ADOPTION NOTICE

SAE-AMS5581, "NICKEL ALLOY, CORROSION AND HEAT RESISTANT, SEAMLESS OR WELDED TUBING 62NI - 21.5CR - 9.0MO - 3.7CB ANNEALED", was adopted on 17-MAR-89 for use by the Department of Defense (DoD). Proposed changes by DoD activities must be submitted to the DoD Adopting Activity: ASC/ENOI, Building 560, 2530 Loop Road West, Wright-Patterson AFB, OH 45433-7101. Copies of this document may be purchased from the Society of Automotive Engineers 400 Commonwealth Drive Warrendale, Pennsylvania, United States, 15096-0001. http://www.sae.org/

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AEROSPACE MATERIAL SPECIFICATION

SAE AMS 5581C

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Superseding AMS 5581B

Nickel Alloy, Corrosion and Heat Resistant, Seamless or Welded Tubing
62Ni - 21.5Cr - 9.0Mo - 3.7Cb
Annealed

UNS N06625

1. SCOPE:

1.1 Form:

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

1.2 Application:

This tubing has been used typically for fluid lines requiring high strength and corrosion resistance at temperatures from cryogenic to 1800 °F (982 °C), but usage is not limited to such applications.

1.3 Classification:

The tubing covered by this specification is classified as follows:

Type 1 - Seamless
Type 2 - Welded

1.3.1 Unless a specific type is specified, either Type 1 or Type 2 may be supplied.

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.

QUESTIONS REGARDING THIS DOCUMENT: (724) 772-7161 FAX: (724) 776-0243
TO PLACE A DOCUMENT ORDER: (724) 776-4970 FAX: (724) 776-0790
SAE WEB ADDRESS: http://www.sae.org

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	Tolerance, 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 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 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 407	Microetching Metals and 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:

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	--	0.10
Manganese	--	0.50
Silicon	--	0.50
Phosphorus	--	0.015
Sulfur	--	0.015
Chromium	20.00	23.00
Molybdenum	8.00	10.00
Columbium	3.15	4.15
Titanium (3.1.1)	--	0.40
Aluminum (3.1.1)	--	0.40
Cobalt (3.1.2)	--	1.00
Iron	--	5.00
Nickel	remainder	

3.1.1 Shall be present but not in excess of specified maximum.

3.1.2 Determination not required for routine acceptance.

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

3.2 Condition:

Annealed and descaled.

3.3 Fabrication:

Tubing shall be produced by a seamless or a welded and drawn 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 centerless ground finish is not acceptable. A light polish to improve surface appearance may be employed.

3.3.1 Welded (Type 2) tubing shall be processed to remove the bead and any dimensional indication of the presence of welds.

3.4 Properties:

Tubing shall conform to the following requirements:

3.4.1 Tensile Properties: Shall be as specified in Table 2, determined in accordance with ASTM E 8 or ASTM E 8M.

TABLE 2 - Minimum Tensile Properties

Property	Value
Tensile Strength	120 ksi (827 MPa)
Yield Strength at 0.2% Offset	60.0 ksi (414 MPa)
Elongation in 2 Inches (50.8 mm)	35%

3.4.2 Flarability: Specimens as in 4.3.1 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 specified in Table 3.

TABLE 3A - Flarability, Inch/Pound Units

Nominal OD Inch	Expanded OD Inch	Nominal OD Inches	Expanded OD Inches
0.125	0.200	0.750	0.937
0.188	0.302	1.000	1.187
0.250	0.359	1.250	1.500
0.312	0.421	1.500	1.721
0.357	0.484	1.750	2.106
0.500	0.656	2.000	2.356
0.625	0.781		

TABLE 3B - Flarability, SI Units

Nominal OD Millimeters	Expanded OD Millimeters	Nominal OD Millimeters	Expanded OD Millimeters
3.18	5.08	19.05	23.80
4.78	7.67	25.40	30.15
6.35	9.12	31.75	38.10
7.92	10.69	38.10	43.71
9.52	12.29	44.45	53.49
12.70	16.66	50.80	59.84
15.88	19.84		

3.4.2.1 Tubing with nominal OD between any two standard sizes given in Table 3 shall take the same percentage flare as shown for the larger of the two sizes.

3.4.2.2 Flarability requirements for tubing over 2.000 inches (50.80 mm) or under 0.125 inch (3.18 mm) in nominal OD shall be as agreed upon by purchaser and vendor.

3.4.3 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.

$$P = S \frac{D^2 - d^2}{D^2 + d^2} \quad \text{(Eq. 1)}$$

where, P = Test pressure in ksi (MPa)
S = 60.0 ksi (41.4 MPa)
D = Nominal OD
d = Nominal ID

3.4.4 Microstructure: Tubing shall reveal no continuous intergranular carbide precipitation when suitably etched and examined microscopically at 500X magnification. The presence of some discontinuous intergranular carbide precipitation shall not be considered detrimental if the other technical requirements are met. Standards for acceptance may be as agreed upon by purchaser and vendor.

3.4.5 Grain Size: Shall be 5 or finer, determined by comparison of a specimen, polished and electrolytically etched in accordance with ASTM E 407, with the chart in ASTM E 112, using 100X magnification.

3.5 Quality:

3.5.1 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.

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

3.6 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 composition (3.1), tensile properties (3.4.1), pressure test (3.4.3), microstructure (3.4.4), grain size (3.4.5), 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: Tests for flarability (3.4.2) are periodic tests and shall be determined at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.3 Sampling and Testing:

Shall be in accordance with AMS 2371 and the following:

4.3.1 Specimens for flarability (3.4.2) test shall be full tubes or sections cut from a tube. The end of the specimen to be flared shall be cut square, with the cut end smooth and free from burrs, but not rounded.

4.4 Reports:

The vendor of tubing shall furnish with each shipment a report showing the results of tests for chemical composition of each heat and for tensile properties, pressure test, microstructure, and grain size of each lot. This report shall include the purchase order number, heat and lot number, AMS 5581C, size, and quantity.

4.5 Resampling and Retesting:

Shall be in accordance with AMS 2371.

5. PREPARATION FOR DELIVERY:

5.1 Sizes:

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