

AEROSPACE MATERIAL SPECIFICATION

An American National Standard

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Superseding AMS 6472B

STEEL BARS AND FORGINGS, NITRIDING
1.6Cr - 0.35Mo - 1.1Al (0.38 - 0.43C)
Hardened and Tempered, 112 ksi (772 MPa) Tensile Strength

UNS K24065

1. SCOPE:

- 1.1 Form: This specification covers an aircraft-quality low-alloy steel in the form of heat treated bars and forgings, and of forging stock.
- 1.2 Application: Primarily for nitrided parts requiring high surface hardness, resistance to heat, and less distortion than parts made from steel requiring quenching to case harden. This steel may be case hardened in dissociated ammonia gas to give a minimum case hardness of 900 HV.

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.

- 2.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

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2.1.1 Aerospace Material Specifications:

AMS 2251 - Tolerances, Low-Alloy Steel Bars
MAM 2251 - Tolerances, Metric, Low-Alloy Steel Bars
AMS 2259 - Chemical Check Analysis Limits, Wrought Low-Alloy and Carbon Steels
AMS 2301 - Aircraft Quality Steel Cleanliness, Magnetic Particle Inspection Procedure
AMS 2370 - Quality Assurance Sampling of Carbon and Low-Alloy Steels, Wrought Products Except Forgings and Forging Stock
AMS 2372 - Quality Assurance Sampling of Carbon and Low-Alloy Steels, Forgings and Forging Stock
AMS 2750 - Pyrometry
AMS 2806 - Identification, Bars, Wire, Mechanical Tubing, and Extrusions, Carbon and Alloy Steels and Corrosion and Heat Resistant Steels and Alloys
AMS 2808 - Identification, Forgings

2.1.2 Aerospace Standards:

AS1182 - Standard Machining Allowance, Aircraft-Quality and Premium Aircraft-Quality Steel Bars and Mechanical Tubing

2.2 ASTM Publications: Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM A 370 - Mechanical Testing of Steel Products
ASTM E 350 - Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron
ASTM E 381 - Macroetch Testing, Inspection, and Rating Steel Products, Comprising Bars, Billets, Blooms, and Forgings

2.3 U.S. Government Publications: Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

2.3.1 Military Standards:

MIL-STD-163 - Steel Mill Products, Preparation for Shipment and Storage

3. TECHNICAL REQUIREMENTS:

- 3.1 Composition: Shall conform to the following percentages by weight,
 0 determined by wet chemical methods in accordance with ASTM E 350, by spectrochemical methods, or by other analytical methods acceptable to purchaser:

	min		max
Carbon	0.38	-	0.43
Manganese	0.50	-	0.80
Silicon	0.20	-	0.40
Phosphorus	--		0.025
Sulfur	--		0.025
Chromium	1.40	-	1.80
Molybdenum	0.30	-	0.40
Aluminum	0.95	-	1.30
Nickel	--		0.25
Copper	--		0.35

- 3.1.1 Check Analysis: Composition variations shall meet the applicable requirements of AMS 2259.

- 3.2 Condition: The product shall be supplied in the following condition:

- 3.2.1 Bars and Forgings: Hardened and tempered.

- 3.2.2 Forging Stock: As ordered by the forging manufacturer.

- 3.3 Heat Treatment: Bars and forgings shall be hardened by quenching from 1700°F ± 25 (927°C ± 14) and tempered to meet the tensile property requirements of 3.4.2. Pyrometry shall be in accordance with AMS 2750.

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

- 3.4.1 Macrostructure: Visual examination of transverse sections as in 4.3.3 from bars and forging stock, etched in accordance with ASTM E 381 in hot hydrochloric acid, shall show no pipe or cracks. Porosity, segregation, inclusions, and other imperfections shall be no worse than the following macrographs of ASTM E 381:

Section Size		Macrographs
Square Inches	Square Centimeters	
Up to 36, incl	Up to 232, incl	S2 - RI - C2
Over 36 to 100, incl.	Over 232 to 645, incl	S2 - R2 - C3
Over 100	Over 645	As agreed upon

3.4.2 Tensile Properties:

Tensile Strength, minimum	112 ksi (772 MPa)
Yield Strength at 0.2% Offset, minimum	90 ksi (620 MPa)
Elongation in 4D, minimum	16%
Reduction of Area, minimum	50%

3.4.3 Hardness:

Nominal Diameter or Section Thickness		Hardness Brinell (HB)
Inches	Millimeters	
Up to 3.125, incl	Up to 79.38, incl	241 - 285
Over 3.125 to 6.000, incl	Over 79.38 to 152.40, incl	229 - 285

3.4.3.1 Hardness shall be determined midway between surface and center of bars.

3.4.4 Decarburization:

3.4.4.1 Bars ordered ground, turned, or polished shall be free from decarburization on the ground, turned, or polished surfaces.

3.4.4.2 Allowable decarburization of bars and billets ordered for redrawing or forging or to specified microstructural requirements shall be as agreed upon by purchaser and vendor.

3.4.4.3 Decarburization of bars to which 3.4.4.1 or 3.4.4.2 is not applicable shall be not greater than shown in Table I.

TABLE I

Nominal Diameter or Distance Between Parallel Sides Inches	Depth of Decarburization Inch
Up to 0.500, incl	0.030
Over 0.500 to 1.000, incl	0.035
Over 1.000 to 1.500, incl	0.040
Over 1.500 to 2.000, incl	0.050
Over 2.000 to 2.500, incl	0.060
Over 2.500 to 3.000, incl	0.070

TABLE I (SI)

Nominal Diameter or Distance Between Parallel Sides Millimeters	Depth of Decarburization Millimeters
Up to 12.70, incl	0.76
Over 12.70 to 25.40, incl	0.89
Over 25.40 to 38.10, incl	1.02
Over 38.10 to 50.80, incl	1.27
Over 50.80 to 63.50, incl	1.52
Over 63.50 to 76.20, incl	1.78

3.4.4.3.1 Limits for depth of decarburization of bars over 3.000 inches (76.20 mm) in nominal diameter or distance between parallel sides shall be as agreed upon by purchaser and vendor.

3.4.4.4 Decarburization shall be measured by the microscopic method or by Rockwell Superficial 30-N scale or equivalent hardness testing method on hardened but untempered specimens protected during heat treatment to prevent changes in surface carbon content. Depth of decarburization, when measured by a hardness method, is defined as the perpendicular distance from the surface to the depth under that surface below which there is no further increase in hardness. Such measurements shall be far enough away from any adjacent surface to be uninfluenced by any decarburization or lack of decarburization thereon.

3.4.4.4.1 When determining the depth of decarburization, it is permissible to disregard local areas provided the decarburization of such areas does not exceed the above limits by more than 0.005 inch (0.13 mm) and the width is 0.065 inch (1.65 mm) or less.

3.5 Quality:

3.5.1 Steel shall be aircraft-quality conforming to AMS 2301.

3.5.2 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.

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

3.5.4 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 re-entrant grain flow.

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