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

AEROSPACE MATERIAL SPECIFICATION

AMS 6378A
Superseding AMS 6378

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STEEL BARS
0.95Cr - 0.20Mo - 0.05Te (0.38 - 0.45C) SAE 4140 Modified
Die-Drawn and Tempered, 130,000 psi (896 MPa) Yield Strength

1. SCOPE:

1.1 Form: This specification covers a low-alloy steel in the form of round bars not over 3.50 in. (88.9 mm) in diameter.

1.2 Application: Primarily for parts such as shafts, axles, pins, fasteners, gears, and screw machine parts which are normally used at hardness of 30 - 36 HRC.

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 2350 - Standards and Test Methods
AMS 2370 - Quality Assurance Sampling of Carbon and Low-Alloy Steels, Wrought Products except Forgings

2.1.2 Aerospace Standards:

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

2.2 ASTM Publications: Available from 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 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 methods:

	min	max
Carbon	0.38	0.45
Manganese	0.75	1.00
Silicon	0.20	0.35
Phosphorus	--	0.040
Sulfur	--	0.040
Chromium	0.80	1.10
Molybdenum	0.15	0.25
Tellurium	0.035	0.060
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: Bars shall be elevated temperature die-drawn, straightened, and tempered.

3.2.1 Temperatures for die drawing shall be selected significantly above room temperature but below the transformation range to produce a uniform structure of deformed pearlite and ferrite providing good machinability.

3.3 Properties: Bars 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 and billets, 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 ordered ground, turned, or polished shall be free from carburization on the ground, turned, or polished surfaces.

3.3.3.2 Decarburization of bars to which 3.3.2.1 is not applicable shall not be greater than shown in Table I.

TABLE I

Nominal Diameter 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 3.500, incl	0.040

TABLE I (SI)

Nominal Diameter 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 88.90, incl	1.02

3.3.3.3 Decarburization shall be measured by the microscopic method or by Rockwell Superficial 30-N scale or equivalent hardness testing method on specimens cut from bars. 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.

3.3.3.3.1 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. (0.13 mm) and the width is 0.065 in. (1.65 mm) or less.

3.3.4 Tensile Properties: Specimens, cut from the center of bars 1.50 in. (38.1 mm) and under in diameter and at the mid-radius on sizes larger than 1.50 in. (38.1 mm), shall conform to the following:

Tensile Strength, min	150,000 psi (1034 MPa)
Yield Strength at 0.2% Offset, min	130,000 psi (896 MPa)
Elongation in 2 in. (50.8 mm) or 4D, min	5%
Reduction of Area, min	20%

3.3.5 Hardness: Should be not lower than 302 HB or equivalent across the section, but bars shall not be rejected on the basis of hardness if the tensile property requirements are met.

3.4 Quality: Bars shall be uniform in quality and condition, clean, sound, and free from foreign materials and from internal and external imperfections, consistent with the steel involved, 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 surfaces.

3.4.2 Bars ordered to surface conditions other than turned and ground, or turned, ground, and polished shall after removal of the standard machining allowance, be free from seams, laps, tears, cracks, and other defects exposed to the machined surface. 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 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, except that tolerances for diameter shall be as follows:

TABLE II

Nominal Diameter Inches	Tolerance, Inch Minus Only
Up to 0.375, incl	0.003
Over 0.375 to 1.500, incl	0.005
Over 1.500 to 2.500, incl	0.006
Over 2.500 to 3.500, incl	0.007

TABLE II (SI)

Nominal Diameter Millimeters	Tolerance, Millimeter Minus Only
Up to 9.52, incl	0.08
Over 9.52 to 38.10, incl	0.13
Over 38.10 to 63.50, incl	0.15
Over 63.50 to 88.90, incl	0.18

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of bars 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 4.4. Purchaser reserves the right to perform such confirmatory testing as he deems necessary to assure that the bars conform 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 AMS 2370.

4.4 Reports:

4.4.1 The vendor of bars shall furnish with each shipment three copies of a report of the results of tests for chemical composition and grain size of each heat in the shipment and for tensile properties of each size from each heat. This report shall include the purchase order number, heat number, material specification number and its revision letter, size, and quantity from each heat.