



# AEROSPACE MATERIAL SPECIFICATION

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

## AMS 5655A

Superseding AMS 5655

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STEEL BARS AND FORGINGS, CORROSION AND MODERATE HEAT RESISTANT  
12.5Cr - 0.75Ni - 1.0Mo - 1.0W - 0.24V

### 1. SCOPE:

- 1.1 Form: This specification covers a corrosion and moderate heat resistant steel in the form of bars, wire, forgings, and forging stock.
- 1.2 Application: Primarily for parts and assemblies, such as compressor discs and blades, requiring oxidation resistance up to 1000° F (540° C). Strength at the higher temperatures is superior to that of the standard 12Cr type (AMS 5613).

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 2374 - Quality Assurance Sampling of Corrosion and Heat Resistant Steels and Alloys, Forgings and Forging Stock
- AMS 2375 - Approval and Control of Critical 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

- 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 - Rating Macroetched Steel

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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:

	min	max
Carbon	0.20	0.25
Manganese	--	1.00
Silicon	0.20	0.60
Phosphorous	--	0.040
Sulfur	--	0.030
Chromium	11.00	13.50
Nickel	0.50	1.00
Molybdenum	0.75	1.25
Tungsten	0.75	1.25
Vanadium	0.17	0.30
Copper	--	0.50

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 and Wire: Hardened and tempered. Bars 2.750 in. (69.85 mm) and under in nominal diameter or distance between parallel sides and wire shall be cold finished. Larger bars shall be hot finished.

3.2.2 Forgings: Hardened, tempered, and descaled.

3.2.3 Forging Stock: As ordered by the forging manufacturer.

3.3 Heat Treatment: Bars, wire, and forgings shall be hardened by heating to  $1925^{\circ}\text{F} \pm 25$  ( $1050^{\circ}\text{C} \pm 15$ ), holding at heat for not less than 1 hr, and suitably quenching and tempered by heating to not lower than  $1100^{\circ}\text{F}$  ( $595^{\circ}\text{C}$ ), holding at heat for not less than 4 hr, cooling in air, reheating to not lower than  $1000^{\circ}\text{F}$  ( $540^{\circ}\text{C}$ ), holding at heat for not less than 4 hr, and cooling in air.

3.4 Properties: The product shall conform to the following requirements; hardness, tensile, and impact testing shall be performed in accordance with ASTM A370:

3.4.1 Macrostructure: Visual examination of transverse sections from bars, billets, and forging stock, etched in accordance with ASTM E381 in hot hydrochloric acid (1:1) at  $160^{\circ}$  -  $180^{\circ}\text{F}$  ( $71^{\circ}$  -  $82^{\circ}\text{C}$ ) 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 shall be equal to or better than the macrographs of ASTM E381 agreed upon by purchaser and vendor.

3.4.2 Bars, Wire, and Forgings:

3.4.2.1 Tensile Properties:

Tensile Strength, min	140,000 psi (965 MPa)
Yield Strength at 0.2% Offset, min	115,000 psi (793 MPa)
Elongation in 2 in. (50.8 mm) or 4D, min	13%
Reduction of Area, min	25%

3.4.2.2 Hardness: 293 - 341 HB or equivalent.

3.4.2.3 Izod Impact Strength (Notch Sensitivity): Not lower than 8ft-lb (10.8 N·m), determined at room temperature using a V-notched Izod specimen.

3.4.2.4 Decarburization:

3.4.2.4.1  $\emptyset$  Bars and wire ordered ground, turned, or polished shall be free from decarburization on the ground, turned, or polished surfaces.

3.4.2.4.2  $\emptyset$  Allowable decarburization of bars, wire, and billets ordered for forging or to specified microstructural requirements shall be as agreed upon by purchaser and vendor.

3.4.2.4.3 Decarburization of bars and wire to which 3.4.2.4.1 or 3.4.2.4.2 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	0.010
Over 0.500 to 1.000, incl	0.015
Over 1.000 to 1.500, incl	0.020
Over 1.500 to 2.000, incl	0.025
Over 2.000 to 2.500, incl	0.030
Over 2.500 to 3.000, incl	0.035
Over 3.000 to 4.000, incl	0.045

TABLE I (SI)

Nominal Diameter or Distance Between Parallel Sides Millimetres	Depth of Decarburization Millimetres
Up to 12.70, incl	0.25
Over 12.70 to 25.40, incl	0.38
Over 25.40 to 38.10, incl	0.51
Over 38.10 to 50.80, incl	0.64
Over 50.80 to 63.50, incl	0.76
Over 63.50 to 76.20, incl	0.89
Over 76.20 to 101.60, incl	1.14

- 3.4.2.4.3.1 Limits for depth of decarburization of bars over 4.000 in. (101.60 mm) in nominal diameter or distance between parallel sides shall be as agreed upon by purchaser and vendor.
- 3.4.2.4.4 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.
- 3.4.2.4.4.1 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.
- 3.4.3 Forging Stock: When a sample of stock is forged to a test coupon and heat treated as in 3.3, specimens taken from the heat treated coupon shall conform to the requirements of 3.4.2.1, 3.4.2.2, and 3.4.2.3. If specimens taken from the stock after heat treatment as in 3.3 conform to the requirements of 3.4.2.1, 3.4.2.2, and 3.4.2.3, the tests shall be accepted as equivalent to tests of a forged coupon.
- 3.5 Quality: The product, as received by the 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.
- 3.5.1 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.
- 3.5.2 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.
- 3.6 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).
- 3.7 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 4.5. 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: The following are classified as acceptance tests:
- 4.2.1.1 Tests of the product to determine conformance to composition (3.1) and macrostructure (3.4.1) requirements.
- 4.2.1.2 Tests of bars, wire, and forgings to determine conformance to tensile property (3.4.2.1), hardness (3.4.2.2), and impact strength (3.4.2.3) requirements.
- 4.2.1.3 Tests of bars and wire to determine conformance to decarburization (3.4.2.4) and tolerance (3.7) requirements.