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

AEROSPACE MATERIAL SPECIFICATION

AMS 4165E
Superseding AMS 4165D
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UNS A92024

ALUMINUM ALLOY EXTRUSIONS
4.4Cu - 1.5Mg - 0.60Mn (2024-T3511)
Stress-Relief Stretched and Straightened

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 parts subject to excessive warpage during machining due to residual stresses, and for parts requiring high strength and whose fabrication does not normally involve welding. Certain design and processing procedures may cause these extrusions 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

2.1.2 Aerospace Recommended Practices:

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

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

2.2.1 Military Specifications:

MIL-H-6088 - Heat Treatment of Aluminum Alloys

2.2.2 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 in accordance with AMS 2355:

	min	max
Copper	3.8	4.9
Magnesium	1.2	1.8
Manganese	0.30	0.9
Iron	--	0.50
Silicon	--	0.50
Zinc	--	0.25
Zirconium + Titanium	--	0.20
Titanium	--	0.15
Chromium	--	0.10
Other Impurities, each	--	0.05
Other Impurities, total	--	0.15
Aluminum	remainder	

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

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

3.3 Properties: Extrusions shall conform to the following requirements, determined in accordance with AMS 2355:

3.3.1 Tensile Properties: Shall be as specified in Table I, Table II, and 3.3.1.3.

3.3.1.1 Bars, Rods, Wire, and Shapes:

TABLE I

Nominal Dimensions		Tensile Strength	Yield Strength at 0.2% Offset	Elongation in 2 in. or 4D
Diameter or Thickness Inches	Cross Sectional Area Square Inches	psi, min	psi, min	%, min
Up to 0.249, incl	All areas	57,000	42,000	12
Over 0.249 to 0.749, incl	All areas	60,000	44,000	12
Over 0.749 to 1.499, incl	All areas	65,000	46,000	10
Over 1.499	Up to 25, incl	70,000	52,000	10
Over 1.499	Over 25 to 32, incl	68,000	48,000	8

TABLE I (SI)

Nominal Dimensions		Tensile Strength	Yield Strength at 0.2% Offset	Elongation in 50 mm or 4D
Diameter or Thickness Millimetres	Cross Sectional Area Square Centimetres	MPa, min	MPa, min	%, min
Up to 6.32, incl	All areas	393	290	12
Over 6.32 to 19.02, incl	All areas	414	303	12
Over 19.02 to 38.07, incl	All areas	448	317	10
Over 38.07	Up to 161, incl	483	359	10
Over 38.07	Over 161 to 206, incl	469	331	8

3.3.1.2 Round Tubing:

TABLE II

Nominal Wall Thickness and Area Inches	Tensile Strength psi, min	Yield Strength at 0.2% Offset psi, min	Elongation in 2 in. or 4D %, min
Up to 0.249, incl, all areas	57,000	42,000	10
Over 0.249 to 0.749, incl, all areas	60,000	44,000	10
Over 0.749 to 1.499, incl, all areas	65,000	46,000	10
Over 1.499			
Area up to 25 sq in., incl	70,000	48,000	10
Area over 25 to 32 sq in., incl	68,000	46,000	8

TABLE II (SI)

	Tensile Strength MPa, min	Yield Strength at 0.2% Offset MPa, min	Elongation in 2 in. or 4D %, min
Up to 6.32, incl, all areas	393	290	10
Over 6.32 to 19.02, incl, all areas	414	303	10
Over 19.02 to 38.07, incl, all areas	448	317	10
Over 38.07			
Area up to 161 cm^2, incl	483	331	10
Area over 161 to 206 cm^2, incl	469	317	8

3.3.1.3 Tensile property requirements for sizes over 1.499 in. (38.07 mm) in nominal diameter or distance between parallel sides or in nominal wall thickness or over 32 sq in. (206 cm^2) in nominal cross-sectional area shall be as agreed upon by purchaser and vendor.

3.3.1.4 Hardness: Should be not lower than 100 HB/10/500, 100 HB/14.3/1000, or 106 HB/10/1000, but the extrusions shall not be rejected on the basis of hardness if the tensile property requirements are met.

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

3.4.1 When specified, extrusions shall be subjected 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 AMS 2205.

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 requirements for composition (3.1), tensile properties (3.3.1), ultrasonic inspection (3.4.1), when specified, and tolerances (3.5) are classified as acceptance tests and shall be performed on each lot.

4.2.2 Periodic Tests: Tests to determine conformance to requirements for hardness (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.

4.3 Sampling: Shall be in accordance with AMS 2355.

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 number, 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: Extrusions 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 4165 or applicable Federal or Military specification designation, 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.

5.1.2 All straight extrusions other than those of 5.1.1 shall be securely bundled, boxed, or secured on lifts and identified by two durable tags marked with the information of 5.1.1 and attached, not farther than 2 ft (610 mm) from each end, to the extrusions in each bundle, box, or lift.