



AEROSPACE MATERIAL SPECIFICATION

Society of Automotive Engineers, Inc.
TWO PENNSYLVANIA PLAZA, NEW YORK, N.Y. 10001

AMS 4109

Issued 6-1-74
Revised

ALUMINUM ALLOY HAND FORGINGS 5.6Zn - 2.5Mg - 1.6Cu - 0.24Cr (7175-T736)

1. SCOPE:

- 1.1 Form: This specification covers an aluminum-base alloy in the form of hand forgings and forging stock.
- 1.2 Application: Primarily for parts requiring a high level of mechanical properties and good resistance to stress-corrosion cracking.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS) shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

- 2.1 SAE Publications: Available from Society of Automotive Engineers, Inc., Two Pennsylvania Plaza, New York, New York 10001.

2.1.1 Aerospace Material Specifications:

AMS 2201 - Tolerances, Aluminum and Aluminum Alloy Bar, Rod, Wire, and Forging Stock, Rolled or Drawn
AMS 2350 - Standards and Test Methods
AMS 2375 - Approval and Control of Critical Forgings
AMS 2630 - Ultrasonic Inspection
AMS 2808 - Identification, Forgings

- 2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.

ASTM B342 - Electrical Conductivity by Use of Eddy Currents
ASTM B557 - Tension Testing Wrought and Cast Aluminum and Magnesium Alloy Products
ASTM E10 - Brinell Hardness of Metallic Materials
ASTM E34 - Chemical Analysis of Aluminum and Aluminum-Base Alloys

- 2.3 Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.

2.3.1 Federal Standards:

Federal Test Method Standard No. 151 - Metals; Test Methods

2.3.2 Military Specifications:

MIL-I-8950 - Inspection, Ultrasonic, Wrought Metals, Process for

3. TECHNICAL REQUIREMENTS:

- 3.1 Composition: Shall conform to the following percentages by weight, determined by wet chemical methods in accordance with ASTM E34, by spectrographic methods in accordance with Federal Test Method Standard No. 151, Method 112, or by other approved analytical methods.

REAFFIRMED

5/95

	min	max
Zinc	5.1	6.1
Magnesium	2.1	2.9
Copper	1.2	2.0
Chromium	0.18	0.30
Iron	--	0.20
Silicon	--	0.15
Manganese	--	0.10
Titanium	--	0.10
Other Impurities, each	--	0.05
Other Impurities, total	--	0.15
Aluminum		remainder

3.2 Condition: The product shall be supplied in the following condition:

3.2.1 Hand Forgings: Solution and precipitation heat treated to develop the required mechanical properties and resistance to stress-corrosion cracking.

3.2.2 Forging Stock: As ordered by the forging manufacturer.

3.3 Properties: The product shall conform to the following requirements:

3.3.1 Hand Forgings:

3.3.1.1 Tensile Properties: Test specimens, machined from hand forgings having an essentially rectangular or square cross section not exceeding 156 sq in. (1007 cm²) in area and heat treated in the indicated thickness, shall conform to the requirements shown in Table I provided the as-forged thickness does not exceed 6 in. (152 mm), determined in accordance with ASTM B557:

TABLE I

Nominal Thickness At Time of Heat Treatment Inches	Test Direction	Tensile Strength psi, min	Yield Strength at 0.2% Offset psi, min	Elongation in 2 in. or 4D %, min
Up to 3, incl	Longitudinal	73,000	63,000	9
	Long Trans.	71,000	60,000	5
	Short Trans.	69,000	60,000	4
Over 3 to 4, incl	Longitudinal	71,000	61,000	9
	Long Trans.	70,000	58,000	5
	Short Trans.	68,000	57,000	4
Over 4 to 5, incl	Longitudinal	68,000	57,000	8
	Long Trans.	67,000	56,000	5
	Short Trans.	66,000	55,000	4
Over 5 to 6, incl	Longitudinal	65,000	54,000	8
	Long Trans.	64,000	52,000	5
	Short Trans.	63,000	52,000	4

TABLE I (SI)

Nominal Thickness At Time of Heat Treatment Millimetres	Test Direction	Tensile Strength MPa, min	Yield Strength at 0.2% Offset MPa, min	Elongation in 50.8 mm or 4D %, min
Up to 76, incl	Longitudinal	503	434	9
	Long Trans.	490	414	5
	Short Trans.	476	414	4
Over 76 to 102, incl	Longitudinal	490	421	9
	Long Trans.	483	400	5
	Short Trans.	469	393	4
Over 102 to 127, incl	Longitudinal	469	393	8
	Long Trans.	462	386	5
	Short Trans.	455	379	4
Over 127 to 152, incl	Longitudinal	448	372	8
	Long Trans.	441	359	5
	Short Trans.	434	359	4

- 3.3.1.2 Hardness: Should be not lower than 135 HB/10/500 or 135 HB/14.3/1000, or not lower than 140 HB/10/1000, determined in accordance with ASTM E10, but forgings shall not be rejected on the basis of hardness if the tensile properties are met.
- 3.3.1.3 Conductivity: Shall be as follows, determined in accordance with ASTM B342:
- 3.3.1.3.1 If the conductivity is 40% IACS (International Annealed Copper Standard) or higher and tensile properties meet specified requirements, the forgings are acceptable.
- 3.3.1.3.2 If the conductivity is 38 - 40% IACS, if the tensile properties meet specified properties, and if the longitudinal yield strength does not exceed the specified minimum by more than 11,900 psi (82 MPa), the forgings are acceptable.
- 3.3.1.3.3 If the conductivity is below 40% IACS and longitudinal yield strength exceeds the specified minimum value by 11,900 psi (82 MPa) or more, the forgings are suspect.
- 3.3.1.3.3.1 When forgings are suspect they may be subjected to additional precipitation heat treatment or a sample of the forgings may be heated for not less than 30 min. at $870^{\circ}\text{F} + 10$ ($465.6^{\circ}\text{C} + 5.6$) and quenched in cold water. Conductivity shall be measured within 15 min. of quenching. If the difference between this measurement and the original measurement is 6% IACS or more, the forgings are satisfactory. If the difference is less than 6% IACS, the forgings must be given additional precipitation treatment or be completely reprocessed.
- 3.3.1.3.4 If the conductivity is below 38% IACS, the material is unsatisfactory and must be reprocessed, regardless of mechanical property level.
- 3.3.1.4 Resistance to Stress-Corrosion Cracking: Material shall be capable of showing no evidence of stress-corrosion cracking when subjected to the following test:
- 3.3.1.4.1 A tensile test specimen, cut from a forging so that the specimen axis is parallel to the short transverse direction of the forging, shall be stressed to 35,000 psi (241 MPa) for forgings up to 3 in. (76 mm) thick or to 50% of specified minimum longitudinal yield strength for forgings over 3 in. (76 mm) thick and held at constant strain in a suitable fixture. The stressed specimen shall be subjected to cyclic immersion for 30 days in a 3-1/2% solution of sodium chloride in accordance with Federal Test Method Standard No. 151, Method 823.

- 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 and 3.3.1.3. If specimens taken from the stock after heat treatment in the same manner as forgings conforms to the requirements of 3.3.1.1 and 3.3.1.3, the tests shall be accepted as equivalent to tests of a forged coupon. The forging stock supplier, however, shall not be required to conduct such tests.
- 3.4 Quality: The product shall be uniform in quality and condition, clean, sound, and free from foreign materials and from internal and external imperfections detrimental to fabrication or to performance of parts.
- 3.4.1 Internal Soundness: Unless otherwise specified each hand forging shall be inspected ultrasonically for internal defects in accordance with AMS 2630. Limits of acceptability shall be Class A as defined in MIL-I-8950.
- 3.5 Tolerances: Unless otherwise specified, tolerances for forging stock shall conform to all applicable requirements of AMS 2201.
4. QUALITY ASSURANCE PROVISIONS:
- 4.1 Responsibility for Inspection: The vendor of the product shall supply all samples and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.5. Purchaser reserves the right to perform such confirmatory testing as he deems necessary to assure that the product conforms to the requirements of this specification.
- 4.2 Classification of Tests:
- 4.2.1 Acceptance Tests: Tests of the product to determine conformance to composition (3.1) requirements, of forgings to determine conformance to tensile properties (3.3.1.1), and conductivity (3.3.1.3) requirements, and of forging stock to determine conformance to tolerance (3.5) requirements are classified as acceptance or routine control tests.
- 4.2.2 Qualification Tests: Tests of forgings to determine conformance to hardness (3.3.1.2) and stress corrosion (3.3.1.4) requirements and of forging stock to determine capability of developing required properties (3.3.2) are classified as qualification or periodic control tests.
- 4.3 Sampling: Shall be as follows; 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-hr period.
- 4.3.1 Composition: At least one sample shall be taken by the producer from each group of ingots poured simultaneously from the same source of molten metal.
- 4.3.1.1 Unless compliance with 4.3.1 is established, an analysis shall be made for each 6000 lb (2724 kg) or less of material comprising the lot except that not more than one analysis shall be required per piece.
- 4.3.2 Tensile Properties and Conductivity: At least two specimens shall be taken from a hand forging in each lot or from a prolongation representative of forgings in each lot. One specimen shall be taken in the longitudinal direction and one in the short transverse direction. Conductivity shall be measured on each of the specimens.
- 4.3.3 Stress-Corrosion Test: At least one sample shall be taken from the first production lot of forgings and, unless otherwise agreed upon by purchaser and vendor, once each month thereafter.
- 4.4 Approval: When specified, approval and control of critical forgings shall be in accordance with AMS 2375.