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

AEROSPACE MATERIAL SPECIFICATION

AMS 4149

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Revised

ALUMINUM ALLOY DIE FORGINGS
5.6Zn - 2.5Mg - 1.6Cu - 0.24Cr (7175-T736)
Solution and Precipitation Heat Treated

1. SCOPE:

1.1 Form: This specification covers an aluminum alloy in the form of high strength die forgings and forging stock.

1.2 Application: Primarily for parts requiring 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 Specification (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 2808 - Identification, Forgings

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

ASTM B117 - Salt Spray (Fog) Testing
ASTM B342 - Electrical Conductivity By Use of Eddy Currents
ASTM E8 - Tension Testing of Metallic Materials
ASTM E10 - Brinell Hardness of Metallic Materials
ASTM E34 - Chemical Analysis of Aluminum and Aluminum-Base Alloys

2.3 Government Publications: Available from Superintendent of Documents, Government Printing Office, Washington, D. C. 20402.

2.3.1 Federal Standards:

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

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.

	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 Die Forgings: Solution heat treated 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:

3.3.1 Tensile Properties: Test specimens and testing procedures shall be in accordance with ASTM E8.

3.3.1.1 Die Forgings Parallel to Grain Flow: Test specimens machined from forgings not over 3 in. (76.2 mm) in thickness, or from prolongations on such forgings, with the specimen axis approximately parallel to the forging flow lines shall conform to the following requirements:

Tensile Strength, min	76,000 psi (524 MN/m^2)
Yield Strength at 0.2% Offset, min	66,000 psi (455 MN/m^2)
Elongation in 2 in. (50.8 mm) or 4D, min	7 %

3.3.1.2 Die Forgings Across Grain Flow: Test specimens machined from forgings not over 3 in. (76.2 mm) in thickness, or from prolongations on such forgings, so that the specimen axis is transverse to the forging flow lines shall conform to the following requirements:

Tensile Strength, min	71,000 psi (490 MN/m^2)
Yield Strength at 0.2% Offset, min	62,000 psi (428 MN/m^2)
Elongation in 2 in. (50.8 mm) or 4D, min	4 %

3.3.1.3 If the section thickness of the forging is greater than 3 in. (76.2 mm), the tensile properties (parallel and transverse to grain flow) shall be as agreed upon by purchaser and vendor.

3.3.1.4 The elongation requirement shall not apply to test specimens having a gage length diameter less than 0.25 in. (6.35 mm), or located in immediate proximity to an abrupt change in section thickness, or located so that any part of the specimen gage length is located within 1/8 in. (3.2 mm) of the trimmed flashline.

3.3.2 Hardness: Should be not lower than 135 HB/10/500 or 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.

3.3.3 Conductivity:

3.3.3.1 If the conductivity is below 38% IACS (International Annealed Copper Standard), determined in accordance with ASTM B342, the material is considered unsatisfactory and must be reprocessed, regardless of mechanical property level.

3.3.3.2 If the conductivity is 40% IACS or higher and tensile properties meet specified requirements, the forgings are considered to be satisfactory.

3.3.3.3 If conductivity is 38 - 40% IACS, if the tensile properties meet specified requirements, and if the yield strength does not exceed the specified minimum by more than 11,900 psi (82.1 MN/m^2), the forgings are considered to be satisfactory.

3.3.3.4 If conductivity is below 40% IACS and yield strength exceeds the specified minimum value by 12,000 psi (82.7 MN/m^2) or more, the forgings are considered suspect.

3.3.3.5 When forgings are considered suspect, they may be reprocessed or a sample of the forgings may be heated for not less than 30 min. at 870 F ± 10 (465.6 C ± 5.6) and quenched in cold water. Conductivity shall then be measured within 15 min. after quenching. If the difference between this measurement and the original measurement on the forgings is 6% or more, the forgings are satisfactory. If the difference is less than 6%, the forgings must be reprocessed.

3.3.4 Stress-Corrosion Cracking Test: Material shall be capable of showing no evidence of stress-corrosion cracking when subjected to the following test:

3.3.4.1 A tensile test specimen, cut from a forging or from a prolongation so that the axis of the specimen is parallel to the short transverse direction of the forging, shall be stressed to 35,000 psi (241 MN/m^2) 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 conforming to the purity and pH requirements of ASTM B117 and maintained at room temperature; each cycle shall consist of 10 min. immersion in the solution and 50 min. out of the solution. Specimens shall be dry prior to each immersion.

3.3.5 Forging Stock: When a sample of stock is forged to a test coupon and heat treated in the same manner as forgings, tensile test specimens taken from the heat treated coupon shall have properties not lower than those specified in 3.3.1.1, 3.3.1.2, 3.3.3 and 3.3.4. If test specimens taken from the stock after heat treatment in the same manner as forgings have properties not lower than those specified in 3.3.1.1, 3.3.1.2, 3.3.3 and 3.3.4, the tests shall be accepted as equivalent to tests of a forged coupon.

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.

3.5 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 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 material conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Routine Control Tests: Tests of die forgings to determine conformance to composition (3.1), tensile properties (3.3.1), hardness (3.3.2), and conductivity (3.3.3) requirements and of forging stock to determine conformance to composition (3.1) requirements of this specification are classified as routine control tests.

4.2.2 Periodic Control Tests: Tests of die forgings to determine conformance to stress-corrosion (3.3.4) requirements and of forging stock to determine conformance to the requirements of 3.3.5 are classified as qualification and/or periodic control tests.

4.3 Sampling:

4.3.1 At least one sample shall be taken from each group of ingots poured simultaneously from the same source of molten metal by the producer and analyzed to determine conformance to 3.1. Ingots not conforming to this specification shall be rejected. Complete ingot analysis records shall be available to the purchaser.

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 Unless otherwise specified, at least two specimens shall be taken from a forging in each lot or from a forging prolongation representative of forgings in each lot to determine conformance to 3.3.1. One specimen shall be taken with its axis parallel to grain flow and one with its axis across grain flow. Conductivity shall be measured on each of the specimens.

4.3.3 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 for the stress-corrosion test.

4.3.4 A lot shall consist of all forgings of the same configuration heat treated and aged together. For forgings heat treated in a continuous furnace maximum lot size shall be 2000 lb (908 kg) of forgings weighing 5 lb (2.3 kg) or less, or 6000 lb (2724 kg) of forgings weighing over 5 lb (2.3 kg), and charged consecutively during continuous furnace operation.

4.4 Approval: When specified, approval and control of critical forgings shall be in accordance with AMS 2375.

4.5 Reports:

4.5.1 The vendor of forgings shall furnish with each shipment three copies of a report stating that the chemical composition conforms to the requirements specified in 3.1 and showing the results of tests on each lot to determine conformance to all other technical requirements of this specification. This report shall include the purchase order number, material specification number, size or part number, and quantity.

4.5.2 The vendor of forging stock shall furnish with each shipment three copies of a report stating that the material conforms to the chemical composition of this specification. The report shall include the purchase order number, material specification number, size, and quantity.

4.5.3 The vendor of finished or semi-finished parts shall furnish with each shipment three copies of a report showing the purchase order number, material specification number, contractor or other direct supplier of material, part number, and quantity. When material for making parts is produced or purchased by the parts vendor, that vendor shall inspect each lot of material to determine conformance to the requirements of this specification, and shall include in the report a statement that the material conforms, or shall include copies of laboratory reports showing the results of tests to determine conformance.

4.6 Resampling and Retesting: If any specimen used in the above tests fails to meet the specified requirements, disposition of the product may be based on the results of testing two additional specimens. Failure of any retest specimen to meet the specified requirements shall be cause for rejection of the material represented and no additional testing shall be permitted. Results of all tests shall be reported.

5. PREPARATION FOR DELIVERY:

5.1 Identification: The product shall be identified as follows: