Society of Automotive Engineers, Inc.
400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

AEROSPACE MATERIAL SPECIFICATION

AMS 6488C
Superseding AMS 6488B
Issued 7-15-63
Revised 1-15-79

UNS K74015
UNS T20811

STEEL BARS AND FORGINGS
5.0Cr - 1.3Mo - 0.50V (0.38 - 0.43C)
Premium Quality

1. SCOPE:

1.1 Form: This specification covers a premium-quality, low-alloy steel in the form of bars, forgings, and forging stock.

1.2 Application: Primarily for parts requiring a steel capable of through-hardening to a minimum hardness of 50 HRC in section thicknesses up to 12 in. (305 mm) with relatively high levels of strength, fatigue resistance, ductility, and thermal stability for operation between -100° F (-75° C) and 1000° F (540° 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., 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2248 - Chemical Check Analysis Limits, Wrought Heat and Corrosion Resistant Steels and Alloys
AMS 2251 - Tolerances, Low-Alloy Steel Bars
AMS 2300 - Premium Aircraft-Quality Steel Cleanliness, Magnetic Particle Inspection Procedure
AMS 2310 - Qualification Sampling of Steels, Transverse Tensile Properties
AMS 2350 - Standards and Test Methods
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 2375 - Control of Forgings Requiring First-Article Approval
AMS 2806 - Identification, Bars, Wire, Mechanical Tubing, and Extrusions, Carbon and Alloy Steels and Heat and Corrosion Resistant Steels and Alloys
AMS 2808 - Identification, Forgings

2.1.2 Aerospace Standards:

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

Printed in U.S.A.

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 E112 - Estimating the Average Grain Size of Metals
ASTM E350 - Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron

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

2.3.1 Federal Standards:

Federal Test Method Standard No. 151 - Metals; Test Methods

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 E350, by spectrographic methods in accordance with Federal Test Method Standard No. 151, Method 112, or by other analytical methods approved by purchaser:

	min	max
Carbon	0.38	0.43
Manganese	0.20	0.40
Silicon	0.80	1.00
Phosphorus	--	0.015
Sulfur	--	0.015
Chromium	4.75	5.25
Molybdenum	1.20	1.40
Vanadium	0.40	0.60
Nickel	--	0.25
Copper	--	0.35

3.1.1 Check Analysis: Composition variations shall meet the requirements of AMS 2248.

3.2 Condition: The product shall be supplied in the following condition:

3.2.1 Bars:

3.2.1.1 Bars 0.500 In. (12.70 mm) and Under in Nominal 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 Nominal 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 255 HB or equivalent.

3.2.2 Forgings: Annealed having hardness not higher than 235 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 A370:

3.3.1 Macrostructure: Visual examination of transverse sections from bars, billets, and forging stock, etched in accordance with ASTM A604 in hot hydrochloric acid (1:1) at 160° - 180°F (70° - 80°C) for sufficient time to develop a well-defined macrostructure, shall show no imperfections such as pipe or cracks. Porosity, segregation, inclusions, and other imperfections shall be no worse than the following macrographs of ASTM A604:

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

3.3.2 Decarburization:

3.3.2.1 Bars ordered ground, turned, or polished shall be free from decarburization on the ground, turned, or polished surfaces.

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

3.3.2.3 Decarburization of bars to which 3.3.2.1 or 3.3.2.2 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	0.015
Over 0.500 to 0.625, incl	0.020
Over 0.625 to 1.000, incl	0.025
Over 1.000 to 2.000, incl	0.035
Over 2.000 to 3.000, incl	0.048
Over 3.000 to 4.000, incl	0.062
Over 4.000 to 5.000, incl	0.094
Over 5.000	0.125

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	0.38
Over 12.70 to 15.88, incl	0.51
Over 15.88 to 25.40, incl	0.64
Over 25.40 to 50.80, incl	0.89
Over 50.80 to 76.20, incl	1.22
Over 76.20 to 101.60, incl	1.58
Over 101.60 to 127.00, incl	2.39
Over 127.00	3.18

3.3.2.4 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.

3.3.2.4.1 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.

3.3.3 Properties After Heat Treatment: Test specimens as in 4.3.5 shall meet the requirements of 3.3.3.1, 3.3.3.2, and 3.3.3.3 after being hardened by heating to 1850°F ± 25 (1010°C ± 15), holding at heat for 15 - 45 min., and cooling in air to room temperature and tempered three times by heating to not lower than 1000°F (538°C), holding at heat for 2 - 3 hr, and cooling in air.

3.3.3.1 Tensile Properties:

3.3.3.1.1 Longitudinal Tensile Properties: Shall be as follows; testing in the longitudinal direction need not be performed on product tested in the transverse direction:

Tensile Strength, min	260,000 psi (1793 MPa)
Yield Strength at 0.2% Offset, min	215,000 psi (1482 MPa)
Elongation in 4D, min	8%
Reduction of Area (round specimens), min	30%

3.3.3.1.2 Transverse Tensile Properties: Shall be as follows, determined on specimens selected and prepared in accordance with AMS 2310 except as specified in 4.3.5; transverse test requirements are applicable only to product sufficiently large to yield tensile test specimens not less than 2.50 in. (63.5 mm) in length:

Tensile Strength	260,000 - 280,000 psi (1793 - 1931 MPa)
Yield Strength at 0.2% Offset, min	215,000 psi (1482 MPa)
Reduction of Area, min	
Individual Value	6%
Average Value	15%

3.3.3.2 Hardness: Should be 50 - 56 HRC or equivalent but the product shall not be rejected on the basis of hardness if the tensile property requirements are met.

3.3.3.3 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 quality conforming to AMS 2300.

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

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

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 AS 1182.

3.5 Sizes: Except when exact lengths or multiples of exact lengths are ordered, straight 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.

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 ensure that the product conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Except as specified in 3.3.3.1.1, tests to determine conformance to all technical requirements of this specification are classified as acceptance tests and shall be performed on each lot.

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

4.2.2.1 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, the contracting officer, or the request for procurement.

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

4.3.1 Bars: AMS 2370.

4.3.2 Forgings and Forging Stock: AMS 2372.

4.3.3 Specimens for composition determination (3.1) shall be selected from each heat except that carbon and manganese shall be determined on samples from each consumable electrode remelted ingot.