Society of Automotive Engineers, Inc.
400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

AEROSPACE MATERIAL SPECIFICATION

AMS 4163A
Superseding AMS 4163
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ALUMINUM ALLOY EXTRUSIONS

UNS A92219

6.3Cu - 0.30Mn - 0.18Zr - 0.10V - 0.06Ti (2219-T3511)
Solution Heat Treated and Stress-Relieved by Stretching

1. SCOPE:

1.1 Form: This specification covers an aluminum alloy in the form of extruded bars, rods, wire, shapes, and tubing.

1.2 Application: Primarily for structural parts requiring high strength up to 500° F (260° C) after proper precipitation heat treatment. May be welded. Certain design and fabricating procedures may cause material in the specified condition to be 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 (AMS) and Aerospace Recommended Practices (ARP) 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., 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2205 - Tolerances, Aluminum-Base and Magnesium-Base Alloy Extrusions
AMS 2350 - Standards and Test Methods
AMS 2355 - Quality Assurance Sampling and Testing of Aluminum-Base and Magnesium-Base Alloys, Wrought Products (Except Forgings and Forging Stock) and Flash Welded Rings
AMS 2630 - Ultrasonic Inspection
AMS 2770 - Heat Treatment of Aluminum and Aluminum Alloys

2.1.2 Aerospace Recommended Practices:

ARP 823 - Minimizing Stress-Corrosion 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 B117 - Salt Spray (Fog) Testing

2.3 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

Printed in U.S.A.

3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall conform to the following percentages by weight, determined in accordance with AMS 2355:

	min	max
Copper	5.8	6.8
Manganese	0.20	0.40
Zirconium	0.10	0.25
Vanadium	0.05	0.15
Titanium	0.02	0.10
Iron	--	0.30
Silicon	--	0.20
Zinc	--	0.10
Magnesium	--	0.02
Other Impurities, each	--	0.05
Other Impurities, total	--	0.15
Aluminum	remainder	

3.2 Condition: Solution heat treated and stress-relieved by stretching to produce a nominal permanent set of 1-1/2% but not less than 1% nor more than 3%. Solution heat treatment shall be performed in accordance with MIL-H-6088.

3.2.1 Extrusions may receive minor straightening, after stretching, of an amount necessary to meet the requirements of 3.5.

3.2.2 Extrusions shall be supplied with an as-extruded surface finish; light polishing to remove minor surface imperfections is permissible provided such imperfections can be removed within dimensional tolerances.

3.3 Properties: The product shall conform to the following requirements, determined in accordance with AMS 2355. These requirements apply to extrusions 2.999 in. (76.17 mm) and under in nominal diameter or distance between parallel sides with cross-sectional area 25 sq in. (161 cm^2) and under; properties of extrusions 3.000 in. (76.20 mm) and over in nominal diameter or distance between parallel sides or over 25 sq in. (161 cm^2) in nominal cross-sectional area shall be as agreed upon by purchaser and vendor.

3.3.1 As Solution Heat Treated and Stress Relieved by Stretching:

3.3.1.1 Tensile Properties: Shall be as specified in Table I:

TABLE I

Nominal Diameter or Distance Between Parallel Sides Inches	Tensile Strength psi, min	Yield Strength at 0.2% Offset psi, min	Elongation in 2 in. or 4D %, min
Up to 0.499, incl	42,000	26,000	14
Over 0.499 to 2.999, incl	45,000	27,000	14

TABLE I (SI)

Nominal Diameter or Distance Between Parallel Sides Millimetres	Tensile Strength MPa, min	Yield Strength at 0.2% Offset MPa, min	Elongation in 50.8 mm or 4D %, min
Up to 12.67, incl	290	179	14
Over 12.67 to 76.17, incl	310	186	14

3.3.1.2 Hardness: Should be not lower than 77 HB/10/500, 77 HB/14.3/1000, or 82 HB/10/1000 but the extrusions shall not be rejected on the basis of hardness if the tensile property requirements of 3.3.1.1 are met.

3.3.2 After Precipitation Heat Treatment: Extrusions, as received by the purchaser, shall meet Ø the following requirements after being precipitation heat treated in accordance with AMS 2770:

3.3.2.1 Tensile Properties:

3.3.2.1.1 Longitudinal:

Tensile Strength, min	58,000 psi (400 MPa)
Yield Strength at 0.2% Offset, min	42,000 psi (290 MPa)
Elongation in 2 in. (50.8 mm) or 4D, min	6%

3.3.2.1.2 Long-Transverse:

Tensile Strength, min	56,000 psi (386 MPa)
Yield Strength at 0.2% Offset, min	39,000 psi (269 MPa)
Elongation in 2 in. (50.8 mm) or 4D, min	4%

3.3.2.1.2.1 Ø Long-transverse tensile requirements apply only to extrusions from which a test specimen not less than 2.50 in. (63.5 mm) in length can be taken.

3.3.2.1.3 Ø Tensile tests in the longitudinal direction are not required from extrusions tested in the long-transverse direction.

3.3.2.2 Stress-Corrosion Resistance: A test specimen, cut from an extrusion so that the axis of loading of the specimen is parallel to the short-transverse direction of the extrusion, shall be stressed to 30,000 psi (207 MPa) and held at constant strain in a suitable fixture. The stressed specimen shall show no evidence of stress-corrosion cracking when subjected to cyclic immersion at room temperature for 30 days in a 3-1/2% solution of sodium chloride conforming to the purity and pH requirements of ASTM B117; 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.

3.4 Quality: Extrusions, as received by the purchaser, shall be uniform in quality and condition, sound, Ø and free from foreign materials and from internal and external imperfections detrimental to usage of the extrusions.

3.4.1 When specified, extrusions shall be subject to ultrasonic inspection in accordance with AMS 2630. Ø Standards for acceptance shall be as agreed upon by purchaser and vendor.

3.5 Tolerances: Unless otherwise specified, tolerances shall conform to all applicable requirements of Ø AMS 2205 except that surface roughness tolerances shall be double those specified therein.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of extrusions 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 4.4. Purchaser reserves the right to perform such confirmatory testing as he deems necessary to ensure that the extrusions conform to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests to determine conformance to composition (3.1), tensile properties as solution heat treated and stress relieved (3.3.1.1), longitudinal tensile properties after precipitation heat treatment (3.3.2.1.1), ultrasonic inspection (3.4.1) when specified, and tolerance (3.5) requirements are classified as acceptance tests.

4.2.2 Periodic Tests: Tests to determine conformance to hardness as solution heat treated and stress relieved (3.3.1.2), and long-transverse tensile properties (3.3.2.1.2) and resistance to stress-corrosion cracking (3.3.2.2) after precipitation heat treatment requirements are classified as periodic tests.

4.3 Sampling: Shall be in accordance with AMS 2355. Frequency and extent of sampling and locations from which specimens are taken for periodic tests shall be as agreed upon by purchaser and vendor.

4.4 Reports:

4.4.1 The vendor of extrusions shall furnish with each shipment three copies of a report stating that the extrusions conform to the chemical composition and other technical requirements of this specification. This report shall include the purchase order, material specification number and its revision letter, size or section identification number, and quantity.

4.4.2 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 and its revision letter, contractor or other direct supplier of extrusions, part number, and quantity. When extrusions for making parts are produced or purchased by the parts vendor, that vendor shall inspect each lot of extrusions to determine conformance to the requirements of this specification. and shall include in the report a statement that the extrusions conform, or shall include copies of laboratory reports showing the results of tests to determine conformance.

4.5 Resampling and Retesting: Shall be in accordance with AMS 2355.

5. PREPARATION FOR DELIVERY:

5.1 Identification: The product shall be identified as follows:

5.1.1 Each straight bar, rod, and tube 0.500 in. (12.70 mm) and over in OD or least width of flat surface and each straight shape with configuration allowing access to a flat surface at least 0.500 in. (12.70 mm) wide recessed not more than 1/8 in. (3.2 mm) below the outline of the shape shall be marked in a row of characters recurring at intervals not greater than 3 ft (914 mm) with the alloy number and temper, AMS 4163, and manufacturer's identification. The characters shall be of such size as to be clearly legible, shall be applied using a suitable marking fluid, and shall be sufficiently stable to withstand normal handling. The markings shall have no deleterious effect on the extrusions or their performance.