

AEROSPACE
MATERIAL
SPECIFICATION

AMS 5632E
Superseding AMS 5632D

Issued 6-1-42
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STEEL BARS AND FORGINGS, CORROSION RESISTANT

17Cr - 0.50Mo (0.95 - 1.20C) (SAE 51440F)

Free-Machining

UNS S44020 (Type I)

UNS S44023 (Type II)

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 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 SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

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AMS 5632E

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 Corrosion and Heat Resistant Steels and Alloys, Maraging and Other Highly-Alloyed Steels, and Iron Alloys
- 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 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

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 E353 - Chemical Analysis of Stainless, Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron Alloys
- ASTM E381 - Macroetch Testing, Inspection, and Rating Steel Products Comprising Bars, Billets, Blooms, and Forgings

2.3 U.S. 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,
 Ø 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 analytical methods approved by purchaser:

	<u>Type I</u>		<u>Type II</u>	
	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	--	0.08	--	0.08
Copper	--	0.75	--	0.75
Tin	--	0.05	--	0.05

- 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; hardness and tensile strength shall be determined in accordance with ASTM A370:

- 3.2.1 Bars: Annealed having hardness not higher than 285 HB or equivalent.

- 3.2.1.1 Bars 2.750 In. (70 mm) and Under in Nominal Diameter or Distance Between Parallel Sides and All Hexagons: Cold finished. Round bars may be centerless ground.

- 3.2.1.2 Bars, Other Than Hexagons, Over 2.750 In. (70 mm) in Nominal Diameter or Distance Between Parallel Sides: 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 as in 4.3.3 from bars, billets, and forging stock, etched in accordance with ASTM E381 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 pipe or cracks. Porosity, segregation, inclusions, and other imperfections shall be no worse than the macrographs of ASTM E381 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 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 12.50, incl	0.38
Over 12.50 to 25.00, incl	0.50
Over 25.00 to 37.50, incl	0.62
Over 37.50 to 50.00, incl	0.75
Over 50.00 to 62.50, incl	0.88
Over 62.50 to 75.00, incl	1.00

3.3.2.3.1 Limits for depth of decarburization of bars over 3.000 in. (75.00 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. (0.12 mm) and the width is 0.065 in. (1.65 mm) or less.
- 3.3.3 Response to Heat Treatment: Product 0.375 in. (9.50 mm) and under in nominal cross-section and 0.375 in. $\pm$ 0.015 (9.50 mm $\pm$ 0.40) thick specimens cut from larger product shall have hardness not lower than 58 HRC or equivalent after being heated to 1875°F $\pm$ 10 (1025°C $\pm$ 5), held at heat for 30 min. $\pm$ 3, and cooled in still air.
- 3.4 Quality: The product, as received by purchaser, shall be uniform in quality and condition, sound, and free from foreign material 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 (2 - 6 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
Ø 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
Ø composition (3.1), macrostructure (3.3.1), and response to heat treatment (3.3.3) 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
Ø decarburization (3.3.2) 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 and Wire: AMS 2371.

4.3.2 Forgings and Forging Stock: AMS 2374.

4.3.3 Samples for macrostructure (3.3.1) testing shall be full cross-sectional
Ø specimens obtained from the finished billet or suitable rerolled product representing the top and bottom of at least the first, middle, and last usable ingots of each heat.

4.4 Reports:

4.4.1 The vendor of the product shall furnish with each shipment three copies of
Ø a report showing the results of tests for chemical composition of each heat and the results of tests on each lot to determine conformance to the other acceptance test requirements and, when performed, to the periodic test requirements of this specification. This report shall include the purchase order number, heat number, AMS 5632E, size, and quantity from each heat. If forgings are supplied, the part number and the size and melt source of stock used to make the forgings shall also be included.