

MIL-T-8808B
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SUPERSEDING
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MILITARY SPECIFICATION

TUBING, STEEL, CORROSION-RESISTANT (18-8 STABILIZED), AIRCRAFT HYDRAULIC QUALITY

This specification is approved for use by all Departments
and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers seamless or welded and drawn corrosion-resistant steel tubing in the annealed condition.

1.2 Classification. Tubing shall be furnished in the following types and compositions, as specified. Unless otherwise specified, either of the types and compositions indicated may be furnished, at the option of the contractor, provided that all material furnished on an individual order shall be of one type and composition only. (See 6.2.)

Manufacturing process

Type I - Seamless
Type II - Welded and drawn

Composition designation

347 - Columbium or columbium-plus-tantalum stabilized
321 - Titanium stabilized.

2. APPLICABLE DOCUMENTS

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

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: AFWAL/MLSA, Wright-Patterson AFB, Ohio 45433, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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STANDARDS

FEDERAL

Fed. Test Method
Std. No. 151

Metals; Test Methods

FED-STD-183

Continuous Identification Marking of
Iron and Steel Products

MILITARY

MIL-STD-129

Marking for Shipment and Storage

MIL-STD-163

Steel Mill Products Preparation for
Shipment and Storage

* MIL-STD-753A

Corrosion-Resistant Steel Parts:
Sampling, Inspection and Testing for
Surface Passivation

MS33531

Tolerance, Welded Corrosion-Resistant
Steel Tubing

MS33533

Tolerance - Seamless Corrosion-Re-
sistant Steel Tubing Round

MS33584

Tubing End, Standard Dimensions for
Flared

DRAWINGS

AIR FORCE-NAVY AERONAUTICAL STANDARD DRAWINGS

AND10104

Tubing, Steel, Corrosion-Resistant,
Round Standard Dimensions For

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other Publications. The following document forms a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

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AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E112

Estimating the Average Grain Size of Metals.

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

3. REQUIREMENTS

- * 3.1 Materials. The steel shall be manufactured by the electric-furnace process and shall conform to this specification.

3.1.1 Chemical composition. The chemical composition shall conform to the composition limits specified in Table I.

* TABLE I. Chemical composition limits.

Element	Composition limits (percent)		Check analysis tolerance (percent)
	347	321	
Carbon	0.08 max	0.08 max	+0.01
Manganese	2.00 max	2.00 max	+0.04
Phosphorous	0.040 max	0.040 max	+0.005
Sulphur	0.030 max	0.030 max	+0.005
Chromium	17.0 - 19.0	17.0 - 19.0	+0.20
Nickel	9.0 - 12.0	9.0 - 12.0	+0.15
Silicon	1.00 max	1.00 max	+0.05
Copper	0.50 max	0.50 max	+0.05
Columbium <u>1/</u>	1.10 max <u>2/</u>	---	+0.05
Titanium	---	0.75 max <u>3/</u>	+0.05
Molybdenum	0.50 max	0.50 max	+0.03

1/ Columbium or columbium plus tantalum. The separate determination of tantalum is not required.

2/ The sum of the columbium content plus the tantalum content shall be not less than 10 times the carbon content.

3/ The ratio of titanium to carbon shall not be less than 6 to 1.

3.1.2 Grain size. The grain size of tubing in the "as received" condition shall average 5.5 or higher, as determined by method in 4.5.

- * 3.1.3 Fabrication. The tubing may be produced by either the seamless or welded-and-drawn process. External and internal surface conditions may be produced by pickling, bright annealing, or any method producing

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a satisfactory surface condition without affecting the wall thickness or the corrosion resistance, with the exception that centerless ground finish is not acceptable. Light belt polishing or buffing is permissible. Inside diameter (ID) and outside diameter (OD) surfaces shall be passivated.

3.1.4 Resistance to corrosion. The tubing shall exhibit no evidence of intercrystalline surface attack when tested in accordance with 4.7.

3.2 Cleanliness of tubing. All surfaces shall be free from visible surface oxide films, grease, metallic flakes, or foreign matter.

3.3 Physical condition. Tubing shall be solution heat-treated and stress relieved.

4 Mechanical properties. The mechanical properties shall conform to Table II.

TABLE II. Mechanical properties.

Nominal outside diameter (inch)	Nominal wall thickness (inch)	Ultimate tensile strength (psi)	Yield Strength 0.2 percent offset (psi)	Elongation, min (percent)	
				Full section	Strip
0.188 and less	0.016 and less Over 0.016	75,000 - 120,000 max	---	35	---
		75,000 - 105,000 max	30,000 min	35	---
Over 0.188 thru 0.500 incl	0.010 and less Over 0.010	75,000 - 115,000 max	---	35	---
		75,000 - 105,000 max	30,000 min	35	---
Over 0.500	All	75,000 - 100,000 max	30,000 min	35	30

3.5 Flaring properties. One end of each piece of tubing of inside diameter .093 inch and larger shall be flared to the dimensions of standard MS33584 without cracking or forming other visible defects. Tubing with intermediate nominal OD shall be flared to the same percentage increase in diameter as required for the next larger nominal size. After flaring, the inner and outer surfaces shall be smooth and sound, and capable of forming pressure-tight joints with standard fittings. Removal of the flared portion after inspection is optional.

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3.6 Hydrostatic pressure resistance. Tubing shall be capable of withstanding an internal hydrostatic pressure P, without bulging, leakage, or other defects, except that any diametric permanent set shall be disregarded. Hydrostatic test pressure shall be calculated according to the following formula:

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

where: P = test pressure in psi.

S = 30,000 psi.

D = maximum permissible outside diameter (nominal OD plus tolerance), inch.

d = maximum permissible inside diameter, inch, (computed as D less twice the minimum permissible wall thickness).

3.7 Rejectable defects. Tubes having discontinuities of depth exceeding the limits of Table III, or which are not removable by grinding or buffing without reducing the diameter or wall thickness below dimensional tolerance limits, are rejectable. Surfaces of tubing shall be free from contaminants removable by standard pickling procedures. Centerless grinding is not acceptable.

TABLE III. Limits of depth of defects
(Applicable only to defects removable
within tubing dimensional tolerances.)

Nominal wall thickness (inch)	Maximum permissible depth of defect
0.015 and under	0.0015
0.016 to 0.030 incl	0.002
0.031 to 0.040 incl	0.0025
0.041 to 0.050 incl	0.003
0.051 to 0.066 incl	0.004
0.067 to 0.085 incl	0.006

3.8 Latent defects. When material which has been inspected, tested, and accepted, contains defects covered by this specification, subsequently exposed, the contractor may be required to replace the defective material without expense to the Government.

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3.9 Dimensions and tolerances.

3.9.1 Sizes. Tubing shall be furnished in standard diameters and wall thicknesses indicated in AND10104, or as specified by contract or purchase order. (See 6.2.)

- * 3.9.1.1 Tolerances. The variation between measured dimensions and nominal dimensions shall not exceed the tolerances of MS33533 for Type I tubing and MS33531 for Type II tubing.

3.10 Identification of product. Tubing over 1/4 inch in outside diameter shall be marked in accordance with FED-STD-183. The markings shall include the following items:

Type (seamless or welded)
Composition (347 or 321)
Heat number of the steel
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3.10.1 Unless identified in accordance with 3.10, tubes 1/4 inch and less in OD may be securely bundled and identified by metal tags stamped with the above information and securely attached at each end of the bundle.

3.11 Workmanship. The tubing shall have a good workmanlike finish conforming to the best practice for high-quality aircraft material. The tubing shall be free from defects as defined in 3.7.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, 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 the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Examination of product. All tubing shall be carefully examined to determine compliance with requirements concerning workmanship and marking and absence of defects. Spot checks shall be made as necessary to assure compliance with applicable dimensions and tolerances.

4.3 Chemical Analysis

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4.3.1 Sampling. Samples for chemical analysis shall be selected to represent each heat in the shipment. The sample shall consist of not less than 2 ounces.

- * 4.3.1.1 Waiver. Samples for chemical analysis may be waived, provided that all of the material under inspection can be identified as being made from a heat previously analyzed and found to be in conformance with the chemical composition specified herein.

4.3.1.2 Selection of samples. The method of selecting samples specified above is based on the assumption that the material is produced from ingots from the same heat, at one time, and is essentially homogeneous in all respects. If the material is taken from stock and is not identifiable relative to heat and method of manufacture, or if the identity of any portion of the shipment is obscure in any respect, the Inspector shall select the necessary additional samples to determine conformance of all portions of the shipment to this specification.

4.3.2 Method. Analysis shall be by wet chemical, spectrochemical, or other analytic methods. In the event of dispute, analysis for elements other than carbon shall be by wet chemical methods.

4.4 Tensile test.

4.4.1 Sampling. Samples shall be selected in accordance with Table IV to represent tubing of one diameter and wall thickness, produced under the same processing conditions, from the same heat of steel, essentially uniform in all respects, and presented for acceptance at one time.

TABLE IV. Sampling plans.

Lot size in feet of tubing	Sample	Sample size in pieces of tubing	Accumulative acceptance number	Accumulative rejection number
10,000 or less	First	3	0	2
	Second	6	1	2
10,000 - 20,000	First	7	1	3
	Second	14	2	3
20,001 - 50,000	First	10	1	4
	Second	20	3	4

4.4.1.1 Double sampling plans. When the number of defectives found in the first sample is equal to or less than the first acceptance number

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of the sampling plan, the lot from which the samples were drawn shall be accepted. When the number of defectives found in the first sample is equal to or greater than the first rejection number, the lot shall be rejected. When the number of defectives found in the first sample is between the first acceptance and rejection numbers, a second sample of the size indicated in the sampling plan shall be examined. The number of defectives found in the first and second samples shall be accumulated. If the cumulative number of defectives is equal to or less than the second acceptance number of the sampling, the lot shall be accepted. If the cumulative number of defectives is equal to or greater than the second rejection number, the lot shall be rejected.

4.4.2 Specimens. One specimen shall be cut from each piece of tubing comprising the sample. Specimens shall consist of a full section of tubing, when practicable, or may be machined to conform to Types T1 or T2, Method 211, of Fed. Std. No. 151.

4.4.3 Method. Specimens shall be tested in accordance with Method 211 of Fed. Std. No. 151.

- * 4.5 Grain size. One or more specimens shall be selected to represent tubing of one size and wall thickness, from the same heat of steel, annealed in the same charge, and submitted for inspection at one time. Specimens shall be prepared in accordance with ASTM Method E-112 and the grain size evaluated using plate 2 of E-112 for comparison. In the event of doubt concerning grain size determination, the Heyn intercept method of E-112 shall be used. The average grain size shall be the average of five fields of view on each specimen.

4.6 Hydrostatic pressure test. Two samples each consisting of a full length of tubing, shall be selected to represent each 1,000 feet of tubing up to 5,000 linear feet, plus two samples from each additional 5,000 feet of tubing of the same size and wall thickness, from the same heat, and submitted for inspection at one time. The samples shall be subjected to an internal hydrostatic pressure calculated in accordance with 3.6, and examined for defects and deformation.

- * 4.7 Embrittlement. One or more samples shall be selected to represent tubing of one size and wall thickness, from the same heat of steel, heat-treated in the same charge, and submitted for inspection at one time. Duplicate specimens of the "as received" tubing (full sections whenever practicable) shall be sensitized by heating at $1250^{\circ} \pm 10^{\circ}\text{F}$ for a period of 1 hour, air cooled, and then treated for a period of 48 hours in a boiling copper-sulfate sulfuric-acid solution of the following formula:

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Copper sulfate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$) 10 g
 Sulphuric acid (H_2SO_4 - sp gr 1.84) . 10 ml
 Distilled water 90 ml

Specimens shall be covered with a minimum of 30 ml of this solution per square inch of specimen surface area. A reflux condenser or similar device shall be used to prevent change in concentration of the solution. After exposure, full-section specimens shall be flattened between parallel plates by a gradually applied load normal to the axis of the tubing, until the distance between the pressure plates is not more than four times the wall thickness. Sector specimens of tubing over 0.625 inch in diameter shall be bent around a diameter equal to double the wall thickness of the tubing. The outside surface of the tube shall be on the outside of the bend. In either flattening or bending, the fold shall be along a weld zone if the specimen is of welded tubing. There shall be no evidence of cracks or defects due to bending.

4.8 Rejection. Where failure of a sample is definitely ascribed to faulty material or processing, all the tubing represented by the sample or specimen shall be rejected. After the removal of all defective tubes, rejected material may be resubmitted for acceptance but at an increased frequency of sampling.

* 4.9 Passivation.

4.9.1 Sampling. One sample shall be selected to represent each lot of tubing.

4.9.2 Method. Tests shall be in accordance with Method 102 or 103 of MIL-STD-753. The tests shall not result in any attack of the surface, either pitting or intergranular. Daily examination for this behavior shall be made using a microscopic method at a magnification of 20 diameters. If there are any indications of either pitting or intergranular attack, the conditions shall be verified using a metallographic section through the questionable area at a magnification of 100 diameters.

5. PACKAGING

5.1 Application. The requirements of Section 5 apply only to direct purchase by or direct shipments to the Government.

5.2 Packaging. The tubing shall be properly separated by size (outside diameter), type, and wall thickness. The ends of tubing shall be sealed to exclude dirt and dust.

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5.3 Packaging for shipment. Material shall be packaged for shipment in accordance with the methods prescribed in MIL-STD-163.

5.4 Marking of shipments. Interior packages and exterior shipping containers shall be marked in accordance with MIL-STD-129. The identification shall include the following information listed in the order shown:

Stock No. or other identification number as specified in the purchase document
 * TUBING, STEEL, CORROSION-RESISTANT (18-8 STABILIZED), AIRCRAFT HYDRAULIC QUALITY
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 Size (diameter)
 Wall thickness
 Heat No.
 Quantity contained
 Name of manufacturer
 Name of contractor (if different from manufacturer)
 Contract or Order No.

* NOTE: The contractor shall enter the Federal Stock No. specified in the purchase document or as furnished by the procuring activity. When the Federal Stock No. is not provided or available from the procuring activity, leave space there for and enter the stock number or other identification as provided by the procuring activity.

6. NOTES

6.1 Intended use. Steel tubing procurable to this specification is intended for use in high-pressure hydraulic and pneumatic systems where corrosion and heat resistance is required and in which welding or brazing may be involved during fabrication. The material resists oxidation at temperatures to 1200°F, but is useful at that temperature only when stresses are low.

6.2 Ordering data. Requisitions and purchase orders should state the outside diameter, wall thickness (see 3.4), length (when exact lengths are required), type, and composition designation (see 1.2) (when a specific type of material is required).

* 6.3 Changes from previous issue. The margins of the specification are marked with an asterisk to indicate where changes (additions, modifications, corrections, deletions) from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document

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based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

Custodians:

Air Force - 11
Army - MR
Navy - AS

Preparing Activity

Air Force - 11

Review Activities:

Army - ME, SM, EA, AV
Air Force - 99

(Project 4710-0539)

User:

Army - AR

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