

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

SAE AMS 5773B

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Superseding AMS 5773A

STEEL BARS, FORGINGS, TUBING, AND RINGS, CORROSION RESISTANT
15Cr - 6.5Ni - 0.75Mo - 0.30 (Cb + Ta) - 1.5Cu
Consumable Electrode Melted, Solution Heat Treated

UNS S45000

1. SCOPE:

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

1.2 Application: Primarily for parts requiring corrosion resistance approximating that of steels of the 18-8 types and high strength exceeding that of the 12Cr martensitic type up to 700°F (370°C). This steel can be used in the solution heat treated condition and is capable of being precipitation heat treated to tensile strengths as high as 180,000 psi (1240 MPa) with good ductility and strength in the transverse directions in large section sizes. Although this steel is relatively immune to stress-corrosion cracking, reference should be made to ARP 1110 for recommended practices to minimize such conditions.

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 Recommended Practices 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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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 7490 - Rings, Flash Welded, Corrosion and Heat Resistant Austenitic Steels and Austenitic-Type Alloys

2.1.2 Aerospace Recommended Practices:

- ARP 1110 - Minimizing Stress Corrosion Cracking in Heat Treatable Wrought Low Alloy and Martensitic Corrosion Resistant Steels

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 E353 - 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, \emptyset determined by wet chemical methods in accordance with ASTM E353 or by spectrographic or other analytical methods approved by purchaser:

	min	max
Carbon	--	0.05
Manganese	--	1.00
Silicon	--	1.00
Phosphorus	--	0.020
Sulfur	--	0.015
Chromium	14.00 - 16.00	
Nickel	6.00 - 7.00	
Molybdenum	0.50 - 1.00	
Columbium + Tantalum	8xC	--
Copper	1.25 - 1.75	

- 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, Wire, Mechanical Tubing, Forgings, and Flash Welded Rings: Solution heat treated.

- 3.2.1.1 Bars:

- 3.2.1.1.1 Rounds: Centerless ground after solution heat treatment.

- 3.2.1.1.2 Squares, Hexagons, and Flats: Hot finished before solution heat treatment and descaled, or cold drawn after solution heat treatment or descaling, as ordered.

- 3.2.1.2 Wire: Cold drawn after solution heat treatment.

- 3.2.1.3 Mechanical Tubing: Cold finished and solution heat treated.

- 3.2.1.4 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 7490.

- 3.2.2 Stock for Forging or Flash Welded Rings: As ordered by the forging or flash welded ring manufacturer.

- 3.3 Solution Heat Treatment: Bars, wire over 3/16 in. (4.5 mm) in nominal \emptyset diameter, forgings, mechanical tubing, and flash welded rings shall be solution heat treated by heating to 1900°F \pm 25 (1040°C \pm 15), holding at heat for not less than 1 hr, and cooling rapidly.

3.3.1 Wire 3/16 in. (4.5 mm) and under in nominal diameter shall be solution heat treated by heating to 1900°F + 25 (1040°C + 15), holding at heat for a time commensurate with the wire size, and cooling rapidly.

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

3.4.1 All Products:

3.4.1.1 Macrostructure: Visual examination of transverse sections as in 4.3.3 from bars, billets, extrusions, and stock for forging or flash welded rings, 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. Porosity, segregation, inclusions, and other imperfections for product 80 sq in. (525 cm²) and under in nominal cross-sectional area shall be no worse than the following macrographs of ASTM A604; macrostructure standards for product over 80 sq in. (525 cm²) in nominal cross-sectional area shall be as agreed upon by purchaser and vendor:

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

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

3.4.2.1 As Solution Treated:

3.4.2.1.1 Tensile Properties:

3.4.2.1.1.1 Bars, Forgings, Tubing, and Flash Welded Rings:

Tensile Strength, min	125,000 psi (860 MPa)
Yield Strength at 0.2% Offset, min	95,000 psi (655 MPa)
Elongation in 4D, min	10%
Reduction of Area, min	40%

3.4.2.1.1.2 Wire: Not higher than 165,000 psi (1140 MPa) or equivalent hardness.

3.4.2.1.2 Hardness:

3.4.2.1.2.1 Bars: Not higher than 311 HB, or equivalent, determined midway between surface and center.

3.4.2.1.2.2 Tubing, Flash Welded Rings, and Forgings: Not higher than 311 HB, or equivalent.

3.4.2.2 After Precipitation Heat Treatment: The solution heat treated product, precipitation heat treated to a particular condition by heating to the corresponding temperature shown in Table I, holding at heat for not less than 4 hr, and cooling in air, shall have the mechanical properties shown in Table II and Table III for that particular condition. Tensile and hardness tests shall be made in only one precipitation heat treated condition. Unless otherwise specified, the precipitation heat treated condition for acceptance testing as in 4.2.1 shall be H1050.

TABLE I

Condition	Temperature
H 900	900°F + 15 (480°C + 8)
H 950	950°F + 15 (510°C + 8)
H1000	1000°F + 15 (540°C + 8)
H1050	1050°F + 15 (565°C + 8)
H1100	1100°F + 15 (595°C + 8)
H1150	1150°F + 15 (620°C + 8)

3.4.2.2.1 Tensile Properties: The following properties apply to product up to 12.00 in. (300 mm), incl, in nominal diameter or distance between parallel sides; tensile property requirements for product over 12.00 in. (300 mm) in nominal diameter or distance between parallel sides shall be as agreed upon by purchaser and vendor:

TABLE II

Condition	Specimen Orientation	Tensile Strength psi, min	Yield Strength at 0.2% Offset psi, min	Elongation in 4D %, min	Reduction of Area %, min
H 900	Longitudinal	180,000	170,000	10	40
	Transverse	180,000	170,000	6	20
H 950	Longitudinal	170,000	160,000	10	40
	Transverse	170,000	160,000	7	22
H1000	Longitudinal	160,000	150,000	12	45
	Transverse	160,000	150,000	8	27
H1050	Longitudinal	145,000	135,000	12	45
	Transverse	145,000	135,000	9	30
H1100	Longitudinal	130,000	105,000	16	50
	Transverse	130,000	105,000	11	30
H1150	Longitudinal	125,000	75,000	18	55
	Transverse	125,000	75,000	12	35

TABLE II (SI)

Condition	Specimen Orientation	Tensile Strength MPa, min	Yield Strength at 0.2% Offset MPa, min	Elongation in 4D %, min	Reduction of Area %, min
H 900	Longitudinal	1240	1170	10	40
	Transverse	1240	1170	6	20
H 950	Longitudinal	1170	1105	10	40
	Transverse	1170	1105	7	22
H1000	Longitudinal	1105	1035	12	45
	Transverse	1105	1035	8	27
H1050	Longitudinal	1000	930	12	45
	Transverse	1000	930	9	30
H1100	Longitudinal	895	725	16	50
	Transverse	895	725	11	30
H1150	Longitudinal	860	515	18	55
	Transverse	860	515	12	55

3.4.2.2.1.1 Longitudinal tensile requirements apply to specimens taken in the longitudinal direction from bars and wire, to specimens taken from forgings with axis of specimen in the area of gage length within 15 deg of parallel to the forging flow lines, and to specimens taken in the circumferential direction from parent metal of flash welded rings; transverse tensile requirements apply to all other specimens.

3.4.2.2.2 Hardness: Should be not lower than shown in Table III for the corresponding precipitation heat treatment condition but the product shall not be rejected on the basis of hardness if the tensile property requirements of Table II for that condition are met.

TABLE III

Condition	Hardness, Brinell min
H 900	363
H 950	341
H1000	331
H1050	321
H1100	285
H1150	262

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

3.4.3 Stock for Flash Welded Rings: Specimens taken from the stock after heat treatment as in 3.3 and 3.4.2.2 shall conform to the requirements of 3.4.2.2.1 and 3.4.2.2.2.

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 consumable electrode practice in the remelt cycle.

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

3.5.3 Grain flow, except in areas of die forgings which contain end grain, shall follow the general contour of the forging, showing no evidence of re-entrant flow.

3.6 Sizes: Except when exact lengths or multiples of exact lengths are ordered, straight bars, wire, and tubing 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: AMS 2243 or MAM 2243.

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 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 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 (3.4.1.1) of each heat.
- 4.2.1.2 Tensile properties (3.4.2.1.1) and hardness (3.4.2.1.2) of each lot of bars, wire, forgings, mechanical tubing, and flash welded rings as solution treated.
- 4.2.1.3 Tensile properties (3.4.2.2.1) and hardness (3.4.2.2.2) of each lot of bars, wire, forgings, mechanical tubing, and flash welded rings after precipitation heat treatment as in 3.4.2.2.
- 4.2.1.4 Tolerances (3.7) of bars, wire, and mechanical tubing.
- 4.2.2 Periodic Tests: Tests of forging stock (3.4.2) or stock for flash welded rings (3.4.3) to demonstrate ability to develop 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:
- 4.2.3.1 Forgings: Tests to determine conformance to all applicable technical requirements of this specification other than tensile properties and hardness after precipitation heat treatment to other than the specified condition when AMS 2375 is specified are classified as preproduction tests and shall be performed 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.
- 4.2.3.1.1 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.
- 4.2.3.2 Bars, Wire, Mechanical Tubing, and Flash Welded Rings: When specified by purchaser, tests to determine conformance to requirements for tensile properties and hardness after precipitation heat treatment to other than the specified testing condition are classified as preproduction tests and shall be performed on the first-article shipment of a product to a purchaser and when purchaser deems confirmatory testing to be required.
- 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, Mechanical Tubing, Flash Welded Rings, and Stock for Flash Welded Rings: AMS 2371.
- 4.3.2 Forgings and Forging Stock: AMS 2374.