Society of Automotive Engineers, Inc.
TWO PENNSYLVANIA PLAZA, NEW YORK, N.Y. 10001

AEROSPACE MATERIAL SPECIFICATION

AMS 6472A
Superseding AMS 6472
Issued 2-15-65
Revised 5-15-71

STEEL BARS AND FORGINGS, NITRIDING
1.6Cr - 0.35Mo - 1.13Al (0.38 - 0.43C)
Heat Treated, 112,000 psi (772 MN/m^2) Tensile

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1. SCOPE:

1.1 Form: This specification covers a nitriding grade of 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 highest surface hardness, resistance to heat, and less distortion than parts made from steel requiring quenching to case harden. The 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 Aerospace Material Specifications (AMS) and Aerospace Standards (AS) shall apply; the applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from Society of Automotive Engineers, Inc., Two Pennsylvania Plaza, New York, New York 10001.

2.1.1 Aerospace Material Specifications:

AMS 2251 - Tolerances, 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 2350 - Standards and Test Methods
AMS 2370 - Quality Assurance Sampling of Carbon and Low Alloy Steels, Wrought Products Except Forgings
AMS 2372 - Quality Assurance Sampling of Carbon and Low Alloy Steels, Forgings and Forging Stock
AMS 2375 - Approval and Control of Critical Forgings
AMS 2808 - Identification, Forgings

2.1.2 Aerospace Standards:

AS 1182 - Standard Machining Allowance, Aircraft Quality and Premium Quality Steel Products

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.

ASTM A370 - Mechanical Testing of Steel Products
ASTM E350 - Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron
ASTM E381 - Rating Macroetched Steel

2.3 Government Publications: Available from Superintendent of Documents, Government Printing Office, Washington, D. C. 20402.

2.3.1 Federal Standards:

Federal Test Method Standard No. 151 - Metals; Test Methods

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3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall conform to the following percentages by weight, determined by wet chemical methods in accordance with ASTM E350, by spectrographic methods in accordance with Federal Test Method Standard 151, Method 112, or by other approved analytical methods.

	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 requirements of AMS 2259, paragraph titled "Low Alloy Steels".

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: The product shall be hardened by quenching from 1700 F ± 25 (926.7 C ± 14) and tempered to meet the tensile property requirements of 3.4.1.

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

3.4.1 Macrostructure: Visual examination of transverse sections of bars and forging stock which have been etched in accordance with ASTM E381 in hot hydrochloric acid (1:1) at 160 - 180 F (71.1 - 82.2 C) for sufficient time to develop a well-defined macrostructure, shall show no injurious imperfections such as pipe, internal cracks, porosity, segregation, and inclusions detrimental to fabrication or to performance of parts. Macrostructure shall be equal to or better than the following macrographs of ASTM E381:

Section Size		
Square Inches	(Square Centimeters)	Macrographs
Up to 36, incl	(Up to 232.3, incl)	S2 - R1 - C2
Over 36 to 100, incl	(Over 232.3 to 645.2, incl)	S2 - R2 - C3
Over 100	(Over 645.2)	As agreed upon

3.4.2 Tensile Properties:

Tensile Strength, min	112,000 psi (772 MN/m^2)
Yield Strength at 0.2% Offset, min	90,000 psi (621 MN/m^2)
Elongation in 2 in. (50.8 mm) or 4D, min	16%
Reduction of Area (round specimens) min	50%

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3.4.3 Hardness:

Nominal Diameter or Section Thickness		Hardness
Inches	(Millimeters)	Brinell
Up to 3.125, incl	(Up to 79.4, incl)	241 - 285
Over 3.125 to 6.000, incl	(Over 79.4 to 152.4, 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 0.50, incl	0.030
Over 0.50 to 1.00, incl	0.035
Over 1.00 to 1.50, incl	0.040
Over 1.50 to 2.00, incl	0.050
Over 2.00 to 2.50, incl	0.060
Over 2.50 to 3.00, incl	0.070

TABLE I (SI)

Nominal Diameter or Distance Between Parallel Sides Millimeters	Depth of Decarburization Millimeters
Up to 12.70, incl	0.762
Over 12.70 to 25.40, incl	0.889
Over 25.40 to 38.10, incl	1.016
Over 38.10 to 50.80, incl	1.270
Over 50.80 to 63.50, incl	1.524
Over 63.50 to 76.20, incl	1.778

3.4.4.3.1 Limits for depth of decarburization of bars over 3.000 in. (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 therein.

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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 limits above by more than 0.005 in. (0.127 mm) and the width is 0.065 in. (1.651 mm) or less.

3.5 Quality: Steel shall be aircraft quality conforming to AMS 2301. The product shall be uniform in quality and condition, clean, sound, and free from foreign materials and from internal and external imperfections detrimental to fabrication or to performance of parts.

3.5.1 Bars ordered ground, turned, or polished shall be free from seams, laps, tears, and cracks open to the ground, turned, or polished surfaces.

3.5.2 Product ordered to surface conditions other than ground, turned, or polished shall, after removal of the standard machining allowance, be free from seams, laps, tears, cracks, and other injurious defects exposed to the machined surfaces. Standard machining allowance shall be in accordance with values shown in AS 1182.

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

3.7 Tolerances: Unless otherwise specified, tolerances for bars shall conform to all applicable requirements of AMS 2251; for all hexagons, tolerances for cold finished shall apply.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor shall supply all samples and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.5. Purchaser reserves the right to perform such confirmatory testing as he deems necessary to assure that material conforms to the requirements of this specification.

4.2 Classification of Tests: Tests to determine conformance to all technical requirements of this specification are classified as routine control tests.

4.3 Sampling: Shall be in accordance with the following:

4.3.1 Bars: AMS 2370.

4.3.2 Forgings and Forging Stock: AMS 2372.

4.4 Approval: When specified, approval and control of critical forgings shall be in accordance with AMS 2375.

4.5 Reports:

4.5.1 The vendor of the product shall furnish with each shipment three copies of a report of the results of tests for chemical composition, macrostructure, and AMS 2301 frequency-severity rating of each heat in the shipment and the results of tests on each size from each heat to determine conformance to the tensile, hardness, and decarburization requirements of this specification. This report shall include the purchase order number, heat number, material specification number and its revision letter, size, and quantity from each heat. If forgings are supplied, the part number and size of stock used to make the forgings shall also be included.

4.5.2 The vendor of finished or semi-finished parts shall furnish with each shipment three copies of a report showing the purchase order number, material specification number and its revision letter, contractor or other direct supplier of material, part number, and quantity. When material for making parts is produced or purchased by the parts vendor, that vendor shall inspect each lot of material to determine conformance to the requirements of this specification, and shall include in the report a statement that the material conforms, or shall include copies of laboratory reports showing the results of tests to determine conformance.

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