SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS 4403

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Aluminum Alloy, Die Forgings
7.5Zn - 1.6Cu - 1.5Mg - 0.12Zr (7085-T7452)
Solution Heat Treated, Compression Stress-Relieved, and Overaged
(Composition similar to UNS A97085)

RATIONALE

This document has been reaffirmed to comply with the SAE five-year review policy.

1. SCOPE

1.1 Form

This specification covers an aluminum alloy in the form of die forgings 12 inches (305 mm) and under in nominal thickness and of forging stock.

1.2 Application

These forgings have been used typically for machined structural parts subject to warpage during machining and requiring high strength and resistance to stress-corrosion cracking, but usage is not limited to such application.

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 cancelled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AMS 2355	Quality Assurance Sampling and Testing, Aluminum Alloys and Magnesium Alloys, Wrought Products, Except Forging Stock, and Rolled, Forged, or Flash Welded Rings
AMS 2808	Identification, Forgings
AMS 2772	Heat Treatment of Aluminum Alloy Raw Materials
AS1990	Aluminum Alloy Tempers

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: http://www.sae.org

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AMS4403

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM B 594	Ultrasonic Inspection of Aluminum-Alloy Wrought Products for Aerospace Applications
ASTM B 645	Plane Strain Fracture Toughness Testing of Aluminum Alloys
ASTM B 660	Packaging/Packing of Aluminum and Magnesium Products
ASTM E 399	Plane-Strain Fracture Toughness of Metallic Materials
ASTM E 1417	Liquid Penetrant Examination
ASTM G 47	Determining Susceptibility to Stress-Corrosion cracking of 2xxx and 7xxx Aluminum Alloys

2.3 ANSI Publications

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036, Tel: 212-642-4900, www.ansi.org.

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.

TABLE 1 - COMPOSITION

Element	min	max
Silicon	--	0.06
Iron	--	0.08
Copper	1.3	2.0
Manganese	--	0.04
Magnesium	1.2	1.8
Chromium	--	0.04
Zinc	7.0	8.0
Titanium	--	0.06
Zirconium	0.08	0.15
Other Elements, each	--	0.05
Other Elements, total	--	0.15
Aluminum	remainder	

3.2 Condition

3.2.1 Die Forgings

Solution heat treated in accordance with AMS 2772, stress-relieved by compressing to produce a 1 to 5% permanent set, and overaged to the T7452 temper (See AS1990). Solution heat-treat and artificial age practices are proprietary.

3.2.2 Forging Stock

As ordered by the forging manufacturer and shall comply with the composition requirements of Table 1. Material shall be free of conditions that are detrimental to the finished product.

3.3 Properties

The product shall conform to the following requirements, determined in accordance with AMS 2355 on the mill produced size.

3.3.1 Die Forgings

3.3.1.1 Tensile Properties

Shall be as follows:

3.3.1.1.1 With Grain Flow (Longitudinal)

Specimens, machined from forgings or from prolongations on such forgings, with axis of specimen in 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 2A - MINIMUM TENSILE PROPERTIES, INCH/POUND UNITS

Nominal Thickness At Time Of Heat Treatment Inches	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 4D %
1.000 to 2.000, incl	72.0	65.0	10
2.001 to 4.000, incl	72.0	65.0	9
4.001 to 6.000, incl	72.0	65.0	9
6.001 to 8.000, incl	72.0	65.0	8
8.001 to 10.000, incl	72.0	65.0	7
10.001 to 12.000, incl	72.0	65.0	7

TABLE 2B - MINIMUM TENSILE PROPERTIES, SI UNITS

Nominal Thickness at Time of Heat Treatment Millimeters	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 4D %
25 to 51, incl	496	448	10
Over 51 to 102, incl	496	448	9
Over 102 to 152, incl	496	448	9
Over 152 to 203, incl	496	448	8
Over 203 to 254, incl	496	448	7
Over 254 to 305, incl	496	448	7

3.3.1.1.2 Across Grain Flow (Long Transverse)

Specimens, machined from forgings or from prolongations on such forgings, with axis of specimen in area of gage length varying not more than 15 degrees from perpendicular to the forging flow lines, shall have properties shown in Table 3.

TABLE 3A - MINIMUM TENSILE PROPERTIES, INCH/POUND UNITS

Nominal Thickness at Time of Heat Treatment Inches	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 4D %
1.000 to 2.000, incl	70.0	62.0	8
2.001 to 4.000, incl	70.0	62.0	7
4.001 to 6.000, incl	70.0	62.0	7
6.001 to 8.000, Incl	70.0	62.0	6
8.001 to 10.000, incl	70.0	62.0	5
10.001 to 12.000, incl	70.0	62.0	4

TABLE 3B - MINIMUM TENSILE PROPERTIES, SI UNITS

Nominal Thickness at Time of Heat Treatment Millimeters	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 4D %
25 to 51, incl	483	427	8
Over 51 to 102, incl	483	427	7
Over 102 to 152, incl	483	427	7
Over 152 to 203, incl	483	427	6
Over 203 to 254, incl	483	427	5
Over 254 to 305, incl	483	427	4

3.3.1.1.3 Across Grain Flow (Short Transverse)

Specimens, machined from forgings or from prolongations on such forgings, with axis of specimen in area of gage length varying not more than 15 degrees from perpendicular to the forging flow lines, shall have properties shown in Table 4.

TABLE 4A - MINIMUM TENSILE PROPERTIES, INCH/POUND UNITS

Nominal Thickness at Time of Heat Treatment Inches	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 4D %
2.001 to 4.000, incl	70.0	59.0	5
4.001 to 6.000, incl	70.0	59.0	4
6.001 to 8.000, incl	70.0	59.0	4
8.001 to 10.000, incl	70.0	59.0	3
10.001 to 12.000, incl	70.0	59.0	3

TABLE4B - MINIMUM TENSILE PROPERTIES, SI UNITS

Nominal Thickness at Time of Heat Treatment Millimeters	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 4D %
51 to 102, incl	483	407	5
Over 102 to 152, incl	483	407	4
Over 152 to 203, incl	483	407	4
Over 203 to 254, incl	483	407	3
Over 254 to 305, incl	483	407	3

3.3.1.2 Corrosion Resistance

Resistance to stress-corrosion cracking of the forging heat lot is acceptable if the conditions of 3.3.1.2.1 are met.

3.3.1.2.1 Electrical Conductivity

Shall be not lower than 38.0% IACS (International Annealed Copper Standard) (22.0 MS/m).

3.3.1.2.2 Forgings not conforming to 3.3.1.2.1 may be given additional overaging and retested to determine conformance to 3.3.1.1 and 3.3.1.2.1

3.3.1.3 Stress-Corrosion Resistance

Specimens, not less than 0.750 inch (19.05 mm) in thickness cut from forgings tested in accordance with ASTM G 47, shall show no evidence of stress-corrosion cracking when stressed in the short-transverse direction at 35.0 ksi (241 MPa).

3.3.1.4 Fracture Toughness

When specified, forgings shall meet the values of K_{IC} shown in Table 5, determined in accordance with ASTM B 645.

TABLE 5 - K_{IC} MINIMUM VALUES

Nominal Thickness Inches	Nominal Thickness Millimeters	Specimen Orientation	Minimum K_{IC} ksi $\sqrt{inch}$	Maximum K_{IC} MPa $\sqrt{m}$
Over 1.000 to 2.000, incl	25 to 51, incl	L-T	31	34
		T-L	26	29
Over 2.000 to 4.000, incl	Over 51 to 102, incl	L-T	29	32
		T-L	24	26
		S-L	23	25
Over 4.000 to 6.000, incl	Over 102 to 152, incl	L-T	27	30
		T-L	22	24
		S-L	22	24
Over 6.000 to 8.000, incl	Over 152 to 203, incl	L-T	25	27
		T-L	20	22
		S-L	20	22

3.3.1.4.1 All K_Q values shall meet all requirements of ASTM E 399 for K_{IC} except that invalid K_Q values which are meaningful as defined by ASTM B 645 and which equal or exceed the K_{IC} limit (3.3.1.4) shall be evidence of acceptable fracture toughness.

3.4 Quality

The product, as received by purchaser, shall be uniform in quality and condition, sound, and free from foreign materials and from conditions detrimental to usage of the product.

3.4.1 When specified, each die forging shall be subjected to ultrasonic inspection in accordance with ASTM B 594 and shall meet Class B acceptance criteria.

3.4.2 When specified, each die forging shall be subjected to fluorescent penetrant inspection in accordance with ASTM E 1417. Forgings shall be free from surface defects such as seams, laps, bursts, and quench cracks.

3.4.3 Grain flow of die forgings, except in areas which contain end grain, shall follow the general contour of the forgings showing no evidence of reentrant grain flow.

3.5 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 forgings 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 specified requirements

4.2 Classification of Tests

4.2.1 Acceptance Tests

Composition (3.1), tensile properties (3.3.1.1), electrical conductivity (3.3.1.2.1), tolerances (3.5), and when specified, ultrasonic inspection (3.4.1), fracture toughness (3.3.1.4) and fluorescent penetrant inspection (3.4.2) are acceptance tests and, except for composition, shall be performed on each lot.