Society of Automotive Engineers, Inc.
TWO PENNSYLVANIA PLAZA, NEW YORK, N.Y. 10001

AEROSPACE MATERIAL SPECIFICATION

AMS 6523A
Superseding AMS 6523

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STEEL SHEET, STRIP, AND PLATE
0.75Cr - 9.0Ni - 4.5Co - 1.0Mo - 0.09V (0.17 - 0.23C)
Premium Quality, Consumable Electrode Melted, Annealed

1. SCOPE:

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

1.2 Application: Primarily for heat treated parts, such as pressure vessels, requiring through-hardening to high strength and toughness levels and where such parts may require welding during fabrication.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS) shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from Society of Automotive Engineers, Inc., Two Pennsylvania Plaza, New York, New York 10001.

2.1.1 Aerospace Material Specifications:

AMS 2252 - Tolerances, Alloy Steel Sheet, Strip, and Plate
AMS 2259 - Chemical Check Analysis Limits, Wrought Low-Alloy and Carbon Steel
AMS 2300 - Premium Aircraft Quality Steel Cleanliness, Magnetic Particle Inspection Procedure
AMS 2350 - Standards and Test Methods
AMS 2370 - Quality Assurance Sampling of Carbon and Low-Alloy Steels, Wrought Products Except Forgings and Forging Stock

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.

ASTM A370 - Mechanical Testing of Steel Products
ASTM A604 - Macroetch Testing of Consumable Electrode Vacuum Arc Remelted Steel Bars and Billets
ASTM E45 - Determining the Inclusion Content of Steel
ASTM E112 - Estimating Average Grain Size of Metals
ASTM E338 - Sharp-Notch Tension Testing of High Strength Sheet Materials
ASTM E399 - Plane-Strain Fracture Toughness of Metallic Materials

2.3 Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.

2.3.1 Federal Standards:

Federal Test Method Standard No. 151 - Metals; Test Methods

3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall conform to the following percentages by weight, determined by wet chemical methods in accordance with ASTM E350, by spectrographic methods in accordance with Federal Test Method Standard No. 151, Method 112 or by other approved analytical methods:

	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 requirements of AMS 2259, paragraph titled "Low Alloy Steels"; check analysis limits for cobalt shall be 0.05 under min or over maximum.

3.2 Condition: The product shall be supplied in the following condition; hardness shall be determined in accordance with ASTM A370:

3.2.1 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.

3.2.2 Plate: Hot rolled, annealed, and descaled, having hardness not higher than 36 HRC or equivalent. When normalized and tempered plate is specified, hardness shall be not higher than 40 HRC or equivalent.

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

3.3.1 Grain Size: Predominantly 5 or finer with occasional grains as large as 3 permissible, ASTM E112, McQuaid-Ehn test.

3.3.2 Macrostructure: Visual examination of transverse sections from slabs, billets, or suitable rerolled product, etched in accordance with ASTM A604 in hot hydrochloric acid (1:1) at 160° - 180° F (71.1° - 82.2° C) for sufficient time to develop a well-defined macrostructure, shall show no injurious imperfections such as pipe, cracks, porosity, segregation, and inclusions detrimental to fabrication or to performance of parts. Macrostructure shall be equal to or better than the following macrographs of ASTM A604:

Class	Condition	Severity
1	Freckles	B
2	White Spots	C
3	Radial Segregation	C
4	Ring Pattern	As agreed upon

3.3.3 Microinclusion Test: Shall be as follows, determined in accordance with ASTM E45, Method D. Two-thirds of all specimens as well as the average of all specimens shall not exceed the following limits except that the length of any inclusion shall be not greater than 0.015 in. (0.38 mm).

Type	Inclusion Rating, Worst Field			
	A	B	C	D
Thin	1.5	1.5	1.5	2.0
Heavy	1.0	1.0	1.0	1.5

3.3.4 Decarburization:

3.3.4.1 Product Under 0.045 In. (1.14 mm) in Thickness: The method of test and the allowance shall be as agreed upon by purchaser and vendor.

3.3.4.2 Product 0.045 to 0.375 In. (1.14 to 9.52 mm), Excl, Thick:

3.3.4.2.1 Specimens: Shall be the full thickness of the product except that specimens from plate over 0.249 in. (6.32 mm) thick shall be slices approximately 0.250 in. (6.35 mm) thick cut parallel to and preserving one original surface of the plate. Recommended specimen size is 1 x 4 in. (25 x 102 mm).

3.3.4.2.2 Procedure: Specimens shall be hardened by austenitizing and quenching; preferably, they shall 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. Protective plating, if used, shall then be removed from specimens of product 0.045 to 0.250 in. (1.14 to 6.35 mm), excl, in thickness and a portion of the specimen shall be ground to a depth of 0.050 in. (1.27 mm) or one-half thickness, whichever is less. Specimens from product 0.250 to 0.375 in. (6.35 to 9.52 mm), excl, in thickness shall be ground to remove 0.020 in. (0.51 mm) of metal from the original surface of the plate and a portion of the specimen shall be further ground to a depth of at least one-third the original thickness of the specimen. At least three Rockwell hardness readings shall be taken on each prepared step and each group of readings averaged.

3.3.4.2.3 Allowance:

3.3.4.2.3.1 Product 0.045 to 0.250 In. (1.14 to 6.35 mm), Excl, Thick: The product shall show no layer of complete decarburization as determined microscopically at a magnification not exceeding 100X. It shall also be free from partial decarburization to the extent that the difference in hardness below the original surface and the portion ground as in 3.3.4.2.2 shall be not greater than 2 units on the Rockwell "A" scale.

3.3.4.2.3.2 Product 0.250 to 0.375 In. (6.35 to 9.52 mm), Excl, Thick: Shall be free from decarburization to the extent that the difference in hardness between the two prepared steps shall be not greater than 3 units on the Rockwell "A" scale.

3.3.4.3 Product 0.375 In. (9.52 mm) and Over in Thickness: The total decarburization as determined microscopically at a magnification not exceeding 100X on the plate, as supplied, shall be not greater than shown in Table I:

TABLE I

Nominal Thickness Inches	Depth of Decarburization Inch
0.375 to 0.500, incl	0.015
Over 0.500 to 1.000, incl	0.025
Over 1.000 to 2.000, incl	0.035
Over 2.000	As agreed upon

TABLE I (SI)

Nominal Thickness Millimeters	Depth of Decarburization Millimeter
9.52 to 12.70, incl	0.38
Over 12.70 to 25.40, incl	0.64
Over 25.40 to 50.80, incl	0.89
Over 50.80	As agreed upon

3.3.5 Response to Heat Treatment: Product normalized by heating to 1650° F ± 25 (898.9° C ± 14), holding at heat for 1 hr per in. (25 mm) of maximum cross-section, and cooling in air or water to room temperature; hardened by heating to 1525° F ± 25 (829.4° C ± 14), holding at heat for 1 hr per in. (25 mm) of maximum section thickness but not less than 1 hr, and quenching in oil or water; and tempered by heating to 1025° F ± 15 (537.8° C ± 8.3), holding at heat for 4 - 8 hr, and suitably cooling to room temperature, shall conform to the requirements of 3.3.5.1, 3.3.5.2, and 3.3.5.3. See 8.2.

3.3.5.1 Tensile Properties:

TABLE II

Tensile Strength, min	190,000 psi
Yield Strength at 0.2% Offset, min	175,000 psi
Elongation in 2 in. or 4D, min	
Nominal Thickness, in.	
Up to 0.249, incl	5%
Over 0.249	10%
Reduction of Area (round specimens) min	45%

TABLE II (SI)

Tensile Strength, min	1310 MPa
Yield Strength at 0.2% Offset, min	1207 MPa
Elongation in 50.8 mm or 4D, min	
Nominal Thickness, mm	
Up to 6.32, incl	5%
Over 6.32	10%
Reduction of Area (round specimens), min	45%

3.3.5.2 Hardness: Should be not lower than 41 HRC or equivalent but the product shall not be rejected on the basis of hardness if the tensile property requirements are met.

3.3.5.3 Fracture Toughness: When specified, product shall be subject to fracture toughness testing. The method of testing and standards for acceptance of product shall be as agreed upon by purchaser and vendor. (ASTM E338 is a suggested method of test for sheet. ASTM E399 is a suggested method of test for plate.)

3.4 Quality:

3.4.1 Steel shall be premium quality conforming to AMS 2300; it shall be multiple melted using vacuum consumable electrode process in the remelt cycle.

3.4.2 The product shall be uniform in quality and condition, clean, sound, and free from foreign materials and from internal and external imperfections detrimental to fabrication or to performance of parts.

3.5 Tolerances: Unless otherwise specified, tolerances shall conform to all applicable requirements of AMS 2252.