AEROSPACE MATERIAL SPECIFICATION

AMS6527™	REV. G

Issued 1980-07
Reaffirmed 2009-06
Revised 2023-05

Superseding AMS6527F

Steel, Bars, Forgings, and Forging Stock
2.0Cr - 10Ni - 14Co - 1.0Mo (0.15 - 0.19C)
Vacuum Melted, Normalized and Overaged
(Composition similar to UNS K92571)

RATIONALE

AMS6527G results from a Five-Year Review and update of this specification. The revision updates the title to match the scope, prohibits unauthorized exceptions (1.1, 3.5.5.3, 3.8, 4.4.4), highlights stress corrosion susceptibility (1.2.1), updates composition reporting (3.3.1), updates macrostructure requirements (3.5.1.1, 8.7), revises decarburization testing methodology (3.5.3.4), adds pyrometry controls (3.5.5.1), reformats response to heat treatment (Table 5) revises tensile and hardness test specifications (3.5.5.1.1,3.5.5.1.2, 3.3.1), and adds optional forging stock tests and reporting (4.4.3, 8.7).

1. SCOPE

1.1 Form

This specification covers a premium aircraft-quality alloy steel in the form of bars, forgings 100 square inches in cross section and less, and forging stock of any size.

1.2 Application

These products have been used typically for heat-treated parts requiring a combination of high strength, toughness, and weldability, 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 after heat treatment. 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 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.

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

For more information on this standard, visit
https://www.sae.org/standards/content/AMS6527G/

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.

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

AMS2251 Tolerances, Low-Alloy Steel Bars

AMS2300 Steel Cleanliness, Premium Aircraft-Quality, Magnetic Particle Inspection Procedure

AMS2310 Qualification Sampling and Testing of Steels for Transverse Tensile Properties

AMS2370 Quality Assurance Sampling and Testing, Carbon and Low-Alloy Steel Wrought Products and Forging Stock

AMS2372 Quality Assurance Sampling and Testing, Carbon and Low-Alloy Steel 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

ARP1110 Minimizing Stress Corrosion Cracking in Wrought Forms of Steels, and Corrosion Resistant Steels and Alloys

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 A604 Macroetch Testing of Consumable Electrode Remelted Steel Bars and Billets

ASTM A751 Chemical Analysis of Steel Products

ASTM E23 Notched Bar Impact Testing of Metallic Materials

ASTM E45 Determining the Inclusion Content of Steel

ASTM E112 Determining Average Grain Size

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 E399 Plane-Strain Fracture Toughness of Metallic Materials

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 the purchaser.

Table 1 - Composition

Element	Min	Max
Carbon	0.15	0.19
Manganese	--	0.10
Silicon	--	0.10
Phosphorus	--	0.008
Sulfur	--	0.005
Phosphorus + Sulfur	--	0.010
Chromium	1.80	2.20
Nickel	9.50	10.50
Cobalt	13.50	14.50
Molybdenum	0.90	1.10
Titanium	--	0.015
Aluminum	--	0.015
Oxygen	--	0.0020 (20 ppm)
Nitrogen	--	0.0015 (15 ppm)

3.1.1 The 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 Melting Practice

Steel shall be multiple melted using vacuum induction melting followed by vacuum consumable electrode practice.

3.3 Condition

The product shall be supplied in the following condition:

3.3.1 Bars and Forgings

Normalized and overaged with hardness not higher than 36 HRC, or equivalent (see 8.2), determined in accordance with ASTM A370. Bar shall not be cut from plate (see 4.4.2).

3.3.2 Forging Stock

As ordered by the forging manufacturer.

3.4 Heat Treatment

Shall conform to the following:

3.4.1 Bars and Forgings

Shall be normalized by heating to 1650 °F ± 25 °F (899 °C ± 14 °C), holding at heat for 60 minutes ± 5 minutes, and cooling to room temperature at a rate equivalent to a still air cool or faster, and overaged by heating to 1250 °F ± 25 °F (677 °C ± 14 °C), holding at heat for not less than 6 hours, and forced-air cooling. Pyrometry shall be in accordance with AMS2750.

3.5 Properties

The product shall conform to the following requirements:

3.5.1 Macrostructure

Visual examination of transverse full cross sections from bars, billets, and forging stock, etched in hot hydrochloric acid in accordance with ASTM A604, shall show no pipe or cracks. Porosity, segregation, inclusions, and other imperfections shall be no worse than the macrographs of ASTM A604 shown in Table 2.

Table 2 - Macrostructure limits

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

3.5.1.1 Macrostructure examination is not required for bored/hollow forgings (including ring forgings) that are produced directly from ingots or large blooms unless otherwise agreed upon by the purchaser and producer (see 8.7).

3.5.2 Micro-Inclusion Rating

No specimen shall exceed the limits shown in Table 3, determined in accordance with ASTM E45, Method D, except that the length of any inclusion shall be not greater than 0.015 inch (0.38 mm).

Table 3 - Micro-inclusion rating limits

Field	A Thin	A Heavy	B Thin	B Heavy	C Thin	C Heavy	D Thin	D Heavy
Worst Field Severity	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Worst Field Frequency, Maximum	a	1	a	1	a	1	3	1
Total Ratable Fields Frequency, Maximum	b	1	b	1	b	1	8	1

a - Combined A+B+C, not more than three fields.
b - Combined A+B+C, not more than eight fields.

3.5.2.1 A ratable field is defined as one which has a type A, B, C, or D inclusion rating of at least 1.0 thin or heavy in accordance with ASTM E45.

3.5.3 Decarburization

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

3.5.3.2 Allowable decarburization of bars and billets ordered for redrawing or forging or to specified microstructural requirements shall be as agreed upon by the purchaser and producer.

3.5.3.3 Where 3.5.3.1 or 3.5.3.2 are not applicable, decarburization of bars shall be no greater than shown in Table 4.

Table 4A - Maximum decarburization, bars, inch/pound units

Nominal Diameter or Distance Between Parallel Sides Inches	Total Depth of Decarburization Inches
Up to 0.375, incl	0.015
Over 0.375 to 0.500, incl	0.017
Over 0.500 to 0.625, incl	0.019
Over 0.625 to 1.000, incl	0.022
Over 1.000 to 1.500, incl	0.025
Over 1.500 to 2.000, incl	0.030
Over 2.000 to 2.500, incl	0.035
Over 2.500 to 4.000, incl	0.040

Table 4B - Maximum decarburization, bars, SI units

Nominal Diameter or Distance Between Parallel Sides Millimeters	Total Depth of Decarburization Millimeters
Up to 9.52, incl	0.38
Over 9.52 to 12.70, incl	0.43
Over 12.70 to 15.88, incl	0.48
Over 15.88 to 25.40, incl	0.56
Over 25.40 to 38.10, incl	0.64
Over 38.10 to 50.80, incl	0.76
Over 50.80 to 63.50, incl	0.89
Over 63.50 to 101.60, incl	1.02

3.5.3.4 Decarburization shall be evaluated by one of the two methods of 3.5.3.4.1 or 3.5.3.4.2.

3.5.3.4.1 Metallographic (Microscopic) Method

A cross section of 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 4.

3.5.3.4.2 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 in a protective atmosphere to prevent changes in surface carbon content. Samples may be tempered at the option of the producer. 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 4.

3.5.3.4.3 When determining the depth of decarburization, it is permissible to disregard local areas provided the decarburization of such areas does not exceed the limits of Table 4 by more than 0.005 inch (0.13 mm) and the width is 0.065 inch (1.65 mm) or less.

3.5.3.4.4 In case of dispute, the total depth of decarburization determined using the microindentation hardness traverse method shall govern.

3.5.4 Average Grain Size

Prior austenitic grain size shall be ASTM No. 6 or finer for product 100 square inches (645 cm^2) and under in cross-sectional area, determined in accordance with ASTM E112.

3.5.5 Response to Heat Treatment

3.5.5.1 Bars and Forgings

Test specimens cut from product 100 square inches (645 cm^2) and under in cross-sectional area that have been normalized and overaged as in 3.4 shall have the following properties after being heated in accordance with Table 5. Pyrometry shall be in accordance with AMS2750.

Table 5 - Response to heat-treatment processing

Processing Step[1]		Temperature	Time at Temperature
1	Normalize[2]	1650 °F ± 25 °F (899 °C ± 14 °C)	60 minutes ± 5 minutes
2	Air Cool[2]	At a rate equivalent to still air cool or faster	
3	Austenitize	1575 °F ± 25 °F (857 °C ± 14 °C)	60 minutes ± 5 minutes
4	Oil Quenched		
5	Subzero Cool	-85 °F (-65 °C) or colder	60 minutes ± 5 minutes
6	Warm in Air to Room Temperature		
7	Age	950 °F ± 10 °F (510 °C ± 6 °C)	5 hours minimum
8	Forced Air Cooled	Room Temperature	

[1] Note that all processing must be performed in the order noted.
[2] Not required if parent product has previously been heat treated as in 3.4.

3.5.5.1.1 Longitudinal Tensile Properties

Shall be as shown in Table 6, determined in accordance with ASTM A370. Testing in the longitudinal direction need not be performed on product tested in the transverse direction.

Table 6 - Minimum longitudinal tensile properties

Property	Value
Tensile Strength	235 ksi (1620 MPa)
Yield Strength at 0.2% Offset	215 ksi (1482 MPa)
Elongation in 2 Inches (50 mm) or 4D	12%
Reduction of Area	60%

3.5.5.1.2 Transverse Tensile Properties

Shall be as shown in Table 7, determined on specimens selected and prepared in accordance with AMS2310 in accordance with ASTM A370. Transverse tensile properties apply only to product where tensile specimens not less than 2.50 inches (63.5 mm) in length can be taken.

Table 7 - Minimum transverse tensile properties

Property	Value
Tensile Strength	235 ksi (1620 MPa)
Yield Strength at 0.2% Offset	215 ksi (1482 MPa)
Elongation in 2 Inches (50 mm) or 4D	12%
Reduction of Area	55%

3.5.5.1.3 Unless otherwise specified, 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. After the yield strain, the speed of the testing machine shall be set between 0.05 and 0.5 in/in (0.05 and 0.5 mm/mm) of the length of the reduced section (or distance between the grips for specimens not having a reduced section) per minute. Alternatively, an extensometer and strain rate indicator may be used to set the strain rate between 0.05 and 0.5 in/in/min (0.05 and 0.5 mm/mm/min).

3.5.5.1.4 Fracture Toughness

Shall not be less than 130 ksi √inch (143 MPa √m) K_{IC} determined in accordance with ASTM E399, with a B dimension of 1.50 inches (38.1 mm) or greater and W dimensions as specified. Sample orientation shall be L-S or L-T for billet, rectangular bar, or forging and L-R or L-C for round bar.

3.5.5.1.4.1 Testing smaller product not accommodated by 3.5.5.1.4 shall be conducted using Charpy V-notch test in accordance with ASTM E23, with longitudinal axis parallel to the grain direction. The minimum impact value shall be 45 foot-pounds (61 J) at room temperature.

3.5.5.2 Forging Stock

When a sample of stock is forged to a test coupon and heat treated as in 3.4 and 3.5.5.1, specimens taken from the heat-treated coupon shall conform to the requirements of 3.5.5.1.1, and/or 3.5.5.1.2, and 3.5.5.1.4. If specimens taken from the stock after heat treatment as in 3.4 and 3.5.5.1 conform to the requirements of 3.5.5.1.1 and/or 3.5.5.1.2, and 3.5.5.1.4, tests shall be accepted as equivalent to tests of a forged coupon.

3.5.5.3 Mechanical property requirements for product outside the size range covered by the tables or scope shall be agreed upon between the purchaser and producer and reported per 4.4.4.

3.6 Quality

The product, as received by the purchaser, shall be uniform in quality and condition, sound, and free from foreign materials and from imperfections detrimental to usage of the product.

3.6.1 Steel shall be premium aircraft-quality conforming to AMS2300, except that a maximum average frequency (F) rating of 0.10 and a maximum average severity (S) rating of 0.20 shall apply.

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

3.6.3 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 reentrant grain flow.

3.7 Tolerances

Bars shall conform to all applicable requirements of AMS2251.

3.8 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 the producer's tests and shall be responsible for the performance of all required tests. The 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), macrostructure (3.5.1), and micro-inclusion rating (3.5.2) of each heat.

4.2.1.2 Hardness (3.3.1), decarburization (3.5.3), and average grain size (3.5.4) of each lot.

4.2.1.3 Tensile properties (3.5.5.1.1 and/or 3.5.5.1.2) and fracture toughness (3.5.5.1.4) of each lot of bars and forgings after heat treatment.

4.2.1.4 Tolerances (3.7) of bars.

4.2.2 Periodic Tests

The following requirements are periodic tests and shall be performed at a frequency selected by the producer unless frequency of testing is specified by the purchaser:

4.2.2.1 Ability of forging stock to develop required properties (3.5.5.2).

4.2.2.2 Frequency severity cleanliness rating (3.6.1).

4.2.2.3 Grain flow of die forgings (3.6.3).

4.3 Sampling and Testing

Shall be as follows:

4.3.1 Bars and Forging Stock

In accordance with AMS2370.

4.3.2 Forgings

In accordance with AMS2372.

4.4 Reports

4.4.1 The producer of the bars and forgings shall furnish with each shipment a report showing the producer's identity, country where the metal was melted (i.e., final melt in the case of metal processed by multiple melting operations), the results of tests for composition, macrostructure, and micro-inclusion rating of each heat, for hardness, average grain size, and response to heat treatment including tensile properties and fracture toughness 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, AMS6527G, product form and size (and/or part number, if applicable), 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 Report the nominal metallurgically worked cross-sectional size and the cut size (see 3.3.1).

4.4.3 The producer of forging stock shall furnish with each shipment a report showing the producer's name, country where the metal was melted (e.g., final melt in the case of metal processed by multiple melting operations) and the composition, macrostructure, micro-inclusion rating of each heat, and the results of additional property requirements imposed by the purchase order (see 8.7). This report shall include the purchase order number, heat number, AMS6527G, size, and quantity.