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400 Commonwealth Dr., Warrendale, PA 15096

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

SAE AMS 5895A

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Superseding AMS 5895

STEEL BARS, FORGINGS, TUBING, AND RINGS, CORROSION AND HEAT RESISTANT
15Cr - 25.5Ni - 1.2Mo - 2.1Ti - 0.006B - 0.30V
Consumable Electrode Melted, 1750°F (955°C) Solution Heat Treated, Welding Grade
Precipitation Hardenable UNS S66286

1. SCOPE:

1.1 Form: This specification covers a corrosion and heat resistant steel in the form of bars, wire, forgings, mechanical tubing, flash welded rings, and stock for forging, flash welded rings, or heading.

1.2 Application: Primarily for parts, such as flanges, cases, and fasteners, requiring high strength up to 1300°F (705°C) and oxidation resistance up to 1500°F (815°C), particularly those which are welded and then heat treated to develop required properties.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications 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 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 Corrosion and Heat Resistant Steels and Alloys
AMS 2808 - Identification, Forgings
AMS 7490 - Rings, Flash Welded, Corrosion and Heat Resistant Austenitic Steels and Austenitic-Type Alloys

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 E112 - Determining Average Grain Size
ASTM E139 - Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials
ASTM E292 - Conducting Time-for-Rupture Notch Tension Tests of Materials
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, Ø determined by wet chemical methods in accordance with ASTM E353 or by spectrographic or other analytical methods approved by purchaser:

	min	max
Carbon	--	0.08
Manganese	--	0.35
Silicon	--	0.30
Phosphorus	--	0.020
Sulfur	--	0.010
Chromium	13.50	16.00
Nickel	24.00	27.00
Molybdenum	1.00	1.50
Titanium	1.90	2.35
Boron	0.0030	0.010
Vanadium	0.10	0.50
Aluminum	--	0.35
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, Wire, Forgings, and Flash Welded Rings: Solution heat treated.

3.2.1.1 Bars and Wire:

3.2.1.1.1 All hexagons, other bars 2.750 in. (70 mm) and under in nominal diameter or distance between parallel sides, and wire shall be cold finished.

3.2.1.1.2 Bars, other than hexagons, over 2.750 in. (70 mm) in nominal diameter or distance between parallel sides shall be hot finished and descaled.

3.2.1.2 Forgings: Shall be descaled.

3.2.1.3 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.

3.2.1.4 Mechanical Tubing: Cold finished.

3.2.2 Stock for Forgings, Flash Welded Rings, or Heading: As ordered by the forging, flash welded ring, or heading manufacturer.

3.3 Heat Treatment: Bars, wire except as specified in 3.3.1, forgings, mechanical tubing, and flash welded rings shall be solution heat treated by heating to 1750°F ± 25 (955°C ± 15), holding at heat for not less than 1 hr, and quenching in oil or water.

3.3.1 Wire up to 3/16 in. (4.5 mm) in nominal diameter shall be solution heat Ø treated by heating to 1750°F ± 25 (955°C ± 15), holding at heat for a time commensurate with wire diameter, 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 Bars, Wire, Forgings, Mechanical Tubing, and Flash Welded Rings:

3.4.1.1 As Solution Heat Treated:

3.4.1.1.1 Tensile Properties: Wire shall have tensile strength not higher than 105,000 psi (725 MPa) or equivalent hardness.

3.4.1.1.2 Hardness: Shall be as follows:

3.4.1.1.2.1 Bars and Mechanical Tubing: Not higher than 201 HB, or equivalent, determined approximately midway between outer surface and center or inner surface as applicable.

3.4.1.1.2.2 Forgings and Flash Welded Rings: Not higher than 201 HB or equivalent.

3.4.1.1.3 Grain Size: Shall be 5 or finer, determined by comparison of a polished and etched specimen with the chart in ASTM E112.

3.4.1.2 After Precipitation Heat Treatment: The product shall have the following properties after being precipitation heat treated by heating to 1325°F ± 15 (720°C ± 8), holding at heat for not less than 16 hr, and cooling in air:

3.4.1.2.1 Longitudinal Tensile Properties: Shall be as follows:

Tensile Strength, min	130,000 psi (895 MPa)
Yield Strength at 0.2% Offset, min	85,000 psi (585 MPa)
Elongation in 4D, min	15%
Reduction of area, min	20%

3.4.1.2.1.1 The requirements of 3.4.1.2.1 apply to specimens taken with the axis approximately parallel to the grain flow and to specimens taken in the radial direction and in the tangential direction at the rim of disc forgings.

3.4.1.2.1.2 Specific locations of specimens from forgings and flash welded rings shall be as agreed upon by purchaser and vendor.

3.4.1.2.2 Hardness: Should be 248 - 341 HB, or equivalent but the product shall not be rejected on the basis of hardness if the tensile property requirements of 3.4.1.2.1 are met.

3.4.1.2.3 Stress-Rupture Properties at 1200°F (650°C): Shall be as follows; testing of notched specimens and of combination smooth-and-notched specimens shall be performed in accordance with ASTM E292 and of smooth specimens in accordance with ASTM E139:

3.4.1.2.3.1 A combination smooth-and-notched specimen machined to the dimensions shown in Fig. 1 and Table I, maintained at 1200°F ± 3 (650° C ± 2) while a load sufficient to produce an initial axial stress of 65,000 psi (450 MPa) is applied continuously, shall not rupture in less than 23 hours. The test shall be continued to rupture without change of load. Rupture shall occur in the smooth section and elongation of this section after rupture, measured at room temperature, shall be not less than 5% in 4D if the specimen ruptures in 48 hr or less and not less than 3% in 4D if the specimen ruptures in more than 48 hours.

3.4.1.2.3.2 As an alternate procedure, separate smooth and notched specimens, machined from adjacent sections of the same piece with gage sections conforming to the respective dimensions of Table I, may be tested individually under the conditions of 3.4.1.2.3.1. The smooth specimen shall not rupture in less than 23 hr and elongation after rupture, measured at room temperature, shall be as specified in 3.4.1.2.3.1. The notched specimen shall not rupture in less time than the companion smooth specimen but need not be tested to rupture.

3.4.1.2.3.3 Ø The tests of 3.4.1.2.3.1 and 3.4.1.2.3.2 may be conducted using a load higher than required to produce an initial axial stress of 65,000 psi (450 MPa) but the load shall not be changed while test is in progress. Time to rupture, rupture location, and elongation requirements shall be as specified in 3.4.1.2.3.1.

3.4.1.2.3.4 When permitted by purchaser, the tests of 3.4.1.2.3.1 and 3.4.1.2.3.2 may be conducted using incremental loading. In such case, the load required to produce an initial axial stress of 65,000 psi (450 MPa) shall be used to rupture or for 23 hr, whichever occurs first. After the 23 hr and at intervals of 8 - 16 hr, preferably 8 - 10 hr, thereafter, the stress shall be increased in increments of 5000 psi (35 MPa). Time to rupture, rupture location, and elongation requirements shall be as specified in 3.4.1.2.3.1.

3.4.1.2.3.5 For tubing from which a solid round specimen cannot be cut, a full section of tubing shall be tested and shall meet the smooth bar requirements of 3.4.1.2.3.1.

3.4.2 Forging Stock: When a sample of stock is forged to a test coupon and heat treated as in 3.3 and 3.4.1.2, specimens taken from the heat treated coupon shall conform to the requirements of 3.4.1.2.1, 3.4.1.2.2, and 3.4.1.2.3. If specimens taken from the stock after heat treatment as in 3.3 and 3.4.1.2 conform to the requirements of 3.4.1.2.1, 3.4.1.2.2, and 3.4.1.2.3, the tests shall be accepted as equivalent to tests of a forged coupon.

3.4.3 Ø Stock for Flash Welded Rings or Heading: A sample of stock heat treated as in 3.3 and 3.4.1.2 shall conform to the requirements of 3.4.1.2.1, 3.4.1.2.2, and 3.4.1.2.3.

3.5 Quality:

3.5.1 Steel shall be produced by multiple melting 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.

3.5.2.1 Ø Forgings shall have substantially uniform macrostructure. Standards for acceptance shall be as agreed upon by purchaser and vendor.

3.5.2.2 Ø Grain flow, except in areas of die forgings which contain flash line end grain, shall follow the general contour of the forgings, 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 mechanical 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 Ø 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) of each heat.

4.2.1.2 Tensile properties (3.4.1.1.1) of each lot of wire as solution heat treated.

4.2.1.3 Hardness (3.4.1.1.2) of each lot of bars, forgings, mechanical tubing, and flash welded rings as solution heat treated.

4.2.1.4 Tensile properties (3.4.1.2.1), hardness (3.4.1.2.1), and stress-rupture properties (3.4.1.2.3) of each lot of bars, wire, forgings, mechanical tubing, and flash welded rings after precipitation heat treatment.

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

4.2.2 Periodic Tests: Tests of forging stock (3.4.2) and of stock for flash welded rings or heading (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: 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.

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; 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 or Heading: AMS 2371.

4.3.2 Forgings and Forging Stock: AMS 2374.

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 of each heat and the results of tests on each lot to determine conformance to the other acceptance test requirements of this specification. This report shall include the purchase order number, AMS 5895A, heat number, 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 5895A, 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 test to determine conformance.

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

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

4.6.2 Forgings and Forging Stock: AMS 2374.

5. PREPARATION FOR DELIVERY:

5.1 Identification: The product shall be identified as follows:

5.1.1 Bars, Wire, and 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 Heading: As agreed upon by purchaser and vendor.

5.2 Packaging:

5.2.1 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 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.

6. ACKNOWLEDGMENT: A vendor shall mention this specification number and its revision letter in all quotations and when acknowledging purchase orders.

7. REJECTIONS: Material not conforming to this specification or to modifications authorized by purchaser will be subject to rejection.

8. NOTES:

8.1 Marginal Indicia: The phi (Ø) symbol is used to indicate technical changes from previous issues of this specification.

8.2 Definition of "Mechanical Tubing": The term "mechanical tubing" as used in AMS means a heavy-walled cylindrical tubing intended primarily for the machining of circular rings, flanges, shafts, etc, having a wall thickness which is a substantial proportion of the outer diameter; such tubing is not usually used for the transmission of fluids and parts made from it are usually machined all over. This product is sometimes known as "hollow bar".

8.3 Dimensions and properties in inch/pound units and the Fahrenheit temperatures are primary; dimensions and properties in SI units and the Celsius temperatures are shown as the approximate equivalents of the primary units and are presented only for information.