



AEROSPACE MATERIAL SPECIFICATION

AMS5614™**REV. G**

Issued 1952-06
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Superseding AMS5614F

Steel, Corrosion- and Heat-Resistant, Bars, Wire, Forgings, and Forging Stock,
12Cr - 0.50Mo (410 plus Mo),
Annealed
(Composition similar to UNS S41025)

RATIONALE

AMS5614G is the result of a Five-Year Review and update of the specification. The revision updates the Title based on the Scope, adds composition reporting requirements (see 3.1.1), clarifies macrostructure requirements (see 3.3.1), adds strain rate for tensile testing based on form (see 3.3.2.1.1 and 3.3.2.1.2), updates requirements for hardness (see 3.3.2.3.1), adds finish requirements and associated guidance (see 3.4.2 and 8.6), updates exception requirements (see 4.4.3 and 8.7), and addresses forging property options (see 4.4.4 and 8.8).

1. SCOPE

1.1 Form

This specification covers a corrosion- and heat-resistant steel in the form of bars, wire, and forgings 7.0 inches (178 mm) and under in nominal diameter or least distance between parallel sides, and forging stock of any size.

1.2 Application

These products have been used typically for parts, such as compressor blades and vanes, requiring oxidation resistance up to 1000 °F (538 °C), useful at the higher temperatures only when stresses are low, but usage is not limited to such applications.

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.

AMS2241 Tolerances, Corrosion- and Heat-Resistant Steel, Iron Alloy, Titanium, and Titanium Alloy Bars and Wire

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AMS2248	Chemical Check Analysis Limits, Corrosion- and Heat-Resistant Steels and Alloys, Maraging and Other Highly Alloyed Steels, and Iron Alloys
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
ANS2750	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 Stock Removal Allowance, Aircraft-Quality and Premium Aircraft-Quality Steel Bars and Mechanical 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 A370	Mechanical Testing of Steel Products
ASTM A751	Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products
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 E381	Macroetch Testing Steel Bars, Billets, Blooms, and Forgings

2.3 Definitions

Terms used in AMS are defined in AS7766.

3. TECHNICAL REQUIREMENTS

3.1 Composition

Composition shall conform to the percentages by weight shown in Table 1, determined in accordance with ASTM A751 or by other analytical methods acceptable to the purchaser.

Table 1 - Composition

Element	Min	Max
Carbon	0.07	0.12
Manganese	0.30	0.60
Silicon	--	0.35
Phosphorus	--	0.040
Sulfur	--	0.030
Chromium	11.50	12.50
Molybdenum	0.40	0.60
Nickel	--	0.60
Copper	--	0.50
Aluminum	--	0.05
Tin	--	0.05
Nitrogen	--	0.08

3.1.1 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.

3.1.2 Check Analysis

Composition variations shall meet the applicable requirements of AMS2248.

3.2 Condition

The product shall be supplied in the following condition; hardness and tensile strength shall be determined in accordance with ASTM A370:

3.2.1 Bars

Bars shall be hot rolled, annealed, and either descaled or ground, having hardness not higher than 223 HBW, or equivalent (see 8.2).

3.2.1.1 Bars shall not be cut from plate (see 4.4.2).

3.2.2 Wire

Wire shall be cold drawn and annealed having tensile strength not higher than 115 ksi (793 MPa), or equivalent hardness (see 8.3).

3.2.3 Forgings

Forgings shall be as ordered.

3.2.4 Forging Stock

Forging stock shall be as ordered by the forging manufacturer.

3.3 Properties

The product shall conform to the following requirements; tensile and hardness testing shall be performed in accordance with ASTM A370:

3.3.1 Macrostructure

Visual examination of transverse full cross sections from bars, wire, billets, and forging stock, etched in hot hydrochloric acid in accordance with ASTM E381, shall show no pipe or cracks. Standards for porosity, segregation, inclusions, and other imperfections as defined in the macrographs of ASTM E381 may be agreed upon by the purchaser and supplier.

3.3.2 Response to Heat Treatment

Samples from product 7.0 inches (178 mm) and under in nominal diameter or least distance between parallel sides shall have the following properties after being hardened by heating to 1750 °F $\pm$ 10 °F (954 °C $\pm$ 5 °C), holding at heat for 25 to 30 minutes, and cooling in air and tempered by heating to a temperature not lower than 1100 °F (593 °C), holding at heat for 60 minutes $\pm$ 5 minutes, and cooling in air. Pyrometry shall be in accordance with AMS2750.

3.3.2.1 Tensile Properties - Response to Heat Treatment

Tensile properties shall be as shown in Table 2; requirements apply in both the longitudinal and transverse directions, but tests in the transverse direction need be made only on product from which a specimen not less than 2.50 inches (63.5 mm) in length can be taken midway between the surface and the center. Tests in the longitudinal direction are not required on product tested in the transverse direction.

Table 2 - Minimum tensile properties - response to heat treatment

Property	Value
Tensile Strength	100 ksi (689 MPa)
Yield Strength at 0.2% Offset	80 ksi (552 MPa)
Elongation in 4D or 2 inches (50 mm)	21%
Reduction of Area	60%

3.3.2.1.1 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.

3.3.2.1.2 Strain rate limitations do not apply to wire.

3.3.2.2 Mechanical properties for product outside the range covered by 1.1 shall be agreed upon between the purchaser and producer and reported in 4.4.

3.3.2.3 Response to Heat Treatment - Hardness

Product 0.375 inch (9.52 mm) and under in nominal diameter or least distance between parallel sides and specimens 0.375 inch $\pm$ 0.010 inch (9.52 mm $\pm$ 0.25 mm) thick cut from larger product shall have hardness of 207 to 248 HBW, or equivalent (see 8.2).

3.3.2.3.1 Product shall not be rejected on the basis of hardness if the tensile property requirements of 3.3.2.1 are acceptable. Tensile properties shall be determined on material taken from the same sample as that with nonconforming hardness or from another sample with similar nonconforming hardness.

3.4 Quality

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

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

3.4.2 Bars shall be free from seams, laps, tears, and cracks after removal of the standard stock removal allowance in accordance with AS1182

3.5 Tolerances

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

3.6 Exceptions

Any exceptions shall be authorized by the purchaser and reported as in 4.4.3.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The producer of the product 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 product conforms to specified requirements.

4.2 Classification of Tests

4.2.1 Acceptance Tests

For Each Heat:

Composition (see 3.1)

Macrostructure (see 3.3.1)

For Each Lot:

Condition (see 3.2)

Response to heat treatment - tensile properties and hardness (see 3.3.2)

Tolerances of bars and wire (see 3.5)

4.2.2 Periodic Tests

Grain flow of die forgings (see 3.4.1) is a periodic test and shall be performed at a frequency selected by the producer unless a frequency of testing is specified by the purchaser.

4.3 Sampling and Testing

Sampling and testing shall be as follows:

4.3.1 Bars, wire, and forging stock shall be sampled and tested in accordance with AMS2371.

4.3.2 Forgings shall be sampled and tested in accordance with AMS2374.