

3.4.1.1.2 Hand Forgings: Specimens, machined from forgings having an essentially square or rectangular cross section not exceeding 144 square inches (929 cm^2) and heat treated in the indicated thickness, shall have properties as specified in Table 4 provided the as-forged thickness does not exceed 4 inches (102 mm).

TABLE 4A - Minimum Tensile Properties, Inch/Pound Units

Nominal Thickness at Time of Heat Treatment Inches	Specimen Orientation	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 4D %
Up to 2, incl	Longitudinal	58.0	47.0	7
	Long-Trans.	55.0	42.0	5
Over 2 to 3, incl	Longitudinal	57.0	46.0	7
	Long-Trans.	55.0	42.0	5
	Short-Trans.	52.0	42.0	4
Over 3 to 4, incl	Longitudinal	56.0	45.0	7
	Long-Trans.	53.0	40.0	5
	Short-Trans.	51.0	39.0	4

TABLE 4B - Minimum Tensile Properties, SI Units

Nominal Thickness at Time of Heat Treatment Millmeters	Specimen Orientation	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation % in 4D	Elongation % in 5D
Up to 51, incl	Longitudinal	400	324	7	6
	Long-Trans.	379	290	5	4
Over 51 to 76, incl	Longitudinal	393	317	7	6
	Long-Trans.	379	290	5	4
	Short-Trans.	359	290	4	3
Over 76 to 102, incl	Longitudinal	386	310	7	6
	Long-Trans.	365	276	5	4
	Short-Trans.	352	269	4	3

3.4.1.1.2.1 Short-transverse property requirements of Table 4 apply only to thicknesses 2.375 inches (60.32 mm) and over.

3.4.1.1.3 Rolled Rings:

3.4.1.1.3.1 Tangential: Specimens, machined from rolled rings not over 4 inches (102 mm) in nominal thickness at time of heat treatment with the axis of specimen tangential to the ring circumference (approximately parallel to the direction of rolling), shall have the properties shown in Table 5.

TABLE 5 - Minimum Tensile Properties

Property	Value
Tensile Strength	55.0 ksi (379 MPa)
Yield Strength at 0.2% Offset	41.0 ksi (283 MPa)
Elongation in 4D	6%
in 5D	5%

3.4.1.1.3.2 Axial: Specimens, machined from rolled rings not over 4 inches (102 mm) in nominal thickness at time of heat treatment with the axis of specimen parallel to the axis of the ring (transverse to direction of rolling), shall have properties as specified in 3.4.1.1.3.1 except that elongation may be as low as 5% in 4D or 4% in 5D.

3.4.1.1.4 Test Specimens: Specimens, machined from separately-forged coupons or from forging stock representing the forgings and, in either case, heat treated with the forgings or machined from prolongations on heat treated die forgings, shall have the following properties shown in Table 6.

TABLE 6 - Minimum Tensile Properties

Property	Value
Tensile Strength, minimum	58.0 ksi (400 MPa)
Yield Strength at 0.2% Offset, minimum	48.0 ksi (331 MPa)
Elongation in 4D, minimum	6%
in 5D, minimum	5%

3.4.1.2 Grain flow of die forgings, except in areas which contain flash-line end grain, shall follow the general contour of the forgings showing no evidence of re-entrant grain flow.

3.4.2 Forging Stock: When a sample of stock is forged to a test coupon having a 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 3.4.1.1.4. If specimens taken from the stock after heat treatment in the same manner as forgings conform to the requirements of 3.4.1.1.4, the tests shall be accepted as equivalent to tests of a forged coupon. The forging stock supplier, however, shall not be required to conduct such tests.

3.5 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.

3.5.1 Each die forging and rolled ring 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 and rolled rings are acceptable.

3.5.1.1 When approved by purchaser, a sampling plan may be used in lieu of etching each die forging or rolled ring.

3.5.2 When specified, die forgings and rolled rings shall be subjected to fluorescent penetrant inspection in accordance with ASTM E 1417, to ultrasonic inspection in accordance with ASTM B 594, or both. Standards for acceptance shall be as agreed upon by purchaser.

3.6 Tolerances:

Forging stock shall conform to all applicable requirements of ANSI H35.2 or ANSI H35.2M.

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 the performance of all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to the specified requirements.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: The following requirements are acceptance tests and shall except for composition be performed on each inspection lot:

4.2.1.1 Composition (3.1) of the product.

4.2.1.2 Tensile properties (3.4.1.1) of each lot of die forgings, hand forgings, and rolled rings and, when specified, fluorescent penetrant and/or ultrasonic inspections (3.5.2) of each lot of die forgings and rolled rings.

4.2.1.3 Visual surface inspection (3.5.1) of each lot of die forgings and rolled rings.

4.2.1.4 Tolerances (3.6) of forging stock.

4.2.2 Periodic Tests: The following requirements are 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 Grain flow of die forgings (3.4.1.2).

4.2.2.2 Ability of forging stock to develop required properties (3.4.2).

4.3 Sampling and Testing:

Shall be in accordance with AMS 2355 or MAM 2355 and 4.3.1. A lot shall be all forgings and rolled rings of the same nominal cross section and configuration heat treated in the same batch-furnace load or quenched from a continuous furnace consecutively during an 8-hour period. The maximum lot size for forgings and rolled rings heat treated in a continuous furnace shall be 6000 pounds (2722 kg).

4.3.1 Rolled Rings: At least two tensile specimens shall be taken from a ring or ring prolongation representing the lot; one specimen shall be tangential to the ring OD and the other parallel to the axis of the ring.

4.4 Reports:

4.4.1 The vendor of the product shall furnish with each shipment a report stating that the product conforms to the chemical composition, tolerances, and when specified, fluorescent penetrant or ultrasonic nondestructive tests, and showing the numerical results of tests on each inspection lot to determine conformance to the other acceptance test requirements. This report shall include the purchase order number, inspection lot number(s), AMS 4132E, size, and quantity. The report shall also identify the producer, the product form, and the size of the mill product.

4.4.2 The vendor of forging stock shall furnish with each shipment a report stating that the chemical composition of the stock conforms to the requirements of this specification. This report shall include the purchase order number, AMS 4132E, size, and quantity.

4.5 Resampling and Retesting:

Shall be in accordance with AMS 2355 or MAM 2355.

5. PREPARATION FOR DELIVERY:

5.1 Identification:

Shall be as follows:

5.1.1 Die Forgings and Rolled Rings: In accordance with AMS 2808.

5.1.2 Hand Forgings: Marked with the alloy number and temper, the characters recurring at intervals not greater than 6 inches (152 mm) and applied in the longitudinal grain direction.