

INCH-POUND

MIL-T-50777A(OS)  
15 May 1990  
 SUPERSEDING  
 MIL-T-50777(MU)  
 1 March 1972

## MILITARY SPECIFICATION

**TUBE, ALUMINUM ALLOY, 2024, SEAMLESS (FOR PROPELLANT ACTUATED DEVICES)**

*This specification is approved for use by the Naval Sea Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.*

**1. SCOPE**

**1.1 Scope.** This specification establishes the minimum requirements for a round, seamless, aluminum alloy tubing for use in propellant actuated devices employed in emergency escape systems.

**2. APPLICABLE DOCUMENTS****2.1 Government documents.**

**2.1.1 Standards.** The following standards form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

## STANDARDS

## FEDERAL

FED-STD-151                      Metals, Test Methods

FED-STD-184                      Identification Marking of Aluminum, Magnesium, and Titanium

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commanding Officer, Naval Ordnance Station, Standardization Branch (3730), Indian Head, MD 20640-5000, by using the self addressed Standardization Document Improvement

AMSC N/A

FSC 1377

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MIL-STD-129                      Marking for Shipment and Storage

(Unless otherwise indicated, copies of federal and military standards are available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

**2.2 Non-Government publications.** The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

E 8                                      Tension Testing of Metallic Materials

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

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187.)

**2.3 Order of precedence.** In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

**3. REQUIREMENTS**

**3.1 Chemical composition.** The chemical composition shall conform to the requirements shown in table I. The contractor shall furnish an analysis of each melt in the lot showing the percentage of each of the elements designated in table I. The procuring activity may waive chemical analysis of the individual melts if it determines the contractor's method of composition control is acceptable or that material in the lot can be identified as being from lots previously analyzed and found to be in conformance with the chemical composition requirements.

**3.2 Mechanical properties.** The mechanical property requirements for the wall thicknesses and diameters specified in table II shall be as follows: tensile strength, minimum = 64,000 psi; yield strength (0.2 percent offset), minimum = 42,000 psi; extension under load = 0.0060 inch per inch; and elongation as shown in table II. NOTE: Tensile test samples taken from tubing reheat treated from T3 temper to T42 temper and not cold worked before testing shall show a minimum tensile strength of 64,000 psi and a minimum yield strength of 40,000 psi.

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**3.2.1 Flattening.** The tubing shall withstand, without cracking, the flattening test of 4.3.3.

TABLE I. Chemical composition.

Element	Percent, minimum	Percent, maximum
Titanium	-	0.15
Copper	3.80	4.90
Magnesium	1.20	1.80
Silicon	-	0.50
Chromium	-	0.10
Iron	-	0.50
Manganese	0.30	0.90
Zinc	-	0.25
Others, each	-	0.05
Others, total	-	0.15
Aluminum	Remainder	

TABLE II. Elongation requirements.

Temper	Wall thickness, inch	Elongation, in 2 inches (minimum percent)
T3 - Solution heat treated and then cold reworked 14	Dia. 1/2 to 2 inches 0.050 to 0.259	
	0.260 to 0.500	16
	Dia. greater than 2 inches to 8 inches 0.050 to 0.259	10
	0.260 to 0.500	12

**3.2.2 Test for leaks.** Each length of round tube shall be tested as specified in either 3.2.2.1 or 3.2.2.2 (at the option of the producer), consistent with the size limitations indicated for each method.

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**3.2.2.1 Pressure.** Each length of round tube shall withstand an air pressure of 250 psi applied to the inside of the tube for not less than 5 seconds while immersed (see 4.3.4.1).

**3.2.2.2 Electromagnetic (eddy current).** Each length of tube having a 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 4.3.4.2.

### 3.3 Tolerances.

**3.3.1 Diameter.** The tolerance on diameter shall be as shown in table III.

TABLE III. Tolerance on diameter.

Specified diameter, inches <sup>1</sup>	Allowable deviation of diameter at any point from specified diameter, inches <sup>2</sup>
0.501 - 1.000	± 0.008
1.001 - 2.000	± 0.010
2.001 - 3.000	± 0.012

<sup>1</sup> When outside diameter, inside diameter, and wall thickness are all specified, standard tolerances are applicable to any two of these dimensions, but not to all three. When both outside and inside diameter are specified, tolerances applicable to the outside diameter dimension shall apply to both the outside and inside diameter.

<sup>2</sup> Not applicable to tube having a wall thickness less than 0.020 inch or less than 2.5 percent of the outside diameter.

**3.3.2 Wall thickness.** The wall-thickness tolerance (see 6.3.1) for wall thickness of 0.050 to 0.500 inch shall be ± 10 percent of the wall thickness. The mean wall thickness shall be the average of two measurements taken opposite each other.

**3.3.3 Straightness.** The straightness tolerance for outside diameter of 0.500 inch to 3.000 inches, measured as departure of the tube from the straight edge, shall be 0.010 inch per foot of length.

**3.3.4 Length.** The tolerances on length for outside diameter of 0.500 inch to 3.000 inches shall be: + 1/8 inch for lengths up to 12 feet; + 1/4 inch for lengths over 12 feet and up to 30 feet; + 3/8 inch for lengths over 30 feet and up to 50 feet; and + 1 inch for lengths over 50 feet.

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**3.4 Marking for identification.** Unless otherwise specified, tubing shall be marked in accordance with FED-STD-184.

**3.5 Workmanship.** The tubing shall be seamless and uniform in quality. Exterior and interior surfaces shall be clean and smooth. Seams, slivers, laps, laminations, grooves, or inclusions and other defects specified in figures 1 through 12 shall not be permitted. Tube may be supplied with a ground finish provided that the depth of grinding is sufficient to remove surface imperfections, so, if later etched, the surface does not show imperfections equal to those shown on figures 1 to 12. If supplied with a ground finish, it shall be at least equal to RMS 100.

#### 4. QUALITY ASSURANCE PROVISIONS

**4.1 Responsibility for inspection.** Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in this specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

**4.1.1 Responsibility for compliance.** All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

**4.2 Quality conformance inspection.** Quality conformance inspection shall consist of sufficient spot checks to ensure conformance with the dimensional tolerances specified. If the procuring activity approves, a system of statistical quality control may be used for dimensional inspection. Each piece of tubing shall be examined to determine conformance to 3.5.

**4.2.1 Inspection lot.** An inspection lot shall consist of tubing of the same nominal outside and inside diameter submitted for inspection at one time.

##### 4.2.2 Sampling.

###### 4.2.2.1 For chemical analysis.

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**4.2.2.1.1 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 to 3.1. Ingots not conforming to the requirements of this specification shall be rejected. Completed ingot analysis records shall be available to the procuring activity at the producer's plant.

**4.2.2.1.2 Finish product analysis.** When compliance with 4.2.2.1.1 cannot be established, samples shall be selected as follows: From the tube having a nominal weight of less than 1 pound per linear foot, one sample shall be selected from each lot weighing 1000 pounds or less; from lot weighing more than 1000 pounds, one additional sample shall be taken for each 1000 pounds or fraction thereof in excess of the first 1000 pounds. From tube having a nominal weight of 1 pound or more per linear foot, one sample shall be taken from each lot consisting of 1000 feet or less; from lot consisting of more than 1000 feet, one additional sample shall be taken from each 1000 feet or fraction thereof in excess of the first 1000 feet. Only one test specimen shall be taken from any one piece when more than one piece is available. Not more than one analysis shall be required per piece.

**4.2.2.2 For mechanical property tests.**

**4.2.2.2.1 Tensile tests.** From tube having a nominal weight of less than 1 pound per linear foot, one tension test sample shall be selected from each lot weighing 1000 pounds or less; from lots weighing more than 1000 pounds, one additional sample shall be taken for each 1000 pounds or fraction thereof in excess of the first 1000 pounds. From tube having a nominal weight of 1 pound or more per linear foot, one tension test sample shall be taken from each lot consisting of 1000 feet or less; from lots consisting of more than 1000 feet, one additional sample shall be taken for each 1000 feet or fraction thereof in excess of the first 1000 feet. Only one tension test specimen shall be taken from any one piece when more than one piece is available.

**4.2.2.2.2 Flattening test.** Flattening test samples equal in number to those required by 4.2.2.2.1 shall be taken and tested to determine compliance with 3.2.1.

**4.2.2.2.3 Leak test.** Each length of round tube shall be leak tested for compliance with 3.2.2.

**4.3 Tests.**

**4.3.1 Chemical analysis.** Chemical analysis shall be made by the wet chemical or spectrochemical method in conformance with method 111 or 112 of FED-STD-151. In case of dispute, analysis shall be by method 111.

**4.3.2 Mechanical property tests.** Specimens shall not be required to be tested within 4 days after completion of the heat treatment. If the manufacturer so elects, samples may be tested prior to 4 days aging and if they fail to show the specified properties, the tests shall be discarded and additional tests made after 4 days aging.

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**4.3.2.1 Tensile tests.** Tensile tests shall be conducted in accordance with ASTM E 8.

**4.3.2.2 Yield strength.** The yield strength shall be determined either by the offset method or extension under load method described in ASTM E 8. In case of dispute, the offset method shall be used.

**4.3.3 Flattening test.** Flattening test specimens shall be of the full section of the material and shall have a length approximately equal to  $1\frac{1}{2}$  times the outside diameter. Test specimens representing round tubing shall be flattened sidewise into an oval shape, until the outside minor axis is not more than eight times the original wall thickness. In case the tube does not flatten so as to give a uniform radius of bend, suitable jigs may be used to bring about this result; or a section of not less than  $\frac{1}{2}$  inch in length, with the subtended arc not greater than  $\frac{1}{2}$  or less than  $\frac{1}{3}$  the circumference of the original tube, shall be removed from the tube and without further treatment shall be bent around a mandrel having a diameter equal to six times the wall thickness of the tube. The bend shall be made with the pin placed on the inside surface of the specimen with the longitudinal axis of the pin and specimen parallel. The bend shall be continued until the specimen encloses at least 180 degrees of the pin. The outside surface of the tubing shall be examined for cracks.

**4.3.4 Leak test.**

**4.3.4.1 Pressure test.** While the tube is completely immersed in water or other suitable liquid, an air pressure of 250 psi shall be applied to the inside of the tube for not less than 5 seconds. The tube may be subjected to this test after reduction to size but before the final anneal. Any tube leakage, as indicated by the formation of air bubbles in the liquid, shall be cause for rejection.

**4.3.4.2 Electromagnetic (eddy current).** The eddy current test shall be conducted in accordance with ASTM E 215. The reference standards specified in the appendix of ASTM E 215 shall be used to standardize the equipment and ensure proper functioning.

**4.4 Criteria of acceptability.** If a test specimen fails to meet any of the tests required by this specification, the lot represented by the sample shall be rejected except when a statistical sampling plan is provided.

**4.4.1 Retests.** Retests shall be permitted in accordance with FED-STD-151.

## 5. PACKAGING

**5.1 Packing.** All material shall be separated by size, shape, and temper when packed for shipment. Unless otherwise specified, material shall be packed in substantial commercial containers of the type, size, and kind commonly used for the purpose in such a manner as to ensure acceptance by carrier for transportation at the lowest rate applicable and to afford maximum protection from normal hazards of transportation.

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**5.2 Marking.** Shipping containers shall be marked with the name of the material, specification number, temper, size of tubing, quantity contained therein, name of manufacturer, name of contractor (if not the same as manufacturer), number of the contract or order, and gross weight. Any additional marking shall be in accordance with MIL-STD-129.

## 6. NOTES

(This section contains information of a general or explanatory nature that may be helpful but is not mandatory).

**6.1 Intended use.** The tubing is intended for use in propellant actuated devices used by military aircraft personnel in emergency escape systems.

**6.2 Acquisition requirements.** Acquisition documents must specify the following:

- a. Title, number, and date of this specification.
- b. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1 and 2.2).
- c. Inside and outside dimensions of the tubing required.
- d. Pressure test, if required.
- e. Packing and marking, if other than as specified in section 5.

### 6.3 Definition.

**6.3.1 Wall thickness tolerance.** Wall thickness tolerance is the difference between the thickness of the wall at any point and the mean wall thickness.

**6.4 Changes from previous issue.** Asterisks are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

### 6.5 Subject term (key word) listing.

Emergency escape systems, aircrew  
Ejection systems, aircrew



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Preparing Activity:

Navy - OS

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FIGURE 1. Unacceptable sidewall imperfection.

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FIGURE 2. Unacceptable sidewall imperfection.

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FIGURE 3. Unacceptable sidewall imperfection.

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FIGURE 4. Unacceptable sidewall imperfection.

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FIGURE 5. Unacceptable sidewall imperfection.

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FIGURE 6. Unacceptable sidewall imperfection.

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FIGURE 7. Unacceptable sidewall imperfection.



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FIGURE 8. Unacceptable sidewall imperfection.

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FIGURE 9. Unacceptable sidewall imperfection.

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FIGURE 10. Unacceptable sidewall imperfection.

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FIGURE 11. Unacceptable sidewall imperfection.

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FIGURE 12. Unacceptable sidewall imperfection.