



AEROSPACE MATERIAL SPECIFICATION

AMS4333**REV. D**Issued 1988-10
Revised 2015-07

Superseding AMS4333C

Aluminum Alloy, Die Forgings
6.2Zn - 2.3Cu - 2.2Mg - 0.12Zr (7050-T7452)
Solution Heat Treated, Compression Stress-Relieved, and Overaged
(Composition similar to UNS A97050)

RATIONALE

AMS4333D revises Properties (Tables 2A and 3A, 3.3.1.1.3), Fracture Toughness (3.3.1.4, Table 4), and Reports (4.4.2), and is a Five Year Review and update of this specification (See 8.5).

1. SCOPE

1.1 Form

This specification covers an aluminum alloy in the form of die forgings 4.000 inches (102 mm) and under in nominal thickness and of forging stock of any size.

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 +1 724-776-4970 (outside USA), www.sae.org.

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

AMS2772 Heat Treatment of Aluminum Alloy Raw Materials

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<http://www.sae.org/technical/standards/AMS4333D>

AMS2808 Identification, Forgings

AS1990 Aluminum Alloy Tempers

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

ASTM B645 Linear-Elastic Plane Strain Fracture Toughness Testing of Aluminum Alloys

ASTM B660 Packaging/Packing of Aluminum and Magnesium Products

ASTM E399 Linear Elastic Plane-Strain Fracture Toughness (K_{Ic}) of Metallic Materials

ASTM E1417 Liquid Penetrant Testing

2.3 ANSI Publications

Available from American National Standards Institute, 25 West 43rd Street, 4th Floor, 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 AMS2355.

Table 1 - Composition

Element	min	max
Silicon	--	0.12
Iron	--	0.15
Copper	2.0	2.6
Manganese	--	0.10
Magnesium	1.9	2.6
Chromium	--	0.04
Zinc	5.7	6.7
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 AMS2772, stress-relieved by compressing to produce a 1 to 5% permanent set, and overaged to the T7452 temper (See AS1990) (See 8.2).

3.2.2 Forging Stock

As ordered by the forging manufacturer.

3.3 Properties

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

3.3.1 Die Forgings

3.3.1.1 Tensile Properties

3.3.1.1.1 With Grain Flow

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 %
Up to 2.000, incl	72.0	60.0	9
Over 2.000 to 4.000, incl	71.0	59.0	8

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 51, incl	496	414	9
Over 51 to 102, incl	490	407	8

3.3.1.1.2 Across Grain Flow

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 %
Up to 2.000, incl	68.0	55.0	5
Over 2.000 to 4.000, incl	67.0	53.0	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 %
Up to	51, incl		469	379	5
Over	51 to	102, incl	462	365	4

3.3.1.1.3 Mechanical property requirements for product outside of the range covered by 1.1 shall be agreed upon between purchaser and producer.

3.3.1.1.4 Special Purpose Forgings

Tensile specimens cut from special purpose forgings shall meet the tensile property requirements specified on the drawing or as agreed upon by purchaser and vendor.

3.3.1.2 Corrosion Resistance

Resistance to stress-corrosion cracking and to exfoliation-corrosion of the forging heat lot is acceptable if the conditions of 3.3.1.2.1 and 3.3.1.2.2 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 Stress-Corrosion Susceptibility Factor (SCF)

Shall be not greater than 32.0 (220), determined by subtracting the electrical conductivity, AA.A percent IACS (12 times BB.B MS/m) from the highest actual with grain yield strength limit, XX.X ksi (YYY MPa).

Examples:

Inch/Pound Units	72.0 ksi - 38.5% IACS = 33.5	Unacceptable
	68.0 ksi - 40.2% IACS = 27.8	Acceptable
SI Units	496 MPa - 12 x 22.3 MS/m = 228.4	Unacceptable
	469 MPa - 12 x 23.3 MS/m = 189.4	Acceptable

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

3.3.1.3 Stress-Corrosion Resistance

Specimens, not less than 0.750 inch (19.05 mm) in thickness cut from forgings, 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, plane strain fracture toughness shall be tested in accordance with ASTM E399 and ASTM B645 for forgings 1.000 to 4.000 inches (25.40 to 101.60 mm) inclusive 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 4.

Table 4 – Minimum K_{IC} OR K_Q “useable for lot release” fracture toughness

Nominal Thickness Inches	Nominal Thickness Millimeters	Specimen Orientation	Minimum K_{IC} or K_Q ksi $\sqrt{\text{inch}}$	Minimum K_{IC} or K_Q MPa $\sqrt{\text{m}}$
1.000 to 3.500, incl	25.40 to 88.90, incl	L-T	27	30
		T-L	19	21
		S-L	19	21
Over 3.500 to 4.000, incl	88.90 to 101.60, incl	L-T	25	27
		T-L	19	21
		S-L	19	21

3.3.2 Forging Stock

When a sample of stock is forged to a test coupon and heat treated in the same manner as forgings, specimens taken from the heat treated coupon shall conform to the requirements of 3.3.1.1. If specimens taken from the stock prior to forging and after heat treatment in the same manner as forgings conform to the requirements of 3.3.1.1, the tests shall be accepted as equivalent to tests of a forged coupon. The forging stock supplier, however, shall not be required to use unforged coupons when performing lot conformance testing.

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 B594 and shall meet Class B acceptance criteria.

3.4.2 When specified, each die forging shall be subjected to fluorescent penetrant testing in accordance with ASTM E1417. 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

The following requirements are acceptance tests and, except for composition, shall be performed on each inspection lot.

4.2.1.1 Composition (3.1) of the product.