

Aluminum Alloy Forgings
5.6Zn - 2.5Mg - 1.6Cu - 0.23Cr (7175-T7452)
Solution Heat Treated, Stress Relieved, and Precipitation Heat Treated
(Composition similar to UNS A97175)

RATIONALE

This document has been reaffirmed to comply with the SAE 5-year Review policy.

1. SCOPE:

1.1 Form:

This specification covers an aluminum alloy in the form of die forgings, hand forgings, and forging stock.

1.2 Application:

These products have been used typically for parts requiring a high level of mechanical properties and good 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 canceled and no superseding document has been specified, the last published issue of that document shall apply.

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<http://www.sae.org/technical/standards/AMS4179C>**

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or 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
MAM 2355	Quality Assurance Sampling and Testing, Aluminum Alloys and Magnesium Alloys, Wrought Products, Except Forging Stock and Rolled, Forged or Flash Welded Rings, Metric (SI) Units
AMS 2772	Heat Treatment of Aluminum Alloy Raw Materials
AMS 2808	Identification, Forgings
AS1990	Aluminum Alloy Tempers

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959 or www.astm.org.

ASTM B 594	Ultrasonic Inspection of Aluminum Alloy Wrought Products for Aerospace Applications
ASTM E 1417	Liquid Penetrant Examination

2.3 ANSI Publications:

Available from ANSI, 25 West 43rd Street, New York, NY 10036-7406.

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 or MAM 2355:

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 Elements, each	--	0.05
Other Elements, total	--	0.15
Aluminum	remainder	

3.2 Condition:

The product shall be supplied in the following condition:

- 3.2.1 Forgings: Solution heat treated, stress relieved by compression to produce a permanent set of 1 to 5%, and precipitation heat treated (See 8.2). Heat treatment shall be performed using pyrometry in accordance with AMS 2772.
- 3.2.2 Forging Stock: Forging stock used to produce forgings to this specification shall be ingot or wrought stock in the O or F temper. (See AS1990). Forge stock ordered to this specification is for manufacturing forgings defined in 3.2.1. Material shall comply with the requirements of Table 1.

3.3 Properties:

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

3.3.1 Die and Hand Forgings:

3.3.1.1 Tensile Properties: Shall be as follows:

3.3.1.1.1 Die Forgings:

3.3.1.1.1.1 Longitudinal (With Grain Flow): Specimens, machined from forgings not over 3 inches (76 mm) in nominal thickness at time of heat treatment with axis of specimen in the 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 2 - Minimum Tensile Properties

Property	Value
Tensile Strength	73.0 ksi (503 MPa)
Yield Strength at 0.2% Offset	63.0 ksi (434 MPa)
Elongation	
in 4D	7%
in 5D	6%

3.3.1.1.1.2 Transverse (Across Grain Flow): Specimens, machined from forgings not over 3 inches (76 mm) in nominal section thickness at time of heat treatment with axis of specimens in the area of the gage length varying not more than 15 degrees from perpendicular to the forging flow lines, shall have the properties shown in Table 3.

TABLE 3 - Minimum Tensile Properties

Property	Value
Tensile Strength	68.0 ksi (469 MPa)
Yield Strength at 0.2% Offset	55.0 ksi (379 MPa)
Elongation	
in 4D	4%
in 5D	3%

3.3.1.1.1.2.1 Elongation requirement applies only to specimens having a gage-length diameter not less than 0.250 inch (6.35 mm) and cut so that the length of the specimen is in a plane parallel to the parting plane.

3.3.1.1.2 Hand Forgings: Specimens, machined from forgings not over 6 inches (152 mm) in nominal as-forged thickness and having an essentially rectangular or square cross-section not exceeding 156 square inches (1007 cm²) in area and heat treated in the indicated thickness, shall have the properties specified in Table 4.

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	71.0	61.0	9
	Long.-Trans.	69.0	58.0	5
Over 2 to 3, incl	Longitudinal	71.0	61.0	9
	Long.-Trans.	69.0	58.0	5
	Short-Trans.	67.0	54.0	4
Over 3 to 4, incl	Longitudinal	68.0	57.0	9
	Long.-Trans.	67.0	55.0	5
	Short-Trans.	65.0	51.0	4
Over 4 to 5, incl	Longitudinal	65.0	54.0	8
	Long.-Trans.	64.0	52.0	5
	Short-Trans.	63.0	49.0	4
Over 5 to 6, incl	Longitudinal	63.0	51.0	8
	Long.-Trans.	61.0	49.0	5
	Short-Trans.	60.0	46.0	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 4D %
Up to 50, incl	Longitudinal	490	420	9
	Long.-Trans.	476	400	5
Over 50 to 75, incl	Longitudinal	490	420	9
	Long.-Trans.	476	400	5
	Short-Trans.	462	372	4
Over 75 to 100, incl	Longitudinal	469	393	9
	Long.-Trans.	462	379	5
	Short-Trans.	448	352	4
Over 100 to 125, incl	Longitudinal	448	372	8
	Long.-Trans.	441	359	5
	Short-Trans.	434	338	4
Over 125 to 150, incl	Longitudinal	434	351	8
	Long.-Trans.	420	338	5
	Short-Trans.	414	317	4

- 3.3.1.2 Conductivity: Shall be as follows, determined on the surface of the tensile sample:
- 3.3.1.2.1 If the conductivity is 40.0% IACS (International Annealed Copper Standard) (23.2 MS/m), or higher and tensile properties meet specified requirements, the forgings are acceptable.
 - 3.3.1.2.2 If the conductivity is 38.0 to 39.9% IACS (22.0 to 23.1 MS/m), if the tensile properties meet specified properties, and if the longitudinal yield strength does not exceed the specified minimum by more than 11.9 ksi (82 MPa), the forgings are acceptable.
 - 3.3.1.2.3 If the conductivity is below 40.0% IACS (23.2 MS/m) and longitudinal yield strength exceeds the specified minimum value by more than 11.9 ksi (82 MPa), the forgings are suspect.
 - 3.3.1.2.3.1 When forgings are suspect, they may be subjected to additional precipitation heat treatment and if they then meet the requirements of 3.3.1.2.1 or 3.3.1.2.2, they are acceptable
 - 3.3.1.3 Stress-Corrosion Resistance: Specimens as in 4.3 cut from forgings shall show no evidence of stress-corrosion cracking when stressed in the short-transverse direction at 35.0 ksi (241 MPa) for die and hand forgings 3 inches (76 mm) and under in section thickness or to 50% of the specified minimum longitudinal yield strength for hand forgings over 3 inches (76 mm) in section thickness and held at constant strain.
 - 3.3.1.4 Grain flow of die forgings, except in areas which contain end grain, shall follow the general contour of the forging, showing no evidence of re-entrant flow.
 - 3.3.2 Forging Stock: When a sample of stock is forged to a test coupon having a degree of mechanical working not greater than the forging 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 and 3.3.1.2. If specimens taken from the stock after heat treatment in the same manner as forgings conform to the requirements of 3.3.1.1 and 3.3.1.2, the tests shall be accepted as equivalent to tests of a forged coupon.
 - 3.4 Quality:

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

 - 3.4.1 Each hand forging, and when specified, each die forging, shall be subjected to ultrasonic inspection in accordance with ASTM B 594 and shall meet the following acceptance criteria:
 - 3.4.1.1 Hand Forgings: Class A.
 - 3.4.1.2 Die Forgings: Class B.

3.4.2 Each forging shall be free from surface defects, such as seams, laps, bursts, and quench cracks, when etched by swabbing or immersing in an aqueous solution of sodium hydroxide, thoroughly rinsing in tap water, followed by washing in nitric acid or chromic-sulfuric acid solution or equivalent solution which will produce a surface suitable for visual inspection. Surfaces shall be evaluated for defects and, if defects can be removed so that they do not reappear on re-etching and if the required section thickness is maintained, the forgings are acceptable. Forgings shall be thoroughly dried after each etch and rinse operation to prevent fluid entrapment.

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

3.4.3 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.

3.4.4 Forge stock shall be uniform in quality and condition, sound and free of foreign materials and from imperfections detrimental to use as starting stock for product produced to this specification

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 the product 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 the 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), ultrasonic inspection (3.4.1), surface evaluation (3.4.2), when specified, fluorescent penetrant examination (3.4.3) and tolerances are acceptance tests and, except for composition, shall be performed on each lot.

4.2.2 Periodic Tests: Stress corrosion resistance (3.3.1.3), grain flow of die forgings (3.3.1.4), and ability of forging stock to develop required properties are periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.3 Sampling and Testing:

Shall be in accordance with AMS 2355 or MAM 2355 and the following: a lot shall be all forgings of the same nominal cross-section and configuration, heat treated in the same batch furnace load or in 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 (2.6 kg) and under and shall be 6000 pounds (2721 kg) for forgings weighing over 5 pounds (2.6 kg).

4.4 Reports:

- 4.4.1 The vendor of the product shall furnish with each shipment a report stating that the product conforms to the composition and tolerances, results of nondestructive inspection, and showing the numerical results of tests on each lot to determine conformance to the acceptance test requirements and when performed, the periodic test requirements. This report shall include the purchase order number, lot number(s), AMS 4179C, sizes and quantity. The report shall also include the identity of the producer and the size of the mill product.
- 4.4.2 The vendor of forging stock shall furnish with each shipment a report stating the product conforms to the composition requirements of Table 1 (3.1) of this specifications and other requirements or tests as may be required by the purchaser. This report shall identify the supplier, the purchase order number, lot or ingot cast number, AMS 4179C, size and quantity

4.5 Resampling and Retesting:

Shall be in accordance with AMS 2355 or MAM 2355.

5. PREPARATION FOR DELIVERY:

5.1 Identification:

The product shall be identified as follows:

- 5.1.1 Forgings: In accordance with AMS 2808.
- 5.1.2 Forging Stock: As agreed upon by purchaser and vendor.

5.2 Packaging:

The product shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the product to ensure carrier acceptance and safe delivery.