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INTERNATIONAL
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS-T-7081

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Submitted for recognition as an American National Standard

Tube, Aluminum Alloy, Seamless, Round, Drawn, 6061, Aircraft Hydraulic Quality

NOTICE

This document has been taken directly from Military Specification MIL-T-7081D, Amendment 5, Notice 1, (which renders it Inactive for New Design) and contains only minor editorial and format changes required to bring it into conformance with the publishing requirements of SAE technical standards. The initial release of this document is intended to replace MIL-T-7081D, Amendment 5, Notice 1. Any part numbers established by the original specification remain unchanged.

The original Military Specification was adopted as an SAE standard under the provisions of the SAE Technical Standards Board (TSB) Rules and Regulations (TSB 001) pertaining to accelerated adoption of government specifications and standards. TSB rules provide for (a) the publication of portions of unrevised government specifications and standards without consensus voting at the SAE Committee level, and (b) the use of the existing government specification or standard format.

Under Department of Defense policies and procedures, any qualification requirements and associated qualified products lists are mandatory for DOD contracts. Any requirement relating to qualified products lists (QPL's) has not been adopted by SAE and is not part of this SAE technical document.

1. SCOPE:

1.1 Scope:

This specification covers 6061 aluminum alloy, round, drawn, seamless tube having outside diameters of 3/16 inch through 1-1/2 inches.

1.2 Classification:

Tubes shall be furnished in one of the following tempers, as specified (see 6.2):

T4 (solution heat-treated)
T6 (solution heat-treated and artificially aged)

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2. APPLICABLE DOCUMENTS:

The following publications, of the issues in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

2.1 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-H-5440	Hydraulic Systems, Aircraft, Types I and II, Design, Installation and Data Requirements for
MIL-H-6088	Heat Treatment of Aluminum Alloys
MIL-H-25475	Hydraulic Systems, Missile, Design, Installation, Tests, and Data Requirements, General Requirements for
FED-STD-151	Metals; Test Methods
FED-STD-184	Identification Marking of Aluminum, Magnesium and Titanium
FED-STD-245	Tolerances for Aluminum Alloy and Magnesium Alloy Wrought Products
MIL-STD-129	Marking for Shipment and Storage
MIL-STD-649	Aluminum and Magnesium Products, Preparation for Shipment and Storage
MS33583	Tubing End, Double Flare, Standard Dimensions for
MS33584	Tubing End, Standard Dimensions for Flared

2.2 ASTM Publications:

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

ASTM E 215-63T	Standardizing Equipment for Electromagnetic Testing of Seamless Aluminum Alloy Tube

3. REQUIREMENTS:

3.1 Chemical composition:

3.1.1 The chemical composition shall conform to table I.

TABLE I - Composition 1/

Element	6061 Percent	
	Minimum	Maximum
Copper	0.15	0.40
Silicon	0.40	0.8
Iron	—	0.7
Manganese	—	0.15
Magnesium	0.8	1.2
Zinc	—	0.25
Chromium	0.04	0.35
Titanium	—	0.15
Other elements, each	—	0.05
Other elements, total	—	0.15
Aluminum	Remainder	

1/ Analysis shall regularly be made only for the elements specifically mentioned in table I. If, however, the presence of other elements is indicated in the course of routine analysis, further analysis shall be made to determine conformance to the limits specified for other elements.

3.2 Mechanical properties:

3.2.1 Tensile Strength: The tensile properties parallel to the direction of drawing shall conform to table II.

3.2.1.1 Heat treatment: Heat treatment shall be in accordance with MIL-H-6088.

3.2.2 Flattening: Tube shall withstand, without cracking, the flattening test described in 4.4.3.2.

TABLE II - Mechanical properties

TABLE II. Mechanical properties

Temper	Wall thickness (inch)	Tensile strength psi minimum		Elongation in 2 inches or 4D 1/ percent, minimum	
		Ultimate	Yield	Full section specimen 2/	Cut-out specimen 3/
T4—Solution heat treated	0.025 thru 0.049	30,000	16,000	16	14
	0.050 thru 0.259	30,000	16,000	18	16
	0.260 thru 0.500	30,000	16,000	20	18
T6—Solution heat treated and artificially aged	0.025 thru 0.049	42,000	35,000	10	8
	0.050 thru 0.259	42,000	35,000	12	10
	0.260 thru 0.500	42,000	35,000	14	12

1/ D represents diameter of cut-out specimens.
2/ Tube shall be tested in full section unless the limitations of the testing machine preclude the use of such a specimen.
3/ Values apply to a cut-out specimen when a full-section specimen cannot be used.

3.2.3 Test for leaks: Unless otherwise specified, each length of tube shall be tested as specified in 3.2.3.1 or 3.2.3.2, consistent with the size limitations indicated for each method.

3.2.3.1 Pressure: Each length of tube 1-1/2 inches or less in diameter shall withstand a pressure of 250 psi for a period of not less than 5 seconds (see 4.4.3.3.1).

3.2.3.2 Eddy current: Each length of tube 1-1/2 inches or less in diameter and maximum wall thickness of 0.083 inch shall produce eddy current indications less than those from the 2A holes of the applicable reference standard of ASTM E 215 or an equivalent secondary standard, when tested in accordance with 4.4.3.3.2.

3.2.4 Flaring:

3.2.4.1 Single flare: Tube with a diameter of 3/16 inch with a wall thickness of 0.049 inch and greater and tube with a diameter of 1/4 inch and over shall withstand being single-flared to the dimensions specified on MS33584 without signs of cracks or defects. The inside surface of the flare shall be smooth and show no evidence of a bead that might prevent the assembly being pressure-tight when subjected to proof pressure as specified in MIL-H-5440 or MIL-H-25475 and when tested as specified in 4.4.3.4.

3.2.4.2 Double flare: Tube with a diameter of 3/16 to 3/8 inch, inclusive, shall withstand being double-flared to the dimensions specified on MS33583 without signs of cracks or defects. The inside surface of the flare shall be smooth and shall show no evidence of a bead that might prevent the assembly being pressure-tight when subjected to proof pressure as specified in MIL-H-5440 or MIL-H-25475.

3.2.5 Hydraulic strength: Tube shall be capable of withstanding, without diametral set exceeding 0.002 inch per inch of mean outside diameter, and internal hydrostatic pressure (P), calculated by the following formula. (See 6.3.) The mean outside diameter is the average of two diameter measurements taken at right angles to each other at any point along the length of the tube.

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

Where: P = Test pressure in psi
S = Specified minimum yield strength, psi
D = Maximum OD (nominal OD plus tolerance), inch
d = Maximum ID (computed as D minus twice the minimum permissible wall thickness), inch

3.3 Cleanliness:

Tube shall be free from grease or other foreign matter. The inner bore shall show no metallic flakes nor particles.

3.4 Tolerances:

The tolerances shall not exceed those specified in FED-STD-245 for outside diameter, wall thickness, straightness, and length of drawn tube, as applicable.

3.5 Requirements for tube in sizes not specifically covered:

The mechanical properties and tolerances of tube in sizes outside the limits covered in this specification shall be as specified in the contract or order.

3.6 Marking for identification:

All tubing 3/16 inch and greater in diameter shall be marked with ink which is resistant to water and lubricating oil. Tubing shall be marked in accordance with FED-STD-184. Additional marking shall include the following:

MIL-T-7081D
Lot Number
Manufacturer's Name or Trademark

3.7 Workmanship:

The tube shall be seamless and uniform in quality and temper. The exterior and interior surfaces shall be clean, smooth, and free from slivers, laminations, folds, grooves, cracks, and other injurious defects within the limits consistent with the best commercial practice. Discoloration due to heat treatment will not be cause for rejection. Ground tube shall not be acceptable.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for inspection:

Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 General:

Sampling and inspection shall be in accordance with FED-STD-151 and as specified herein.

4.3 Sampling:

4.3.1 Lot: A lot shall consist of tube of the same temper and nominal size submitted for inspection at one time.

4.3.2 Sampling for chemical analysis:

4.3.2.1 Ingot analysis: At least one sample shall be taken from each group of ingots of the same alloy poured simultaneously from the same source of molten metal by the producer and analyzed to determine conformance with 3.1. Ingots not conforming to the requirements of this specification shall be cause for rejection. Complete ingot analysis records shall be available to the producer's cognizant Government quality assurance representative.

4.3.2.2 Finish product analysis: When sampling has not been made in accordance with 4.3.2.1, a sample shall be selected in accordance with Method 111 or 112 of FED-STD-151 for each 4,000 pounds or less of material comprising the lot, except that not more than one analysis shall be required per piece.

4.3.3 Samples for mechanical property tests:

4.3.3.1 Number of test samples in temper supplied: From material having a nominal weight of less than 1 pound per lineal foot, one tension-test sample and one flattening-test sample shall be selected from each lot weighing 500 pounds or less; from lots weighing more than 500 pounds, one additional sample shall be taken from each 1,000 pounds or fraction thereof in excess of the first 500 pounds. For material having a nominal weight of 1 pound or more per lineal foot, one tension-test sample and one flattening-test sample shall be taken from each lot consisting of 500 feet or less; from lots consisting of more than 500 feet, one additional sample shall be taken for each 1,000 feet or fraction thereof in excess of the first 500 feet. Only one tension-test specimen and one flattening-test specimen shall be taken from a given piece when more than one piece is available.

4.3.3.2 Samples for flaring test. Each length of tubing shall be tested.

4.3.4 Samples for cleanliness test: At least one sample shall be selected from each 1,200 feet, or less, from each lot of tube in the shipment.

4.3.5 Rejection and retest: When any lot fails to meet the requirements because of inadequate heat treatment, the material may be reheat-treated and resubmitted for test. Only two such reheat treatments shall be allowed. Tube not conforming to this specification shall be rejected. Tube which has been rejected may be reworked or replaced to correct the defects and resubmitted for acceptance. Before resubmitting, full particulars concerning previous rejection and the action taken to correct the defects found in the original shall be furnished the inspector. Retests are permitted in accordance with FED-STD-151. Units rejected after retest shall not be resubmitted without specific approval of the procuring activity.

4.3.6 Rejectible defects: Tube with discontinuities of depth which exceed the limits of table III shall be rejected.

TABLE III - Limits of depth of defects

Nominal wall thickness, inch	Maximum permissible depth of defect, inch
0.020 and under	10 percent of nominal wall thickness
0.021 through 0.030	0.002
0.031 through 0.040	0.0025
0.041 through 0.050	0.003
0.051 through 0.066	0.004
0.067 and over	0.006

4.4 Inspection methods:

4.4.1 Examination of product: Each piece of tube shall be carefully examined to determine conformance to this specification with respect to workmanship. Sufficient spot checks shall be made to insure conformance to the tolerances specified. On approval of the procuring activity, a system of statistical quality control may be used for dimensional and workmanship inspection.

4.4.2 Chemical analysis: Chemical analysis shall be made by wet chemical or spectrographic methods. In case of dispute, the chemical analysis by wet chemical methods shall be the basis for acceptance.

4.4.3 Mechanical properties:

4.4.3.1 Tensile tests:

4.4.3.1.1 Tensile strength: Tensile strength shall be determined in accordance with FED-STD-151, Method 211.

4.4.3.1.2 Yield strength: The yield strength shall be determined either by the offset method or the extension-under-load method in accordance with FED-STD-151, Method 211. In case of dispute, the offset method shall be used.

4.4.3.2 Flattening test:

4.4.3.2.1 Type of specimen: Flattening test specimens shall be of the full section of the material and shall be not less than 2 inches in length.