

Steel Bars, Forgings, and Tubing
1.0Cr – 3.2Ni – 0.2Mo (0.12 – 0.17C)
Premium Aircraft-Quality
Double Vacuum Melted

(Composition similar to UNS K43214)

RATIONALE

AMS6549 is a new specification to cover double vacuum melted premium aircraft-quality UNS K43214.

1. SCOPE

1.1 Form

This specification covers a premium aircraft-quality, low-alloy steel in the form of bars, forgings, mechanical tubing, and forging stock.

1.2 Application

These products have been used typically for carburizing parts requiring high minimum core hardness within a narrow range, reduced distortion and subject to very rigid magnetic particle inspection standards, 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 724-776-4970 (outside USA), www.sae.org.

AMS2251	Tolerances, Low-Alloy Steel Bars
AMS2253	Tolerances, Carbon and Alloy Steel Tubing
AMS2259	Chemical Check Analysis Limits, Wrought Low-Alloy and Carbon Steels
AMS2300	Steel Cleanliness, Premium Aircraft-Quality, Magnetic Particle Inspection Procedure
AMS2370	Quality Assurance Sampling and Testing, Carbon and Low-Alloy Steel, Wrought Products and Forging Stock

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AMS2372	Quality Assurance Sampling and Testing, Carbon and Low-Alloy Steel, Forgings
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

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 E 45	Determining the Inclusion Content of Steels
ASTM A 255	Determining Hardenability of Steel
ASTM A 370	Mechanical Testing of Steel Products
ASTM A 604	Macroetch Testing of Consumable Electrode Remelted Steel Bars and Billets
ASTM E 112	Determining Average Grain Size
ASTM E 350	Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron

3. TECHNICAL REQUIREMENTS

3.1 Composition

Shall conform to the following percentages by weight shown in Table 1, determined by wet chemical methods in accordance with ASTM E 350, by spectrochemical methods, or by other analytical methods acceptable to purchaser.

TABLE 1 - COMPOSITION

Element	min	max
Carbon	0.12	0.17
Manganese	0.30	0.60
Silicon	0.15	0.40
Phosphorus	--	0.015
Sulfur	--	0.005
Chromium	0.80	1.10
Nickel	3.00	3.50
Molybdenum	0.22	0.32
Copper	--	0.35

3.1.1 Check Analysis

Composition variations shall meet the applicable requirements of AMS2259.

3.2 Melting Practice

Steel shall be double vacuum melted, using vacuum induction melting (VIM) followed by vacuum arc consumable electrode remelting (VAR).

3.3 Condition

The product shall be supplied in the following condition; hardness, tensile, and impact testing shall be performed in accordance with ASTM A 370:

3.3.1 Bars

Bar shall not be cut from plate. (Also see 4.4.2).

3.3.1.1 Bars 0.500 inch (12.70 mm) and under in Nominal Diameter or Least Distance between Parallel Sides

Cold finished having tensile strength not higher than 138 ksi (950 MPa) or hardness not higher than 285 HB or equivalent (See 8.2).

3.3.1.2 Bars over 0.500 inch (12.70 mm) in Nominal Diameter or Least Distance Between Parallel Sides

Hot finished and annealed, unless otherwise ordered, having hardness not higher than 241 HB or equivalent (See 8.2). Bars ordered cold finished may have hardness as high as 285 HB or equivalent (See 8.2).

3.3.2 Forgings

As ordered.

3.3.3 Mechanical Tubing

Cold finished, unless otherwise ordered, having hardness not higher than 285 HB, or equivalent (See 8.2). Tubing ordered hot finished and annealed or tempered shall have hardness not higher than 285 HB or equivalent (See 8.2).

3.3.4 Forging Stock

As ordered by the forging manufacturer.

3.4 Properties

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

3.4.1 Macrostructure

Visual examination of transverse full cross-sections from bars, billets tube rounds (solid, not hollow), and forging stock, etched in hot hydrochloric acid in accordance with ASTM A 604, shall show no pipe or cracks. Porosity, segregation, inclusions, and other imperfections 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

3.4.1.1 Macrostructure examination is not required for hollow tubes that are produced directly from ingots or blooms unless specified by purchaser, in which case the purchaser shall specify standards to be used.

3.4.2 Micro-Inclusion Rating of Each Heat

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

TABLE 3 – MICRO-INCLUSIONS RATING LIMITS

Type	A Thin	A Heavy	B Thin	B Heavy	C Thin	C Heavy	D Thin	D Heavy
Worst Field Severity	1.5	1.0	1.0	1.0	1.0	1.0	1.5	1.0
Worst Field Frequency, maximum	a	1	a	1	a	1	3	1
Total Rateable Fields, Frequency, maximum	b	1	b	1	b	1	5	1
a - Combined A+B+C, not more than 3 fields								
b - Combined A+B+C, not more than 8 fields								

3.4.2.1 A rateable field is defined as one that has type A, B, C or D inclusion rating of at least No. 1.0 thin or heavy in accordance with Jernkontoret chart, Plate I-r, ASTM E 45.

3.4.3 Average Grain Size of Bars, Forgings and Tubing

Shall be ASTM No. 6 or finer determined in accordance with ASTM E 112.

3.4.4 Hardenability of Each Heat

Shall be J 1/16 inch (1.6 mm) = 48 HRC maximum and J 23/64 inch (9.1 mm) = 33 HRC minimum, determined on the standard end-quench test specimen in accordance with ASTM A 255 except that the steel shall be normalized at 1562 °F ± 10 (850 °C ± 6) and the test specimen austenitized at 1517 °F ± 10 (825 °C ± 6).

3.5 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.

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

3.5.2 Product ordered hot finished or cold finished or ground, turned, or polished shall, after removal of the standard stock removal allowance in accordance with AS1182, be free from seams, laps, tears, and cracks open to the machined, ground, turned, or polished surface.

3.5.3 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.

3.6 Tolerances

3.6.1 Bars

In accordance with AMS2251.

3.6.2 Mechanical Tubing

In accordance with AMS2253,

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.