



AEROSPACE MATERIAL SPECIFICATION

AMS4149™**REV. F**

Issued	1971-05
Reaffirmed	2010-05
Revised	2023-12

Superseding AMS4149E

Aluminum Alloy, Die and Hand Forgings
5.6Zn - 2.5Mg - 1.6Cu - 0.23Cr (7175-T74)
Solution and Precipitation Heat Treated
(Composition similar to UNS A97175)

RATIONALE

AMS4149F results from a Five-Year Review and update of this specification with changes to prohibit unauthorized exceptions (see 3.3.5, 3.6, 4.4.1.1, and 8.5), reorder elements to reflect standard presentation of Composition (see Table 1), relocate Definitions (see 2.4), remove obsolete weight criteria from Ultrasonic Testing (see 3.4.3.1 and 3.4.3.2), update Applicable Documents (see Section 2), Stress Corrosion Resistance Indicator Test (see 3.3.2.2 and 3.3.2.3), Hardness (see 8.2), and Ordering Information (see 8.6), and allow the use of the immediate prior specification revision (see 8.4).

1. SCOPE

1.1 Form

This specification covers an aluminum alloy in the form of die and hand forgings 6.000 inches (152.00 mm) and under in nominal thickness at time of heat treatment (see 8.6).

1.2 Application

These products have been used typically for parts requiring a combination of good 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

AMS2772 Heat Treatment of Aluminum Alloy Raw Materials

AMS2808 Identification, Forgings

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For more information on this standard, visit
<https://www.sae.org/standards/content/AMS4149F>

SAE WEB ADDRESS:

AMS-A-22771 Aluminum Alloy Forgings, Heat Treated

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 Linear-Elastic Plane-Strain Fracture Toughness Testing of Aluminum Alloys

ASTM B660 Packaging/Packing of Aluminum and Magnesium Products

ASTM E10 Brinell Hardness of Metallic Materials

ASTM E1417/E1417M Liquid Penetrant Testing

2.3 ANSI Accredited Publications

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

ANSI H35.1/H35.1M Alloy and Temper Designation Systems 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 AMS2355.

Table 1 - Composition

Element	Min	Max
Silicon	--	0.15
Iron	--	0.20
Copper	1.2	2.0
Manganese	--	0.10
Magnesium	2.1	2.9
Chromium	0.18	0.28
Zinc	5.1	6.1
Titanium	--	0.10
Other Impurities, each	--	0.05
Other Impurities, total	--	0.15
Aluminum	remainder	

3.2 Condition

3.2.1 Solution and precipitation heat treated to the T74 temper in accordance with AMS2772.

3.2.2 Forge stock used to produce forgings to this specification shall be ingot or wrought stock in -O or -F temper (refer to ANSI H35.1/H35.1M). Forge stock ordered to this specification is for processing to the requirements of 3.2.

3.3 Properties

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

3.3.1 Tensile Properties

Shall be as follows:

3.3.1.1 Die Forgings

3.3.1.1.1 Longitudinal (With Grain Flow)

Specimens, machined from forgings 6.000 inches (152.00 mm) and under in nominal thickness at time of heat treatment or from prolongations on such forgings, with axis of specimen in area of the gauge length varying not more than 15 degrees from parallel to 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 2 Inches or 4D %
Up to 3.000, incl	76.0	66.0	7
Over 3.000 to 4.000, incl	73.0	63.0	7
Over 4.000 to 5.000, incl	70.0	61.0	7
Over 5.000 to 6.000, incl	68.0	58.0	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 50.8 mm or 4D %
Up to 76.00, incl	524	455	7
Over 76.00 to 102.00, incl	503	434	7
Over 102.00 to 127.00, incl	483	420	7
Over 127.00 to 152.00, incl	469	400	7

3.3.1.1.2 Across Grain Flow

Specimens, machined from forgings 6 inches (152 mm) and under in nominal thickness at time of heat treatment or from prolongations on such forgings, with axis of specimen in area of gauge length varying not more than 15 degrees from perpendicular to forging flow lines, shall have the properties shown in Table 3. If configuration of the forging or prolongation cannot accommodate transverse specimen described, acceptance of the forging shall be based on testing as in 3.3.1.1.3.

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 2 Inches or 4D %
Up to 3.000, incl	71.0	62.0	4
Over 3.000 to 4.000, incl	70.0	60.0	4
Over 4.000 to 5.000, incl	68.0	58.0	4
Over 5.000 to 6.000, incl	65.0	55.0	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 50.8 mm or 4D %
Up to 76.00, incl	490	427	4
Over 76.00 to 102.00, incl	483	414	4
Over 102.00 to 127.00, incl	469	400	4
Over 127.00 to 152.00, incl	448	379	4

3.3.1.1.2.1 Elongation requirements shall not apply to specimens having a gauge length diameter less than 0.250 inch (6.35 mm), located in immediate proximity to an abrupt change in section thickness, or located so that any part of the specimen gauge length is located within 1/8 inch (3.2 mm) of the trimmed flash line.

3.3.1.1.3 At Angle to Grain Flow

Specimens, machined from forgings 6.000 inches (152.00 mm) and under in nominal thickness at time of heat treatment or from prolongations on such forgings, with axis of specimen in area of gauge length varying more than 15 degrees from parallel and also more than 15 degrees from perpendicular to forging flow line, shall have the properties shown in Table 4. Such test results shall be identified as neither longitudinal nor transverse tensile test 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 4 provided that as-forged section thickness does not exceed 6 inches (150 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 2 Inches or 4D %
Up to 2.000, incl	Longitudinal	73.0	63.0	9
	Long Trans.	71.0	60.0	5
Over 2.000 to 3.000, incl	Longitudinal	73.0	63.0	9
	Long Trans.	71.0	60.0	5
	Short Trans.	69.0	60.0	4
Over 3.000 to 4.000, incl	Longitudinal	71.0	61.0	9
	Long Trans.	70.0	58.0	5
	Short Trans.	68.0	57.0	4
Over 4.000 to 5.000, incl	Longitudinal	68.0	57.0	8
	Long Trans.	67.0	56.0	5
	Short Trans.	66.0	55.0	4
Over 5.000 to 6.000, incl	Longitudinal	65.0	54.0	8
	Long Trans.	64.0	52.0	5
	Short Trans.	63.0	52.0	4

Table 4B - Minimum tensile properties, SI units

Nominal Thickness at Time of Heat Treatment Millimeters		Specimen Orientation	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 50.8 mm or 4D %
Up to	51.00, incl	Longitudinal	503	434	9
		Long Trans.	490	414	5
Over	51.00 to 76.00, incl	Longitudinal	503	434	9
		Long Trans.	490	414	5
Over	76.00 to 102.00, incl	Short Trans.	476	414	4
		Longitudinal	490	421	9
		Long Trans.	483	400	5
Over	102.00 to 127.00, incl	Short Trans.	469	393	4
		Longitudinal	469	393	8
		Long Trans.	462	386	5
Over	127.00 to 152.00, incl	Short Trans.	455	379	4
		Longitudinal	448	372	8
		Long Trans.	441	359	5
		Short Trans.	434	359	4

3.3.2 Stress-Corrosion Resistance Indicator Test

Conductivity shall be determined on the surface of the test specimen or sample, in accordance with AMS2355.

3.3.2.1 If conductivity is 40.0% IACS (International Annealed Copper Standard) (23.2 MS/m) or higher and tensile properties meet specified requirements (see 3.3.1), forgings are acceptable.

3.3.2.2 If conductivity is 38.0 to 39.9 IACS (22.0 to 23.1 MS/m), inclusive, if tensile properties meet specified requirements (see 3.3.1), and if the longitudinal yield strength does not exceed the specified minimum by more than 11.9 ksi (82 MPa), forgings are acceptable.

3.3.2.3 If conductivity is below 40.0 IACS (23.2 MS/m) and the longitudinal yield strength exceeds the specified minimum value (see 3.3.1) by more than 11.9 ksi (82 MPa), forgings are not acceptable.

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

3.3.2.5 Forgings that are not acceptable according to the requirements of 3.3.2.3 or 3.3.2.4 may be reheat treated or given additional precipitation heat treatment and retested. After such treatment, if all specified properties are met, the forging is acceptable.

3.3.3 Stress-Corrosion Cracking Resistance Testing

Specimens, cut from forgings 0.750 inch (19.05 mm) and over in nominal thickness, shall show no evidence of stress-corrosion cracking when stressed in the short-transverse direction (perpendicular to grain flow) to 35.0 ksi (241 MPa) for forgings 3.000 inches (76.00 mm) and under in nominal thickness and to 50% of the specified minimum longitudinal (with grain flow) yield strength for forgings over 3.000 inches (76.00 mm) in nominal thickness.

3.3.4 Fracture-Toughness

When specified, plane strain fracture toughness shall be tested in accordance with ASTM E399 and ASTM B645 for die forgings having nominal thickness of 1.500 to 6.000 inches (38.10 to 152.40 mm), inclusive, and hand forgings 2.600 to 6.000 inches (66.00 to 152.40 mm) in nominal thickness. A valid K_{IC} meeting the requirements of ASTM E399 or a K_Q "useable for lot release" in accordance with ASTM B645 shall meet or exceed the values specified in Table 5. The required test directions shall be specified by the purchaser.

Table 5 - Minimum K_{Ic} or K_Q “useable for lot release” fracture toughness

	K_{Ic} or K_Q	K_{Ic} or K_Q
Test Direction	$\text{ksi}\sqrt{\text{in}}$	$\text{MPa}\sqrt{\text{m}}$
Die Forgings		
L-T	27.0	29.7
T-L	21.0	23.1
S-L	21.0	23.1
Hand Forgings		
L-T	30.0	33.0
T-L	25.0	27.5
S-L	21.0	23.1

3.3.5 Mechanical property requirements for product outside the range covered by 1.1 shall be agreed upon between the purchaser and producer and reported per 4.4.1.1 (see 8.6).

3.3.6 Grain Flow

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 reentrant grain flow.

3.4 Quality

Forgings, as received by the 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 Forge stock shall be uniform in quality and condition, sound, and free of foreign materials and from imperfections detrimental to usage as starting stock for product produced to this specification.

3.4.2 When specified, die forgings shall be etched to produce a surface suitable for visual examination of the forging surfaces for defect indications, such as seams, laps, bursts, and quench cracks. Surface imperfections which can be removed, which do not reappear on re-etching, and do not reduce required section thickness are acceptable.

3.4.3 When specified, forgings shall be subjected to ultrasonic inspection in accordance with ASTM B594 and shall meet the following requirements of that specification:

3.4.3.1 Die forgings 0.500 to 4.000 inches (12.70 to 101.60 mm), inclusive, in nominal thickness shall meet Class A.

3.4.3.2 Hand forgings 1.000 to 6.000 inches (25.40 to 152.40 mm), inclusive, in nominal thickness shall meet Class A.

3.4.4 When specified, forgings shall be subjected to fluorescent penetrant inspection in accordance with ASTM E1417. Standards for acceptance shall be as agreed upon by the purchaser and producer.

3.5 Tolerances

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

3.6 Exceptions

Any exceptions shall be authorized by the purchaser and reported as in 4.4.1.1.

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 forgings conform to specified requirements.