AEROSPACE MATERIAL SPECIFICATION

AMS5609	REV. D

Issued 1964-01
Revised 1999-10
Reaffirmed 2013-08

Superseding AMS5609C

Steel, Corrosion and Heat Resistant, Bars, Wire, Forgings, Tubing, and Rings
12Cr - 0.12Cb (SAE 51410 Modified)
Ferrite Controlled, Annealed
(Composition similar to UNS S41040)

RATIONALE

AMS5609D has been reaffirmed to comply with the SAE 5-year Review policy.

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 issue of the following documents in effect on the date of the purchase order form a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been canceled and no superseding document has been specified, the last published issue of that document shall apply.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AMS5609D

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, 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 Wrought Forms of Steels and Corrosion Resistant Steels and Alloys

AS1182 Standard Machining Allowance, Aircraft-Quality and Premium Aircraft-Quality Steel Bars and Mechanical Tubing

2.2 ASTM Publications

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM A 370 Mechanical Testing of Steel Products

ASTM E 112 Determining the 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

3. TECHNICAL REQUIREMENTS

3.1 Composition

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:

3.2.1 Bars

Annealed.

3.2.1.1 Round Bar

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

Annealed and cold drawn.

3.2.3 Forging and Flash Welded Rings

Annealed.

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

3.2.4 Mechanical Tubing

Annealed and cold finished.

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; hardness and tensile testing shall be performed in accordance with ASTM A 370.

3.3.1 Tensile Properties and Hardness as Received

3.3.1.1 Bars, Forging, Mechanical Tubing, and Flash Welded Rings

Hardness shall not be higher than 241 HB or equivalent (See 8.2).

3.3.1.2 Wire

Tensile strength shall not be higher than 115 ksi (793 MPa) or equivalent hardness (See 8.3).

3.3.2 Macrostructure

Visual examination of transverse sections from bars, wire, billets, tube rounds, 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. Porosity, segregation, inclusions, and other imperfections shall be no worse than macrostructure standards acceptable to purchaser.

3.3.3 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.

3.3.4 Average Grain Size

Shall be ASTM No. 5 or finer, determined in accordance with ASTM E 112 (See 8.4).

3.3.5 Ferrite Content

Shall be not more than 5%, determined in accordance with AMS 2315.

3.3.6 Response to Heat Treatment

Tensile specimens, taken from the product, or from precursor material (for forgings See 3.3.6.1), having a minimum nominal diameter of 0.250 inches (6.35 mm), which have been heat treated in accordance with 3.3.6.2 and tested in accordance with ASTM A 370 shall meet the requirements shown in Table 2 and 3.3.6.4.

3.3.6.1 To test forgings, specimen may be taken from forgings, forging stock, or stock which has been forged to simulate the least reduced section of the forgings.

3.3.6.2 Heat to 1700 °F ± 10 (927 °C ± 6), hold at heat for not less than 1 hour ± 0.1, and cool in still air and double temper 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.

TABLE 2 - MINIMUM LONGITUDINAL TENSILE PROPERTIES

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

3.3.6.3 Long-Transverse Tensile Tests

May be used instead of longitudinal tests if suitable specimens are obtainable from the product, and shall meet the longitudinal tensile properties of Table 2.

3.3.6.4 Hardness

Shall be 40 to 45 HRC, or equivalent (See 8.2). Product shall not be rejected on the basis of hardness if the tensile properties of 3.3.6, determined on specimens taken from the same sample as that with nonconforming hardness or from another sample with similar nonconforming hardness, are acceptable.

3.3.7 Stock for Flash Welded Rings

Specimens taken from the stock after heat treatment as in 3.3.6.2 shall conform to the requirements of Table 2 and 3.3.6.4.

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 Bars and tubing ordered hot rolled or cold drawn, or ground, turned, or polished, shall, after removal of the standard machining allowance in accordance with AS1182, be free from seams, laps, tears, and cracks open to the ground, turned, or polished surface.

3.4.3 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 be as follows:

3.5.1 Bars and Wire

In accordance with AMS 2241 or MAM 2241.

3.5.2 Mechanical Tubing

In accordance with 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 the performance of all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to specified requirements.

4.2 Classification of Tests

4.2.1 Acceptance Tests

Composition (3.1), tensile properties and hardness as received (3.3.1), macrostructure (3.3.2), decarburization (3.3.3), average grain size (3.3.4), ferrite content (3.3.5), response to heat treatment (3.3.6), 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 (3.3.6.1) and stock for flash welded rings (3.3.7) to demonstrate ability to develop required properties, and grain flow of die forgings 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

Shall be as follows:

4.3.1 Bars, Wire, Mechanical Tubing, Flash Welded Rings, and Stock for Forging or Flash Welded Rings

In accordance with AMS 2371.

4.3.2 Forgings

In accordance with AMS 2374.