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AEROSPACE MATERIAL SPECIFICATION

AMS 5655B
Superseding AMS 5655A

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STEEL BARS AND FORGINGS, CORROSION AND MODERATE HEAT RESISTANT
12.5Cr - 0.75Ni - 1.0Mo - 1.0W - 0.24V
Hardened and Tempered UNS S42200

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, 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 steels (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 SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2241 - Tolerances, Corrosion and Heat Resistant Steel, Iron Alloy, 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 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
AMS 5613 - Steel Bars, Forgings, Tubing, and Rings, Corrosion and Moderate Heat Resistant, 12.5Cr (SAE 51410)

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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

2.3.3 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 analytical methods approved by purchaser:

	min	max
Carbon	0.20 -	0.25
Manganese	--	1.00
Silicon	0.20 -	0.60
Phosphorus	--	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.

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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. (70 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°F ± 25 (1050°C ± 15), holding at heat for not less than 1 hr, and suitably quenching and tempered by heating to not lower than 1100°F (595°C), holding at heat for not less than 4 hr, cooling in air, reheating to not lower than 1000°F (540°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 as in 4.3.3 from Ø 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.

3.4.2 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 (795 MPa)
Elongation in 4D, min	13%
Reduction of Area, min	25%

3.4.2.2 Hardness: Should be 293 - 341 HB or equivalent, but the product shall Ø not be rejected on the basis of hardness if the tensile property requirements are met.

3.4.2.3 Charpy Impact Strength (Notch Sensitivity): Not lower than 10 ft-lb Ø (13.5 J), determined at room temperature using a V-notched Charpy specimen.

3.4.2.4 Decarburization:

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

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

3.4.2.4.3 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 12.50, incl	0.25
Over 12.50 to 25.00, incl	0.38
Over 25.00 to 37.50, incl	0.50
Over 37.50 to 50.00, incl	0.62
Over 50.00 to 62.50, incl	0.75
Over 62.50 to 75.00, incl	0.88
Over 75.00 to 100.00, incl	1.12

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3.4.2.4.3.1 Limits for depth of decarburization of bars over 4.000 in. (100.00 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. (0.12 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 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 (2 - 6 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 for vendor's tests and shall be responsible for performing all Ø required tests. Results of such tests shall be reported to the purchaser as required by 4.5. 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 the following Ø requirements are classified as acceptance tests and shall be performed on each heat or lot as applicable:

4.2.1.1 Composition (3.1) and macrostructure (3.4.1) of each heat.

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4.2.1.2 Tensile properties (3.4.2.1), hardness (3.4.2.2), and Charpy impact strength (3.4.2.3) of each lot of bars, wire, and forgings.

4.2.1.3 Decarburization (3.4.2.4) and tolerances (3.7) of bars and wire.

4.2.2 Periodic Tests: Tests of forging stock to demonstrate ability to develop Ø required properties are classified as periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.2.3 Preproduction Tests: Tests of forgings to determine conformance to all Ø applicable technical requirements of this specification when AMS 2375 is specified are classified as preproduction tests and shall be performed prior to or on the first-article shipment of a forging to a purchaser, when a change in material or processing, or both, requires reapproval as in 4.4, and when purchaser deems confirmatory testing to be required.

4.2.3.1 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:

4.3.1 Bars and Wire: AMS 2371.

4.3.2 Forgings and Forging Stock: AMS 2374.

4.3.3 Samples for macrostructure (3.4.1) 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 Approval: When specified, approval and control of forgings shall be in accordance with AMS 2375.

4.5 Reports:

4.5.1 The vendor of the product shall furnish with each shipment three copies of a report showing the results of tests for chemical composition and macrostructure of each heat and for hardness, tensile properties, and impact strength of each lot of bars, wire, and forgings. This report shall include the purchase order number, heat number, AMS 5655B, 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.

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