SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS6523 REV. G

Issued 1970-11
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Superseding AMS6523F

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

AMS6523G results from a Five Year Review and update of this specification that includes revision of the decarburization requirements.

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 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 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

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

AMS2750 Pyrometry

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/AMS6523G

AMS2759 Heat Treatment of Steel Parts, General Requirements

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

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 A 370 Mechanical Testing of Steel Products

ASTM A 604 Macroetch Testing of Consumable Electrode Remelted Steel Bars and Billets

ASTM E 45 Determining the Inclusion Content of Steel

ASTM E 112 Determining Average Grain Size

ASTM E 350 Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron

ASTM E 384 Knoop and Vickers Hardness of Materials

ASTM E 399 Plane-Strain Fracture Toughness of Metallic Materials

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 350, by spectrochemical methods, 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 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 A 370.

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 (677 °C ± 14), holding at heat for 4 hours ± 0.25, air cooling to room temperature, reheating to 1150 °F ± 25 (621 °C ± 14), holding at heat for 8 hours ± 0.25, and cooling in air to room temperature.

3.4.2 Normalizing

When specified by purchaser, product shall be normalized prior to annealing by heating to 1650 °F ± 25 (899 C° ± 14) , holding at heat for not less than 1 hour per inch (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 A 370:

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 A 604, shall show no pipe or cracks. Porosity, segregation, inclusions, and other imperfections shall be no worse than the macrographs of ASTM A 604 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 E 45, 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 3 fields
b - Combined A+B+C, not more than 8 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 the Jernkontoret Chart, Plate I-r, of ASTM E 45 (See 8.4).

3.5.3 Average Grain Size of Each Lot

Shall be ASTM No. 5 or finer, determined in accordance with ASTM E 112.

3.5.4 Decarburization of Each Lot

Decarburization shall be evaluated by one of the methods of 3.5.4.1, 3.5.4.2, or 3.5.4.3 at the discretion of the producer.

3.5.4.1 Metallographic Method

A cross section of the surface shall be visually examined metallographically at a magnification not to exceed 100X. The product shall show no layer of complete or partial decarburization exceeding the limits of Table 4.

3.5.4.2 Step Method

Specimen shall be full thickness of the product up to 0.250 inch (6.35 mm) or reduced to 0.250 inch (6.35 mm) preserving one original surface for heavier product. Recommended size is 1 inch x 4 inches (25 mm x 102 mm). Specimens shall be hardened by austenitizing and quenching. They should not be tempered, but if tempered, the tempering temperature shall be not higher than 300 °F (149 °C). During heat treatment, specimens shall be protected by suitable atmosphere or medium or by suitable plating to prevent carburization or further decarburization. The protective plating, if used, shall be removed.

For product less than 0.250 inch (6.35 mm), a portion of the specimen shall be ground to a depth of 0.050 inch (1.27 mm) or one-half thickness, whichever is less using sufficient coolant to prevent thermal or mechanical effects. The product shall show not show evidence of complete decarburization (ferrite) when examined metallographically at a magnification not exceeding 100X. It shall be free of partial decarburization to the extent that the difference in hardness between the original surface and the surface (depth) generated by grinding shall not be greater than two units on the HRA scale or equivalent (See 8.2)

For product 0.250 inch (6.35 mm) and thicker, the specimens shall be ground to remove 0.010 inch (0.25 mm) of metal and a portion of the specimen shall be further ground to a depth of at least one-third the original thickness of the specimen. The difference in the hardness between the two prepared steps shall be no greater than three units on the HRA scale or equivalent (See 8.2).

3.5.4.3 Hardness Traverse Method

The total depth of decarburization determined by a traverse method using microhardness testing in accordance with ASTM E 384 at a magnification not exceeding 100X, shall be defined as the perpendicular distance from the surface to the depth under the surface below which there is not further increase in hardness. The sample shall be hardened as listed in 3.5.4.2. Acceptance shall be as listed in Table 4.

TABLE 4A - MAXIMUM DECARBURIZATION, INCH/POUND UNITS

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

3.5.4.4 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.

3.5.4.5 In the case of dispute, the microhardness traverse method shall govern.

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

Product shall meet the following properties after being normalized by heating to 1650 °F ± 25 (899 °C ± 14), holding at heat for 1 hour per inch (25 mm) of maximum cross-section, and cooling in air to room temperature; hardened by heating to 1525 °F ± 25 (829 °C ± 14), holding at heat for 1 hour per inch (25 mm) of maximum cross-section but not less than 1 hour, and quenching in oil or water; cooling to 100 °F ± 10 (73 °C ± 6) within 2 hours, holding at 100 °F ± 10 (73 °C ± 6) for not less than 2 hours, warming to room temperature, and double tempered by heating to 1035 °F ± 15 (557 °C ± 8), holding at heat for 2 hours per inch (25 mm) of maximum cross-section but not less than 2 hours, cooling to approximately 125 °F (52 °C), reheating to 1035 °F ± 15 (557 °C ± 8), holding at heat for 2 hours per inch (25 mm) of maximum cross-section but not less than 2 hours, and cooling in air to room temperature. If the first temper cannot be performed within 2 hours of subzero treatment, snap temper the product at 350 to 450 °F (177 to 232 °C) for 2 hours per inch (25 mm) of thickness. Normalizing may be omitted if the product was supplied normalized or annealed. Heat treating equipment and controls shall be in accordance with AMS2759.

3.5.5.1 Tensile Properties

Shall be as shown in Table 5.

TABLE 5A - 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 5B - 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