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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 5611C

Issued 1 MAY 1970
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Superseding AMS 5611B

Submitted for recognition as an American National Standard

STEEL, CORROSION AND HEAT RESISTANT, BARS, WIRE, FORGINGS, TUBING, AND RINGS
12Cr
Ferrite Controlled, Consumable Electrode Melted

UNS S41040

1. SCOPE:

1.1 Form:

This specification covers a premium 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 pressure vessels or structural parts requiring uniformly high room-temperature tensile properties with oxidation resistance up to 1000 °F (538 °C), where control of ferrite 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.

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

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

2.1 SAE Publications (Continued):

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 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 A 604 Macroetch Testing of Consumable Electrode Remelted Steel Bars and Billets
ASTM E 112 Determining Average Grain Size
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
Nickel	--	0.75
Molybdenum	--	0.20
Aluminum	--	0.05
Copper	--	0.50
Tin	--	0.05
Nitrogen	--	0.18

3.1.1 Check Analysis: Composition variations shall meet the requirements of AMS 2248.

3.2 Melt Practice:

Steel shall be multiple melted using vacuum consumable electrode practice in the remelt cycle.

3.3 Condition:

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

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

3.3.1.1 Bars over 0.500 to 2.750 inches (12.70 to 69.85 mm), inclusive, in nominal diameter or distance between parallel sides and all hexagons shall be cold finished.

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

3.3.2 Wire: Cold drawn and annealed having tensile strength not higher than 115 ksi (793 MPa).

3.3.3 Forgings and Flash Welded Rings: Normalized and tempered having hardness not higher than 241 HB, or equivalent.

3.3.3.1 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.

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

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

3.4 Properties:

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

3.4.1 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 A 604, shall show no pipe or cracks. Except as specified in 3.4.1.1, porosity, segregation, inclusions, and other imperfections for product 36 square inches (232 cm^2) and under in nominal cross-sectional area shall be no worse than the macrographs of ASTM A 604 shown in Table 2; macrostructure standards for product over 36 square inches (232 cm^2) in nominal cross-sectional area shall be as agreed upon by purchaser and vendor:

TABLE 2 - Macrostructure

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

3.4.1.1 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.

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

3.4.2.1 Decarburization: Bars, wire, tubing, and flash welded rings 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.

3.4.2.2 (R) Properties After Heat Treatment: Bars, wire, forgings, tubing, and flash welded rings shall have the properties shown in Table 3, determined on full-section specimens taken from product 0.500 inch (12.70 mm) and under in nominal diameter or distance between parallel sides or on specimens 0.500 inch ± 0.100 (12.70 mm ± 2.54) in diameter cut from larger product after being hardened by heating in a neutral atmosphere to 1735 °F ± 10 (946 °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 in air reheating to 600 °F ± 10 (316 °C ± 6), holding at heat for 2 hours ± 0.25, and cooling in air.

3.4.2.2.1 Longitudinal Tensile Properties:

TABLE 3 - Minimum Tensile Properties

Property	Value
Tensile Strength	180 ksi (1241 MPa)
Yield Strength at 0.2% Offset	145 ksi (1000 MPa)
Elongation in 4D	10%
Reduction of Area	30%

3.4.2.2.1.1 Long-Transverse Tests: May be used instead of longitudinal tests if obtainable from the product form and shall conform to requirements of Table 3.

3.4.2.2.2 Hardness: Should be 39 - 44 HRC, or equivalent, but the product shall not be rejected on the basis of hardness if the tensile property requirements are met.

3.4.2.2.3 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.

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

3.4.3 Forging Stock: When a sample of stock is forged to a test coupon and heat treated as in 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, 3.4.2.2.3, and 3.4.2.2.4. If specimens taken from the stock after heat treatment as in 3.4.2.2 conform to the requirements of 3.4.2.2.1, 3.4.2.2.2, 3.4.2.2.3, and 3.4.2.2.4, the tests shall be acceptable as equivalent to tests of a forged coupon.

3.4.4 Stock for Flash Welded Rings: Specimens taken from the stock after heat treatment as in 3.3.2.2 shall conform to the requirements of 3.4.2.2.1, 3.4.2.2.2, 3.4.2.2.3, and 3.4.2.2.4.

3.5 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.

3.5.1 Steel shall be premium aircraft quality conforming to AMS 2300 or MAM 2300.

3.5.2 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.

3.6 Tolerances:

Shall conform to all applicable requirements of the following:

3.6.1 Bars and Wire: AMS 2241 or MAM 2241.

3.6.2 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 Acceptance Tests: Tests for the following requirements are acceptance
(R) tests and shall be performed on each heat or lot as applicable.

4.2.1.1 Composition (3.1) and frequency-severity cleanliness rating (3.5.1) of
(R) each heat.

4.2.1.2 Macrostructure (3.4.1) of the product.
(R)

4.2.1.3 Decarburization (3.4.2.1) of each lot of bars, wire, tubing, and flash
(R) welded rings.

4.2.1.4 Tensile properties (3.4.2.2.1), hardness (3.4.2.2.2.), grain size
(R) (3.4.2.2.3), and ferrite content (3.4.2.2.4) of each lot of bars, wire, tubing, and flash welded rings after heat treatment.

4.2.1.5 Tolerances of bars and wire (3.6.1) and mechanical tubing (3.6.2).
(R)

4.2.2 Periodic Tests: Tests for grain flow of die forgings (3.5.2) and tests of
(R) forging stock (3.4.3) and of stock for flash welded rings (3.4.4) 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 Forgings and Flash Welded Rings: AMS 2371.

4.3.1.1 Specimens for grain size of flash welded rings shall be cut from parent metal not including the weld-heat-affected zone.