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400 Commonwealth Dr., Warrendale, PA 15096

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

AMS 5719A

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Superseding AMS 5719

STEEL BARS, FORGINGS, TUBING, AND RINGS, CORROSION RESISTANT
11.8Cr - 2.5Ni - 1.8Mo - 0.33V (0.08 - 0.15C)
Annealed, Vacuum Consumable Electrode Melted

UNS S64152

1. SCOPE:

1.1 Form: This specification covers a premium aircraft-quality corrosion-resistant steel in the form of bars, wire, forgings, mechanical tubing, flash welded rings, extrusions, and stock for forging, flash welded rings, or extruding.

1.2 Application: Primarily for parts, such as compressor wheels and structural members, requiring high strength and oxidation resistance up to 800°F (425°C).

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications and Aerospace Standards 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
MAM 2241 - Tolerances, Metric, Corrosion and Heat Resistant Steel, Iron Alloy, Titanium, and Titanium Alloy Bars and Wire
AMS 2243 - Tolerances, Corrosion and Heat Resistant Steel Tubing
MAM 2243 - Tolerances, Metric, Corrosion and Heat Resistant Steel Tubing
AMS 2248 - Chemical Check Analysis Limits, Wrought Corrosion and Heat Resistant Steels and Alloys, Maraging and Other Highly-Alloyed Steels, and Iron Alloys
AMS 2300 - Premium Aircraft-Quality Steel Cleanliness, Magnetic Particle Inspection Procedure
MAM 2300 - Premium Aircraft-Quality Steel Cleanliness, Magnetic Particle Inspection Procedure, Metric (SI) Measurement
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 7493 - Rings, Flash Welded, Non-Austenitic Corrosion Resistant Steels

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 A604 - Macroetch Testing of Consumable Electrode Remelted Steel Bars and Billets
ASTM E112 - Determining Average Grain Size
ASTM E363 - Chemical Analysis of Stainless, Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron Alloys

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

2.3.1 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 or by spectrographic or other analytical methods approved by purchaser:

Ø

	min	max
Carbon	0.08	0.15
Manganese	0.50	0.90
Silicon	--	0.35
Phosphorus	--	0.025
Sulfur	--	0.025
Chromium	11.00	12.50
Nickel	2.00	3.00
Molybdenum	1.50	2.00
Vanadium	0.25	0.40
Nitrogen	0.01	0.05
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:

3.2.1.1 Rounds: Annealed and centerless ground, turned, or polished.

3.2.1.2 Hexagons: Annealed and cold finished.

3.2.1.3 Squares and Rectangles: Annealed and descaled.

3.2.2 Wire: Cold drawn, annealed, and cold finished.

3.2.3 Forgings, Flash Welded Rings, and Extrusions: Annealed and descaled.

3.2.3.1 Flash welded rings shall not be supplied unless specified or permitted on purchaser's part drawing. When supplied, they shall be manufactured in accordance with AMS 7493.

3.2.4 Mechanical Tubing: Cold finished and annealed.

3.2.5 Stock for Forging, Flash Welded Rings, or Extruding: As ordered by the forging, flash welded ring, or extrusion manufacturer.

3.3 Heat Treatment: Bars, wire, forgings, flash welded rings, extrusions, and mechanical tubing shall be annealed by heating to 1275°F ± 20 (690°C ± 10), holding at heat for not less than 6 hr, and cooling in air.

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

3.4.1 The Product:

3.4.1.1 Ø Macrostructure: Visual examination of transverse sections as in 4.3.3 from bars, billets, tube rounds or tubes, and stock for forging, flash welded rings, or extruding, etched in accordance with ASTM A604 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. Except as specified in 3.4.1.1.1, porosity, segregation, inclusions, and other imperfections for product 36 sq in. (230 cm^2) and under in nominal cross-sectional area shall be no worse than the following macrographs of ASTM A604; macrostructure standards for product over 36 sq in. (230 cm^2) in cross-sectional area shall be as agreed upon by purchaser and vendor:

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

3.4.1.1.1 Ø If tubes are produced directly from ingots or large blooms, transverse sections may be taken from tubes rather than tube rounds. Macrostructure standards for such tubes shall be as agreed upon by purchaser and vendor.

3.4.2 Bars, Wire, Forgings, Flash Welded Rings, Extrusions, and Mechanical Tubing:

3.4.2.1 As Annealed:

3.4.2.1.1 Bars, Forgings, Flash Welded Rings, Extrusions, and Mechanical Tubing: Shall have hardness not higher than 311 HB, or equivalent.

3.4.2.1.2 Wire: Shall have tensile strength not higher than 155,000 psi (1070 MPa) or equivalent hardness.

3.4.2.2 Ø After Hardening and Double Tempering: Product 7.00 in. (175.0 mm) and under in nominal diameter or least distance between parallel sides shall have the following properties after being hardened by heating to 1925°F ± 25 (1050°C ± 15), holding at heat for not less than 30 min., and quenching in oil and double tempered by heating to a temperature within the range 1040° - 1075°F (560° - 580°C), holding at the selected temperature within ±15°F (±8°C) for not less than 60 min., cooling in air to room temperature, reheating to a temperature within the range 1000° - 1040°F (540° - 560°C), holding at the selected temperature within ±15°F (±8°C) for not less than 3 hr, and cooling in air; property requirements for product over 7.00 in. (175.0 mm) in nominal diameter or least distance between parallel sides shall be as agreed upon by purchaser and vendor:

3.4.2.2.1 Tensile Properties:

3.4.2.2.1.1 Smooth Bar: Shall be as follows; determined in either the
Ø longitudinal or transverse direction except that testing in the transverse direction applies only to product from which a tensile specimen not less than 2.50 in. (62.5 mm) in length can be obtained. Testing in the longitudinal direction is not required on product tested in the transverse direction.

Tensile Strength, min	155,000 psi (1070 MPa)
Yield Strength at 0.2% Offset, min	130,000 psi (895 MPa)
Elongation, min	
in 4D	12%
in 5D	9%
Reduction of Area, min	30%

3.4.2.2.1.2 Notched Bar: Shall be not less than 1.4 times the smooth-bar tensile strength, determined on specimens machined to the dimensions shown in Fig. 1 and Table I.

3.4.2.2.2 Hardness: Should be 341 - 375 HB, or equivalent, but the product shall
Ø not be rejected on the basis of hardness if the tensile property requirements of 3.4.2.2.1.1 are met.

3.4.2.2.3 Charpy Impact Value: Shall be not less than 165 ft-lb per sq in.
Ø (35 J/cm^2), determined on the V-notched specimen at room temperature.

3.4.2.2.4 Grain Size: Predominantly 5 or finer with occasional grains as large as 3 permissible, determined by comparison of a polished and etched specimen with the chart in ASTM E112.

3.4.3 Forging Stock: When a sample of stock is forged to a test coupon and heat
Ø treated as in 3.3 and 3.4.2.2, specimens taken from the heat treated coupon shall conform to the requirements of 3.4.2.2.1, 3.4.2.2.2, and 3.4.2.2.4. If specimens taken from the stock after heat treatment as in 3.3 and 3.4.2.3 conform to the requirements of 3.4.2.2.1, 3.4.2.2.2, and 3.4.2.2.4, the tests shall be accepted as equivalent to tests of the forged coupon.

3.4.4 Stock for Flash Welded Rings or Extruding: A sample of stock heat treated
Ø as in 3.3 and 3.4.2.2 shall conform to the requirements of 3.4.2.2.1, 3.4.2.2.2, and 3.4.2.2.4.

3.5 Quality:

3.5.1 Steel shall be premium aircraft-quality conforming to AMS 2300 or MAM 2300; it shall be multiple melted using vacuum consumable electrode practice in the remelt cycle.

3.5.2 The product, as received by purchaser, shall be uniform in quality and
Ø condition, sound, and free from foreign materials and from imperfections detrimental to usage of the product.

3.5.2.1 Bars, mechanical tubing, and flash welded rings 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 Ø 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.

3.5.2.3 Grain flow of die forgings, except in areas having flash-line end grain, shall follow the general contour of the forgings showing no evidence of re-entrant flow.

3.6 Sizes: Ø Except when exact lengths or multiples of exact lengths are ordered, straight bars, wire, mechanical tubing, and extrusions 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: Shall conform to all applicable requirements of the following:

3.7.1 Bars and Wire: AMS 2241 or MAM 2241.

3.7.2 Mechanical Tubing: Ø AMS 2243 or MAM 2243.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: Ø 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 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: Ø Tests to determine conformance to the following requirements are classified as acceptance tests and shall be performed on each heat or lot as applicable:

4.2.1.1 Ø Composition (2.1), macrostructure (3.4.1.1), and frequency/severity cleanliness rating (3.5.1) of each heat.

4.2.1.2 Ø Hardness (3.4.2.1.1) of each lot of bars, forgings, flash welded rings, extrusions, and mechanical tubing as annealed.

4.2.1.3 Ø Tensile strength (3.4.2.1.2) of each lot of wire as annealed.

4.2.1.4 Ø Tensile properties (3.4.2.2.1), hardness (3.4.2.2.2), and grain size of each lot of bars, wire, forgings, flash welded rings, extrusions, and mechanical tubing after hardening and double tempering as in 3.4.2.2.

4.2.1.5 Tolerances (3.7) of bars, wire, and mechanical tubing.
Ø

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:
Ø

4.2.2.1 Charpy impact value (3.4.2.2.3) of each lot of bars, wire, forgings, flash welded rings, extrusions, and meachnical tubing after hardening and double tempering as in 3.4.2.2.
Ø

4.2.2.2 Ability of forging stock (3.4.3) and of stock for flash welded rings or extruding (3.4.4) to develop required properties.
Ø

4.2.3 Preproduction Tests: Tests of forgings to determine conformance to all 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, processing, or both requires reapproval as in 4.4, and when purchaser deems confirmatory testing to be required.
Ø

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 acitivity, the contracting officer, or the request for procurement.
Ø

4.3 Sampling: Shall be in accordance with the following; a heat shall be the consumable electrode remelted ingots produced from steel originally melted as a single furnace charge.

4.3.1 Bars, Wire, Flash Welded Rings, Extrusions, Mechanical Tubing, and Stock for Flash Welded Rings or Extruding: AMS 2371.
Ø

4.3.2 Forgings and Forging Stock: AMS 2374.
Ø

4.3.3 Samples for macrostructure (3.4.1.1) testing shall be full cross-sectional 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.
Ø

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 a report showing the results of tests for chemical composition, macrostructure, and frequency-severity cleanliness rating of each heat and the results of tests to determine conformance to the other acceptance tests requirements of this specification. This report shall include the purchase order number, heat number, AMS 5719A, size, and quantity. If forgings are supplied, the part number and the size and melt source of stock used to make the forgings shall also be included.

4.5.2 The vendor of finished or semi-finished parts shall furnish with each shipment a report showing the purchase order number, AMS 5719A, contractor or other direct supplier of material, part number, and quantity. When material for making parts is produced or purchased by the parts vendor, that vendor shall inspect each lot of material to determine conformance to the requirements of this specification and shall include in the report either a statement that the material conforms or copies of laboratory reports showing the results of tests to determine conformance.

4.6 Resampling and Retesting: Shall be in accordance with the following:

4.6.1 Ø Bars, Wire, Flash Welded Rings, Extrusions, Mechanical Tubing, and Stock for Flash Welded Rings or Extruding: AMS 2371.

4.6.2 Ø Forgings and Forging Stock: AMS 2374.

5. PREPARATION FOR DELIVERY:

5.1 Identification: The product shall be identified as follows:

5.1.1 Ø Bars, Wire, Extrusions, and Mechanical Tubing: In accordance with AMS 2806.

5.1.2 Forgings: In accordance with AMS 2808.

5.1.3 Flash Welded Rings and Stock for Forging, Flash Welded Rings, or Extruding: As agreed upon by purchaser and vendor.

5.2 Packaging:

5.2.1 Ø The product shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the product to ensure carrier acceptance and safe delivery. Packaging shall conform to carrier rules and regulations applicable to the mode of transportation.

5.2.2 Ø For direct U.S. Military procurement, packaging shall be in accordance with MIL-STD-163, Level A or Level C, as specified in the request for procurement. Commercial packaging as in 5.2.1 will be acceptable if it meets the requirements of Level C.