AEROSPACE MATERIAL SPECIFICATION

AMS4147™	REV. F

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Superseding AMS4147E

Aluminum Alloy Forgings
5.6Zn - 2.5Mg - 1.6Cu - 0.23Cr (7075-T7352)
Solution Heat Treated, Stress Relieved by Compression, and Overaged
(Composition similar to UNS A97075)

RATIONALE

AMS4147F results from a Five-Year Review and update of this specification with changes to add provisions for AS6279 (see 3.6), remove obsolete weight criteria from Ultrasonic Inspection (see 3.4.1), update wording to prohibit unauthorized exceptions (see 3.3.1.4 and 8.5), relocate Definitions (see 2.4), and update Applicable Documents (see Section 2), Hardness note (see 8.2), and Ordering Information (see 8.6).

1. SCOPE

1.1 Form

This specification covers an aluminum alloy in the form of die forgings up to 4 inches (102 mm), inclusive, in thickness and hand forgings up to 6 inches (152 mm), inclusive, in thickness (see 8.6).

1.2 Application

These forgings have been used typically for parts requiring a combination of good strength and resistance to stress-corrosion cracking, and where good stability is required during machining, 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/AMS4147F/

AMS2772 Heat Treatment of Aluminum Alloy Raw Materials

AMS2808 Identification, Forgings

AS6279 Standard Practice for Production, Distribution, and Procurement of Metal Stock

AS7766 Terms Used in Aerospace Metals Specifications

2.2 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

2.3 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

ASTM B660 Packaging/Packing of Aluminum and Magnesium Products

ASTM E10 Brinell Hardness of Metallic Materials

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	--	0.40
Iron	--	0.50
Copper	1.2	2.0
Manganese	--	0.30
Magnesium	2.1	2.9
Chromium	0.18	0.28
Zinc	5.1	6.1
Titanium	--	0.20
Other Elements, each	--	0.05
Other Elements, total	--	0.15
Aluminum	remainder	

3.2 Condition

Solution heat treated, stress relieved by compression to produce a permanent set of not less than 1% nor more than 5%, and precipitation heat treated to the -T7352 temper (refer to ANSI H35.1/H35.1M). The direction and method of compression shall be as agreed upon by the purchaser and producer. Solution and precipitation heat treatment shall be performed in accordance with AMS2772.

3.3 Properties

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

3.3.1 Tensile Properties

Shall be as follows:

3.3.1.1 Die Forgings

3.3.1.1.1 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 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 %
Up to 3, incl	66.0	56.0	7
Over 3 to 4, incl	64.0	53.0	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 %
Up to 76, incl	455	386	7
Over 76 to 102, incl	441	365	7

3.3.1.1.2 Across Grain Flow

Specimens, machined from forgings not over 4 inches (102 mm) in nominal section thickness at time of heat treatment with axis of specimen as close to short-transverse direction as possible, shall have the properties shown in Table 3 except as specified in 3.3.1.1.2.1.

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 %
Up to 3, incl	62.0	51.0	3
Over 3 to 4, incl	61.0	49.0	2

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 %
Up to 76, incl	427	352	3
Over 76 to 102, incl	421	338	2

3.3.1.1.2.1 The elongation requirements shall not apply to specimens having a gauge length diameter less than 0.250 inch (6.35 mm), or located in immediate proximity to an abrupt change in thickness, or located so that any part of the specimen gauge length is located within 0.125 inch (3 mm) of the trimmed flash line.

3.3.1.2 Hand Forgings

Specimens, machined from forgings having an essentially square or rectangular cross section heat treated in the indicated thickness, shall have the properties shown in Table 4 provided the as-forged section thickness does not exceed 6 inches (152 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	66.0	54.0	7
	Long-Trans.	64.0	52.0	4
Over 2 to 3, incl	Longitudinal	66.0	54.0	7
	Long-Trans.	64.0	52.0	4
	Short-Trans.	61.0	50.0	3
Over 3 to 4, incl	Longitudinal	64.0	53.0	7
	Long-Trans.	63.0	50.0	3
	Short-Trans.	60.0	48.0	2
Over 4 to 5, incl	Longitudinal	62.0	51.0	7
	Long-Trans.	61.0	48.0	3
	Short-Trans.	58.0	46.0	2
Over 5 to 6, incl	Longitudinal	61.0	49.0	6
	Long-Trans.	59.0	46.0	3
	Short-Trans.	57.0	44.0	2

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 4D %
Up to 51, incl	Longitudinal	455	372	7
	Long-Trans.	441	359	4
Over 51 to 76, incl	Longitudinal	455	372	7
	Long-Trans.	441	359	4
	Short-Trans.	421	345	3
Over 76 to 102, incl	Longitudinal	441	365	7
	Long-Trans.	434	345	3
	Short-Trans.	414	331	2
Over 102 to 127, incl	Longitudinal	427	352	7
	Long-Trans.	421	331	3
	Short-Trans.	400	317	2
Over 127 to 152, incl	Longitudinal	421	338	6
	Long-Trans.	407	317	3
	Short-Trans.	393	303	2

3.3.1.3 Special Purpose Forgings

Tensile property requirements for specimens cut from special forgings or from forgings beyond the size and configuration limits of 3.3.1.1 and 3.3.1.2 shall be as specified on the drawing or as agreed upon by the purchaser and producer (see 8.6).

3.3.1.4 Mechanical property requirements for product outside of the range covered by 1.1 shall be agreed upon between the purchaser and producer and reported per 4.4.1 (see 8.6).

3.3.2 Stress-Corrosion Resistance

Forgings shall meet the electrical conductivity test of 3.3.2.1 and shall exhibit no evidence of stress-corrosion cracking when tested in accordance with 3.3.2.2. The test of 3.3.2.2 need not be performed on forgings meeting the requirements of 3.3.2.1.1 and 3.3.2.1.2.

3.3.2.1 Electrical Conductivity

Shall be as follows, determined on the surface of the sample:

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

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

3.3.2.1.3 If the conductivity is between 38.0 to 39.9% IACS (22.0 to 23.1 MS/m) and longitudinal yield strength exceeds the specified maximum value by more than 11.9 ksi (82 MPa), the forgings shall be given additional overaging. If, after such treatment, the forgings meet the requirements of 3.3.1 and 3.3.2.1.1 or 3.3.2.1.2, the forgings are acceptable.

3.3.2.1.4 If the conductivity is below 38.0% IACS (22.0 MS/m), the forgings are not acceptable but may be reheat treated or additionally overaged to meet the specified requirements.

3.3.2.2 Stress-Corrosion Cracking Resistance

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 to 75% of the specified minimum yield strength in the principal test direction (longitudinal for die forgings or long transverse for hand forgings).

3.3.3 Grain Flow

Grain flow of die forgings, except in areas that 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 Each forging shall be ultrasonically inspected in accordance with ASTM B594 and shall meet the following requirements:

3.4.1.1 Die forgings 0.375 to 4.000 inches (9.52 to 101.60 mm), inclusive, in nominal thickness shall meet Class B.

3.4.1.2 Hand forgings 1.000 to 8.000 inches (25.40 to 203.20 mm) in nominal thickness shall meet Class A.

3.4.1.3 Acceptance criteria for forgings exceeding the limits of 3.4.1.1 or 3.4.1.2 shall be as agreed upon by the purchaser and producer (see 8.6).

3.4.2 Each die forging shall be etched to produce a surface suitable for visual inspection. Surfaces shall be evaluated for defects such as seams, laps, bursts, and quench cracks. Surface imperfections, which can be removed so that they do not reappear on re-etching and the required section thickness can be maintained, are acceptable.

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

3.5 Exceptions

Any exceptions shall be authorized by the purchaser and reported as in 4.4.1.

3.6 Production, distribution, and procurement of metal stock shall comply with AS6279. This requirement becomes effective 18 months after publication of AMS4147F.

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.

4.2 Classification of Tests

4.2.1 Acceptance Tests

Composition (see 3.1), tensile properties (see 3.3.1), conductivity (see 3.3.2.1), and ultrasonic soundness (see 3.4.1) are acceptance tests and shall be performed on each lot.

4.2.2 Periodic Tests

Stress-corrosion resistance (see 3.3.2.2) and grain flow (see 3.3.3) are periodic tests 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: a lot shall be all forgings of the same configuration heat treated in the same batch furnace load or a continuous furnace consecutively during an 8-hour period. Maximum lot size for forgings heat treated in a continuous furnace and charged consecutively during continuous furnace operation shall be 2000 pounds (907 kg) for forgings weighing 5 pounds (2.3 kg) and under and 6000 pounds (2722 kg) for forgings weighing over 5 pounds (2.3 kg).

4.4 Reports

The producer of forgings shall furnish with each shipment a report stating that the product conforms to the composition and tolerances 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, lot number, AMS4147F, size or part number, and quantity. The report shall also identify the producer, the product form, and the size of the mill product.

4.4.1 When material produced to this specification is beyond the sizes allowed in the scope or tables, or other exceptions authorized by the purchaser are taken to the technical requirements listed in Section 3, the report shall contain a statement "This material is certified as AMS4147F(EXC) because of the following exceptions:" and the specific exceptions shall be listed.

4.5 Resampling and Retesting

Shall be in accordance with AMS2355.