

NOTICE OF
ADOPTION

ADOPTION NOTICE
15 August 1990 for
AMS 5900A
1 January 1989
SUPERSEDING
AMS 5900
30 October 1981

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Title of Document: Steel Bars, Forgings, and Tubing, Corrosion Resistant
14Cr - 2.1Mo - 0.30Cb - 1.0V (1.05 - 1.15C)
Premium Aircraft Quality for Bearing Applications,
Double Vacuum Melted

Date of Specific Issue Adopted: 1 January 1989

Releasing Non-Government Standards Body: SAE

Custodians:

Air Force - 11
Army - MR
Navy - AS

Military Coordinating Activity
Air Force - 11

(Project No: 9510-0769)

FSC 9510

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400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

**AEROSPACE
MATERIAL
SPECIFICATION**

Submitted for recognition as an American National Standard

AMS 5900A

Issued 7-1-81
Revised 1-1-89

Superseding AMS 5900

STEEL BARS, FORGINGS, AND TUBING, CORROSION RESISTANT
14Cr - 2.1Mo - 0.30Cb - 1.0V (1.05 - 1.15C)
Premium Aircraft Quality for Bearing Applications, Double Vacuum Melted
UNS S42800

1. SCOPE:

- 1.1 **Form:** This specification covers a premium-aircraft-quality, corrosion-resistant steel in the form of bars, wire, forgings, mechanical tubing, and forging stock.
- 1.2 **Application:** Primarily for critical bearing components requiring a through-hardening, corrosion-resistant steel operating under heavy loads and high speeds at moderate temperatures and subject to very rigid inspection standards.

2. **APPLICABLE DOCUMENTS:** The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications and Aerospace Standards shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

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

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2.1.1 Aerospace Material Specifications:

- AMS 2241 - Tolerances, Corrosion and Heat Resistant Steel, Iron Alloy, Titanium, and Titanium Alloy Bars and Wire
- MAM 2241 - Tolerances, Metric, Corrosion and Heat Resistant Steel, Iron Alloy, Titanium, and Titanium Alloy Bars and Wire
- AMS 2243 - Tolerances, Corrosion and Heat Resistant Steel Tubing
- MAM 2243 - Tolerances, Metric, Corrosion and Heat Resistant Steel Tubing
- AMS 2248 - Chemical Check Analysis Limits, Wrought Corrosion and Heat Resistant Steels and Alloys, Maraging and Other Highly-Alloyed Steels, and Iron Alloys
- 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 2350 - Standards and Test Methods
- AMS 2371 - Quality Assurance Sampling of Corrosion and Heat Resistant Steels and Alloys, Wrought Products Except Forgings and Forging Stock
- AMS 2374 - Quality Assurance Sampling of Corrosion and Heat Resistant Steels and Alloys, Forgings and Forging Stock
- AMS 2375 - Control of Forgings Requiring First Article Approval
- AMS 2806 - Identification, Bars, Wire, Mechanical Tubing, and Extrusions, Carbon and Alloy Steels, Corrosion and Heat Resistant Steels and Alloys
- AMS 2808 - Identification, Forgings

2.1.2 Aerospace Standards:

- AS1182 - 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, PA 19103.

- ASTM A370 - Mechanical Testing of Steel Products
- ASTM A604 - Macroetch Testing of Consumable Electrode Remelted Steel Bars and Billets
- ASTM E45 - Determining the Inclusion Content of Steels
- ASTM E112 - Determining Average Grain Size
- ASTM E353 - Chemical Analysis of Stainless, Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron Alloys

2.3 U.S. Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

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 E353, by spectrochemical methods, or by other analytical methods acceptable to purchaser:

	min	max
Carbon	1.05 -	1.15
Manganese	0.25 -	0.50
Silicon	0.20 -	0.40
Phosphorus	--	0.015
Sulfur	--	0.010
Chromium	13.75 -	14.75
Molybdenum	1.90 -	2.25
Columbium	0.25 -	0.35
Vanadium	0.90 -	1.15
Nickel	--	0.35
Copper	--	0.35

- 3.1.1 Check Analysis: Composition variations shall meet the requirements of AMS2248.

- 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: Annealed having hardness not higher than 255 HB, or equivalent.

- 3.2.1.1 All hexagons and other bars 2.75 inches (69.8 mm) and under in nominal diameter or distance between parallel sides shall be cold finished.

- 3.2.1.2 Bars, other than hexagons, over 2.75 inches (69.8 mm) in nominal diameter or distance between parallel sides shall be hot finished.

- 3.2.2 Wire: Cold finished and annealed having a tensile strength not higher than 130,000 psi (896 MPa) except that for wire 0.062 inch (1.57 mm) and under in nominal diameter tensile strength shall be as agreed upon by purchaser and vendor.

- 3.2.3 Forgings: As ordered.

- 3.2.4 Mechanical Tubing: Annealed and cold finished having hardness not higher than 293 HB, or equivalent.

- 3.2.5 Forging Stock: As ordered by the forging manufacturer.

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

3.3.1 Macrostructure: Visual examination of transverse sections as in 4.3.3 from bars, billets, tubes or tube rounds, and forging stock, etched in accordance with ASTM A604, shall show no pipe or cracks. Except as specified in 3.3.1.3, porosity, segregation, inclusions, and other imperfections shall be no worse than the following macrographs of ASTM A604:

3.3.1.1 Section Size 225 Square Inches (1452 mm²) and Under:

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

3.3.1.2 Section Size Over 225 Square Inches (1452 mm²): As agreed upon by purchaser and vendor.

3.3.1.3 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 4.3.4 shall exceed the following limits, determined in accordance with ASTM E45, 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 3 fields

** Combined A+B+C, not more than 8 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 No. 1.0 thin or heavy in accordance with the Jernkontoret chart, Plate III, ASTM E45.

3.3.3 Response to Heat Treatment: Specimens, representing full cross-section of the product and ground on both faces normal to the axis of the product, shall have hardness not lower than 60 HRC, or equivalent, after being treated as follows in a neutral atmosphere or neutral salt to minimize scale and prevent either carburization or decarburization:

3.3.3.1 Preheat at $1500^{\circ}\text{F} \pm 10$ ($816^{\circ}\text{C} \pm 6$) for not less than 15 minutes.

3.3.3.2 Heat to $2100^{\circ}\text{F} \pm 25$ ($1149^{\circ}\text{C} \pm 14$), hold at heat for 7 to 10 minutes. Oil quench to room temperature or, preferably, quench into salt maintained at $1050^{\circ} - 1150^{\circ}\text{F}$ ($566^{\circ} - 621^{\circ}\text{C}$), hold at temperature for 2 minutes ± 0.2 , and cool in air to room temperature.

3.3.3.3 Stress relieve by heating to $300^{\circ}\text{F} \pm 15$ ($149^{\circ}\text{C} \pm 8$), holding at temperature for 60 minutes ± 5 , and cooling in air to room temperature.

3.3.3.4 Subzero cool to $-100^{\circ}\text{F} \pm 10$ ($-73^{\circ}\text{C} \pm 6$), hold at temperature for not less than 15 minutes, and allow to return to room temperature in air.

3.3.3.5 Temper within 4 hours after the subzero cool by heating to $975^{\circ}\text{F} \pm 15$ ($524^{\circ}\text{C} \pm 8$), holding at heat for 2 hours ± 0.25 , and cooling in air to room temperature.

3.3.4 Decarburization:

3.3.4.1 Bars, wire, and mechanical 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, wire, billets, and tubing ordered for redrawing or forging or to specified microstructural requirements shall be as agreed upon by purchaser and 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 0.500, incl	0.015
Over 0.500 to 1.000, incl	0.030
Over 1.000 to 2.000, incl	0.040
Over 2.000 to 3.000, incl	0.050
Over 3.000 to 4.000, incl	0.065
Over 4.000 to 5.000, incl	0.095

TABLE I (SI)

Nominal Diameter or Distance Between Parallel Sides Millimetres	Depth of Decarburization Millimetres
Up to 12.70, incl	0.38
Over 12.70 to 25.40, incl	0.76
Over 25.40 to 50.80, incl	1.02
Over 50.80 to 76.20, incl	1.27
Over 76.20 to 101.60, incl	1.65
Over 101.60 to 127.00, incl	2.41

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 and 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 Outside Diameter Inches	Depth of Decarburization Inch
Up to 1.000, incl	0.025
Over 1.000 to 2.000, incl	0.035
Over 2.000 to 3.000, incl	0.045
Over 3.000 to 4.000, incl	0.055
Over 4.000 to 5.000, incl	0.080

TABLE II (SI)

Nominal Outside Diameter Millimetres	Depth of Decarburization Millimetres
Up to 25.40, incl	0.64
Over 25.40 to 50.80, incl	0.89
Over 50.80 to 76.20, incl	1.14
Over 76.20 to 101.60, incl	1.40
Over 101.60 to 127.00, incl	2.03

- 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 and sub-zero cooled 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.
- 3.3.4.5.1 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 Grain Size: Predominantly 7 or finer with occasional grains as large as 5 permissible, determined in accordance with ASTM E112.
- 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 vacuum induction melting followed by vacuum-arc-consumable-electrode remelting.
- 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, wire, 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 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 AS1182.
- 3.4.2.3 Forgings shall have substantially uniform macrostructure. Standards for acceptance shall be as agreed upon by purchaser and vendor.
- 3.4.2.4 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 re-entrant grain flow.
- 3.5 Sizes: Except when exact lengths or multiples of exact lengths are ordered, straight bars, wire, and tubing will be acceptable in mill lengths of 6 - 20 feet (1.8 - 6.1 m) but not more than 10% of any shipment shall be supplied in lengths shorter than 10 feet (3 m).

3.6 Tolerances: Shall conform to all applicable requirements of the following:

3.6.1 Bars and Wire: AMS 2241 or MAM 2241; for sizes not covered by AMS 2241 or MAM 2241, tolerances shall be as agreed upon by purchaser and vendor.

3.6.2 Mechanical Tubing: AMS 2243 or MAM 2243.

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 performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.5. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure 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 requirements for composition (3.1), condition (3.2), macrostructure rating (3.3.1), micro-inclusion rating (3.3.2), response to heat treatment (3.3.3), decarburization (3.3.4), grain size (3.3.5), quality (3.4.2), and tolerances (3.6) are classified as acceptance tests and shall be performed on each heat or lot as applicable.

4.2.2 Periodic Tests: Tests to determine conformance to requirements for frequency-severity cleanliness rating (3.4.1) are classified as periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.2.3 Preproduction Tests: Tests of forgings to determine conformance to all applicable technical requirements of this specification when AMS 2375 is specified are classified as preproduction tests and shall be performed prior to or on the first-article shipment of a forging to a purchaser, when a change in material and/or processing requires reapproval as in 4.4, and when purchaser deems confirmatory testing to be required.

4.2.3.1 For direct U.S. Military procurement of forgings, substantiating test data and, when requested, preproduction forgings shall be submitted to the cognizant agency as directed by the procuring activity, contracting officer, or request for procurement.

4.3 Sampling: Shall be in accordance with the following; a heat shall be the consumable electrode remelted ingots produced from steel originally melted as a single furnace charge.

4.3.1 Bars, Wire, and Mechanical Tubing: AMS 2371.

4.3.2 Forgings and Forging Stock: AMS 2372.