Society of Automotive Engineers, Inc.
TWO PENNSYLVANIA PLAZA, NEW YORK, N.Y. 10001

AEROSPACE MATERIAL SPECIFICATION

AMS 5576D
Superseding AMS 5576C

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STEEL TUBING, WELDED, CORROSION AND HEAT RESISTANT
18Cr - 10Ni - Ti (SAE 30321)

1. SCOPE:

1.1 Form: This specification covers a corrosion and heat resistant steel in the form of welded tubing.

1.2 Application: Primarily for parts and assemblies requiring both heat and corrosion resistance, especially when subjected to welding, brazing, or other exposure to temperatures over 800 F (427 C) during fabrication. Parts and assemblies requiring oxidation resistance up to approximately 1500 F (816 C), but useful at that temperature only when stresses are low.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS) shall apply; the applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from Society of Automotive Engineers, Inc., Two Pennsylvania Plaza, New York, New York 10001.

2.1.1 Aerospace Material Specifications:

AMS 2243 - Tolerances, Corrosion and Heat Resistant Steel Tubing
AMS 2248 - Chemical Check Analysis Limits, Wrought Heat and Corrosion Resistant Steels and Alloys
AMS 2350 - Standards and Test Methods
AMS 2371 - Quality Assurance Sampling of Corrosion and Heat Resistant Alloys, Wrought Products Except Forgings

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.

ASTM A370 - Mechanical Testing of Steel Products
ASTM A393 - Conducting Acidified Copper Sulfate Test for Intergranular Attack in Austenitic Stainless Steel
ASTM E353 - Chemical Analysis of Stainless, Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron Alloys

2.3 Government Publications: Available from Superintendent of Documents, Government Printing Office, Washington, D. C. 20402.

2.3.1 Federal Standards:

Federal Test Method Standard No. 151 - Metals; Test Methods

3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall conform to the following percentages by weight, determined by wet chemical methods in accordance with ASTM E353, by spectrographic methods in accordance with Federal Test Method Standard No. 151, Method 112, or by other approved analytical methods.

	min	max
Carbon	--	0.08
Manganese	--	2.00
Silicon	--	1.00
Phosphorus	--	0.040
Sulfur	--	0.030
Chromium	17.00	19.00
Nickel	9.00	13.00
Titanium	6xC	0.70
Molybdenum	--	0.75
Copper	--	0.50

3.1.1 Check Analysis: Composition variations shall meet the requirements of AMS 2248.

3.2 Condition: Solution heat treated and descaled.

3.3 Fabrication: Tubing 2.00 in. (50.8 mm) and under in nominal OD shall be cold worked after welding. Any surface finishing operation applied to remove objectionable pits and surface blemishes shall be performed prior to final solution heat treatment. A light polish to improve surface appearance may be employed after solution heat treatment. Passivation treatment shall follow any polishing treatment.

3.4 Properties:

3.4.1 Tensile Properties: Shall be as specified in Table I, determined in accordance with ASTM A370:

TABLE I

Nominal OD Inches	Nominal Wall Thickness Inch	Tensile Strength psi, max	Elongation % in 2 in., min	
			Strip	Full Tube
Up to 0.188, incl	Up to 0.016, incl	120,000	--	33
	Over 0.016	105,000	--	35
Over 0.188 to 0.500, incl	Up to 0.010, incl	115,000	30	35
	Over 0.010	105,000	30	35
Over 0.500	Up to 0.010, incl	120,000	25	30
	Over 0.010	105,000	30	35

TABLE I (SI)

Nominal OD Millimeters	Nominal Wall Thickness Millimeters	Tensile Strength MN/m^2, max	Elongation % in 50.8 mm, min	
			Strip	Full Tube
Up to 4.77, incl	Up to 0.406, incl	827	--	33
	Over 0.406	724	--	35
Over 4.77 to 12.70, incl	Up to 0.254, incl	793	30	35
	Over 0.254	724	30	35
Over 12.70	Up to 0.254, incl	827	25	30
	Over 0.254	724	30	35

3.4.2 Flarability: Tubing shall be capable of being flared without formation of cracks or other visible defects. Specimens for flaring may be cut from any portion of a tube or an entire tube may be used as a specimen. The end of the specimen to be flared shall be cut square, with the cut end smooth and free from burrs, but not rounded. The specimen shall, at room temperature, be forced axially with steady pressure over a hardened and polished tapered steel pin having a 74 deg (1.29 rad) included angle, to produce a flare having the permanent expanded OD specified in Table II.

TABLE II

Nominal OD Inches	Expanded OD Inches	Nominal OD Inches	Expanded OD Inches
0.125	0.200	0.750	0.937
0.188	0.290	1.000	1.187
0.250	0.359	1.250	1.500
0.312	0.421	1.500	1.721
0.375	0.484	1.750	2.106
0.500	0.656	2.000	2.356
0.625	0.781		

TABLE II (SI)

Nominal OD Millimeters	Expanded OD Millimeters	Nominal OD Millimeters	Expanded OD Millimeters
3.18	5.08	19.04	23.80
4.78	7.36	25.40	30.15
6.35	9.11	31.75	35.10
7.93	11.70	38.10	43.71
9.54	12.29	44.45	53.49
12.70	16.68	50.80	59.74
15.88	19.82		

3.4.2.1 Tubing with nominal OD between any two standard sizes given in 3.4.2 shall take the same percentage flare as shown for the larger of the two sizes.

3.4.2.2 Tubing with nominal OD greater than 2.000 in. (50.8 mm) or less than 0.125 in. (3.18 mm) shall have flarability as agreed upon by purchaser and vendor.

3.4.3 Embrittlement: Tubing, after sensitizing treatment, shall be capable of being exposed to acidified copper sulfate in accordance with ASTM A393 without evidence of intercrystalline surface attack. After exposure, full cross-sectional specimens of tubing 0.625 in. (15.88 mm) or less in nominal OD shall be flattened to a total thickness under load of three times the wall thickness of the tubing and 1 in. (25.4 mm) long specimens of tubing over 0.625 in. (15.88 mm) in nominal OD shall be split and bent 180 deg (3.14 rad) with outside surface of tube on inside of bend, around a diameter equal to the nominal wall thickness, without showing cracks or other defects. In either flattening or bending, the fold shall be made parallel to the axis of the tube, and shall coincide with the weld.

3.5 Quality: Tubing shall be uniform in quality and condition and shall have a workmanlike finish conforming to the best practice for high quality material. It shall be smooth, clean, and free from heavy scale or oxide, burrs, seams, tears, grooves, laminations, slivers, pits, and other injurious conditions. Surface imperfections such as handling marks, straightening marks, light mandrel and die marks, shallow pits, and scale pattern will not be considered injurious if the imperfections are removable within the tolerances specified for wall thickness. The removal of surface imperfections is not required.

3.6 If beads are present at the welds on the inner surfaces of tubing over 2.00 in. (50.8 mm) in nominal OD, such beads shall not be thicker than 0.010 in. (0.254 mm), unless otherwise specified. The outer surfaces of all tubing and the inner surfaces of tubing 2.00 in. (50.8 mm) and under in nominal OD shall be free from beads.

3.7 Sizes: Except when exact lengths or multiples of exact lengths are ordered, tubing will be acceptable in mill lengths of 6 - 20 ft (1.8 - 6.1 m) but not more than 10% of any shipment shall be supplied in lengths shorter than 10 ft (3 meters).

3.8 Tolerances: Unless otherwise specified, tolerances shall conform to all applicable requirements of AMS 2243.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor shall supply all samples and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.4. Purchaser reserves the right to perform such confirmatory testing as he deems necessary to assure that material conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Routine Control Tests: Tests to determine conformance to composition (3.1), condition (3.2), tensile property (3.4.1), and tolerance (3.8) requirements are classified as routine control tests.

4.2.2 Periodic Control Tests: Tests to determine conformance to flarability (3.4.2) and embrittlement (3.4.3) requirements are classified as qualification and/or periodic control tests.

4.3 Sampling: Shall be in accordance with AMS 2371.

4.4 Reports:

4.4.1 The vendor of the product shall furnish with each shipment three copies of a report of the results of tests for chemical composition of each heat in the shipment and for tensile properties of each size from each heat. This report shall include the purchase order number, heat number, material specification number and its revision letter, size, and quantity from each heat.

4.4.2 The vendor of finished or semi-finished parts shall furnish with each shipment three copies of a report showing the purchase order number, material specification number and its revision letter, contractor or other direct supplier of material, part number, and quantity. When material for making parts is produced or purchased by the parts vendor, that vendor shall inspect each lot of material to determine conformance to the requirements of this specification, and shall include in the report a statement that the material conforms, or shall include copies of laboratory reports showing the results of tests to determine conformance.

4.5 Resampling and Retesting: If any specimen used in the above tests fails to meet the specified requirements, disposition of the tubing may be based on the testing of three additional specimens for each original nonconforming specimen. Failure of any retest specimen to meet the specified requirements shall be cause for rejection of the tubing represented and no additional testing shall be permitted. Results of all tests shall be reported.

5. PREPARATION FOR DELIVERY:

5.1 Identification: Tubing shall be identified as follows:

5.1.1 Straight Tubes 0.029 In. (0.74 mm) and Over in Wall Thickness and 0.500 In. (12.7 mm) and Over in OD, Minor Axis, or Least Width of Flat Surface: Shall be marked in a row of characters recurring at intervals not greater than 3 ft (914 mm) with AMS 5576D, heat number, manufacturer's identification, and nominal wall thickness. The characters shall be of such size as to be clearly legible, shall be applied using a suitable marking fluid, and shall be capable of being removed in hot alkaline cleaning solution without rubbing. The markings shall have no deleterious effect on the material or its performance and shall be sufficiently stable to withstand normal handling.