



# AEROSPACE MATERIAL SPECIFICATION

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

**AMS 6488A**

Superseding AMS 6488

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## STEEL BARS AND FORGINGS

5.0Cr - 1.3Mo - 0.50V (0.38 - 0.43C)  
Premium Quality

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### 1. SCOPE:

- 1.1 Form: This specification covers a premium-quality, low-alloy steel in the form of bars, forgings, and forging stock.
- 1.2 Application: Primarily for parts requiring a steel capable of through-hardening to a minimum hardness of 50 HRC in section thicknesses up to 12 in. (304.8 mm) with relatively high levels of strength, fatigue resistance, ductility, and thermal stability for operation between -100 F (-73 C) and 1000 F (538 C) and where such parts may require welding. In appropriate section sizes, this material is capable of meeting the transverse tensile property requirements of AMS 2310.
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 2248 - Chemical Check Analysis Limits, Wrought Heat and Corrosion Resistant Steels and Alloys
- AMS 2251 - Tolerances, Alloy Steel Bars
- AMS 2300 - Premium Aircraft Quality Steel Cleanliness, Magnetic Particle Inspection
- AMS 2310 - Steel, Transverse Strength and Ductility Requirements, Tensile Strength 260,000 psi, min
- 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 A604 - Macroetch Testing of Consumable Electrode Vacuum Arc Remelted Steel Bars and Billets
- ASTM E112 - Estimating Average Grain Size of Metals
- ASTM E350 - Chemical Analysis of Carbon Steel, Low Alloy Steels, Silicon Electrical Steel, Ingot Iron, and Wrought Iron

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

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 No. 151, Method 112, or by other approved analytical methods.

	min	max
Carbon	0.38	- 0.43
Manganese	0.20	- 0.40
Silicon	0.80	- 1.00
Phosphorus	--	0.015
Sulfur	--	0.015
Chromium	4.75	- 5.25
Molybdenum	1.20	- 1.40
Vanadium	0.40	- 0.60
Nickel	--	0.25
Copper	--	0.35

3.1.1 Check Analysis: Composition variations shall meet the requirements of AMS 2248.

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

3.2.1 Bars:

3.2.1.1 Bars 0.500 In. (12.7 mm) and Under in Diameter or Distance Between Parallel Sides: Cold finished having tensile strength not higher than 135,000 psi (931 MN/m<sup>2</sup>) or equivalent.

3.2.1.2 Bars Over 0.500 In. (12.7 mm) in Diameter or Distance Between Parallel Sides: Hot finished having hardness not higher than 235 HB or equivalent except that bars ordered cold finished may have hardness as high as 255 HB or equivalent.

3.2.2 Forgings: Normalized and tempered having hardness not higher than 248 HB or equivalent.

3.2.3 Forging Stock: As ordered by the forging manufacturer.

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

3.3.1 Macrostructure: Specimens shall be etched in accordance with ASTM A604 in hot hydrochloric acid (1:1) at 71.1 - 82.2 C for sufficient time to develop a well-defined macrostructure. Such specimens, when examined visually, 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 macrographs of ASTM A604 agreed upon by purchaser and vendor.

3.3.2 Decarburization:

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

3.3.2.2 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.

3.3.2.3 Decarburization of bars to which 3.3.2.1 or 3.3.2.2 is not applicable shall not be greater than shown in Table I:

TABLE I

Nominal Diameter or Distance Between Parallel Sides Inches	Depth of Decarburization Inch
Up to 0.375, incl	0.010
Over 0.375 to 0.500, incl	0.015
Over 0.500 to 0.625, incl	0.020
Over 0.625 to 1.000, incl	0.025
Over 1.000 to 2.000, incl	0.035
Over 2.000 to 3.000, incl	0.048
Over 3.000 to 4.000, incl	0.062
Over 4.000 to 5.000, incl	0.094
Over 5.000	0.125

TABLE I (SI)

Nominal Diameter or Distance Between Parallel Sides Millimeters	Depth of Decarburization Millimeters
Up to 9.52, incl	0.254
Over 9.52 to 12.70, incl	0.381
Over 12.70 to 15.88, incl	0.508
Over 15.88 to 25.40, incl	0.635
Over 25.40 to 50.80, incl	0.889
Over 50.80 to 76.20, incl	1.219
Over 76.20 to 101.60, incl	1.575
Over 101.60 to 127.000, incl	2.388
Over 127.000	3.175

3.3.2.4 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.

3.3.2.4.1 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.

3.3.3 Properties After Heat Treatment: Test specimens machined from the product and austenitized by heating to 1850 F  $\pm$  25 (1010 C  $\pm$  14), holding at heat for 15 - 45 min., and cooling in air to room temperature and then tempered three times by heating to not lower than 1000 F (538 C), holding at heat for 2 - 3 hr, and cooling in air shall conform to the following requirements:

3.3.3.1 Longitudinal Tensile Properties: The following requirements apply to specimens taken from bars and forging stock 25 sq in. (161.3 sq cm) and under in cross sectional area and from forgings with axis approximately parallel to the forging flow lines; in addition, specimens from coupons of stock over 25 sq in. (161.3 sq cm) in cross sectional area forged to 25 sq in. (161.3 sq cm) in area shall be capable of meeting these requirements. Testing in the longitudinal direction need not be performed on product tested in the transverse direction.

Tensile Strength, min	260,000 psi (1793 MN/m <sup>2</sup> )
Yield Strength at 0.2% Offset, min	215,000 psi (1482 MN/m <sup>2</sup> )
Elongation in 2 in. (50.8 mm) or 4D, min	8%
Reduction of Area (round specimens), min	30%

3.3.3.2 Transverse Tensile Properties: Shall conform to the requirements of AMS 2310 on specimens selected and prepared in accordance with that specification. Transverse tensile properties apply only to material from which a test specimen not less than 2.50 in. (63.5 mm) long can be taken.

3.3.3.3 Hardness: The product should have hardness of 50 - 56 HRC or equivalent, but shall not be rejected on the basis of hardness if the tensile property requirements are met.

3.3.3.4 Grain Size: Predominantly 7 or finer with occasional grains as large as 5 permissible, ASTM E112, Fracture test.

3.4 Quality: Steel shall be premium quality conforming to AMS 2300. 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.

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

3.4.2 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.

3.5 Sizes: Except when exact lengths or multiples of exact lengths are ordered, bars will be acceptable in 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).

3.6 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.