AEROSPACE MATERIAL SPECIFICATION

AMS6523™	REV. J

Issued 1970-11
Revised 2022-11

Superseding AMS6523H

Steel, Sheet, Strip, and Plate
0.75Cr - 9.0Ni - 4.5Co - 1.0Mo - 0.09V (0.17 - 0.23C)
Vacuum Consumable Electrode Melted, Annealed
(Composition similar to UNS K91472)

RATIONALE

AMS6523J is the result of a Five-Year Review and update of this specification. The revision prohibits unauthorized exceptions (3.8, 4.4.1, 5.1.1, 8.7), updates composition testing and reporting (3.1, 3.1.1), includes continuous heat treatment (3.4.1.1), incorporates updates to decarburization test methods (3.5.4), updates response to heat treatment requirements (3.5.5), adds strain rate (3.5.5.2), incorporates grain size options (4.2.1, 4.2.2, 4.4, 8.7), addresses cleanliness (4.4, 8.8), and allows prior revisions (8.6).

1. SCOPE

1.1 Form

This specification covers a premium aircraft-quality, low-alloy steel in the form of sheet, strip, and plate.

1.2 Application

These products have been used typically for parts requiring through-hardening to high strength and toughness levels and where such parts may require welding during fabrication, but usage is not limited to such applications.

2. APPLICABLE DOCUMENTS

The following publications form a part of this document 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. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

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.

AMS2252 Tolerances, Low-Alloy Steel Sheet, Strip, and Plate

AMS2259 Chemical Check Analysis Limits, Wrought Low-Alloy and Carbon Steels

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

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
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For more information on this standard, visit
https://www.sae.org/standards/content/AMS6523J/

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

AMS2750 Pyrometry

AMS2807 Identification, Carbon and Low-Alloy Steels, Corrosion and Heat-Resistant Steels and Alloys Sheet, Strip, Plate, and Aircraft 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 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 purchaser.

Table 1 - Composition

Element	Min	Max
Carbon	0.17	0.23
Manganese	0.20	0.40
Silicon	--	0.20
Phosphorus	--	0.010
Sulfur	--	0.010
Chromium	0.65	0.85
Nickel	8.50	9.50
Cobalt	4.25	4.75
Molybdenum	0.90	1.10
Vanadium	0.06	0.12
Copper	--	0.35

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 AMS2259.

3.2 Melting 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 shall be determined in accordance with ASTM A370.

3.3.1 Sheet and Strip

Cold finished, bright or atmosphere annealed, and descaled if necessary; or hot rolled, annealed, and descaled having hardness not higher than 36 HRC, or equivalent (see 8.2).

3.3.2 Plate

Hot rolled, annealed, and descaled having hardness not higher than 36 HRC, or equivalent (see 8.2).

3.3.2.1 If allowed by the purchaser, cold rolled, annealed, and descaled having hardness not higher than 36 HRC, or equivalent (see 8.2).

3.3.3 When normalized and tempered product is ordered, hardness shall be not higher than 40 HRC, or equivalent (see 8.2).

3.4 Heat Treatment

Shall be as follows; pyrometry shall be in accordance with AMS2750:

3.4.1 Annealing

Product shall be annealed by heating to 1250 °F ± 25 °F (677 °C ± 14 °C), holding at heat for 4 hours ± 0.25 hour, air cooling to room temperature, reheating to 1150 °F ± 25 °F (621 °C ± 14 °C), holding at heat for 8 hours ± 0.25 hour, and cooling in air to room temperature.

3.4.1.1 Continuous Heat Treatment

When continuous heat treating is used process parameters (e.g., furnace temperature set points, heat input, travel rate, etc.) for continuous heat treating lines shall be established by the material producer and validated by testing of product to the requirements of 3.3 and 3.5.

3.4.2 Normalizing

When specified by purchaser, product shall be normalized prior to annealing by heating to 1650 °F ± 25 °F (899 °C ± 14 °C), holding at heat for not less than 1 h/in (25 mm) of maximum thickness, but not less than 1 hour, and cooling in air to room temperature.

3.5 Properties

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

3.5.1 Macrostructure of Each Heat

Visual examination of full transverse cross-sections of slab, billet or suitable rerolled product, 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

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

3.5.2 Micro-Inclusion Rating

No specimen shall exceed the limits shown in Table 3, determined in accordance with ASTM E45, Method D.

Table 3 - Micro-inclusion rating limits

	A Thin	A Heavy	B Thin	B Heavy	C Thin	C Heavy	D Thin	D Heavy
Worst Field Severity	1.5	1.0	1.5	1.0	1.5	1.0	1.5	1.0
Worst Field Frequency, Max	a	1	a	1	a	1	3	1
Total Rateable Fields Frequency, Max	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 rateable field is defined as one that has a type A, B, C, or D inclusion rating of at least 1.0 thin or heavy in accordance with ASTM E45 (see 8.4).

3.5.3 Average Grain Size of Each Lot

Shall be ASTM No. 5 or finer, determined in accordance with ASTM E112.

3.5.4 Decarburization of Each Lot

Decarburization shall be evaluated by one of the methods of 3.5.4.1 or 3.5.4.2.

3.5.4.1 Metallographic (Microscopic) Method

A cross section taken perpendicular to the surface shall be prepared, etched, and visually 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.

3.5.4.2 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.

Table 4A - Maximum decarburization, inch/pound units

Nominal Thickness Inches	Total Depth of Decarburization Inches
Up to 0.500, incl	0.015
Over 0.500 to 1.000, incl	0.025
Over 1.000	0.035

Table 4B - Maximum decarburization, SI units

Nominal Thickness Millimeters	Total Depth of Decarburization Millimeters
Up to 12.70, incl	0.38
Over 12.70 to 25.40, incl	0.64
Over 25.40	0.89

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

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

3.5.5 Response to Heat Treatment

3.5.5.1 Properties After Normalizing, Hardening, Sub-Zero Cooling, and Double Tempering Heat Treatment

Samples from product shall meet the following properties after being heat treated in accordance with Table 5.

Table 5 - Response to heat treatment processing

Processing Step[1][4]		Temperature	Time at Temperature
1	Normalized[2]	1650 °F ± 25 °F (899 °C ± 14 °C)	1 h/in (25 mm) of maximum cross-section
2	Cool in air to room temperature		
3	Hardened	1525 °F ± 25 °F (829 °C ± 14 °C)	1 h/in (25 mm) of maximum cross-section, but not less than 1 hour
4	Quenching in oil or water		
5	Subzero cool	-90 °F (-68 °C) or lower within 2 hours	Not less than 2 hours
6	Warm in air to room temperature		
7	Temper (1), within 2 hours of reaching room temperature[3]	1035 °F ± 15 °F (557 °C ± 8 °C)	2 h/in (25 mm) of maximum cross-section, but not less than 2 hours
8	Cool to approximately 125 °F (52 °C) or lower		
9	Temper (2)	1035 °F ± 15 °F (557 °C ± 8 °C)	2 h/in (25 mm) of maximum cross-section, but not less than 2 hours
10	Cool in air to room temperature		

(1) Note that all processing must be performed in the order noted.
(2) Normalizing may be omitted if the product was supplied normalized and annealed.
(3) If the first temper cannot be performed within 2 hours of subzero treatment, a snap temper may be performed at 350 to 450 °F (177 to 232 °C) for 2 h/in (25 mm) of thickness. Then perform double temper steps 7 through 10.
(4) Heat treating equipment and controls shall be in accordance with AMS2750.

3.5.5.2 Tensile Properties

Shall be as shown in Table 6.

Table 6A - Minimum tensile properties, inch/pound units

Nominal Thickness Inches	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 2 Inches or 4D %	Reduction of Area %
Up to 0.250, excl	190	175	5	45
0.250 and over	190	175	10	45

Table 6B - Minimum tensile properties, SI units

Nominal Thickness Millimeters	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 50.8 mm or 4D %	Reduction of Area %
Up to 6.35, excl	1310	1207	5	45
6.35 and over	1310	1207	10	45

3.5.5.2.1 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 in/in and 0.5 in/in (0.05 mm/mm 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 in/in/min and 0.5 in/in/min (0.05 mm/mm/min and 0.5 mm/mm/min). The requirement for compliance becomes effective for material produced 1 year after the publication date of this specification.

3.5.5.3 Hardness

Shall be 41 to 46 HRC, or equivalent (see 8.2).

3.5.5.4 Fracture Toughness

When specified, the product shall be subject to fracture toughness testing. There is no recognized standard for fracture toughness testing of sheet, strip, and plate under 1/2 inch thick. Method of test and acceptance standards shall be as specified by the purchaser. Procedure for thicker product shall conform to ASTM E399 or, when permitted by purchaser, ASTM E1304. Results of tests on sheet and strip over 4 inches (102 mm) wide and plate less than 1.50 inches (38.1 mm) in thickness shall be reported. Plate over 1.50 inches (38.1 mm) in thickness shall have fracture toughness not less than 120 ksi √inch (132 MPa √m) in the longitudinal direction (LT) and 110 ksi √inch (121 MPa √m) in the long-transverse (TL) direction.

3.6 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.

3.6.1 Steel shall be premium aircraft-quality conforming to AMS2300.

3.7 Tolerances

Shall be in accordance with AMS2252.

3.8 Exceptions

Any exceptions shall be authorized by the purchaser and reported as in 4.4.1.