

NOTICE OF
ADOPTION

ADOPTION NOTICE
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1 July 1990

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Title of Document: 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

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AEROSPACE MATERIAL SPECIFICATION

SAE AMS-6257

Issued 1990-07-01

Submitted for recognition as an American National Standard

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: Primarily 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.

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 following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order.

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

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SAE AMS-6257

2.1.1 Aerospace Material Specifications:

- 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
- 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 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-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

2.1.2 Aerospace Standards:

- AS1182 - Standard Machining Allowance, Aircraft-Quality and Premium Aircraft-Quality Steel Products

2.1.3 Aerospace Recommended Practices:

- ARP1110 - Minimizing Stress Corrosion Cracking in Heat Treatable Wrought Low Alloy and Martensitic Corrosion Resistant Steels

2.2 ASTM Publications: Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

- 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

2.3 U.S. Government Publications: Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

2.3.1 Military Specifications:

- MIL-H-6875 - Heat Treatment of Steel, Process for

2.3.2 Military Standards:

MIL-STD-163 - Steel Mill Products, Preparation for Shipment and Storage

3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall conform to the following percentages by weight, determined by wet chemical methods in accordance with ASTM E 350, by spectrochemical methods, or by other analytical methods acceptable to purchaser:

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

3.2.1 Bars and Tubing: Normalized and tempered at a temperature not higher than 1250°F (677°C). Pyrometry shall be in accordance with AMS-2750.

3.2.1.1 Bars 0.500 Inch (12.70 mm) and Under in Nominal Diameter or Distance Between Parallel Sides: Cold finished having tensile strength not higher than 130,000 psi (896 MPa).

3.2.1.2 Bars Over 0.500 Inch (12.70 mm) in Nominal Diameter or Distance Between Parallel Sides: Hot finished having hardness not higher than 341 HB, or equivalent, except that bars ordered cold finished may have hardness as high as 341 HB, or equivalent.

3.2.1.3 Mechanical Tubing: Cold finished having hardness not higher than 341 HB or equivalent, except that tubing ordered hot finished and annealed shall have hardness not higher than 99 HRB, or equivalent.

3.2.2 Forgings: Normalized and tempered in accordance with MIL-H-6875 to a hardness not higher than 341 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 A 370:

3.3.1 Macrostructure: Visual examination of transverse sections as in 4.3.3 from bars, billets, tube rounds or tubes, and forging stock, etched in accordance with ASTM A 604, shall show no pipe or cracks. Except as specified in 3.3.1.1, porosity, segregation, inclusions, and other imperfections for product 144 square inches (929-cm²) and under in nominal cross-sectional area shall be no worse than the following macrographs of ASTM A 604; macrostructure standards for product over 144 square inches (929 cm²) in nominal cross-sectional area shall be as agreed upon by purchaser and vendor:

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

3.3.1.1 If tubes are produced directly from ingots or large blooms, transverse sections may be taken from tubes rather than tube rounds. Macrostructure standards for such tubes shall be as agreed upon by purchaser and vendor.

3.3.2 Micro-inclusion Rating: No specimen as in 4.3.3 shall exceed the following limits, determined in accordance with ASTM E 45, Method D:

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

* Combined A+B+C not more than three fields

** Combined A+B+C not more than eight fields

3.3.2.1 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.

3.3.3 Grain Size: Predominantly 6 or finer with occasional grains as large as 4 permissible, determined in accordance with ASTM E 112.

3.3.4 Decarburization:

- 3.3.4.1 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 II.
- 3.3.4.2 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 or vendor.
- 3.3.4.3 Decarburization of bars to which 3.3.4.1 or 3.3.4.2 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 5.000, incl	0.045

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	0.30
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

- 3.3.4.3.1 Limits for depth of decarburization of bars over 5,000 inches (127.00 mm) in nominal diameter or distance between parallel sides shall be as agreed upon by purchaser or vendor.
- 3.3.4.4 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 II.

TABLE II

Nominal Wall Thickness Inch	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 0.203, 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 Millimetres	Depth of Decarburization Millimetres	
	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	0.30	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

3.3.4.5 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 hardening 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.

3.3.4.5.1 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.

3.3.5 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 in air:

3.3.5.1 Tensile Properties:

3.3-5.1.1 Longitudinal: Shall be as follows; testing in the longitudinal direction need not be performed on product qualified by testing in the transverse direction:

Tensile Strength, minimum	280,000 psi (1931 MPa)
Yield Strength at 0.2% Offset, minimum	230,000 psi (1586 Mpa)
Elongation in 4D, minimum	8%
Reduction of Area, minimum	30%

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

TABLE III

Nominal Cross-Sectional Area Square Inches	Tensile Strength psi	Yield Strength at 0.2% Offset psi, min	Reduction of Area %, min	
			Average	Individual
Up to 100, incl	280,000 - 305,000	230,000	30	25
Over 100 to 144, incl	280,000 - 305,000	230,000	25	20
Over 144	280,000 - 305,000	230,000	20	15

TABLE III (SI)

Nominal Cross-Sectional Area Square Inches	Tensile Strength Mpa	Yield Strength at 0.2% Offset MPa, min	Reduction of Area %, min	
			Average	Individual
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

3.4 Quality:

3.4.1 Steel shall be premium aircraft-quality conforming to AMS-2300 or MAM-2300; it shall be multiple melted using consumable electrode vacuum practice in the remelt cycle.

3.4.2 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.

3.4.2.1 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.

3.4.2.2 Bars and tubing ordered to surface conditions other than ground, turned, or polished shall, after removal of the standard machining allowance in accordance with AS1182, be free from seams, laps, tears, cracks, and other defects exposed to the machined surfaces.