SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS5588 REV. G

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Superseding AMS5588F

Nickel Alloy, Corrosion and Heat-Resistant, Welded Tubing
47.5Ni - 22Cr - 1.5Co - 9.0Mo - 0.60W - 18.5Fe
Solution Heat Treated

(Composition similar to UNS N06002)

RATIONALE

AMS5588G results from a Five Year Review and update of this specification.

1. SCOPE

1.1 Form

This specification covers a corrosion and heat-resistant nickel alloy in the form of welded and drawn tubing.

1.2 Application

This tubing has been used typically for fluid lines operating in service under appreciable stresses at elevated temperatures, but usage is not limited to such applications. This alloy has good strength up to 1800 °F (982 °C) and oxidation resistance up to 2200 °F (1204 °C).

2. APPLICABLE DOCUMENTS

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AMS2263 Tolerances, Nickel, Nickel Alloy, and Cobalt Alloy Tubing

AMS2269 Chemical Check Analysis Limits, Nickel, Nickel Alloys and Cobalt Alloys

AMS2371 Quality Assurance Sampling and Testing, Corrosion and Heat-Resistant Steels and Alloys, Wrought Products and Forging Stock

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AMS5588G

AMS2632 Inspection, Ultrasonic, of Thin Materials, 0.50 Inch (12.7 mm) and Under in Cross-Sectional Thickness

AMS2807 Identification, Carbon and Low-Alloy Steels, Corrosion and Heat-Resistant Steels and Alloys, Sheet, Strip, Plate, and Aircraft Tubing

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM E 8/E 8M Tension Testing of Metallic Materials

ASTM E 112 Determining Average Grain Size

ASTM E 354 Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys

ASTM E 426 Electromagnetic (Eddy-Current) Examination of Seamless and Welded Tubular Products, Austenitic Stainless Steel and Similar Alloys

ASTM E 1417 Liquid Penetrant Testing

3. TECHNICAL REQUIREMENTS

3.1 Composition

Shall conform to the percentages by weight shown in Table 1, determined by wet chemical methods in accordance with ASTM E 354, by spectrochemical methods, or by other analytical methods acceptable to purchaser.

TABLE 1 - COMPOSITION

Element	min	max
Carbon	0.05	0.15
Manganese	--	1.00
Silicon	--	1.00
Phosphorus	--	0.040
Sulfur	--	0.030
Chromium	20.50	23.00
Cobalt	0.50	2.50
Molybdenum	8.00	10.00
Tungsten	0.20	1.00
Iron	17.00	20.00
Aluminum	--	0.50
Titanium	--	0.15
Boron	--	0.010
Copper	--	0.50
Nickel	remainder	

3.1.1 Check Analysis

Composition variations shall meet the applicable requirements of AMS2269.

3.2 Condition

Solution heat treated, and unless solution heat treatment is performed in an atmosphere yielding a bright finish, pickled as required. No specific solution heat treating instructions are specified but it is recommended that the tubing be solution heat treated by heating in a suitable protective atmosphere to 2150 °F ± 25 (1177 °C ± 14), holding at heat for a time commensurate with section thickness, and cooling rapidly. In no case shall the solution heat treatment temperature be lower than 2100 °F (1149 °C).

3.3 Fabrication

Tubing shall be fabricated from hot or cold rolled strip, fusion welded without addition of filler metal, cold drawn, and solution heat treated. The cold drawing operation on tubing 3.0 inches (76 mm) and under in nominal OD shall result in not less than 15% reduction in wall thickness; the amount of wall thickness reduction on tubing over 3.0 inches (76 mm) in nominal OD shall be as agreed upon by purchaser and vendor.

3.4 Properties

Tubing shall conform to the following requirements:

3.4.1 Tensile Properties

Shall be as shown in Table 2, determined in accordance with ASTM E 8/E 8M on tubing having nominal OD of 0.125 inch (3.18 mm) and over with nominal wall thickness of 0.015 inch (0.38 mm) and over.

TABLE 2 - MINIMUM ROOM TEMPERATURE, TENSILE PROPERTIES

Property	Value
Tensile Strength	100 ksi (689 MPa)
Yield Strength at 0.2% Offset	45.0 ksi (310 MPa)
Elongation in 2 Inches (50.8 mm)	
Strip Specimens	20%
Full-Section Specimens	25%

3.4.2 Average Grain Size

Shall be ASTM No. 4 or finer, determined in accordance with ASTM E 112, for tubing 0.125 inch (3.18 mm) and under in nominal wall thickness.

3.4.3 Flarability

Specimens as in 4.3.1 shall withstand, without formation of cracks or other visible defects, flaring at room temperature by being forced axially with steady pressure over a hardened and polished tapered steel pin having a 74-degree included angle to produce a flare having a permanent expanded OD not less than 1.2 times the original nominal diameter.

3.4.4 Pressure Test

Tubing shall show no bulges, leaks, pinholes, cracks, or other defects when subjected to an internal hydrostatic pressure (P), except that a diametric permanent set of 0.002 inch per inch (0.002 mm/mm) of diameter is acceptable. The hydrostatic pressure (P) shall be determined from Equation 1.

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

where:

P = Test pressure in ksi (MPa)
S = 45.0 ksi (310 MPa)
D = Nominal OD in inches (mm)
d = Nominal ID in inches (mm)

3.5 Quality

Tubing, as received by purchaser, shall be uniform in quality and condition and shall have a finish conforming to the best practice for high quality aircraft tubing. It shall be smooth and free from grease, oil and other matter, heavy scale or oxide, burrs, seams, tears, grooves, laminations, slivers, pits, and other imperfections detrimental to usage of the tubing. 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, but removal of such imperfections is not required.

3.5.1 If beads are present at the weld on the inner surface of tubing over 3.0 inches (76 mm) in nominal OD, such weld reinforcement shall be not thicker than 0.010 inch (0.25 mm). The outer surface of all tubing and the inner surface of tubing 3.0 inches (76 mm) and under in nominal OD shall be free from weld reinforcement.

3.5.2 When specified by purchaser, tubing shall be subjected to fluorescent penetrant inspection in accordance with ASTM E 1417, to ultrasonic inspection in accordance with AMS2632, to electromagnetic (eddy-current) inspection in accordance with ASTM E 426, or to any combination thereof. Standards for acceptance shall be as agreed upon by purchaser and vendor (See 8.4).

3.6 Tolerances

Shall conform to all applicable requirements of AMS2263.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The vendor of tubing shall supply all samples for vendor's tests and shall be responsible for the performance of all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the tubing conforms to specified requirements.

4.2 Classification of Tests

4.2.1 Acceptance Tests

Composition (3.1), tensile properties (3.4.1), average grain size (3.4.2), quality (3.5), and tolerances (3.6) are acceptance tests and shall be performed on each heat or lot as applicable.

4.2.2 Periodic Tests

Flarability (3.4.3) and pressure test (3.4.4) are periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.