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Superseding
MIL-T-8506
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MILITARY SPECIFICATION

TUBING, STEEL, CORROSION-RESISTANT, (304), ANNEALED, SEAMLESS AND WELDED

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

1. SCOPE

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

2. APPLICABLE DOCUMENTS

2.1 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:

SPECIFICATIONS

Military

MIL-H-6875 Heat Treatment of Steels (Aircraft Practice),
Process for

STANDARDS

Federal

QQ-P-35 Passivation Treatments for Austenitic, Ferritic, and
Martensitic Corrosion-Resisting Steel (Fastening
Devices)
Fed. Test Method
Std. No. 151 Metals; Test Methods
Fed. Std. No. 183 Continuous Identification Marking for 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-753 Corrosion-Resistant Steel Parts; Sampling, Inspection
and Testing for Surface Passivation

FSC 4710

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AND10104

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

MS33584

Tubing End - Standard Dimensions for Flared

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

2.2. Other publication.-- 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:

Aeronautical Material Specification

AMS 2243

Tolerances, Corrosion and Heat Resistant Steel Tubing

(Copies of AMS publications may be obtained from the Society of Automotive Engineers, Inc., 485 Lexington Avenue, New York, New York 10017.)

3. REQUIREMENTS

3.1 Materials.-- The steel shall be manufactured by the electric furnace process. Heat treating equipment used in connection with tubing production shall be capable of meeting the temperature control requirements of section 3 of MIL-R-6875. Heating shall be accomplished in air or protective atmosphere which will provide a smooth gray surface free from carburization, nitriding, or other deleterious surface effects.

3.1.1 Chemical composition.-- The chemical composition shall be as specified in table I.

TABLE I. Chemical composition

Element	Limits (percent)	Check analysis tolerance ^{1/} (under min. or over max.)	
Carbon	0.08 (max)	--	0.01
Manganese	2.00 (max)	--	.04
Phosphorus	0.03 (max)	--	.005
Sulfur	0.030 (max)	--	.005
Silicon	1.00 (max)	--	.05
Chromium	18.00 - 20.00	0.20	.20
Nickel	8.00 - 12.00	0.10	.15
Molybdenum	0.50 (max)	--	.03
Copper	0.50 (max)	--	.03

^{1/} Individual determinations may vary from the specified range to the extent shown in the check analysis column, except that elements in any heat shall not vary both above and below the specified range.

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3.2 Surface treatment.-- The interior and exterior surfaces shall be pickled or treated by other methods producing equally satisfactory surface conditions that do not affect the wall thickness or corrosion resistance of the material. After treatment, tubing shall be washed to remove acid residue and loose particles.

3.3 Mechanical properties.-- The mechanical properties of the tubing shall be as specified in table II.

TABLE II. Mechanical properties

Nominal outside diameter (inch)	Nominal wall thickness (inch)	Ultimate tensile strength (psi) (max)	Elongation in 2 inches (percent) (min)	
			Full tube	Strip
0.187 and under	0.016 and under	115,000	35	--
	Over 0.016	100,000	40	--
Over 0.187 to 0.500, incl.	0.010 and under	110,000	37	32
	Over 0.010	100,000	40	35
Over 0.500	0.010 and under	100,000	32	27
	Over 0.010	100,000	35	30

3.4 Flaring.-- Tubing 0.125-inch outside diameter and over shall flare to the respective dimensions of MS33584 as a minimum without rupture, when tested as specified in 4.7. The flared zones shall be sound, uniform and smooth, and capable of forming pressure-tight joints with standard fittings.

3.5 Corrosion resistance.--

3.5.1 Resistance to acidified copper-sulfate solution.-- The tubing shall exhibit no evidence of cracks due to intergranular attack when subjected to the examination after exposure to boiling acidified copper-sulfate solution at the conditions specified in 4.8.

3.5.2 Passivation treatment.-- Treatment of inner and outer surfaces by other than pickling shall be followed by a passivation treatment in accordance with QQ-P-35. The surfaces shall be passive to tests specified in 4.9.

3.6 Dimensions and tolerances.--

3.6.1 Sizes.-- Tubing shall be furnished in standard diameters and wall thicknesses specified on AND10104, as specified by the contract or purchase order (see 6.2).

3.6.1.1 Tolerances.-- The variation between actual outside diameter, wall thickness, and ovality from the nominal dimension shall be within the tolerances of AMS 2243 for welded tubing.

3.6.1.2 Weld bead.-- When tubing is fabricated by welding, it shall be so processed as to remove the bead or any dimensional indication beyond the limits of allowable tolerance of the presence of the weld.

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3.6.2 Straightness.- In no portion of any piece of tubing shall departure from straightness exceed 0.060 inch in a length of 3 feet.

3.6.3 Length.-

3.6.3.1 Exact lengths.- Tubing of all sizes may be ordered to exact lengths or in lengths expressed as a multiple of a definite unit, with tolerances as specified in the contract or purchase order (see 6.2).

3.6.3.2 Mill lengths.- When exact or multiple lengths are not specified (see 6.2), tubing will be accepted in mill lengths of 5 to 24 feet, but not more than 10 percent of any order shall be furnished in lengths shorter than 12 feet.

3.7 Identification of product.- Tubing shall be marked in accordance with Federal Standard No. 183. The following additional marking items shall be included:

Outside diameter
Wall thickness

3.7.1 In lieu of continuous marking, tubing less than 1/4 inch in diameter may be bundled and each bundle identified by metal tags impression stamped with the legend as specified in Federal Standard No. 183 and 3.7, and securely attached near each end of the bundle.

3.8 Workmanship.- Tubing surfaces shall be smooth, clean, and free from burrs, seams, tears, grooves, laminations, slivers, pits, scale, carbonaceous residue, heat discoloration, or other injurious defects. Welded tubing shall contain no welds other than the longitudinal weld and shall show no dimensional indications of the weld bead.

3.8.1 Surface imperfections.- Surface imperfections such as handling marks, straightening marks, light mandrel and die, or roll marks, shallow pits, and scale pattern will not be considered as injurious defects provided the imperfections are removable without reducing either the diameter or wall thickness of the tubing below the permissible tolerance limits. The removal of surface imperfections is not required.

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 Classification of inspection.- All the examinations and tests specified herein for the testing of tubing are classified as quality conformance inspections.

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4.3 Inspection lot.- A lot shall consist of one size and wall thickness from one heat of steel, and annealed in the same charge (batch anneal) or all tubing of the same size and heat annealed at the same temperature, time and atmosphere, without interruption, in a continuous furnace.

4.4 Examination of product.- Each length of tubing shall be visually examined for compliance with surface condition and workmanship requirements. Samples selected in accordance with table III shall be examined for compliance with nominal dimensions, identification marking requirements, and preparation for delivery for compliance with section 5.

TABLE III. Sampling plan

Lot size	Sample size	Acceptance No.
1 to 110	5	0
111 to 500	7	0
501 to 800	10	0
801 to 1,200	15	0
Over 1,200	25	0

4.5 Chemical tests.-

4.5.1 Sampling for chemical analysis.- A random sample, consisting of not less than 2 ounces of material, shall be selected from each lot and processed in accordance with Method 111 or Method 112 of Federal Test Method Standard No. 151.

4.5.1.1 Samples for check 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 conform to the chemical composition specified herein.

4.5.2 Analysis.- Analysis shall be by Method 111 or 112 of Federal Test Method Standard No. 151. In the event of dispute, analysis shall be by Method 111.

4.6 Mechanical properties.-

4.6.1 Sampling.- Two samples shall be selected to represent each 2,000 feet of tubing of each lot up to 5,000 feet, and two additional samples from each additional 5,000 feet.

4.6.2 Method.- Samples shall be tested as full-tube specimens with a test section of not less than 6 inches between plugs, as required by figure 1, Method 211 of Federal Test Method Standard No. 151, entitled "Metal plugs used for testing tubing, location of plugs in tubular specimen, and proper location of specimens in heads of testing machine." In larger diameters of tubing, type T1 or T2 specimens may be used. Tests shall comply with the applicable requirements of Method 211.

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4.7 Flaring test.-

4.7.1 Sampling.- One end of each tube or specimen cut therefrom shall be flared by spinning or by forcing axially over a tapered pin, except that not less than 10 samples from each lot, or one from each tube comprising lots of less than 10, shall be tested by the latter method. For flare test without spinning, the specimen shall be 1 inch or 1.5 diameters in length.

4.7.2 Method.- The end of each specimen to be flared without spinning shall be cut square, with the cut end smooth and free from burrs but the corners not rounded. The specimen shall, at room temperature, be forced axially by steady pressure over a hardened and polished tapered steel pin to produce the tubing flare configuration specified on MS33584. Both the tube and pin shall be clean and dry during the flaring operation. Surfaces of flares shall be examined at magnifications of 3 to 5 diameters for freedom from cracks and other defects.

4.7.3 Removal of flare.- Unless otherwise specified (see 6.2), removal of the flare portion after inspection and prior to shipping is optional.

4.8 Corrosion resistance (acidified copper-sulfate test).-

4.8.1 Sampling.- Two specimens shall be selected from each lot.

4.8.2 Method.-

4.8.2.1 Preparation of specimen.- Specimens of the as-received tubing (full sections whenever practicable) shall be treated for a period of 48 hours in a boiling copper-sulfate sulfuric acid solution of the following formula:

Copper sulfate ($\text{CuSO}_4 \cdot 5 \text{H}_2\text{O}$).....10g.

Sulfuric acid (H_2SO_4) sp. gr. 1.84.....10 ml.

Water (distilled).....90 ml.

The specimens shall be covered with a minimum of 30 milliliters (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.

4.8.2.2 Examination.- 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 greater than four times the wall thickness. Strip section specimens shall be bent around a diameter equal to the wall thickness. In either flattening or bending, the fold shall be along a weld zone if the specimen is of welded tubing. The folded areas shall be examined at a magnification of 20 X to determine compliance with 3.5.1.

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 compliance with Method 102 or 103 of MIL-STD-753.

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4.10 Rejection and retest.- Failure of a specimen to meet the test requirements shall be cause for rejection of the lot. At the discretion of the supplier, retest will be permitted. A retest sample of five specimens shall be tested to replace each failed specimen of the original sample. If one of the retest specimens fails, the lot shall be rejected with no further retesting permitted.

5. PREPARATION FOR DELIVERY

5.1 Preparation for shipment.- Unless otherwise specified, tubing shall be prepared for shipment in accordance with level A of MIL-STD-163 (see 6.2).

5.2 Marking of shipment.- Shipping containers shall be marked in accordance with MIL-STD-129.

6. NOTES

6.1 Intended use.- The tubing procurable to this specification is intended for use in the fabrication of aircraft parts requiring a high degree of resistance to corrosion. It is practically nonmagnetic in the annealed condition but permeability increases with cold working. The tubing is used for low-pressure applications, such as fuel lines. It is not to be used in high-pressure hydraulic control systems.

6.2 Ordering data.- Procurement documents should specify:

- (a) Title, number, and date of this specification.
- (b) Diameter, wall thickness, length (random mill lengths or exact lengths as desired) (see 3.6.1 and 3.6.3).
- (c) Whether removal of flare is required (see 4.7.3).
- (d) Level, if other than level A (see section 5).

Custodians:

Army - MR
Navy - AS
Air Force - 11

Preparing activity:

Air Force - 11

Project No. 4710-0010

Reviewer activities:

Army - MI, MR
Air Force - 11, 69

User activity:

Army - AV

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