Society of Automotive Engineers, Inc.
400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

AEROSPACE MATERIAL SPECIFICATION

AMS 6485C
Superseding AMS 6485B
Issued 11-1-59
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STEEL BARS AND FORGINGS
5.0Cr - 1.3Mo - 0.50V (0.38 - 0.43C)

1. SCOPE

1.1 Form: This specification covers an aircraft-quality, low-alloy steel in the form of bars, forgings, and forging stock.

1.2 Application: Primarily for parts requiring relatively high levels of strength, fatigue resistance, toughness, ductility, and thermal stability for operation between -100° F (-73° C) and 1000° F (538° C) and where such parts may require welding.

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., 400 Commonwealth Drive, Warrendale, Pennsylvania 15096.

2.1.1 Aerospace Material Specifications:

AMS 2251 - Tolerances, 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 2310 - Qualification Sampling of Steels, Transverse Tensile Properties
AMS 2350 - Standards and Test Methods
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 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 E21 - Short-Time Elevated-Temperature Tension Tests of Materials
ASTM E112 - Estimating the Average Grain Size of Metals
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 Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.

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:

Ø

	min	max
Carbon	0.38	0.43
Manganese	0.20	0.40
Silicon	0.80	1.00
Phosphorus	--	0.020
Sulfur	--	0.020
Chromium	4.75	5.25
Molybdenum	1.20	1.40
Vanadium	0.40	0.60
Nickel	--	0.25
Copper	--	0.35

Ø 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; hardness and tensile strength Ø shall be determined in accordance with ASTM A370:

3.2.1 Bars:

3.2.1.1 Bars 0.500 In. (12.70 mm) and Under in Diameter or Distance Between Parallel Sides: Cold Ø finished having tensile strength not higher than 135,000 psi (931 MPa) or equivalent hardness.

3.2.1.2 Bars over 0.500 In. (12.70 mm) in Diameter or Distance Between Parallel Sides: Hot finished Ø 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: As ordered.

3.2.3 Forging Stock: As ordered by the forging manufacturer.

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

3.3.1 Macrostructure: Visual examination of transverse sections from bars, billets, and forging stock, Ø 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, 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 Centimetres)	Macrographs
Up to 36, incl	(Up to 232, incl)	S2 - R1 - C2
Over 36 to 100, incl	(Over 232 to 645, incl)	S2 - R2 - C3
Over 100	(Over 645	As agreed upon

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 3.3.3.2 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 0.375, 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 Millimetres	Depth of Decarburization Millimetres
Up to 9.52, incl	0.25
Over 9.52 to 12.70, incl	0.38
Over 12.70 to 15.88, incl	0.51
Over 15.88 to 25.40, incl	0.64
Over 25.40 to 50.80, incl	0.89
Over 50.80 to 76.20, incl	1.22
Over 76.20 to 101.60, incl	1.57
Over 101.60 to 127.00, incl	2.39
Over 127.00	3.18

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 above limits by more than 0.005 in. (0.13 mm) and the width is 0.065 in. (1.65 mm) or less.

3.3.3 Ø Properties After Heat Treatment: Test specimens as specified in 4.3.3 shall conform to the requirements of 3.3.3.1.1.1, 3.3.3.1.2, 3.3.3.2, and 3.3.3.3 and shall be capable of meeting the requirements of 3.3.3.1.1.2 after being austenitized by heating to 1850° F ± 25 (1010° C ± 14), holding at heat for 15 - 45 min., and cooling in air to room temperature and tempered three times by heating to a temperature not lower than 1000° F (538° C), holding at heat for 2 - 3 hr, and cooling in air.

3.3.3.1 Tensile Properties:

3.3.3.1.1 Longitudinal: These requirements apply to test specimens taken from bars and forging stock 25 sq in. (161 cm^2) and under in cross-sectional area, from forgings with axis approximately parallel to the forging flow lines, and from coupons of stock over 25 sq in. (161 cm^2) in cross-sectional area forged to 25 sq in. (161 cm^2) prior to heat treatment as in 3.3.3. Testing in the longitudinal direction need not be performed on product tested in the transverse direction.

3.3.3.1.1.1 At Room Temperature:

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

3.3.3.1.1.2 At 1000° F (537.8° C): Test specimens shall be heated to 1000° F ± 10 (537.8° C ± 5.6) held at 1000° F ± 10 (537.8° C ± 5.6) for 30 min. ± 3, and tested in accordance with ASTM E21 at 1000° F ± 10 (537.8° C ± 5.6).

Tensile Strength, min	175,000 psi (1207 MPa)
Yield Strength at 0.2% Offset, min	135,000 psi (931 MPa)
Elongation in 2 in. (50.8 mm) or 4D, min	10%
Reduction of Area (round specimens), min	35%

3.3.3.1.2 Transverse: These requirements apply to test specimens taken from bars and forging stock over 25 to 256 sq in. (over 161 to 1652 cm^2) incl, in cross-sectional area.

Tensile Strength, min	260,000 psi (1793 MPa)
Yield Strength at 0.2% Offset, min	215,000 psi (1482 MPa)
Reduction of Area (round specimens)	

Section Size		Percent	
Square Inches	Square Centimetres	Minimum	Average
Over 25 to 75, excl	Over 161 to 484, excl	6	15
75 to 100, incl	484 to 645, incl	6	10
Over 100 to 150, incl	Over 645 to 968, incl	5	-
Over 150 to 225, incl	Over 968 to 1452, incl	4	-
Over 225 to 256, incl	Over 1452 to 1652, incl	3	-

3.3.3.2 Hardness: Should be 50 - 56 HRC or equivalent but the product shall not be rejected on the basis of hardness if the tensile property requirements of 3.3.3.1.1.1 or 3.3.3.1.2 are met.

3.3.3.3 Ø Grain Size: Predominantly 7 or finer with occasional grains as large as 5 permissible, ASTM E112; the procedure used shall be the fracture test unless otherwise agreed upon by purchaser and vendor.

3.4 Quality:

3.4.1 Steel shall be aircraft quality conforming to AMS 2301.

3.4.2 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.

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

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

3.5 Sizes: Except when exact lengths or multiples of exact lengths are ordered, bars will be acceptable Ø 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 Ø requirements of AMS 2251.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of the product shall supply all samples and shall be Ø 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 the product conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests to determine conformance to the following requirements are classified Ø as acceptance or routine control tests for the forms listed:

4.2.1.1 Composition (3.1), Condition (3.2), Macrostructure (3.3.1), Quality (3.4), and Hardness (3.3.3.2) Ø and Grain Size (3.3.3.3) After Heat Treatment: All products.

Ø 4.2.1.2 Decarburization (3.3.2): Bars.

4.2.1.3 Longitudinal Tensile Properties at Room Temperature (3.3.3.1.1.1): Bars, forgings, and Ø forging stock.

4.2.1.4 Transverse Tensile Properties (3.3.3.1.2): Bars and forging stock over 25 to 256 sq in. Ø (161 to 1652 cm^2), incl, in cross-sectional area.

4.2.2 Qualification Tests: Tests to determine conformance to the following requirements are classified Ø as qualification or periodic control tests for the forms listed:

Ø 4.2.2.1 Longitudinal Tensile Properties at 1000° F (537.8° C) (3.3.3.1.1.2): Bars and forgings.

4.3 Sampling: Shall be in accordance with the following:

4.3.1 Bars: AMS 2370 and 4.3.3 and 4.3.4 below.