



AEROSPACE MATERIAL SPECIFICATION	AMS5655™	REV. G
	Issued 1959-01 Reaffirmed 2010-10 Revised 2022-09	
Superseding AMS5655F		
Steel, Corrosion- and Heat-Resistant, Bars, Wire, Forgings, and Forging Stock 12.5Cr - 0.75Ni - 1.0Mo - 1.0W - 0.24V (0.20-0.25C) Hardened and Tempered (Composition similar to UNS S42200)		

RATIONALE

AMS5655G is the result of a Five-Year Review and update of the specification. The revision updates the title to match the scope, updates composition and reporting (3.1, 3.1.1), prohibits bars being cut from plate (3.2.1.1, 4.4.3), adds tensile strain rate for bar and forgings (3.4.2.1.1), updates decarburization requirement (3.4.2.4.4), removes hardness and impact requirements from wire as not applicable (3.4.2.2, 3.4.2.3, 4.2.1.3), adds AS1182 (3.5.1, 8.4), prohibits unauthorized exceptions (3.7, 4.4.4, 5.2.1.1, 8.6), allows prior revision (8.5), and adds forging stock properties (8.7).

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 cancelled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AMS2241 Tolerances, Corrosion- and Heat-Resistant Steel, Iron Alloy, Titanium, and Titanium Alloy Bars and Wire

AMS2248 Chemical Check Analysis Limits, Corrosion- and Heat-Resistant Steels and Alloys, Maraging and Other Highly Alloyed Steels, and Iron Alloys

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SAE WEB ADDRESS:

For more information on this standard, visit
<https://www.sae.org/standards/content/AMS5655G/>

AMS2371	Quality Assurance Sampling and Testing, Corrosion- and Heat-Resistant Steels and Alloys, Wrought Products and Forging Stock
AMS2374	Quality Assurance Sampling and Testing, Corrosion- and Heat-Resistant Steel and Alloy Forgings
AMS2750	Pyrometry
AMS2806	Identification, Bars, Wire, Mechanical Tubing, and Extrusions, Carbon and Alloy Steels and Corrosion- and Heat-Resistant Steels and Alloys
AMS2808	Identification, Forgings
AS1182	Standard Stock Removal Allowance, Aircraft-Quality and Premium Aircraft-Quality Steel Bars and Mechanical Tubing
AS7766	Terms Used in Aerospace Metals Specifications

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM A370	Mechanical Testing of Steel Products
ASTM A751	Chemical Analysis of Steel Products
ASTM E140	Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, Scleroscope Hardness, and Leeb Hardness
ASTM E381	Macroetch Testing, Steel Bars, Billets, Blooms, and Forgings
ASTM E1077	Estimating the Depth of Decarburization of Steel Specimens

2.3 Definitions

Terms used in AMS are defined in AS7766.

3. TECHNICAL REQUIREMENTS

3.1 Composition

Shall conform to the percentages by weight shown in Table 1, determined in accordance with ASTM A751 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 Producer may test for any element not listed in Table 1 and include this analysis in the report of 4.4. Reporting of any element not listed in the composition table is not a basis for rejection, unless limits of acceptability are specified by the purchaser.

3.1.2 Check Analysis

Composition variations shall meet the applicable requirements of AMS2248.

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.

3.2.1.1 Bars shall not be cut from plate (see 4.4.3).

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 $1925^{\circ}\text{F} \pm 25^{\circ}\text{F}$ ($1052^{\circ}\text{C} \pm 14^{\circ}\text{C}$), holding at heat for not less than 1 hour, and suitably quenching, and tempered by heating to a temperature not lower than a furnace setpoint of 1100°F (593°C), holding at heat for not less than 4 hours, cooling in air, reheating to a temperature not lower than a furnace setpoint of 1000°F (538°C), holding at heat for not less than 4 hours, and cooling in air. Pyrometry shall be in accordance with AMS2750.

3.4 Properties

The product shall conform to the following requirements; hardness, tensile, and impact testing shall be performed in accordance with ASTM A370:

3.4.1 Macrostructure

Visual examination of transverse full cross-sections from bars, billets, and forging stock, etched in accordance with ASTM E381, shall show no pipe or cracks. When specified, porosity, segregation, inclusions, and other imperfections shall be no worse than the macrographs of ASTM E381 agreed upon by purchaser and producer.

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%

3.4.2.1.1 Unless otherwise specified, for bar and forgings, the strain rate shall be set at 0.005 in/in/min (0.005 mm/mm/min) and maintained within a tolerance of ± 0.002 in/in/min (0.002 mm/mm/min) through 0.2% offset yield strain. The strain rate after yield may be increased to any value up to 0.5 in/in/min (or 0.5 mm/mm/min) or equivalent crosshead speed as a function of gage length.

3.4.2.2 Hardness of Bars and Forgings

Shall be 293 to 341 HB, or equivalent (see 8.2).

3.4.2.3 Charpy Impact Strength (Notch Sensitivity) of Bars and Forgings

Shall be not lower than 10 ft-lbf (13.5 J), determined at room temperature using a Charpy V-notch 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 producer.

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 Decarburization Inches
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 evaluated by one of the following methods.

3.4.2.4.4.1 Metallographic (Microscopic) Method

A cross section taken perpendicular to the surface shall be etched and examined metallographically at a magnification not to exceed 200X in accordance with ASTM E1077. The sample shall not show a layer of complete (ferrite) or partial decarburization exceeding the limits of Table 3.

3.4.2.4.4.2 Hardness Traverse (Microindentation Method)

The total depth of decarburization shall be determined by a traverse method using microindentation hardness testing in accordance with ASTM E1077. Samples shall be hardened but untempered and protected during heat treatment to prevent changes in surface carbon content. Measurements shall be far enough away from any adjacent surface to be uninfluenced by any decarburization on the adjacent surface. Acceptance shall be as listed in Table 3.

3.4.2.4.4.3 In case of dispute, the depth of decarburization determined using the microhardness traverse method shall govern.

3.4.2.4.4.4 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 shall be free from seams, laps, tears, and cracks after removal of the standard stock removal allowance in accordance with AS1182.

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 AMS2241.

3.7 Exceptions

Any exceptions shall be authorized by the purchaser and reported as in 4.4.4.

4. QUALITY ASSURANCE PROVISIONS.

4.1 Responsibility for Inspection

The producer of the product shall supply all samples for producer'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) of each lot of bars, wire, and forgings.

4.2.1.3 Hardness (3.4.2.2), and Charpy impact strength (3.4.2.3) of each lot of bars and forgings.

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

4.2.2 Periodic Tests

The ability of forging stock 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 producer 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 AMS2371.

4.3.2 Forgings

In accordance with AMS2374.

4.4 Reports

4.4.1 The producer of the product shall furnish with each shipment a report showing the producer's name and country where the metal was melted (e.g., final melt in the case of metal processed by multiple melting operation) and the results of tests for chemical composition and macrostructure of each heat and for hardness, tensile properties, impact strength, decarburization, and tolerances 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, AMS5655G, size, and quantity. If forgings are supplied, the size and melt source of stock used to make the forgings shall also be included.

4.4.2 The producer of forging stock shall furnish with each shipment a report showing the producer's name and country where the metal was melted (e.g., final melt in the case of metal processed by multiple melting operation) and the results of tests for composition and macrostructure of each heat. This report shall include the purchase order number, heat number, AMS5655G, size, and quantity.

4.4.3 Report the nominal metallurgically worked cross sectional size and the cut size, if different (see 3.2.1.1).

4.4.4 When material produced to this specification has exceptions taken to the technical requirements listed in Section 3, the report shall contain a statement "This material is certified as AMS5655G(EXC) because of the following exceptions:" and the specific exceptions shall be listed (also see 5.2.1.1).

4.5 Resampling and Retesting

Shall be as follows:

4.5.1 Bars, Wire, and Forging Stock

In accordance with AMS2371.