SAE Aerospace
An SAE International Group

AEROSPACE MATERIAL SPECIFICATION

SAE AMS5922 REV. A

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Superseding AMS5922

Steel, Corrosion-Resistant, Bars, and Forgings
10Cr - 5.5Ni - 14Co - 2Mo - 1W (0.19-0.23C)
Vacuum Induction Melted, Vacuum Arc Remelted, Normalized, Annealed

UNS S10500

RATIONALE

AMS5922A revisesTable 1 to present the correct precision for reporting aluminum content .

1. SCOPE

1.1 Form

This specification covers a corrosion-resistant, premium aircraft-quality alloy steel in the form of bars, forgings, and stock for forging.

1.2 Application

These products have been used typically for heat treated parts requiring a combination of high strength, good toughness, weldability, and stress corrosion resistance, but usage is not limited to such applications. Product after heat treatment should attain a minimum tensile strength of 280 ksi (1931 MPa).

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.

AMS2241	Tolerances, Corrosion and Heat-Resistant Steel, Iron Alloy, Titanium, and Titanium Alloy Bars and Wire
AMS2248	Chemical Check Analysis Limits, Corrosion and Heat-Resistant Steels and Alloys, Maraging and Other Highly-Alloyed Steels, and Iron Alloys
AMS2300	Steel Cleanliness, Premium Aircraft-Quality, Magnetic Particle Inspection Procedure
AMS2315	Determination of Delta Ferrite Content

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/AMS5922A

AMS2371 Quality Assurance Sampling and Testing, Corrosion and Heat-Resistant Steels and Alloys, Wrought Products and Forging Stock
AMS2374 Quality Assurance Sampling and Testing, Corrosion and Heat-Resistant Steel and Alloy Forgings
AMS2750 Pyrometry
AMS2806 Identification, Bars, Wire, Mechanical Tubing, and Extrusions, Carbon and Alloy Steels and Corrosion and Heat-Resistant Steels and Alloys
AMS2808 Identification, Forgings

AS1182 Standard Machining Allowance, Aircraft-Quality and Premium Aircraft-Quality Steel Bars and Mechanical 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 A 370 Definitions for Mechanical Testing of Steel Products
ASTM A 604 Macroetch Testing of Consumable Electrode Remelted Steel Bars and Billets
ASTM E 45 Determining the Inclusion Content of Steel
ASTM E 353 Chemical Analysis of Stainless, Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron Alloys
ASTM E 399 Plane-Strain Fracture Toughness of Metallic Materials
ASTM E 1181 Characterizing Duplex Grain Sizes

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 353, by spectrochemical methods, or by other analytical methods acceptable to purchaser.

TABLE 1 - COMPOSITION

Element	min	max
Carbon	0.19	0.23
Manganese	--	0.10
Silicon	--	0.10
Phosphorus	--	0.008
Sulfur	--	0.005
Chromium	9.50	10.50
Nickel	5.20	5.80
Cobalt	13.50	14.50
Molybdenum	1.80	2.20
Tungsten	0.80	1.20
Titanium	--	0.015
Aluminum	--	0.01
Vanadium	0.25	0.35
Oxygen	--	0.0020 (20 ppm)
Nitrogen	--	0.0015 (15 ppm)

3.1.1 Check Analysis

Composition variations shall meet the applicable requirements of AMS2248. No variation is permitted for oxygen and nitrogen.

3.2 Melting Practice

Steel shall be multiple melted using vacuum induction melting followed by vacuum arc remelting.

3.3 Condition

The product shall be supplied in the following condition; hardness shall be determined in accordance with ASTM A 370:

3.3.1 Bars and Forgings

Normalized and annealed having hardness not higher than 372 HB, or equivalent (See 8.2), and descaled.

3.3.2 Stock for Forging

As ordered by the forging manufacturer.

3.4 Heat Treatment

Bars and forgings shall be normalized by heating to 1976 °F ± 36 (1080 °C ± 20), holding at the selected temperature for 60 minutes ± 15, cooling in air to room temperature, cooling to -100 °F (-73 °C) or lower, holding at temperature for a minimum of 60 minutes, and air warming to room temperature, and annealed by heating to 1256 °F ± 25 (680 °C ± 14), holding at temperature for 8 hours +2, -0.5, and cooling in air. Pyrometry shall be in accordance with AMS2750.

3.5 Properties

The product shall conform to the following requirements; tensile and hardness testing shall be performed in accordance with ASTM A 370:

3.5.1 Macrostructure

Visual examination of transverse full cross-sections from bars, billets, and stock for forging, flash welded rings, or extrusions, etched in hot hydrochloric acid in accordance with ASTM A 604, shall show no pipe or cracks. Porosity, segregation, inclusions, and other imperfections for product 36 square inches (232 cm^2) and under in nominal cross-sectional area shall be no worse than the macrographs of ASTM A 604 shown in Table 2.

TABLE 2 - MACROSTRUCTURE LIMITS

Class	Condition	Severity
1	Freckles	A
2	White Spots	A
3	Radial Segregation	B
4	Ring Pattern	B

3.5.2 Micro-Inclusion Rating

No specimen shall exceed the limits shown in Table 3, determined in accordance with ASTM E 45, Method A.

TABLE 3 - MICRO-INCLUSION RATING LIMITS

Type	A	B	C	D
Thin	1.5	1.5	1.5	1.5
Thick	1.0	1.0	1.0	1.0

3.5.3 Response to Heat Treatment

Test specimens, cut from product 50 square inches (323 cm^2) and under in cross-sectional area shall conform to the following requirements after being hardened by heating to 1985 °F ± 27 (1085 °C ± 15), holding at heat for 60 minutes +10, -0, quenching in oil (or equivalent), cooling to -100 °F (-73 °C) or lower, holding at temperature for 1 hour +2, -0, and warming in air to room temperature; and double tempered by heating to 934 °F ± 12 (501 °C ± 7), holding at heat for 3 hours ± 0.5, quenching in oil (or equivalent), cooling to -100 °F (-73 °C) or lower, holding at temperature for 1 hour +2, -0, and warming in air to room temperature, reheating to 900 °F ± 18 (482 °C ± 10), holding at heat for 12 hours +2, -1, and cooling in air (or equivalent).

3.5.3.1 Tensile Properties

Longitudinal and transverse tensile properties shall be as shown in Table 4. Testing in the longitudinal direction need not be performed on product qualified by testing in the transverse direction.

TABLE 4 - MINIMUM TENSILE PROPERTIES

Property	Value
Tensile Strength	280 ksi (1931 MPa)
Yield Strength at 0.2% Offset	213 ksi (1468 MPa)
Elongation in 4D	11%
Reduction of Area	44%

3.5.3.2 Hardness

Shall be not lower than 53 HRC, or equivalent (See 8.2).

3.5.3.3 Fracture Toughness

Shall be not lower than 50 ksi $\sqrt{inch}$ (55 MPa $\sqrt{m}$) K_{IC}, determined in accordance with ASTM E 399 on specimens in the longitudinal LS or LR orientation from product over 3.00 inches (76.2 mm) and over in nominal section thickness. If product size precludes use of specimens which will provide valid K_{IC} results, a K_Q value not lower than 50 ksi $\sqrt{inch}$ (55 MPa $\sqrt{m}$) will be acceptable. Invalid test results in accordance with ASTM E 399 shall be considered meaningful and the material shall be accepted to K_{IC} requirements if the calculated K_Q equals or exceeds the required K_{IC} and the invalidity is due to P_{max}/P_q >1.10.

3.5.3.4 Average Grain Size

Shall be ASTM No. 4 or finer, range ASTM No. 12 to ASTM No. 1, for product 50 square inches (232 cm^2) and under in cross-sectional area, determined in accordance with ASTM E 1181, Duplex, Wide-range.

3.5.4 Forging Stock

When a sample of stock is forged to a test coupon acceptable to purchaser (See 8.3.1) and heat treated as in 3.4 and 3.5.3, specimens taken from the heat treated coupon shall conform to the requirements of 3.5.3.1, 3.5.3.2, 3.5.3.3, and 3.5.3.4. If specimens taken from the stock after heat treatment as in 3.4 and 3.5 conform to the requirements of 3.5.3.1, 3.5.3.2, 3.5.3.3, and 3.5.3.4, the tests shall be accepted as equivalent to tests of a forged coupon.

3.6 Quality

The product, as received by purchaser, shall be uniform in quality and condition, sound, and free from foreign materials and from imperfections detrimental to usage of the product.

3.6.1 Steel shall be premium aircraft-quality conforming to AMS2300.

3.6.2 Bars ordered hot rolled, or ground, turned, or polished shall, after removal of the standard machining allowance in accordance with AS1182, be free of seams, laps, tears, and cracks open to the ground, turned or polished surface.

3.6.3 Grain flow of die forgings, except in areas which contain flash-line end grain, shall follow the general contour of the forgings showing no evidence of reentrant grain flow.

3.7 Tolerances

Bars and wire shall conform to all applicable requirements of AMS2241.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The vendor of the product 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 product conforms to specified requirements.

4.2 Classification of Tests

4.2.1 Acceptance Tests

The following requirements are acceptance tests and shall be performed on each heat or lot as applicable:

4.2.1.1 Composition (3.1), macrostructure rating (3.5.1), and micro-inclusion rating (3.5.2) of each heat.

4.2.1.2 Tensile properties (3.5.3.1) and hardness (3.5.3.2) of each lot of bars and forgings after heat treatment.

4.2.1.3 Tolerances (3.7) of bars and wire.

4.2.2 Periodic Tests

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 Average grain size (3.5.3.4) of bars and forgings after heat treatment.

4.2.2.2 Fracture toughness (3.5.3.3) of bars and forgings after heat treatment.

4.2.2.3 Ability of forging stock (3.5.4) to develop required properties.

4.2.2.4 Frequency-severity cleanliness rating (3.6.1).

4.2.2.5 Grain flow of die forgings (3.6.3).

4.3 Sampling and Testing

4.3.1 Bars and Stock for Forging

In accordance with AMS2371.

4.3.2 Forgings

In accordance with AMS2374.