AEROSPACE MATERIAL SPECIFICATION

AMS4414™	REV. A

Issued 2008-01
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Revised 2025-02

Superseding AMS4414

Aluminum Alloy, Hand 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

AMS4414A results from a Five-Year Review and update of this specification with changes to update wording to prohibit unauthorized exceptions (see 3.3.1.4, 3.6, 4.4.2, and 8.4); relocate Definitions (see 2.4); update Form (see 1.1), Applicable Documents (see Section 2), Hand Forgings (see 3.2.1), metric elongation values for consistency with SAE policy as stated in 8.2 (see Tables 2B, 3B, and 4B), sampling and testing requirements for tensile specimens (see 4.3.1), and Ordering Information (see 8.5); and allow use of the immediate prior revision of this specification (see 8.3).

1. SCOPE

1.1 Form

This specification covers an aluminum alloy in the form of hand forgings 12 inches (305 mm), inclusive, and under in nominal thickness and forging stock of any size (see 8.5).

1.2 Application

These forgings have been used typically for machined structural parts requiring high strength and resistance to stress-corrosion cracking, 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 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 +1 724-776-4970 (outside USA), www.sae.org.

AMS2355 Quality Assurance, Sampling and Testing, Aluminum Alloys and Magnesium Alloy, Wrought Products (Except Forging Stock), and Rolled, Forged, or Flash Welded Rings

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**

For more information on this standard, visit
https://www.sae.org/standards/content/AMS4414A/

AMS2772 Heat Treatment of Aluminum Alloy Raw Materials

AMS2808 Identification, Forgings

AS7766 Terms Used in Aerospace Metals Specifications

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 B594 Ultrasonic Inspection of Aluminum-Alloy Wrought Products for Aerospace Applications

ASTM B645 Plane Strain Fracture Toughness Testing of Aluminum Alloys

ASTM B660 Packaging/Packing of Aluminum and Magnesium Products

ASTM E399 Plane-Strain Fracture Toughness of Metallic Materials

ASTM G47 Determining Susceptibility to Stress-Corrosion Cracking of 2xxx and 7xxx Aluminum Alloy Products

2.3 ANSI Accredited Publications

Copies of these documents are available online at https://webstore.ansi.org/.

ANSI H35.1/H35.1M Standard Alloy and Temper Designation System for Aluminum

ANSI H35.2 Dimensional Tolerances for Aluminum Mill Products

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

2.4 Definitions

Terms used in AMS are defined in AS7766.

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 Hand Forgings

Solution heat treated in accordance with AMS2772, stress relieved by compressing to produce a 1 to 5% permanent set, and overaged to the T7452 temper (refer to ANSI H35.1/ANSI H35.1M). Solution heat treatment 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 (see 8.5).

3.3 Properties

The product shall conform to the following requirements, determined in accordance with AMS2355 on the mill-produced size:

3.3.1 Tensile Properties

Specimens machined from forgings having essentially a rectangular or square cross section, heat treated in the indicated thickness, shall have the properties shown in Tables 2 through 4 provided the as-forged thickness does not exceed 12.0 inches (305 mm). The long-transverse direction for square forgings shall be identified by the producer.

3.3.1.1 With Grain Flow (Longitudinal)

Specimens, machined from forgings or from prolongations on such forgings, with axis of specimen in area of gauge 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 %
2.001 to 4.000, incl	74.0	67.0	10
4.001 to 6.000, incl	72.0	65.0	10
6.001 to 8.000, incl	71.0	64.0	10
8.001 to 10.000, incl	69.0	62.0	10
10.001 to 12.000, incl	68.0	61.0	9

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 %
Over 51 to 102, incl	510	462	10
Over 102 to 152, incl	496	448	10
Over 152 to 203, incl	490	441	10
Over 203 to 254, incl	476	427	10
Over 254 to 305, incl	469	421	9

3.3.1.2 Across Grain Flow (Long-Transverse)

Specimens, machined from forgings or from prolongations on such forgings, with axis of specimen in area of gauge length varying not more than 15 degrees from perpendicular to the forging flow lines, shall have the 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 %
2.001 to 4.000, incl	73.0	66.0	6
4.001 to 6.000, incl	72.0	65.0	6
6.001 to 8.000, incl	70.0	63.0	6
8.001 to 10.000, incl	69.0	61.0	6
10.001 to 12.000, incl	67.0	59.0	5

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 %
Over 51 to 102, incl	503	455	6
Over 102 to 152, incl	496	448	6
Over 152 to 203, incl	483	434	6
Over 203 to 254, incl	476	421	6
Over 254 to 305, incl	462	407	5

3.3.1.3 Across Grain Flow (Short-Transverse)

Specimens, machined from forgings or from prolongations on such forgings, with axis of specimen in area of gauge length varying not more than 15 degrees from perpendicular to the forging flow lines, shall have the 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	71.0	62.0	3
4.001 to 6.000, incl	70.0	60.0	3
6.001 to 8.000, incl	69.0	59.0	3
8.001 to 10.000, incl	68.0	57.0	3
10.001 to 12.000, incl	67.0	56.0	2

Table 4B - 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	490	427	3
Over 102 to 152, incl	483	414	3
Over 152 to 203, incl	476	407	3
Over 203 to 254, incl	469	393	3
Over 254 to 305, incl	462	386	2

3.3.1.4 Mechanical property requirements for product outside the thickness ranges of 1.1 shall be as agreed upon by the purchaser and producer and reported per 4.4.2 (see 8.5).

3.3.2 Corrosion Resistance

Resistance to stress-corrosion cracking of the forging heat lot is acceptable if the conditions of 3.3.2.1 are met.

3.3.2.1 Electrical Conductivity

Shall be not lower than 38.0% IACS (International Annealed Copper Standard) (22.0 MS/m). Forgings with electrical conductivity measured to be 38.0 to 39.9% IACS (22.0 to 23.1 MS/m) on tensile bar blanks at T/2 shall have SCC testing performed per 3.3.2.3 in order to verify acceptable SCC resistance. This provision is being added into this governing specification until enough data is acquired to assure that electrical conductivities within the range of 38.0 to 39.9% IACS (22.0 to 23.1 MS/m) can satisfy the requirements of 3.3.2.3.

3.3.2.2 Forgings not conforming to 3.3.2.1 may be given additional overaging and retested to determine conformance to 3.3.1 and 3.3.2.1.

3.3.2.3 Stress-Corrosion Resistance

Specimens, not less than 0.750 inch (19.05 mm) in thickness cut from forgings tested in accordance with ASTM G47, shall show no evidence of stress-corrosion cracking when stressed in the short-transverse direction at 35.0 ksi (241 MPa).

3.3.3 Fracture Toughness

When specified, forgings shall meet the values of K_{IC} shown in Table 5, determined in accordance with ASTM B645.

Table 5 - K_{IC} minimum values

Nominal Thickness Inches	Nominal Thickness Millimeters	Specimen Orientation	Minimum K_{IC} ksi $\sqrt{\text{inch}}$	Minimum K_{IC} MPa $\sqrt{\text{m}}$
Over 2.000 to 4.000, incl	Over 51 to 102, incl	L-T	30	33
		T-L	19	21
		S-L	19	21
Over 4.000 to 6.000, incl	Over 102 to 152, incl	L-T	28	31
		T-L	19	21
		S-L	17	19
Over 6.000 to 8.000, incl	Over 152 to 203, incl	L-T	26	29
		T-L	17	19
		S-L	16	18
Over 8.000 to 10.000, incl	Over 203 to 254, incl	L-T	24	26
		T-L	15	16
		S-L	15	16
Over 10.000 to 12.000, incl	Over 254 to 305, incl	L-T	22	24
		T-L	14	15
		S-L	13	14

3.3.3.1 K_Q values shall meet all requirements of ASTM E399 for K_{IC} except that invalid K_Q values that are meaningful as defined by ASTM B645 and that equal or exceed the K_{IC} limit (see 3.3.3) shall be evidence of acceptable fracture toughness.

3.4 Quality

The product, as received by the 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 hand forging shall be subjected to ultrasonic inspection in accordance with ASTM B594 and shall meet Class B acceptance criteria.

3.4.2 Forging surfaces shall be free of any form of surface discontinuities that would lead to rejections within final machined product.

3.5 Tolerances

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

3.6 Exceptions

Any exceptions shall be authorized by the purchaser and reported as in 4.4.2.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The producer of forgings shall supply all samples for the producer's tests and shall be responsible for the performance of all required tests. The 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 (see 3.1), tensile properties (see 3.3.1), electrical conductivity (see 3.3.2.), tolerances of forging stock (see 3.5), and, when specified, ultrasonic inspection (see 3.4.1) and fracture toughness (see 3.3.3) are acceptance tests and, except for composition, shall be performed on each lot.

4.2.2 Periodic Tests

Stress-corrosion cracking (see 3.3.2.3) is a periodic test and shall be performed at a frequency selected by the producer unless frequency of testing is specified by the purchaser.

4.3 Sampling and testing

Shall be in accordance with AMS2355 and the following:

4.3.1 Tensile specimens machined from forgings shall be excised from the area specified on the engineering drawing.

4.3.2 For ultrasonic inspection, when required, each forging shall be inspected.

4.4 Reports

The producer of the forging shall furnish with each shipment a report stating that the product conforms to the composition, tensile properties, electrical conductivity, tolerances, and, when specified, ultrasonic inspection and fracture toughness; and showing the numerical results of tests on each inspection lot to determine conformance to the other acceptance test requirements. The report shall state that the final product conforms to the other technical requirements and shall include the forging producer, purchase order number, inspection lot number, AMS4414A, and the section identification number.

4.4.1 The producer of forging stock shall furnish with each shipment a report stating that the chemical composition of the stock conforms to specified requirements. This report shall include the purchase order number, inspection lot number, AMS4414A, size, and quantity.

4.4.2 When material produced to this specification is beyond the sizes allowed in the scope or tables, or other exceptions are taken to the technical requirements listed in Section 3, the report shall contain a statement "This material is certified as AMS4414A(EXC) because of the following exceptions:" and the specific exceptions shall be listed.