

# AEROSPACE MATERIAL SPECIFICATION



AMS 4083K

Issued NOV 1948  
Revised SEP 2000  
Reaffirmed APR 2006

Superseding AMS 4083J

Aluminum Alloy Tubing, Hydraulic, Seamless, Drawn, Round  
1.0Mg - 0.60Si - 0.28Cu - 0.20Cr (6061-T6)  
Solution and Precipitation Heat Treated

(Ref. UNS 96061)

## 1. SCOPE:

### 1.1 Form:

This specification covers an aluminum alloy in the form of seamless round tubing.

### 1.2 Application:

This tubing has been used typically for parts operating under high pressure, such as hydraulic systems and fuel and oil lines, but usage is not limited to such applications.

## 2. APPLICABLE DOCUMENTS:

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been canceled and no superseding document has been specified, the last published issue of that document shall apply.

### 2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 2355	Quality Assurance Sampling and Testing, Aluminum Alloys and Magnesium Alloys, Wrought Products, Except Forging Stock, and Rolled, Forged, or Flash Welded Rings
MAM 2355	Quality Assurance Sampling and Testing, Aluminum Alloys and Magnesium Alloys, Wrought Products, Except Forging Stock, and Rolled, Forged, or Flash Welded Rings, Metric (SI) Units
AMS 2772	Heat Treatment of Aluminum Alloy Raw Materials

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## 2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM B 660 Packaging/Packing of Aluminum and Magnesium Products  
 ASTM B 666/B 666M Identification Marking of Aluminum Products

## 2.3 ANSI Publications:

Available from American National Standards Institute, Inc., 11 West 42nd Street, New York, NY 10036.

ANSI H35.2 Dimensional Tolerances for Aluminum Mill Products  
 ANSI H35.2M Dimensional Tolerances for Aluminum Mill Products (Metric)

## 3. TECHNICAL REQUIREMENTS:

## 3.1 Composition:

Shall conform to the percentages by weight shown in Table 1, determined in accordance with AMS 2355 or MAM 2355.

TABLE 1 - Composition

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

## 3.2 Condition:

Solution and precipitation heat treated in accordance with AMS 2772.

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

## 3.3 Properties:

Tubing shall conform to the following requirements, determined in accordance with AMS 2355 or MAM 2355, except as specified in 3.4.3.2:

## 3.3.1 Tensile Properties: Shall be as specified in Table 2:

TABLE 2A - Minimum Tensile Properties, Inch/Pound Units

Nominal Wall Thickness Inch	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 2 Inches or 4D Cut Out Specimen %	Elongation in 2 Inches or 4D Full Section Specimen %
0.025 to 0.049, incl	42.0	35.0	8	10
Over 0.049 to 0.259, incl	42.0	35.0	10	12
Over 0.259 to 0.500, incl	42.0	35.0	12	14

TABLE 2B - Minimum Tensile Properties, SI Units

Nominal Wall Thickness Millimeters	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 50.8 mm or 4D Cut Out Specimen %	Elongation in 50.8 mm or 4D Full Section Specimen %
0.64 to 1.24, incl	291	240	8	10
Over 1.24 to 6.58, incl	291	240	10	12
Over 6.58 to 12.70, incl	291	240	12	14

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 eight times the nominal wall thickness. Tubing having nominal wall thickness 10% or more of the nominal OD shall withstand without cracking, flattening sideways under a load applied gradually at room temperature until the outside dimension under load equals 90% of the nominal OD.

3.3.2.1 If tubing does not pass the flattening test of 3.3.2, a section of tube not less than 0.5 inch (12.7 mm) in length and embracing one-third to one-half the circumference of the tube shall withstand, without cracking, bending at room temperature through an angle of 180 degrees around a mandrel having 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.

3.3.3 Flarability: Specimens as in 4.3.1 from tubing 0.375 inch (9.52 mm) and under in nominal OD shall withstand being double-flared (See 8.2) and from tubing over 0.375 inch (9.52 mm) in nominal OD shall withstand being single flared without formation of cracks or other visible defects by being forced axially, at room temperature, with steady pressure over a hardened and polished tapered steel pin having a 74-degree included angle to produce a flare having a permanent expanded OD not less than specified in Table 3.

TABLE 3A - Flarability Requirements, Inch/Pound Units

Nominal OD Inch	Expanded OD Inch	Nominal OD Inches	Expanded OD Inches
0.125	0.200	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 3B.- Flarability Requirements, SI Units

Nominal OD Millimeters	Expanded OD Millimeters	Nominal OD Millimeters	Expanded OD Millimeters
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 shown in Table 3 shall take the same percentage flare as that for the larger of the two sizes.

- 3.3.4 Hydraulic Strength: Tubing shall withstand an internal hydrostatic pressure (P), based on Equation 1, without developing leaks and without an increase in mean diameter of more than 0.2%:

$$P = S \frac{D^2 - d^2}{D^2 + d^2} \quad (\text{Eq. 1})$$

where:

S = 3.50 ksi (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:

Tubing, 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 tubing.

- 3.4.1 Metallographic Examination: A polished and etched cross-section of a tube from each lot 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 light hand-sanding, using 180-grit or finer sandpaper.
- 3.4.3 Leak Test: Each length of tubing shall be tested for leaks in accordance with either 3.4.3.1 or 3.4.3.2; the method of test shall be at the option of the vendor unless purchaser specifies the method of test.
- 3.4.3.1 Immersion Test: A tube, immersed in water or other suitable liquid while an air pressure of 250 psi (1724 kPag) is applied to the inside of the tube and held for not less than five seconds, shall show no leakage as indicated by bubbles in the immersion fluid.
- 3.4.3.2 Eddy Current Test: Secondary reference standards in accordance with ASTM E 215 shall be used to set threshold levels. Tubes exhibiting eddy current responses equivalent to or smaller than those obtained from the  $d_a$  holes are acceptable. Tubes exhibiting eddy current responses equivalent to or greater than those obtained from the  $d_b$  holes in the reference standard are not acceptable.
- 3.4.4 Prior to use, tubing should be cleaned and chemically film treated to increase corrosion resistance. Metallic flakes or particles shall not be collected by a clean white cloth drawn through the length of the bore of a test sample. Discoloration of the cloth without the presence of flakes or particles is acceptable.

### 3.5 Tolerances:

Tubing shall conform to all applicable requirements of ANSI H35.2 or ANSI H 35.2M.

## 4. QUALITY ASSURANCE PROVISIONS:

### 4.1 Responsibility for Inspection:

The vendor of tubing shall supply all samples for vendor's tests and shall be responsible for the performance of all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the tubing conforms to specified requirements.

### 4.2 Classification of Tests:

4.2.1 Acceptance Tests: Composition (3.1), tensile properties (3.3.1), flarability (3.3.3), microexamination (3.4.1), leak determination (3.4.3) and tolerances (3.5) are acceptance tests and, except for composition, shall be performed on each lot.

4.2.2 Periodic Tests: Flattening (3.3.2), and hydraulic strength (3.3.4) are periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

### 4.3 Sampling and Testing:

Shall be in accordance with AMS 2355 or MAM 2355 and the following:

4.3.1 Specimens for flarability test (3.3.3) 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.

### 4.4 Reports:

The vendor of tubing shall furnish with each shipment a report stating that the tubing conforms to the chemical composition and tolerances (and NDT inspection, when required); and showing the numerical results of tests on each inspection lot to determine conformance to the other acceptance test requirements and periodic test requirements when performed. This report shall include the purchase order number, inspection lot number(s), AMS 4083K, size, and quantity. The report shall also identify the producer, the product form, and the size of the mill product.

### 4.5 Resampling and Retesting:

Shall be in accordance with AMS 2355 or MAM 2355.