SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS 6432C

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Superseding	AMS 6432B

Steel Bars, Forgings, and Tubing
1.05Cr - 0.55Ni - 1.0Mo - 0.12V (0.43 - 0.49C)

CANCELLATION NOTICE

This specification has been declared “CANCELLED” by the Aerospace Materials Division, SAE, as of September, 2005. By this action, this document will remain listed in the Numerical Section of the Index of Aerospace Material Specifications indicating that it has been “CANCELLED”.

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1. SCOPE:

1.1 Form:

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

1.2 Application:

Primarily for ultra-high strength structural applications requiring a through-hardening, weldable material for use at temperatures up to 600°F (316°C).

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 Materials Specifications:

AMS 2251	Tolerances, Alloy Steel Bars
AMS 2253	Tolerances, Carbon and Alloy Steel Tubing
AMS 2259	Chemical Check Analysis Limits, Wrought Low-Alloy and Carbon Steel
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 E112	Estimating 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 Publication and Form 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:

	min		max
Carbon	0.43	-	0.49
Manganese	0.60	-	0.90
Silicon	0.15	-	0.30
Phosphorus	- -		0.025
Sulfur	- -		0.025
Chromium	0.90	-	1.20
Nickel	0.40	-	0.70
Molybdenum	0.90	-	1.10
Vanadium	0.08	-	0.15
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; hardness and tensile strength 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 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 having hardness not higher than 235 HB or equivalent except that bars ordered cold finished may have hardness as high as 269 HB or equivalent.

3.2.2 Forgings: As ordered.

3.2.3 Mechanical Tubing: Cold finished having hardness not higher than 30 HRC or equivalent except that tubing ordered hot finished shall have hardness not higher than 22 HRC or equivalent.

3.2.4 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 Grain Size: Predominantly 5 or finer with occasional grains as large as 3 permissible, ASTM E112, McQuaid-Ehn test.

3.3.2 Macrostructure: Visual examination of transverse sections from bars, billets, forging stock, and tube rounds, 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 Centimeters)	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

3.3.3 Decarburization:

3.3.3.1 Bars and tubing ordered ground, turned, or polished shall be free from decarburization on the ground, turned, or polished surfaces. Decarburization on tubing ID shall not exceed the maximum depth specified in Table II.

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

3.3.3.3 Decarburization of bars to which 3.3.3.1 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	0.012
Over 0.500 to 0.625, incl	0.014
Over 0.625 to 1.000, incl	0.017
Over 1.000 to 1.500, incl	0.020
Over 1.500 to 2.000, incl	0.025
Over 2.000 to 2.500, incl	0.030
Over 2.500 to 3.000, incl	0.035
Over 3.000 to 4.000, incl	0.045

TABLE I (SI)

Nominal Diameter or Distance Between Parallel Sides Millimeters	Depth of Decarburization Millimeters
Up to 9.52, incl	0.25
Over 9.52 to 12.70, incl	0.30
Over 12.70 to 15.88, incl	0.36
Over 15.88 to 25.40, incl	0.43
Over 25.40 to 38.10, incl	0.51
Over 38.10 to 50.80, incl	0.64
Over 50.80 to 63.50, incl	0.76
Over 63.50 to 76.20, incl	0.89
Over 76.20 to 101.60, incl	1.14

3.3.3.3.1 Limits for depth of decarburization of bars over 4,000 in. (101.60 mm) in nominal diameter or distance between parallel sides shall be as agreed upon by purchaser and vendor.

3.3.3.4 Decarburization of tubing to which 3.3.3.1 or 3.3.3.2 is not applicable shall be not greater than shown in Table II:

TABLE II

Nominal Wall Thickness Inches	Depth of Decarburization Inch	
	ID	OD
Up to 0.109, incl	0.008	0.015
Over 0.109 to 0.203, incl	0.010	0.020
Over 0.203 to 0.400, incl	0.012	0.025
Over 0.400 to 0.600, incl	0.015	0.030
Over 0.600 to 1.000, incl	0.017	0.035
Over 1.000	0.020	0.040

TABLE II (SI)

Nominal Wall Thickness Millimeters	Depth of Decarburization Millimeters	
	ID	OD
Up to 2.77, incl	0.20	0.38
Over 2.77 to 5.16, incl	0.25	0.51
Over 5.16 to 10.16, incl	0.35	0.64
Over 10.16 to 15.24, incl	0.38	0.76
Over 15.24 to 25.40, incl	0.43	0.89
Over 25.40	0.51	1.02

3.3.3.5 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.

3.3.3.5.1 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.

3.3.4 Properties After Heat Treatment: Test specimens machined from bars, forgings, and mechanical tubing, after being hardened by heating in a protective atmosphere to a temperature within the range 1600 - 1650 F (871.1 - 898.9 C), holding at the selected temperature within ± 10 F (± 5.6 C), holding at heat for 1 hr ± 5 min., and quenching in oil, stress relieved by heating to 400 F ± 10 (204.4 C ± 5.6), holding at heat for 1 hr ± 5 min., and cooling in air, and tempered by heating to not lower than 1000 F (538 C), holding at heat for 4 hr ± 15 min., and cooling in air, shall conform to the following requirements:

3.3.4.1 Tensile Properties:

Tensile Strength, min	225,000 psi (1551 MPa)
Yield Strength at 0.2% Offset, min	195,000 psi (1345 MPa)
Elongation in 2 in. (50.8 mm) or 4D, min	7%
Reduction of Area (rounded specimens), min	30%

3.3.4.2 Hardness: Not lower than 47 HRC or equivalent.

3.4 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.

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

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 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 and tubing 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 shall conform to all applicable requirements of the following:

3.6.1 Bars: AMS 2251.

3.6.2 Mechanical Tubing: AMS 2253.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

The vendor of the product 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 the product 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 acceptance or routine control tests.

4.3 Sampling:

Shall be in accordance with the following:

4.3.1 Bars and Tubing: AMS 2370.

4.3.2 Forgings and Forging Stock: AMS 2372.

4.3.3 Macrostructure: Specimens for macrostructure (3.3.2) testing shall represent the full cross-section of stock taken from the top and bottom of at least the first, middle, and last usable ingots of each heat. Samples shall be full cross-sectional specimens obtained from the finished billet or a suitable rerolled product.

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, grain size, macrostructure, tensile properties after heat treatment, and AMS 2301 frequency-severity rating of each heat in the shipment. 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 the size and melt source 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.