



# AEROSPACE MATERIAL

Society of Automotive Engineers, Inc.

400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

## SPECIFICATION

**AMS 5632D**  
Superseding AMS 5632C

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UNS S44020 (Type I)  
STEEL BARS AND FORGINGS, CORROSION RESISTANT UNS S44023 (Type II)  
17Cr - 0.50Mo (0.95 - 1.20C) (SAE 5144OF)  
Free-Machining

### 1. SCOPE:

1.1 Form: This specification covers two types of free-machining, corrosion-resistant steel in the form of bars, wire, forgings, and forging stock.

1.2 Application: Primarily for parts requiring resistance to both corrosion and wear with minimum hardness up to 58 HRC, where the amount of machining warrants use of a free-machining steel.

1.3 Classification: The steel compositions covered by this specification are classified as follows:

Type I - 17Cr - 0.50Mo - 0.22S (0.95 - 1.20C)

Type II - 17Cr - 0.50Mo - 0.20Se (0.95 - 1.20C)

1.3.1 Unless a specific type is ordered, either Type I or Type II may be supplied.

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 2241 - Tolerances, Corrosion and Heat Resistant Steel Bars and Wire and Titanium and Titanium Alloy Bars and Wire

AMS 2248 - Chemical Check Analysis Limits, Wrought Heat and Corrosion Resistant Steels and Alloys

AMS 2350 - Standards and Test Methods

AMS 2371 - Quality Assurance Sampling of Corrosion and Heat Resistant Alloys, Wrought Products Except Forgings

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

SAE Technical Board rules provide that: "All technical reports, including standards approved and practices recommended, are advisory only. Their use by anyone engaged in industry or trade is entirely voluntary. There is no agreement to adhere to any SAE standard or recommended practice, and no commitment to conform to or be guided by any technical report. In formulating and approving technical reports, the Board and its Committees will not investigate or consider patents which may apply to the subject matter. Prospective users of the report are responsible for protecting themselves against liability for infringement of patents."

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 E340 - Macroetching Metals and Alloys

ASTM E353 - Chemical Analysis of Stainless, Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron Alloys

2.3 Government Publications: Available from Commanding Officer, 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 E353, by spectrographic methods in accordance with Federal Test Method Standard No. 151, Method 112, or by other approved analytical methods:

	Type I		Type II	
	min	max	min	max
Carbon	0.95	1.20	0.95	1.20
Manganese	--	1.25	--	1.25
Silicon	--	1.00	--	1.00
Phosphorus	--	0.040	--	0.040
Sulfur	0.10	0.35	--	0.030
Chromium	16.00	18.00	16.00	18.00
Molybdenum	0.40	0.60	0.40	0.60
Selenium	--	--	0.15	0.25
Nickel	--	0.75	--	0.75
Nitrogen (3.1.1)	--	0.08	--	0.08
Copper	--	0.50	--	0.50
Tin	--	0.05	--	0.05

3.1.1 Determination not required for routine acceptance.

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

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 286 HB or equivalent.

3.2.1.1 Bars 2.750 in. (69.85 mm) and under in nominal diameter or distance between parallel sides and all hexagons shall be cold finished, unless otherwise ordered.

3.2.1.2 Bars, other than hexagons, over 2.750 in. (69.85 mm) in nominal diameter or distance between parallel sides shall be hot finished.

- 3.2.2 Wire: Annealed and cold finished having tensile strength not higher than 140,000 psi (965 MPa) or equivalent hardness.
- 3.2.3 Forgings: As ordered.
- 3.2.4 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 from bars, wire, billets, and forging stock, etched in accordance with ASTM E340 in hot hydrochloric acid (1:1) at 160° - 180°F (71.1° - 82.2°C) for sufficient time to develop a well-defined macrostructure, shall show no imperfections, such as pipe, cracks, porosity, segregation, and inclusions, detrimental to fabrication or to performance of parts. Macrostructure standards shall be as agreed upon by purchaser and vendor.
- 3.3.2 Decarburization:
- 3.3.2.1 Bars and wire 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, wire, 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 and wire 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	0.015
Over 0.500 to 1.000, incl	0.020
Over 1.000 to 1.500, incl	0.025
Over 1.500 to 2.000, incl	0.030
Over 2.000 to 2.500, incl	0.035
Over 2.500 to 3.000, incl	0.040

TABLE II (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	0.51
Over 25.40 to 38.10, incl	0.64
Over 38.10 to 50.80, incl	0.76
Over 50.80 to 63.50, incl	0.89
Over 63.50 to 76.20, incl	1.02

- 3.3.2.3.1 Limits for depth of decarburization of bars over 3.000 in. (76.20 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 in. (0.13 mm) and the width is 0.065 in. (1.65 mm) or less.
- 3.3.3 Response to Heat Treatment: Product 0.375 in. (9.52 mm) and under in nominal diameter or distance between parallel sides and 0.375-in.  $\pm$  0.015 (9.52-mm  $\pm$  0.38 thick specimens cut from thicker product shall have hardness not lower than 58 HRC or equivalent after being heated to 1875°F  $\pm$  10 (1023.9°C  $\pm$  5.6), held at heat for 30 min.  $\pm$  3, and cooled in still air.
- 3.4 Quality: The product, as received by the purchaser, shall be uniform in quality and condition, sound, and free from foreign materials and, consistent with the type of steel involved, from internal and external imperfections detrimental to usage of the product.
- 3.4.1 Bars and wire 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 AS 1182.
- 3.5 Sizes: Except when exact lengths or multiples of exact lengths are ordered, straight bars and wire 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 and wire shall conform to all applicable requirements of AMS 2241.
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 4.4. 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: Tests to determine conformance to all technical requirements of this specification are classified as acceptance tests.
- 4.3 Sampling: Shall be in accordance with the following:
- ∅ 4.3.1 Bars and Wire: AMS 2371.
- ∅ 4.3.2 Forgings and Forging Stock: As agreed upon by purchaser and vendor.