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

AEROSPACE MATERIAL SPECIFICATION

AMS 4083G
Superseding AMS 4083F
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UNS A96061

ALUMINUM ALLOY TUBING, HYDRAULIC, SEAMLESS, DRAWN, ROUND
1.0Mg - 0.60Si - 0.28Cu - 0.20Cr (6061-T6)

1. SCOPE:

1.1 Form: This specification covers an aluminum alloy in the form of seamless, drawn, round tubing.

1.2 Application: Primarily for parts and assemblies operating under high pressure, such as hydraulic systems and fuel and oil lines, where high quality is required.

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., 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2203 - Tolerances, Aluminum Alloy Drawn Tubing
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

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 Ø AMS 2355:

	min	max
Magnesium	0.8	1.2
Silicon	0.40	0.8
Copper	0.15	0.40
Chromium	0.04	0.35
Iron	--	0.7
Zinc	--	0.25
Manganese	--	0.15
Titanium	--	0.15
Other Impurities, each	--	0.05
Other Impurities, total	--	0.15
Aluminum	remainder	

ø 3.2 Condition: Solution and precipitation heat treated in accordance with MIL-H-6088.

3.2.1 Tubing shall be supplied unground with an as-drawn surface finish, unless otherwise specified.

3.3 Properties: Tubing shall conform to the following requirements determined in accordance with
ø AMS 2355:

3.3.1 Tensile Properties: Shall be as specified in Table I and 3.3.1.1.

TABLE I

Nominal Wall Thickness Inch	Tensile Strength psi, min	Yield Strength at 0.2% Offset psi, min	Elongation in 2 in. or 4D %, min	
			Strip	Full Section
0.025 to 0.049, incl	42,000	35,000	8	10
Over 0.049 to 0.259, incl	42,000	35,000	10	12
Over 0.259 to 0.500, incl	42,000	35,000	12	14

TABLE I (SI)

Nominal Wall Thickness Millimetres	Tensile Strength MPa, min	Yield Strength at 0.2% Offset MPa, min	Elongation in 50 mm or 4D %, min	
			Strip	Full Section
0.64 to 1.24, incl	290	241	8	10
Over 1.24 to 6.58, incl	290	241	10	12
Over 6.58 to 12.70, incl	290	241	12	14

3.3.1.1 Tensile property requirements for tubing having nominal wall thickness under 0.025 in. (0.64 mm) or over 0.500 in. (12.70 mm) shall be as agreed upon by purchaser and vendor.

3.3.2 Flattening: Tubing having nominal wall thickness less than 10% of the nominal OD shall withstand, without cracking, flattening sideways under a load applied gradually at room temperature until the outside dimension under load is equal to 8 times the nominal wall thickness.

3.3.2.1 If tubing does not pass the flattening test of 3.3.2, a section of tube not less than 1/2 in. (13 mm) in length and embracing 1/3 to 1/2 the circumference of the tube shall withstand, without cracking, bending at room temperature through an angle of 180 deg around a diameter equal to 6 times the nominal wall thickness of the tubing with axis of bend parallel to axis of tube and with inside of tube on inside of bend.
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3.3.3 Flarability: Tubing with nominal OD of 0.375 in. (9.52 mm) and under shall withstand double-flaring and tubing with nominal OD over 0.375 in. (9.52 mm) shall withstand being single-flaring without formation of cracks or other visible defects by being forced, at room temperature, axially with steady pressure over a hardened and polished tapered steel pin having a 74 deg included angle to produce a flare having a permanent expanded OD not less than specified in Table II.

TABLE II

Nominal OD Inches	Expanded OD Inches	Nominal OD Inches	Expanded OD Inches
0.125	0.224	1.000	1.187
0.188	0.302	1.250	1.500
0.250	0.359	1.500	1.721
0.312	0.421	1.750	2.106
0.375	0.484	2.000	2.356
0.500	0.656	2.500	2.856
0.625	0.781	3.000	3.356
0.750	0.937		

TABLE II (SI)

Nominal OD Millimetres	Expanded OD Millimetres	Nominal OD Millimetres	Expanded OD Millimetres
3.18	5.08	25.40	30.15
4.78	7.67	31.75	38.10
6.35	9.12	38.10	43.71
7.92	10.69	44.45	53.49
9.52	12.29	50.80	59.84
12.70	16.66	63.50	72.54
15.88	19.84	76.20	85.24
19.05	23.80		

3.3.3.1 Tubing with nominal OD between any two standard sizes specified in Table II shall take the same percentage flare as that for the larger of the two sizes.

3.3.3.2 Flarability requirements for tubing having nominal OD greater than 3.000 in. (76.20 mm) or less than 0.125 in. (3.18 mm) shall be as agreed upon by purchaser and vendor.

3.3.4 Hydraulic Strength: Each length of tubing shall withstand an internal hydrostatic pressure (P), based on the following equation without developing leaks and without an increase in mean diameter of more than 0.2%.

$$P = S \frac{D^2 - d^2}{D^2 + d^2}$$

where, S = Minimum yield strength (35,000 psi (241 MPa))
D = Maximum OD (nominal OD plus tolerance)
d = Maximum ID (D minus twice the minimum wall thickness)

3.3.4.1 Mean diameter is the average of two diameters at right angles to each other in the same transverse plane; measurements before and after testing should be taken at substantially the same location.

3.4 Quality:

3.4.1 Tubing, as received by purchaser, shall be uniform in quality and condition, sound, and free from foreign materials and from internal and external imperfections detrimental to usage of the tubing.

3.4.1.1 A polished and etched cross-section of a tube shall show no evidence of cracks, seams, or folds when examined at 100X magnification.

3.4.2 Detrimental imperfections include, but are not limited to, cracks, splits, seams, inclusions, or severe cross-hatching (surface breaks) that cannot be removed by lightly hand-sanding, using 180 grit or finer sandpaper.

3.4.3 Tubing shall be cleaned and chemically film treated to increase the corrosion resistance prior to usage of the tubing. No metallic flakes or particles shall be collected by a clean black cloth when it is drawn through the length of the bore of a sample tube. Discoloration of the cloth without the presence of flakes or grit is acceptable.

3.5 Tolerances: Unless otherwise specified, tolerances shall conform to all applicable requirements of AMS 2203.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of tubing 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 tubing conforms 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 property (3.3.1), and tolerance (3.6) requirements are classified as acceptance tests.

4.2.2 Periodic Tests: Tests to determine conformance to flattening (3.3.2), flarability (3.3.3), and pressure test (3.3.4) requirements are classified as periodic tests.

4.3 Sampling: Shall be in accordance with AMS 2355, and the following:

4.3.1 Specimens for flarability test shall be full tubes or sections cut from tubes. The end of the specimen to be flared shall be cut square, with the cut end smooth and free from burrs, but not rounded except for sizes 0.375 in. (9.52 mm) and under.

4.4 Reports:

4.4.1 The vendor of tubing shall furnish with each shipment three copies of a report stating that the tubing conforms 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, 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 tubing, part number, and quantity. When tubing for making parts is produced or purchased by the parts vendor, that vendor shall inspect each lot of tubing to determine conformance to the requirements of this specification, and shall include in the report a statement that the tubing conforms, 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.