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

AEROSPACE MATERIAL SPECIFICATION

AMS 6527

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Revised

STEEL BARS AND FORGINGS
2.0Cr - 10Ni - 14Co - 1.0Mo (0.13 - 0.17C)
Premium Quality, Vacuum Melted

1. SCOPE:

1.1 Form: This specification covers a premium-quality alloy steel in the form of bars, forgings, and forging stock.

1.2 Application: Primarily for heat treated parts requiring high strength, high toughness, and weldability.

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, Iron Alloy, Titanium, and Titanium Alloy Bars and Wire
AMS 2248 - Chemical Check Analysis Limits, Heat and Corrosion-Resistant Steels and Alloys
AMS 2300 - Premium Aircraft Quality Steel Cleanliness, Magnetic Particle Inspection Procedure
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, Mechnical 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

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM A604 - Macroetch Testing of Consumable Electrode Remelted Steel Bars and Billets
ASTM E8 - Tension Testing of Metallic Materials
ASTM E45 - Determining the Inclusion Content of Steel
ASTM E112 - Estimating the Average Grain Size of Metals
ASTM E353 - Chemical Analysis of Stainless, Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron Alloys
ASTM E399 - Plain-Strain Fracture Toughness of Metallic Materials

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

Printed in U.S.A.

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 analytical methods approved by purchaser:

	min	max
Carbon	0.13	0.17
Manganese	--	0.10
Silicon	--	0.10
Phosphorus	--	0.008
Sulfur	--	0.005
Phosphorus + Sulfur	--	0.010
Chromium	1.80	2.20
Nickel	9.50	10.50
Cobalt	13.50	14.50
Molybdenum	0.90	1.10
Titanium	--	0.015
Aluminum	--	0.015
Oxygen	--	0.0015 (15 ppm)
Nitrogen	--	0.0015 (15 ppm)

3.1.1 Check Analysis: Composition variations shall meet the requirements of AMS 2248. No variation is permitted for oxygen and nitrogen.

3.2 Condition: The product shall be supplied in the following condition:

3.2.1 Bars and Forgings: Normalized, overaged, and descaled.

3.2.2 Forging Stock: As ordered by the forging manufacturer.

3.3 Heat Treatment: Bars and forgings shall be normalized and overaged by heating to 1650° ± 25 (900°C ± 15), holding at heat for 60 min. ± 5, air cooling to room temperature, and reheating to 1250°F ± 25 (680°C ± 15), holding at heat for not less than 6 hr, and cooling in air.

3.4 Properties: The product shall conform to the following requirements:

3.4.1 Macrostructure: Visual examination of transverse sections as in 4.3.1.3 from bars, billets, and forging stock, etched in accordance with ASTM A604 in hot hydrochloric acid (1:1) at 160° - 180°F (71° - 82°C) for sufficient time to develop a well-defined macrostructure, shall show no imperfections, such as pipe, cracks, porosity, segregation, and inclusions, detrimental to usage of the product. Macrostructure shall be no worse than the following macrographs of ASTM 604:

Class	Condition	Severity
1	Freckles	B
2	White Spots	C
3	Radial Segregation	C
4	Ring Pattern	D

3.4.2 Micro-Inclusion Rating: Two-thirds of the total number of specimens, as well as the average of all specimens, shall not exceed the following limits, determined in accordance with ASTM E45, Method D, except that the length of any inclusion shall be not greater than 0.015 in. (0.38 mm):

	Inclusion Rating			
Type	A	B	C	D
Thin	1.0	1.0	1.0	1.0
Heavy	1.0	1.0	1.0	1.0

3.4.3 Grain Size: Shall be 10 or finer for product having cross-sectional area of 100 sq in. (645 cm^2) and under, determined by comparison of a polished and etched specimen with the chart in ASTM E112. Grain size of product over 100 sq in. (645 cm^2) in cross-sectional area shall be as agreed upon by purchaser and vendor.

3.4.4 After Heat Treatment:

3.4.4.1 Bars and Forgings: Product 100 sq in. (645 cm^2) and under in cross-sectional area shall have the properties specified in 3.4.4.1.1 and 3.4.4.1.2 after being heated to 1650°F ± 25 (900°C ± 15), held at heat for 60 min. ± 5, forced-air cooled, reheated to 1525°F ± 25 (830°C ± 15), held at heat for 60 min. ± 5, forced-air cooled, cooled to -100°F ± 15 (-75°C ± 8), held at temperature for 60 min. ± 5, warmed in air to room temperature, and aged by heating to 950°F ± 10 (510°C ± 5), holding at heat for not less than 5 hr, and forced-air cooling. Properties of product over 100 sq in. (645 cm^2) in cross-sectional area shall be as agreed upon by purchaser and vendor.

3.4.4.1.1 Tensile Properties: Shall be as follows, determined in accordance with ASTM E8 on samples taken in the longitudinal direction:

Tensile Strength, min	235,000 psi (1620 MPa)
Yield Strength at 0.2% Offset, min	215,000 psi (1448 MPa)
Elongation in 4D, min	12%
Reduction of area, min	60%

3.4.4.1.2 Fracture Toughness: Shall be not lower than 130,000 psi$\sqrt{in.}$ (143 MPa$\sqrt{m}$), determined in accordance with ASTM E399 on specimens in the TL orientation from product having a nominal section thickness of 1.50 in. (38.1 mm) and over. Fracture toughness requirements and method of testing shall be as agreed upon by purchaser and vendor for product less than 1.50 in. (38.1 mm) in nominal section thickness.

3.4.4.2 Forging Stock: When a sample of stock is forged to a test coupon and heat treated as in 3.3 and 3.4.4.1 specimens taken from the heat treated coupon shall conform to the requirements of 3.4.4.1.1 and 3.4.4.1.2. If specimens taken from the stock after heat treatment as in 3.3 and 3.4.4.1 conform to the requirements of 3.4.4.1.1 and 3.4.4.1.2, the tests shall be accepted as equivalent to tests of a forged coupon.

3.5 Quality:

3.5.1 Steel shall be premium-aircraft quality conforming to AMS 2300. It shall be multiple melted using vacuum induction melting followed by vacuum arc remelting.

3.5.2 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.

3.5.2.1 Bars ordered ground, turned, or polished shall be free from seams, laps, tears, and cracks open to the ground, turned, or polished surfaces.

3.5.2.2 Bars 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 imperfections 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 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 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 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 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: Tests to determine conformance to the following requirements are classified as acceptance tests and shall be performed on each lot.

4.2.1.1 Composition (3.1), macrostructure (3.4.1), micro-inclusion rating (3.4.2), and grain size (3.4.3) of the product.

4.2.1.2 Tensile properties (3.4.4.1.1) of bars and forgings after heat treatment.

4.2.1.3 Tolerances (3.7) of bars.

4.2.2 Periodic Tests: Tests to determine conformance to the following requirements are classified as periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser:

4.2.2.1 Fracture toughness (3.4.4.1.2) of bars and forgings after heat treatment.

4.2.2.2 Ability of forging stock to develop required properties (3.4.4.2).