AEROSPACE MATERIAL SPECIFICATION

AMS5583™	REV. G

Issued 1977-07
Reaffirmed 2006-10
Revised 2024-05

Superseding AMS5583F

(R) Nickel Alloy, Corrosion- and Heat-Resistant, Seamless Tubing, 72Ni - 15.5Cr - 0.95Cb (Nb) - 2.5Ti - 0.70Al - 7.0Fe (X750) Vacuum Melted, Solution Heat Treated, Precipitation Hardenable to 170 ksi (1172 MPa) Tensile Strength (Composition similar to UNS N07750)

RATIONALE

AMS5583G is the result of a Five-Year Review and update of the specification. The revision updates the Title to be consistent with other tubing specifications, adds definitions (see 2.3), updates the applicable testing and reporting of composition (see 3.1 and 3.1.2), revises condition and fabrication to be consistent with other nickel tubing specifications (see 3.3 and 3.6), addresses testing smaller sizes (see Tables 2 and 3), adds strain rate control (see 3.7.2.1.1), updates furnace requirements (see 3.7.2), adds white cloth testing (see 3.8.1), adds NDT test requirements (see 3.8.2, 4.2.2, and 8.6), clarifies product definition (see 5.2), and updates exceptions requirements (see 8.5).

1. SCOPE

1.1 Form

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

1.2 Application

This tubing has been used typically for fluid lines requiring high strength up to 1300 °F (704 °C) and oxidation resistance up to 1800 °F (982 °C), but usage is not limited to such applications. Parts may be formed and then heat treated to improve strength at elevated temperatures.

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 +1 724-776-4970 (outside USA), www.sae.org.

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

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

For more information on this standard, visit
https://www.sae.org/standards/content/AMS5583G/

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

AMS2283 Composition Testing Methods for Nickel- and Cobalt-Based Alloys

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

AMS2634 Ultrasonic Inspection, Thin Wall Metal Tubing

AMS2700 Passivation of Corrosion Resistant Steels

AMS2750 Pyrometry

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

AS7766 Terms Used in Aerospace Metals Specifications

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 B751 Nickel and Nickel Alloy Welded Tube

ASTM B829 Nickel and Nickel Alloys Seamless Pipe and Tube

ASTM E8/E8M Tension Testing of Metallic Materials

ASTM E10 Brinell Hardness of Metallic Materials

ASTM E18 Rockwell Hardness of Metallic Materials

ASTM E112 Determining Average Grain Size

ASTM E140 Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, Scleroscope Hardness, and Leeb Hardness

ASTM E426 Electromagnetic (Eddy-Current) Examination of Seamless and Welded Tubular Products, Titanium, Austenitic Stainless Steel and Similar Alloys

ASTM E1417/E1417M Liquid Penetrant Testing

2.3 Definitions

Terms used in AMS are defined in AS7766 and the following:

2.3.1 Bore conditioning is any mechanical cleaning method that is used in the bore of tubing to improve the final surface appearance, with no resultant change in tubing size beyond the allowable tolerances.

3. TECHNICAL REQUIREMENTS

3.1 Composition

Composition shall conform to the percentages by weight shown in Table 1, determined in accordance with AMS2283, or by other analytical methods acceptable to the purchaser.

Table 1 - Composition

Element	Min	Max
Carbon	--	0.08
Manganese	--	0.35
Silicon	--	0.35
Phosphorus	--	0.015
Sulfur	--	0.010
Chromium	14.00	17.00
Nickel	70.00	--
Columbium (Niobium)	0.70	1.20
Titanium	2.25	2.75
Aluminum	0.40	1.00
Iron	5.00	9.00
Cobalt (see 3.1.1)	--	1.00
Tantalum	--	0.05
Copper	--	0.50

3.1.1 Determination not required for lot acceptance.

3.1.2 The producer may test for any element not listed in Table 1 and include this analysis in the report of 4.4. Reporting of any element not listed in the composition table is not a basis for rejection unless limits of acceptability are specified by the purchaser.

3.1.3 Check Analysis

Composition variations shall meet the applicable requirements of AMS2269.

3.2 Melting Practice

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

3.3 Condition

3.4 Solution heat treat in an atmosphere yielding a bright finish. Alternately, product shall be chemically cleaned to produce a uniform finish. It is permissible to pickle prior to final cleaning treatment. Final chemical cleaning may take place after any final finishing (see 3.6.2). After final chemical cleaning, tube cleanliness shall be verified using the corrosion-resistance test methods specified in AMS2700 for class 2 parts or alternate method acceptable to the purchaser.

3.5 Heat Treatment

Tubing shall be solution heat treated by heating to a temperature not lower than 1800 °F (982 °C), holding at the selected temperature within ±25 °F (±14 °C) for a time commensurate with cross-sectional thickness, and cooling at a rate equivalent to an air cool or faster. Pyrometry shall be in accordance with AMS2750.

3.6 Fabrication

Tubing shall be produced by a seamless and drawn process. Any surface finishing operation applied to remove objectionable pits and blemishes shall be performed prior to solution heat treatment. Only light polishing to improve external surface appearance is permitted after solution heat treatment, and if performed, the product shall be subsequently chemically cleaned.

3.6.1 Bore conditioning (see 2.3) is permitted after final anneal providing the tubing is not sized by metal removal methods beyond the original tolerances. If bore conditioning is used, 100% visual inspection of each tube shall be performed. The tube ID shall be uniformly shiny with no evidence of remnant material.

3.6.2 Tubing shall be chemically cleaned after any ID or OD finishing that occurs after heat treatment.

3.7 Properties

Tubing shall conform to the following requirements:

3.7.1 As Solution Heat Treated

3.7.1.1 Tensile Properties

Tensile properties shall be as shown in Table 2, determined in accordance with ASTM E8/E8M.

Table 2 - Solution heat-treated tensile properties

Property	Value
Tensile Strength, Maximum	140 ksi (965 MPa)
Yield Strength at 0.2% Offset, Maximum(1)	80 ksi (552 MPa)
Elongation in 2 Inches (50 mm) or 4D, Minimum(1) Strip Specimen Full Tube	 30% 35%

(1) Yield strength and elongation are not required to be determined for OD sizes less than 0.125 inch or for wall thicknesses less than 0.015 inch.

3.7.1.2 Average Grain Size

Average grain size shall be ASTM No. 5 or finer, determined in accordance with ASTM E112.

3.7.1.3 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 1.20 times the original nominal OD.

3.7.2 Response to Precipitation Heat Treatment

Samples from tubing shall have the following properties after being precipitation heat treated by heating to 1350 °F ± 15 °F (732 °C ± 8 °C), holding at heat for not less than 8 hours, cooling at a rate of 100 °F ± 15 °F (56 °C ± 8 °C) per hour to 1150 °F ± 25 °F (621 °C ± 14 °C), holding at 1150 °F ± 15 °F (621 °C ± 8 °C) for 8 hours ± 0.5 hour, and cooling at a rate equivalent to cooling in air. Instead of the 100 °F (56 °C) per hour cooling rate to 1150 °F ± 15 °F (621 °C ± 8 °C), tubing may be furnace cooled at any rate provided the time at 1150 °F ± 15 °F (621 °C ± 8 °C) is adjusted to give a total precipitation heat-treatment time of not less than 18 hours. Pyrometry shall be in accordance with AMS2750.

3.7.2.1 Tensile Properties

Response to heat-treatment tensile properties shall be as shown in Table 3, determined in accordance with ASTM E8/E8M.

Table 3 - Minimum tensile properties after response to heat treatment

Property	Value
Tensile Strength	170 ksi (1172 MPa)
Yield Strength at 0.2% Offset(1)	115 ksi (793 MPa)
Elongation in 2 Inches (50 mm) or 4D(1) Strip Specimen Full Tube	 12% 15%

(1) Yield strength and elongation are not required to be determined for OD sizes less than 0.125 inch or for wall thicknesses less than 0.015 inch.

3.7.2.1.1 Unless otherwise specified, the strain rate shall be set at 0.005 in/in/min (0.005 mm/mm/min) and maintained within a tolerance of ±0.002 in/in/min (±0.002 mm/mm/min) through 0.2% offset yield strain. After the yield strain, the speed of the testing machine shall be set between 0.05 in/in and 0.5 in/in (0.05 mm/mm and 0.5 mm/mm) of the length of the reduced parallel section (or distance between the grips for specimens not having a reduced section) per minute. Alternatively, an extensometer and strain rate indicator may be used to set the strain rate between 0.05 in/in/min and 0.5 in/in/min (0.05 mm/mm/min and 0.5 mm/mm/min). The requirement for compliance becomes effective for material produced 1 year after the publication date of this specification.

3.7.2.2 Hardness

Hardness should be not lower than 30 HRC, or equivalent (see 8.2), determined in accordance with ASTM E18 or ASTM E10. Tubing shall not be rejected on the basis of hardness if the tensile property requirements of 3.7.2.1 are acceptable, determined on specimens taken from the same sample as that with nonconforming hardness or from another sample with similar nonconforming hardness.

3.8 Quality

Tubing as received by the 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 foreign 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, and scale pattern are considered acceptable if the imperfections are removable within the tolerances specified for wall thickness, but removal of such imperfections is not required.

3.8.1 A clean, white cloth or plug drawn or blown through the length of the bore of a test sample at least 12 inches (30 cm) in length shall show no visual evidence of metallic flakes or particles. Discoloration of the cloth or plug, without the presence of flakes or particles, is acceptable. Alternate methods for evaluating tube cleanliness may be used for tubing 0.500 inch (12.7 mm) and under ID.

3.8.2 When no inspection is specified by the purchaser, tubing shall be subjected to either ultrasonic or eddy-current inspection in accordance with ASTM B751 or ASTM B829 except that suspect indications shall not be accepted based on visual observation (i.e., indications must be either rejected or reconditioned and retested to pass the test). Alternate methods of inspection may be used for tube 0.25 inch (0.64 cm) and under in nominal diameter.

3.8.3 When specified by the purchaser (see 8.6), tubing shall be subjected to fluorescent penetrant inspection in accordance with ASTM E1417/E1417M, to ultrasonic inspection in accordance with AMS2634, to electromagnetic (eddy-current) inspection in accordance with ASTM E426, or to any combination thereof. Tubing shall meet the requirements of acceptance criteria established by the cognizant engineering organization.

3.9 Tolerances

Tolerances shall conform to all applicable requirements of AMS2263.

3.10 Exceptions

Any exception shall be authorized by the purchaser and reported as in 4.4.5.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The producer of tubing shall supply all samples for the producer's tests and shall be responsible for the performance of all required tests. The 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 (see 3.1), tensile properties (see 3.7.1.1), response to precipitation heat treatment (see 3.7.2.1), average grain size (see 3.7.1.2), hardness (see 3.7.2.2), and tolerances (see 3.9) are acceptance tests and shall be performed on each heat or lot as applicable.

4.2.2 Nondestructive inspection per 3.8.2 shall be performed on each finished tube or as specified (see 3.8.3). The requirements of 3.8.2 shall become effective 1 year after the publication date of this document.

4.2.3 Periodic Tests

Flarability (see 3.7.1.3) is a periodic test and shall be performed at a frequency selected by the producer unless frequency of testing is specified by the purchaser.

4.3 Sampling and Testing

Shall be in accordance with AMS2371 and the following:

4.3.1 Specimens for flarability test (see 3.7.1.3) 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 producer of the product shall furnish with each shipment a report showing the producer’s name, country where the metal was melted (e.g., final melt in the case of metal processed by multiple melting operations), and the following results of tests and relevant information:

4.4.1 For each heat:

Composition.