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AEROSPACE MATERIAL SPECIFICATION

SAE AMS 5590C

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Submitted for recognition as an American National Standard

Superseding AMS 5590B

NICKEL ALLOY, CORROSION AND HEAT RESISTANT, SEAMLESS TUBING
52.5Ni - 19Cr - 3.0Mo - 5.1(Cb + Ta) - 0.90Ti - 0.50Al - 18Fe
Consumable Electrode or Vacuum Induction Melted
1950 °F (1066 °C) Solution Heat Treated

UNS N07718

1. SCOPE:

1.1 Form:

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

1.2 Application:

This tubing has been used typically for fluid lines and structural components requiring high strength at cryogenic temperatures and for short-time service up to 1200 °F (649 °C) and oxidation resistance up to 1800 °F (982 °C), particularly those parts which are formed or welded and then heat treated to develop desired properties, but usage is not limited to such applications.

2. APPLICABLE DOCUMENTS:

The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 2263 Tolerances, Nickel, Nickel Alloy, and Cobalt Alloy Tubing
MAM 2263 Tolerances, Metric, Nickel, Nickel Alloy, and Cobalt Alloy Tubing
AMS 2269 Chemical Check Analysis Limits, Wrought Nickel Alloys and Cobalt Alloys
AMS 2371 Quality Assurance Sampling and Testing, Corrosion and Heat Resistant Steels and Alloys, Wrought Products and Forging Stock
AMS 2632 Ultrasonic Inspection of Thin Materials, 0.5 Inch (13 mm) and Thinner
AMS 2645 Fluorescent Penetrant Inspection
AMS 2807 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, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM E 8 Tension Testing of Metallic Materials
ASTM E 8M Tension Testing of Metallic Materials (Metric)
ASTM E 18 Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials
ASTM E 112 Determining the 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) Testing of Seamless and Welded Tubular Products, Austenitic Stainless Steel and Similar Alloys

2.3 U.S. Government Publications:

Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-STD-163 Steel Mill Products, Preparation for Shipment and Storage

3. TECHNICAL REQUIREMENTS:

3.1 Composition:

(R)

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	--	0.08
Manganese	--	0.35
Silicon	--	0.35
Phosphorus	--	0.015
Sulfur	--	0.015
Chromium	17.00	21.00
Nickel	50.00	55.00
Molybdenum	2.80	3.30
Columbium + Tantalum	4.75	5.50
Titanium	0.65	1.15
Aluminum	0.20	0.80
Cobalt	--	1.00
Boron	--	0.006
Copper	--	0.30
Iron	remainder	

3.1.1 Check Analysis: Composition variations shall meet the requirements of AMS 2269.

3.2 Melting Practice:

Alloy shall be produced by multiple melting using consumable electrode practice in the remelt cycle or shall be induction melted under vacuum. If consumable electrode remelting is not performed in vacuum, electrodes which have been produced by vacuum induction melting shall be used for remelting.

3.3 Condition:

Cold drawn, solution heat treated, and descaled. 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 1950 °F ± 25 (1066 °C ± 14), holding at heat for not more than 30 minutes, and cooling at a rate equivalent to an air cool or faster.

3.4 Fabrication:

Tubing shall be produced by a seamless process. The external and internal surface finishes may be produced by pickling, bright annealing, or any method which will provide the required surface condition and which will not affect limits of wall thickness or corrosion resistance, with the exception that a centerless-ground finish is not acceptable. A light polish to improve surface appearance may be employed.

3.5 Properties:

Tubing shall conform to the following requirements:

3.5.1 As Solution Heat Treated:

3.5.1.1 Tensile Properties: 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 shall have the properties shown in Table 2, determined in accordance with ASTM E 8 or ASTM E 8M.

Table 2 - Tensile Properties

Property	Value
Tensile Strength, maximum	145 ksi (1000 MPa)
Yield Strength at 0.2% Offset, maximum	85.0 ksi (586 MPa)
Elongation in 2 Inches (50.8 mm), minimum	30%

3.5.1.2 (R) Grain Size: Shall be ASTM No. 3 or finer, determined by comparison of a polished and etched specimen with the chart in ASTM E 112.

3.5.1.3 Flarability: Specimens as in 4.3.1 from tubing 0.188 to 2.000 inches (4.78 to 50.80 mm), inclusive, in nominal OD shall withstand flaring at room temperature, without formation of cracks or other visible defects, 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 1.25 times the original nominal outside diameter.

3.5.1.4 Pressure Test: Tubing shall show no bulges, leaks, pinholes, cracks, or other defects when subjected to an internal hydrostatic pressure (P) of 5000 psi (34.5 MPa) or pressure sufficient to cause a tensile stress of 40.0 ksi (276 MPa) in the tubing wall, whichever is less. The hydrostatic pressure (P) shall be calculated from Equation 1:

$$P = 2\frac{St}{D} \qquad \text{(Eq. 1)}$$

where, S = 40.0 ksi (276 MPa) tensile stress
t = Minimum wall thickness (nominal thickness minus maximum negative tolerance)
D = Nominal OD

3.5.2 After Precipitation Heat Treatment: Tubing shall meet the requirements of 3.5.2.1 and 3.5.2.2 after being precipitation heat treated by heating to 1400 °F ± 15 (760 °C ± 8), holding at heat for 10 hours ± 0.5, furnace cooling to 1200 °F ± 15 (649 °C ± 8), holding at 1200 °F ± 15 (649 °C ± 8) until a total precipitation time of 20 hours has been reached, and cooling at a rate equivalent to an air cool or faster.

3.5.2.1 Tensile Properties: Shall be as shown in Table 3 for tubing 0.125 inch (3.18 mm) and over in nominal OD with nominal wall thickness of 0.015 inch (0.38 mm) and over, determined in accordance with ASTM E 8 or ASTM E 8M.

Table 3 - Minumum Tensile Properties

Property	Value
Tensile Strength	170 ksi (1172 MPa)
Yield Strength at 0.2% Offset	145 ksi (1000 MPa)
Elongation in 2 Inches (50.8 mm)	15%

3.5.2.2 (R) Hardness: Shall be not lower than 36 HRC, or equivalent, determined in accordance with ASTM E 18 (See 8.2).

3.6 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 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.

3.6.1 (R) When specified by purchaser, tubing shall be subjected to fluorescent penetrant inspection in accordance with AMS 2645, to ultrasonic inspection in accordance with AMS 2632, to electromagnetic (eddy-current) testing in accordance with ASTM E 426, or to any combination thereof.

3.6.2 Tubing shall be free from grease or other foreign materials. Metallic flakes or particles shall not be collected on a clean white cloth drawn through the length of the bore of a test sample. Discoloration of the cloth, without the presence of flakes or particles, is acceptable.

3.7 Tolerances:

Shall conform to all applicable requirements of AMS 2263 or MAM 2263.

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 performing all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the tubing conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests for the following requirements are acceptance tests and shall be performed on each heat or lot as applicable:

4.2.1.1 Composition (3.1) of each heat.

4.2.1.2 Tensile properties (3.5.1.1) and grain size (3.5.1.2) of each lot as solution heat treated.

4.2.1.3 Tensile properties (3.5.2.1) of each lot after precipitation heat treatment.

4.2.1.4 Quality (3.6) and tolerances (3.7) of each lot.

4.2.2 Periodic Tests: Tests for the following requirements are periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser:

4.2.2.1 Flarability (3.5.1.3) and pressure test (3.5.1.4) of tubing as solution heat treated.

4.2.2.2 Hardness (3.5.2.2) of tubing after precipitation heat treatment.