The Engineering Society For Advancing Mobility Land Sea Air and Space®
400 Commonwealth Dr., Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

AMS 5626D

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Superseding AMS 5626C

STEEL BARS AND FORGINGS, TOOL, HIGH SPEED
4.1Cr - 18W - 1.1V

UNS T12001

1. SCOPE:

1.1 Form: This specification covers an alloy steel in the form of bars, forgings, and forging stock.

1.2 Application: Primarily for parts, such as counterweights, requiring high density and wear resistance, but not high oxidation resistance, up to 900°F (482°C).

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 documents shall be as specified in AMS 2350.

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

2.1.1 Aerospace Material Specifications:

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 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 Quality Steel Products

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

ASTM A370 - Mechanical Testing of Steel Products
ASTM A561 - Macroetch Testing of Tool Steel Bars
ASTM E352 - Chemical Analysis of Tool Steels and Other Similar Medium- and High-Alloy Steels

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

2.3.1 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, Ø determined by wet chemical methods in accordance with ASTM E352, by spectrochemical methods, or by other analytical methods acceptable to purchaser:

	min	max
Carbon	0.65	0.80
Manganese	0.20	0.40
Silicon	0.20	0.40
Phosphorus	--	0.030
Sulfur	--	0.030
Chromium	3.75	4.50
Tungsten	17.25	18.75
Vanadium	0.90	1.30
Molybdenum	--	1.00

3.1.1 Check Analysis: No deviation from the limits of 3.1 will be permitted.

3.2 Condition: The product shall be supplied in the following condition; hardness shall be determined in accordance with ASTM A370:

3.2.1 Bars: Fully annealed.

3.2.1.1 Bars 3.000 inches (76.20 mm) and under in nominal diameter or distance between parallel sides shall be cold finished having hardness not higher than 269 HB, or equivalent.

3.2.1.2 Bars over 3.000 inches (76.20 mm) in nominal diameter or distance between parallel sides shall be hot finished having hardness not higher than 255 HB, or equivalent.

3.2.2 Forgings: As ordered.

3.2.3 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: Examination, at up to 10X magnification, of transverse sections from bars, billets, and forging stock, etched in accordance with ASTM A561 in hot hydrochloric acid at 150° - 170°F (66° - 77°C) for sufficient time to develop a well-defined macrostructure, shall show no imperfections, such as pipe, cracks, porosity, segregation, slag, dirt, and inclusions, detrimental to usage of the product. Macrostructure standards shall be as agreed upon by purchaser and vendor.

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 0.500, incl	0.013
Over 0.500 to 1.000, incl	0.025
Over 1.000 to 2.000, incl	0.038
Over 2.000 to 3.000, incl	0.050
Over 3.000 to 4.000, incl	0.070

TABLE I (SI)

Nominal Diameter or Distance Between Parallel Sides Millimetres	Depth of Decarburization Millimetres
Up to 12.70, incl	0.33
Over 12.70 to 25.40, incl	0.64
Over 25.40 to 50.80, incl	0.97
Over 50.80 to 76.20, incl	1.27
Over 76.20 to 101.60, incl	1.78

3.3.2.3.1 Limits for depth of decarburization of bars over 4.000 inches (101.60 mm) in nominal diameter or distance between parallel sides shall be as agreed upon by purchaser and vendor.

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

3.3.3 Response to Heat Treatment: Product, 0.250 inch (6.35 mm) and under in nominal cross section and 0.250-inch ± 0.015 (6.35-mm ± 0.38) thick specimens cut from larger product, shall have hardness not lower than 63 HRC or equivalent after being hardened by preheating to 1500° - 1600°F (816° - 871°C), transferring to a controlled atmosphere furnace which is at 2350°F ± 25 (1288°C ± 14), heating to 2350°F ± 25 (1288°C ± 14), holding at heat for 5 - 15 minutes, and quenching in oil and double tempered by heating each time to 1025°F ± 10 (552°C ± 6), holding at heat for 2 hours ± 0.1, and cooling in air.

3.4 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.

3.4.1 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 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.

3.4.3 Forgings shall have substantially uniform macrostructure. Standards for Ø acceptance shall be as agreed upon by purchaser and vendor.

3.4.4 Grain flow of die forgings, except in areas which contain flash-line end Ø 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 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 be as follows:

3.6.1 Cold Finished:

3.6.1.1 Rounds, Hexagons, Octagons, and Quarter Octagons:

TABLE II

Nominal Diameter or Distance Between Parallel Sides Inches	Tolerance Inch plus and minus
0.250 to 0.500, excl	0.002
0.500 to 1.000, excl	0.0025
1.000 to 2.750, excl	0.003

TABLE II (SI)

Nominal Diameter or Distance Between Parallel Sides Millimetres	Tolerance Millimetre plus and minus
6.35 to 12.70, excl	0.05
12.70 to 25.40, excl	0.064
25.40 to 69.85, excl	0.08

3.6.1.2 Squares and Flats:

TABLE III

Nominal Thickness or Width Inches	Tolerance, Inch plus and minus
0.250 to 0.750, incl	0.002
Over 0.750 to 1.500, incl	0.003
Over 1.500	0.004

TABLE III (SI)

Nominal Thickness or Width Millimetres	Tolerance, Millimetre plus and minus
6.35 to 19.05, incl	0.05
Over 19.05 to 38.10, incl	0.08
Over 38.10	0.10

3.6.2 Centerless Ground:

TABLE IV

Nominal Diameter Inches	Tolerance, Inch plus and minus
0.250 to 0.500, excl	0.0015
0.500 to 3.0625, excl	0.002

TABLE IV (SI)

Nominal Diameter Millimetres	Tolerance, Millimetre plus and minus
6.35 to 12.70, excl	0.038
12.70 to 77.788, excl	0.05

3.6.3 Hot Finished:

3.6.3.1 Rounds, Squares, Hexagons, Octagons, and Quarter Octagons:

TABLE V

Nominal Diameter or Distance Between Parallel Sides Inches	Tolerance Inch plus	Tolerance Inch minus
Up to 0.500, incl	0.012	0.005
Over 0.500 to 1.000, incl	0.016	0.005
Over 1.000 to 1.500, incl	0.020	0.006
Over 1.500 to 2.000, incl	0.025	0.008
Over 2.000 to 2.500, incl	0.030	0.010
Over 2.500 to 3.000, incl	0.040	0.010
Over 3.000 to 4.000, incl	0.050	0.012
Over 4.000 to 5.500, incl	0.060	0.015
Over 5.500 to 6.500, incl	0.100	0.018
Over 6.500 to 8.000, incl	0.150	0.020

TABLE V (SI)

Nominal Diameter or Distance Between Parallel Sides Millimetres	Tolerance Millimetres plus	minus
Up to 12.70, incl	0.30	0.13
Over 12.70 to 25.40, incl	0.41	0.13
Over 25.40 to 38.10, incl	0.51	0.15
Over 38.10 to 50.80, incl	0.64	0.20
Over 50.80 to 63.50, incl	0.76	0.25
Over 63.50 to 76.20, incl	1.02	0.25
Over 76.20 to 101.60, incl	1.22	0.30
Over 101.60 to 139.70, incl	1.52	0.38
Over 139.70 to 165.10, incl	2.54	0.46
Over 165.10 to 203.20, incl	3.81	0.51

3.6.3.2 Rectangles:

TABLE VI

Nominal Width Inches	Thickness Tolerance, Inch For Thickness Ranges Shown, Inches: Up to 0.250, incl plus	minus	Over 0.250 to 0.500, incl plus	minus	Over 0.500 to 1.000, incl plus	minus	Over 1.000 to 2.000, incl plus	minus
Up to 1.000, incl	0.010	0.006	0.012	0.008	0.016	0.010	--	--
Over 1.000 to 2.000, incl	0.014	0.006	0.016	0.008	0.020	0.010	0.024	0.020
Over 2.000 to 3.000, incl	0.018	0.006	0.020	0.008	0.024	0.010	0.027	0.020
Over 3.000 to 4.000, incl	0.020	0.008	0.022	0.010	0.024	0.013	0.030	0.024
Over 4.000 to 5.000, incl	0.020	0.010	0.024	0.012	0.030	0.015	0.035	0.027
Over 5.000 to 6.000, incl	0.020	0.012	0.030	0.014	0.030	0.018	0.035	0.030

TABLE VI (SI)

Nominal Width Inches	Thickness Tolerance, Millimetre For Thickness Ranges Shown, Millimetres: Up to 6.35, incl plus	minus	Over 6.35 to 12.70, incl plus	minus	Over 12.70 to 25.40, incl plus	minus	Over 25.40 to 50.80, incl plus	minus
Up to 25.40, incl	0.25	0.15	0.30	0.20	0.41	0.25	--	--
Over 25.40 to 50.80, incl	0.36	0.15	0.41	0.20	0.51	0.25	0.61	0.51
Over 50.80 to 76.20, incl	0.46	0.15	0.51	0.20	0.61	0.25	0.69	0.51
Over 76.20 to 101.60, incl	0.51	0.20	0.56	0.25	0.61	0.33	0.76	0.61
Over 101.60 to 127.00, incl	0.51	0.25	0.61	0.30	0.76	0.38	0.89	0.69
Over 127.00 to 152.40, incl	0.51	0.30	0.76	0.36	0.76	0.46	0.89	0.76

3.6.3.2.2 Width:

TABLE VII

Nominal Width Inches	Width Tolerance, Inch plus	minus
Up to 1.000, incl	0.031	0.016
Over 1.000 to 3.000, incl	0.047	0.031
Over 3.000 to 5.000, incl	0.063	0.047
Over 5.000	0.094	0.063

TABLE VII (SI)

Nominal Width Millimetres	Width Tolerance, Millimetres plus	minus
Up to 25.40, incl	0.79	0.41
Over 25.40 to 76.20, incl	1.19	0.79
Over 76.20 to 127.00, incl	1.60	1.19
Over 127.00	2.39	1.60

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 4.4. 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 (3.3.1), decarburization (3.3.2), 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 response to heat treatment (3.3.3) are classified as periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.3 Sampling: Shall be in accordance with the following:

4.3.1 Bars: AMS 2371.

4.3.2 Forgings and Forging Stock: AMS 2374.