SAE Aerospace
An SAE International Group

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 5655E

Issued 1959-01
Revised 2001-11
Reaffirmed 2010-10

Superseding AMS 5655D

Steel, Corrosion and Heat Resistant, Bars, Wire, and Forgings 12.5Cr - 0.75Ni - 1.0Mo - 1.0W - 0.24V (0.20-0.25C) Hardened and Tempered

(Composition similar to UNS S42200)

RATIONALE

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

1. SCOPE:

1.1 Form:

This specification covers a corrosion and heat resistant steel in the form of bars, wire, forgings, and forging stock.

1.2 Application:

These products have been used typically for parts requiring strength and oxidation resistance up to 1000 °F (538 °C), but usage is not limited to such applications.

2. APPLICABLE DOCUMENTS:

The issue of the following documents in effect on the date of the purchase order forms 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.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or www.sae.org.

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

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/AMS5655E

2.1 (Continued):

AMS 2248 Chemical Check Analysis Limits, Corrosion and Heat Resistant Steels and Alloys, Maraging and Other Highly-Alloyed Steels, and Iron Alloys
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 2750 Pyrometry
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

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 or www.astm.org.

ASTM A 370 Mechanical Testing of Steel Products
ASTM E 353 Chemical Analysis of Stainless, Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron Alloys
ASTM E 381 Macroetch Testing, Steel Bars, Billets, Blooms, and Forgings

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	0.20	0.25
Manganese	--	1.00
Silicon	0.20	0.60
Phosphorus	--	0.040
Sulfur	--	0.030
Chromium	11.00	13.50
Nickel	0.50	1.00
Molybdenum	0.75	1.25
Tungsten	0.75	1.25
Vanadium	0.17	0.30
Copper	--	0.50

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

3.2 Condition:

The product shall be supplied in the following condition:

3.2.1 Bars and Wire: Hardened and tempered. Bars 2.750 inches (69.85 mm) and under in nominal diameter or least distance between parallel sides and wire shall be cold finished. Larger bars shall be hot finished.

3.2.2 Forgings: Hardened, tempered, and descaled.

3.2.3 Forging Stock: As ordered by the forging manufacturer.

3.3 Heat Treatment:

Bars, wire, and forgings shall be hardened by heating to 1925 °F ± 25 (1052°C ± 14), holding at heat for not less than one hour, and suitably quenching, and tempered by heating to a temperature not lower than 1100 °F (593 °C), holding at heat for not less than four hours, cooling in air, reheating to a temperature not lower than 1000 °F (538 °C), holding at heat for not less than four hours, and cooling in air. Pyrometry shall be in accordance with AMS 2750.

3.4 Properties:

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

3.4.1 Macrostructure: Visual examination of transverse full cross-sections from bars, billets, and forging stock, etched in accordance with ASTM E 381, shall show no pipe or cracks. When specified, porosity, segregation, inclusions, and other imperfections shall be no worse than the macrographs of ASTM E 381 agreed upon by purchaser and vendor.

3.4.2 Bars, Wire, and Forgings:

3.4.2.1 Tensile Properties: Shall be as shown in Table 2.

TABLE 2 - Minimum Tensile Properties

Property	Value
Tensile Strength	140 ksi (965 MPa)
Yield Strength at 0.2% Offset	115 ksi (793 MPa)
Elongation in 4D	13%
Reduction of Area	25%

3.4.2.2 Hardness: Shall be 293 to 341 HB, or equivalent (See 8.2).

3.4.2.3 Charpy Impact Strength (Notch Sensitivity): Shall be not lower than 10 foot-pounds (13.5J), determined at room temperature using a V-notched Charpy specimen.

3.4.2.4 Decarburization:

3.4.2.4.1 Bars and wire ordered ground, turned, or polished shall be free from decarburization on the ground, turned, or polished surfaces.

3.4.2.4.2 Allowable decarburization of bars, wire, and billets ordered for forging or to specified microstructural requirements shall be as agreed upon by purchaser and vendor.

3.4.2.4.3 Decarburization of bars and wire to which 3.4.2.4.1 or 3.4.2.4.2 is not applicable shall be not greater than shown in Table 3.

TABLE 3A - Maximum Decarburization, Inch/Pound Units

Nominal Diameter or Distance Between Parallel Sides Inches	Total Depth of Decarbrization Inch
Up to 0.500, incl	0.010
Over 0.500 to 1.000, incl	0.015
Over 1.000 to 1.500, incl	0.020
Over 1.500 to 2.000, incl	0.025
Over 2.000 to 2.500, incl	0.030
Over 2.500 to 3.000, incl	0.035
Over 3.000 to 4.000, incl	0.045

TABLE 3B - Maximum Decarburization, SI Units

Nominal Diameter or Distance Between Parallel Sides Millimeters	Total Depth of Decarburization Millimeters
Up to 12.70, incl	0.25
Over 12.70 to 25.40, incl	0.38
Over 25.40 to 38.10, incl	0.51
Over 38.10 to 50.80, incl	0.64
Over 50.80 to 63.50, incl	0.76
Over 63.50 to 76.20, incl	0.89
Over 76.20 to 101.60, incl	1.14

3.4.2.4.4 Decarburization shall be measured by the metallographic method, by HR 30N scale hardness testing method, or by a traverse method using microhardness testing in accordance with ASTM E 384. The hardness method(s) shall be conducted on a hardened but untempered specimen protected during heat treatment to prevent changes in surface carbon content. Depth of decarburization, when measured by a hardness method, is defined as the perpendicular distance from the surface to the depth under that surface below which there is no further increase in hardness. Such measurements shall be far enough away from any adjacent surface to be uninfluenced by any decarburization on the adjacent surface. In case of dispute, the depth of decarburization determined using the microhardness traverse method shall govern.

3.4.2.4.4.1 When determining the depth of decarburization, it is permissible to disregard local areas provided the decarburization of such areas does not exceed the above limits by more than 0.005 inch (0.13 mm) and the width is 0.065 inch (1.65 mm) or less.

3.4.3 Forging Stock: When a sample of stock is forged to a test coupon having a degree of mechanical working not greater than the forging and heat treated as in 3.3, specimens taken from the heat treated coupon shall conform to the requirements of 3.4.2.1, 3.4.2.2, and 3.4.2.3. If specimens taken from the stock after heat treatment as in 3.3 conform to the requirements of 3.4.2.1, 3.4.2.2, and 3.4.2.3, the tests shall be acceptable as equivalent to tests of a forged coupon.

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 Bars and wire 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.

3.5.2 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 reentrant grain flow.

3.6 Tolerances:

Bars and wire shall conform to all applicable requirements of AMS 2241 or MAM 2241.

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: The following requirements are 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) of each heat.

4.2.1.2 Tensile properties (3.4.2.1), hardness (3.4.2.2), and Charpy impact strength (3.4.2.3) of each lot of bars, wire, and forgings.

4.2.1.3 Decarburization (3.4.2.4) and tolerances (3.6) of bars and wire.

4.2.2 Periodic Tests: Tests of forging stock to demonstrate ability to develop required properties (3.4.3) and grain flow of die forgings (3.5.2) 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, and Forging Stock: In accordance with AMS 2371.

4.3.2 Forgings: In accordance with AMS 2374.

4.4 Reports:

The vendor of the product shall furnish with each shipment a report showing the results of tests for chemical composition and macrostructure of each heat and for hardness, tensile properties, and impact strength of each lot, and stating that the product conforms to the other technical requirements. This report shall include the purchase order number, heat and lot numbers, AMS 5655E, size, and quantity. If forgings are supplied, the size and melt source of stock used to make the forgings shall also be included.

4.5 Resampling and Retesting:

Shall be as follows:

4.5.1 Bars, Wire, and Forging Stock: In accordance with AMS 2371.

4.5.2 Forgings: In accordance with AMS 2374.