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AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

AMS 4140F
Superseding AMS 4140E

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ALUMINUM ALLOY DIE FORGINGS
4.0Cu - 2.0Ni - 0.68Mg (2018-T61)
Solution and Precipitation Heat Treated UNS A92018

1. SCOPE:

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

1.2 Application: Primarily for parts, such as pistons for aircraft reciprocating engines. Certain design and processing procedures may cause these forgings to become susceptible to stress-corrosion cracking; ARP 823 recommends practices to minimize such conditions.

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

2.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2201 - Tolerances, Aluminum and Aluminum Alloy Bar, Rod, Wire, and Forging Stock, Rolled or Cold Finished
MAM 2201 - Tolerances, Metric, Aluminum and Aluminum Alloy Bar, Rod, Wire, and Forging Stock, Rolled, Drawn, or Cold Finished
AMS 2350 - Standards and Test Methods
AMS 2375 - Control of Forgings Requiring First-Article Approval
AMS 2808 - Identification, Forgings

2.1.2 Aerospace Recommended Practices:

ARP 823 - Minimizing Stress Corrosion Cracking in Wrought Heat Treatable Aluminum Alloy Products

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

ASTM B557 - Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products
ASTM B594 - Ultrasonic Inspection of Aluminum-Alloy Products for Aerospace Applications
ASTM E10 - Brinell Hardness of Metallic Materials
ASTM E34 - Chemical Analysis of Aluminum and Aluminum Alloys

2.3 U.S. Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.3.1 Military Specifications:

MIL-H-6088 - Heat Treatment of Aluminum Alloys

2.3.2 Military Standards:

MIL-STD-649 - Aluminum and Magnesium Products, Preparation for Shipment and Storage

3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall conform to the following percentages by weight, determined by wet chemical methods in accordance with ASTM E34 or by spectrographic or other analytical methods approved by purchaser:

	min	max
Copper	3.5	4.5
Nickel	1.7	2.3
Magnesium	0.45	0.9
Iron	--	1.0
Silicon	--	0.9
Zinc	--	0.25
Manganese	--	0.20
Chromium	--	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 Forgings: Solution and precipitation heat treated in accordance with MIL-H-6088.

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 Forgings:

3.3.1.1 Tensile Properties: Shall be as follows, determined in accordance with ASTM B557:

3.3.1.1.1 Test Specimens: Specimens, machined from separately-forged coupons or from forging stock representing the forgings and, in either case, heat treated with the forgings or machined from prolongations on heat treated forgings, shall have the following properties:

Tensile Strength, min	55,000 psi (380 MPa)
Yield Strength at 0.2% Offset, min	40,000 psi (275 MPa)
Elongation in 4D, min	10%

3.3.1.1.2 Forgings With Grain Flow: Test specimens machined from forgings, with the axis of specimen in the area of gage length varying not more than 15 deg from parallel to the forging flow lines, shall have properties as specified in 3.3.1.1.1.

3.3.1.2 Hardness: Should be not lower than 100 HB/10/500 or 106 HB/10/1000, determined in accordance with ASTM E10, but forgings shall not be rejected on the basis of hardness if the tensile property requirements are met. Piston forgings shall also meet the requirements of 3.3.1.2.1.

3.3.1.2.1 Piston forgings shall retain hardness not lower than 90 HB/10/500 or 93 HB/10/1000, determined in accordance with ASTM E10, after being heated to 450°F ± 10 (230°C ± 5), held at heat for 5 hr ± 0.2, and cooled in air.

3.3.1.3 Grain Flow: Except in areas of forgings which contain end grain, the Ø grain flow 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 and heat treated in the same manner as forgings, tensile specimens taken from the heat treated coupon shall conform to the requirements of 3.3.1.1.1 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 3.3.1.1.1 and 3.3.1.2, 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, 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 When specified, forgings shall be subjected to ultrasonic inspection in Ø accordance with ASTM B594. Standards for acceptance shall be as agreed upon by purchaser and vendor.

3.4.2 Each forging shall be etched by swabbing or immersing in an aqueous solution of sodium hydroxide, thoroughly rinsing in water, followed by washing in nitric acid or chromic-sulfuric acid solution or equivalent Ø 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.

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

3.5 Tolerances: Forging stock shall conform to all applicable requirements of AMS 2201 or MAM 2201.

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 performing all Ø required tests. Results of such tests shall be reported to the purchaser as required by 4.5. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure 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 requirements for composition (3.1) and of forgings to determine conformance to requirements for tensile properties (3.3.1.1), hardness (3.3.1.2), quality (3.4) and, when specified, ultrasonic inspection (3.4.1) are classified as acceptance tests and shall be performed on each lot.

4.2.2 Periodic Tests: Tests of forgings to determine conformance to requirements for grain flow (3.3.1.3) and, when applicable, hardness retention (3.3.1.2.1) and of forging stock to determine ability to develop required properties (3.3.2) are classified as periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.2.3 Preproduction Tests: Tests of forgings to determine conformance to all applicable technical requirements of this specification when AMS 2375 is Ø specified are classified as preproduction tests and shall be performed prior to or on the first-article shipment of a forging to a purchaser, when a change in material, processing, or both requires reapproval as in 4.4, and when purchaser deems confirmatory testing to be required.

4.2.3.1 For direct U.S. Military procurement of forgings, substantiating test data and, when requested, preproduction forgings shall be submitted to the cognizant agency as directed by the procuring activity, the contracting officer, or the request for procurement.

4.3 Sampling: Shall be as follows; a lot shall be all forgings of the same part number, size, or nominal cross-section and configuration heat treated in the same batch furnace load or in a continuous furnace consecutively during an 8-hr period. Maximum lot size for forgings heat treated in a continuous furnace shall be 6000 lb (2700 kg) of forgings.

4.3.1 For Acceptance Tests:

4.3.1.1 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. Complete ingot analysis records shall be available to purchaser at the producer's facility.

4.3.1.1.1 Unless compliance with 4.3.1.1 is established, an analysis shall be made for each 6000 lb (2700 kg) or less of alloy comprising the lot, except that not more than one analysis shall be required per piece.

4.3.1.2 Tensile Properties:

4.3.1.2.1 Forgings: At least one separately-forged coupon or one forging prolongation heat treated with each lot of forgings.

4.3.1.2.1.1 In lieu of a prolongation or separately-forged coupon, tensile tests shall be conducted on specimens cut, from locations designated on the drawing from a forging representing each lot.

4.3.2 For Periodic Tests and Preproduction Tests: As agreed upon by purchaser and vendor.

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

4.5 Reports:

4.5.1 The vendor of forgings shall furnish with each shipment a report stating that the chemical composition conforms to the requirements of this specification, showing the results of tests on each lot to determine conformance to the other acceptance test requirements, and stating that the forgings conform to the other technical requirements of this specification. This report shall include the purchase order number, lot number, AMS 4140F, size or part number, and quantity.

4.5.2 The vendor of forging stock shall furnish with each shipment a report stating that the chemical composition of the stock conforms to the requirements of this specification. This report shall include the purchase order number, AMS 4140F, size, and quantity.