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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 5609C

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Superseding AMS 5609B

Submitted for recognition as an American National Standard

STEEL, CORROSION AND HEAT RESISTANT, BARS, WIRE, FORGINGS, TUBING, AND RINGS 12Cr - 0.12Cb (SAE 51410 Modified) Ferrite Controlled, Annealed

UNS S41040

1. SCOPE:

1.1 Form:

This specification covers an aircraft-quality, corrosion and heat 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:

These products have been used typically for parts requiring a combination of high room temperature tensile properties with oxidation resistance up to 1000 °F (538 °C) and where control of ferrite content is necessary, but usage is not limited to such applications.

1.2.1 Certain design and processing procedures may cause these products to become susceptible to stress-corrosion cracking; ARP1110 recommends 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 SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order.

Printed in U.S.A.
91-0942/ EG

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

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 2303 Aircraft Quality Steel Cleanliness, Martensitic Corrosion-Resistant Steels, Magnetic Particle Inspection Procedure
MAM 2303 Aircraft Quality Steel Cleanliness, Martensitic Corrosion-Resistant Steels, Magnetic Particle Inspection Procedure, Metric (SI) Measurement
AMS 2315 Determination of Delta Ferrite Content
AMS 2371 Quality Assurance Sampling and Testing, Corrosion and Heat Resistant Steels and Alloys, Wrought Products and Forging Stock
AMS 2374 Quality Assurance Sampling and Testing, Corrosion and Heat Resistant Steel and Alloy Forgings
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 7493 Rings, Flash Welded, Non-Austenitic Corrosion Resistant Steels
ARP1110 Minimizing Stress Corrosion Cracking in Heat Treatable Wrought Low-Alloy and Martensitic Corrosion Resistant Steels

2.2 ASTM Publications:

Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM A 370 Mechanical Testing of Steel Products
ASTM E 112 Determining Average Grain Size
ASTM E 340 Macroetching Metals and Alloys
ASTM E 353 Chemical Analysis of Stainless, Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron Alloys

2.3 U.S. Government Publications:

Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-STD-163 Steel Mill Products, Preparation for Shipment and Storage

3. TECHNICAL REQUIREMENTS:

3.1 Composition:

(R)

Shall conform to the percentages by weight shown in Table 1, determined by wet chemical methods in accordance with ASTM E 353, by spectrochemical methods, or by other analytical methods acceptable to purchaser.

TABLE 1 - Composition

Element	min	max
Carbon	0.12	0.15
Manganese	--	0.60
Silicon	--	0.50
Phosphorus	--	0.025
Sulfur	--	0.025
Chromium	11.50	12.50
Columbium	0.05	0.20
Nickel	--	0.75
Molybdenum	--	0.20
Aluminum	--	0.05
Copper	--	0.50
Tin	--	0.05
Nitrogen	--	0.08

3.1.1 Check Analysis: Composition variations shall meet the requirements of AMS 2248 except that check analysis limits for columbium shall be 0.02 under minimum and 0.05 over maximum.

3.2 Condition:

The product shall be supplied in the following condition; hardness and tensile strength shall be determined in accordance with ASTM A 370:

3.2.1 Bars: Annealed having hardness not higher than 241 HB, or equivalent.

3.2.1.1 Round bars shall be ground or turned.

3.2.1.2 Bars, other than rounds, over 0.500 to 2.750 inches (12.70 to 69.85 mm), inclusive, in nominal distance between parallel sides and all hexagons shall be cold finished.

3.2.1.3 Bars, other than rounds and hexagons, over 2.750 inches (69.85 mm) in nominal diameter or distance between parallel sides shall be hot finished.

3.2.2 Wire: Cold drawn and annealed having tensile strength not higher than 115 ksi (793 MPa) or equivalent hardness.

3.2.3 Forgings and Flash Welded Rings: Annealed having hardness not higher than 241 HB, or equivalent.

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

3.2.4 Mechanical Tubing: Annealed and cold finished having hardness not higher than 241 HB, or equivalent.

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

3.3 Properties:

The product shall conform to the following requirements; tensile and hardness testing shall be performed in accordance with ASTM A 370:

3.3.1 Steel as Annealed:

3.3.1.1 (R) Macrostructure: Visual examination of transverse sections from bars, wire, billets, tube rounds or tubes, and stock for forging or flash welded rings, etched in hot hydrochloric acid in accordance with ASTM E 340, shall show no pipe or cracks. Except as specified in 3.3.1.1.1, porosity, segregation, inclusions, and other imperfections shall be no worse than macrostructure standards acceptable to purchaser.

3.3.1.1.1 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.

3.3.1.2 Decarburization: Bars, wire, and tubing ordered ground, turned, or polished shall be free from decarburization on the ground, turned, or polished surfaces, determined microscopically at a magnification not exceeding 100X.

3.3.1.3 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 E 112.

3.3.1.4 Ferrite Content: Shall be not more than 5%, determined in accordance with AMS 2315.

3.3.2 Bars, Wire, Forgings, Tubing, and Flash Welded Rings:

3.3.2.1 (R) After Heat Treatment: Product 0.500 inch (12.70 mm) and under in nominal diameter or distance between parallel sides and specimens 0.500-inch ± 0.100 (12.70-mm ± 2.54) thick cut from larger product shall have the following properties after being hardened by heating to 1700 °F ± 10 (927 °C ± 6) holding at heat for 1 hour ± 0.1, and cooling in still air and double tempered by heating to 600 °F ± 10 (316 °C ± 6), holding at heat for 2 hours ± 0.25, and cooling at a rate equivalent to a still air cool.

3.3.2.1.1 (R) Longitudinal Tensile Properties:

Tensile Strength, minimum	185 ksi (1276 MPa)
Yield Strength at 0.2% Offset, minimum	152 ksi (1048 MPa)
Elongation in 4D, minimum	10%
Reduction of Area, minimum	30%

3.3.2.1.1.1 Long-Transverse Tensile Tests: May be used instead of longitudinal tests if suitable specimens are obtainable from the product form.

3.3.2.1.2 Hardness: Should be 40 - 45 HRC, or equivalent, but the product shall not be rejected on the basis of hardness if the tensile property requirements of 3.3.2.1.1 are met.

3.3.3 Forging Stock: When a sample of stock is forged to a test coupon and heat treated as in 3.3.2.1, specimens taken from the heat treated coupon shall conform to the requirements of 3.3.2.1.1 and 3.3.2.1.2. If specimens taken from the stock after heat treatment as in 3.3.2.1 conform to the requirements of 3.3.2.1.1 and 3.3.2.1.2, the tests shall be acceptable as equivalent to tests of a forged coupon.

3.3.4 Stock for Flash Welded Rings: Specimens taken from the stock after heat treatment as in 3.3.2.1 shall conform to the requirements of 3.3.2.1.1 and 3.3.2.1.2.

3.4 Quality:

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.

3.4.1 Steel shall be aircraft quality conforming to AMS 2303 or MAM 2303.

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

3.5 Tolerances:

Shall conform to all applicable requirements of the following:

3.5.1 Bars and Wire: AMS 2241 or MAM 2241.

3.5.2 Mechanical Tubing: AMS 2243 or MAM 2243.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

(R) The vendor of the product shall supply all samples for vendor's tests and shall be responsible for performing all required tests. 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 (R) Acceptance Tests: Tests for composition (3.1), condition (3.2), macrostructure (3.3.1.1), decarburization (3.3.1.2), grain size (3.3.1.3), ferrite content (3.3.1.4), longitudinal tensile properties (3.3.2.1.1), hardness (3.3.2.1.2), and frequency-severity cleanliness rating (3.4.1) are acceptance tests and shall be performed on each heat or lot as applicable.

4.2.2 Periodic Tests: Tests of forging stock (3.3.3) and stock for flash welded rings (3.3.4) to demonstrate ability to develop required properties are periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.3 Sampling and Testing:

(R) Shall be in accordance with the following:

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

4.3.2 Forgings: AMS 2374.

4.4 Reports:

4.4.1 (R) The vendor of bars, wire, forgings, mechanical tubing, and flash welded rings shall furnish with each shipment a report showing the results of tests for chemical composition, macrostructure, grain size, and frequency-severity cleanliness rating of each heat and the results of tests of each lot to determine conformance to the other technical requirements. This report shall include the purchase order number, heat and lot number, AMS 5609C, size, and quantity. If forgings are supplied, the part number and the size and melt source of stock, if not the same as the forge shop, used to make the forgings shall also be included.