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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 6257B

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Superseding AMS 6257A

Steel Bars, Forgings, and Tubing
1.6Si - 0.82Cr - 1.8Ni - 0.40Mo - 0.08V (0.40 - 0.44C)
Consumable Electrode Vacuum Remelted
Normalized and Tempered

1. SCOPE:

1.1 Form:

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

1.2 Application:

These products have been used typically for parts under 3.5 inches (89 mm) in thickness requiring a through-hardening steel capable of developing a minimum hardness of 52 HRC, the parts being subject to very rigid magnetic particle inspection standards, but usage is not limited to such applications.

1.2.1 Certain design and processing procedures may cause these products to become susceptible to stress-corrosion cracking after heat treatment; ARP1110 recommends practices to minimize such occurrences.

2. APPLICABLE DOCUMENTS:

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been canceled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 2251 Tolerances, Low-Alloy Steel Bars
MAM 2251 Tolerances, Metric, Low-Alloy Steel Bars
AMS 2253 Tolerances, Carbon and Alloy Steel Tubing
MAM 2253 Tolerances, Metric, Carbon and Alloy Steel Tubing

QUESTIONS REGARDING THIS DOCUMENT: (724) 772-7161 FAX: (724) 776-0243
TO PLACE A DOCUMENT ORDER: (724) 776-4970 FAX: (724) 776-0790
SAE WEB ADDRESS: http://www.sae.org

2,1 (Continued):

AMS 2259	Chemical Check Analysis Limits, Wrought Low-Alloy and Carbon Steels
AMS 2300	Premium Aircraft-Quality Steel Cleanliness, Magnetic Particle Inspection Procedure
MAM 2300	Premium Aircraft-Quality Steel Cleanliness, Magnetic Particle Inspection Procedure, Metric (SI) Measurement
AMS 2310	Qualification Sampling of Steels, Transverse Tensile Properties
AMS 2370	Quality Assurance Sampling and Testing, Carbon and Low-Alloy Steel, Wrought Products and Forging Stock
AMS 2372	Quality Assurance Sampling and Testing, Carbon and Low-Alloy Steel Forgings
AMS 2750	Pyrometry
AMS 2806	Identification, Bars, Wire, Mechanical Tubing, and Extrusions, Carbon and Alloy Steels and Corrosion and Heat Resistant Steels and Alloys
AMS 2808	Identification, Forgings
AS1182	Standard Machining Allowance, Aircraft-Quality and Premium Aircraft-Quality Steel Bars and Mechanical Tubing
ARP1110	Minimizing Stress Corrosion Cracking in Wrought Forms of Steels and Corrosion Resistant Steels and Alloys

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM A 370	Mechanical Testing of Steel Products
ASTM A 604	Macroetch Testing of Consumable Electrode Remelted Steel Bars and Billets
ASTM E 45	Determining the Inclusion Content of Steel
ASTM E 112	Determining Average Grain Size
ASTM E 350	Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron
ASTM E 384	Microhardness of Materials

2.3 U.S. Government Publications:

Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-H-6875 Heat Treatment of Steel

3. TECHNICAL REQUIREMENTS:

3.1 Composition:

Shall conform to the following percentages by weight shown in Table 1, determined by wet chemical methods in accordance with ASTM E 350, by spectrochemical methods, or by other analytical methods acceptable to purchaser.

TABLE 1 - Composition

Element	min	max
Carbon	0.40	0.44
Manganese	0.65	0.90
Silicon	1.45	1.80
Phosphorus	--	0.010
Sulfur	--	0.008
Chromium	0.70	0.95
Nickel	1.65	2.00
Molybdenum	0.35	0.45
Vanadium	0.05	0.10
Copper	--	0.35

3.1.1 Check Analysis: Composition variations shall meet the applicable requirements of AMS 2259, except that check analysis limits for carbon shall be 0.01 under minimum or over maximum.

3.2 Melting Practice:

Steel shall be multiple melted using vacuum consumable electrode practice in the remelt cycle.

3.3 Condition:

The product shall be supplied in the following condition; hardness and tensile strength shall be determined in accordance with ASTM A 370:

3.3.1 Bars and Tubing: Normalized and tempered at a temperature not higher than 130,000 psi (896 MPa) or equivalent hardness (See 8.2). Pyrometry shall be in accordance with AMS 2750.

3.3.1.1 Bars 0.500 Inch (12.70 mm) and Under in Nominal Diameter or Least Distance Between Parallel Sides: Cold finished having tensile strength not higher than 130 ksi (896 MPa), or equivalent hardness (see 8.2).

3.3.1.2 Bars Over 0.500 Inch (12.70 mm) in Nominal Diameter or Least Distance Between Parallel Sides: Hot finished unless otherwise ordered, having hardness not higher than 341 HB, or equivalent (See 8.3). Bars ordered cold finished may have hardness as high as 341 HB (see 8.3).

3.3.1.3 Mechanical Tubing: Cold finished, unless otherwise ordered, having hardness not higher than 341 HB or equivalent, (See 8.3). Tubing ordered hot finished and annealed shall have hardness not higher than 99 HRB, or equivalent.

3.3.2 Forgings: Normalized and tempered in accordance with MIL-H-6875 to a hardness not higher than 341 HB, or equivalent (See 8.3).

3.3.3 Forging Stock: As ordered by the forging manufacturer.

3.4 Properties:

The product shall conform to the following requirements; hardness and tensile testing shall be performed in accordance with ASTM A 370:

3.4.1 Macrostructure: Visual examination of transverse sections from bars, billets, tube rounds, or forging stock, etched in hot hydrochloric acid in accordance with ASTM A 604, shall show no pipe or cracks. Porosity, segregation, inclusions, and other imperfections for product 144 square inches (929 cm^2) and under in nominal cross-sectional area shall be no worse than the macrographs of ASTM A 604 shown in Table 2.

TABLE 2 - Macrostructure Limits

Class	Condition	Severity
1	Freckles	A
2	White Spots	A
3	Radial Segregation	B
4	Ring Pattern	B

3.4.2 Micro-Inclusion Rating: No specimen shall exceed the limits shown in Table 3, determined in accordance with ASTM E 45, Method D:

TABLE 3 - Micro-Inclusion Rating Limits

Type	A Thin	A Heavy	B Thin	B Heavy	C Thin	C Heavy	D Thin	D Heavy
Worst Field Severity	1.5	1.0	1.0	1.0	1.0	1.0	1.5	1.0
Worst Field Frequency, maximum	x	1	x	1	x	1	3	1
Total Rateable Fields, Frequency, maximum	y	1	y	1	y	1	8	1

[x]Combined A+B+C, not more than 3 fields

[y]Combined A+B+C, not more than 8 fields

3.4.2.1 A rateable field is defined as one which has a Type A, B, C, or D inclusion rating of at least 1.0 thin or heavy in accordance with the Jernkontoret chart, Plate III, of ASTM E 45.

3.4.3 Average Grain Size: Predominantly 6 or finer, determined in accordance with ASTM E 112 (See 8.4).

3.4.4 Decarburization:

3.4.4.1 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 5.

3.4.4.2 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.

3.4.4.3 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 4.

Table 4A - Maximum Decarburization, Inch/Pound Units

Nominal Diameter or Distance Between Parallel Sides Inches	Total 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 5.000, incl	0.045

TABLE 4B - Maximum Decarburization, SI Units

Nominal Diameter or Distance Between Parallel Sides Millimeters	Total 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 127.00, incl	1.14

3.4.4.4 Decarburization of tubing to which 3.3.4.1 or 3.3.4.2 is not applicable shall be not greater than shown in Table 5.

TABLE 5A - Maximum Decarburization, Inch/Pound Units

Nominal Wall Thickness Inches	Total Depth of Decarburization Inches ID	Total Depth of Decarburization Inches 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 5B - Maximum Decarburization, SI Units

Nominal Wall Thickness Millimeters	Total Depth of Decarburization Millimeters ID	Total Depth of Decarburization Millimeters 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	0.30	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

3.4.4.5 Decarburization shall be measured by the metallographic method, by HR30N scale hardness testing method, or by the microhardness traverse method in accordance with ASTM E 384 on a hardened but untempered specimen 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 on the adjacent surface. In case of dispute, the depth of decarburization determined using the microhardness traverse method shall govern.

3.4.4.5.1 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 inch (0.13 mm) and the width is 0.065 inch (1.65 mm) or less.

3.4.5 Response to Heat Treatment: Specimens shall conform to the following requirements after being normalized by heating to 1700 °F ± 25 (927 °C ± 14), holding at heat for 60 minutes ± 5, and cooling in air; hardened by heating to 1600 °F ± 25 (871 °C ± 14), holding at heat for 60 minutes ± 5, and quenching in oil; and double tempered by heating to 575 °F ± 10 (302 °C ± 6), holding at heat for 2 hours ± 0.2, cooling in air to room temperature, reheating to 575 °F ± 10 (302 °C ± 6), holding at heat for 2 hours ± 0.2, and cooling at a rate equivalent to cooling in air.

3.4.5.1 Tensile Properties:

3.4.5.1.1 Longitudinal: Shall be as shown in Table 6; testing in the longitudinal direction need not be performed on product qualified by testing in the transverse direction:

TABLE 6 - Minimum Longitudinal Tensile Properties

Property	Value
Tensile Strength	280 ksi (1931 MPa)
Yield Strength at 0.2% Offset	230 ksi (1586 MPa)
Elongation in 4D	8%
Reduction of Area	30%

3.4.5.1.2 Transverse: Shall be as shown in Table 7, determined on specimens selected and prepared in accordance with AMS 2310 for premium aircraft-quality steels.

TABLE 7A - Transverse Tensile Properties, Inch/Pound Units

Nominal Cross-Sectional Area Square Inches	Tensile Strength ksi min	Tensile Strength ksi max	Yield Strength at 0.2% Offset ksi, min	Reduction of Area %, min Average	Reduction of Area %, min Individual Value
Up to 100, incl	280	305	230	30	25
Over 100 to 144, incl	280	305	230	25	20
Over 144	280	305	230	20	15

TABLE 7B - Transverse Tensile Properties, SI Units

Nominal Cross-Sectional Area Square Centimeters	Tensile Strength MPa min	Tensile Strength MPa max	Yield Strength at 0.2% Offset MPa, min	Reduction of Area %, min Average	Reduction of Area %, min Individual Value
Up to 645, incl	1931	2103	1586	30	25
Over 645 to 929, incl	1931	2103	1586	25	20
Over 929	1931	2103	1586	20	15

3.5 Quality:

The product, as received by purchaser, shall be uniform in quality and condition, sound, and free from foreign materials and from imperfections detrimental to usage of the product.

3.5.1 Steel shall be premium aircraft-quality conforming to AMS 2300 or MAM 2300.

3.5.2 Bars and tubing ordered hot rolled or cold drawn, or ground, turned, or polished shall, after removal of the standard machining allowance in accordance with AS1182, be free from seams, laps, tears, and cracks open to the ground, turned, or polished surfaces.

3.5.3 Grain flow of die forgings, except in areas which contain flash-line end grain, shall follow the general contour of the forgings showing no evidence of reentrant grain flow.

3.6 Tolerances:

Shall conform to all applicable requirements of the following:

3.6.1 Bars: AMS 2251 or MAM 2251.

3.6.2 Mechanical Tubing: AMS 2253 or MAM 2253.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

The vendor of the product shall supply all samples for vendor's tests and shall be responsible for the performance of all required tests. Purchaser reserves the right to sample and perform any confirmatory testing deemed necessary to ensure that the product conforms to specified requirements.