The Engineering Society For Advancing Mobility Land Sea Air and Space®
400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

AMS 6523C

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Superseding AMS 6523B

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

UNS K91472

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: Primarily for parts 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 shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2252 - Tolerances, Low-Alloy Steel Sheet, Strip, and Plate
MAM 2252 - Tolerances, Metric, Low-Alloy Steel Sheet, Strip, and Plate
AMS 2259 - Chemical Check Analysis Limits, Wrought Low-Alloy and Carbon Steels
AMS 2300 - Premium Aircraft-Quality Steel Cleanliness, Magnetic Particle Inspection Procedure
MAM 2300 - Premium Aircraft-Quality Steel Cleanliness, Magnetic Particle Inspection Procedure, Metric (SI) Measurement
AMS 2350 - Standards and Test Methods
AMS 2370 - Quality Assurance Sampling of Carbon and Low-Alloy Steels, Wrought Products Except Forgings and Forging Stock
AMS 2750 - Pyrometry
AMS 2759 - Heat Treatment of Steel Parts, General Requirements

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

ASTM A370 - Mechanical Testing of Steel Products
ASTM A604 - Macroetch Testing of Consumable Electrode Remelted Steel Bars and Billets
ASTM E45 - Determining the Inclusion Content of Steel
ASTM E112 - Determining Average Grain Size
ASTM E338 - Sharp-Notch Tension Testing of High-Strength Sheet Materials
ASTM E350 - Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron
ASTM E399 - Plane-Strain Fracture Toughness of Metallic Materials

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

2.3.1 Military Standards:

MIL-STD-163 - Steel Mill Products, Preparation for Shipment and Storage

3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall conform to the following percentages by weight, Ø determined by wet chemical methods in accordance with ASTM E350, by spectrochemical methods, or by other analytical methods acceptable to purchaser:

	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 AMS 2259.

3.2 Condition: The product shall be supplied in the following condition; Ø 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.

3.2.3 When normalized and tempered product is ordered, hardness shall be not higher than 40 HRC, or equivalent.

3.2.4 Annealing: Product shall be annealed by heating to 1250°F ± 25 Ø (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.

3.2.4.1 Normalizing: When specified by purchaser, product shall be Ø 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.

3.2.4.2 Pyrometry shall be in accordance with AMS 2750. Ø

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

3.3.1 Macrostructure: Visual examination of specimens as in 4.3.1, etched in Ø accordance with ASTM A604, shall show no pipe or cracks. Porosity, segregation, inclusions, and other imperfections shall be no worse than the following macrographs of ASTM A604:

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

3.3.2 Micro-Inclusion Rating: No specimen as in 4.3.2 shall exceed the Ø following limits, determined in accordance with ASTM E45, Method D:

	A		B		C		D	
	Thin	Heavy	Thin	Heavy	Thin	Heavy	Thin	Heavy
Worst Field Severity	1.5	1.0	1.5	1.0	1.5	1.0	1.5	1.0
Worst Field Frequency, maximum	*	1	*	1	*	1	3	1
Total Rateable Fields Frequency, maximum	**	1	**	1	**	1	8	1

* Combined A+B+C, not more than 3 field
** Combined A+B+C, not more than 8 fields

3.3.2.1 A rateable field is defined as one which has a type A, B, C, or D Ø inclusion rating of at least 1.0 thin or heavy in accordance with the Jernkontoret Chart, Plate III, of ASTM E45.

3.3.3 Grain Size: Predominantly 5 or finer with occasional grains as large as 3 permissible, determined in accordance with ASTM E112.

3.3.4 Decarburization:

3.3.4.1 Product Under 0.045 Inch (1.14 mm) in Nominal 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 Inch (1.14 to 9.52 mm), Excl, in Nominal Thickness:

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

3.3.4.2.2 Procedure: Specimens shall be hardened by austenitizing and Ø 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 inch (1.14 to 6.35 mm), excl, in nominal thickness and 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. Specimens from product 0.250 to 0.375 inch (6.35 to 9.52 mm), excl, in nominal thickness shall be ground to remove 0.020 inch (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 Inch (1.15 to 6.35 mm), Excl, in Nominal Thickness: The product shall show no layer of complete decarburization, determined microscopically at a magnification not exceeding 100X. It shall also be free from partial decarburization to the extent that the difference in hardness between 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 Inch (6.35 to 9.52 mm), Excl, in Nominal Thickness: 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 Inch (9.52 mm) and Over in Nominal Thickness: The total decarburization, determined microscopically at a magnification not exceeding 100X on the as-supplied plate, 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 Millimetres	Depth of Decarburization Millimetre
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 Ø 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 first temper cannot be performed within 2 hours of sub-zero treatment, snap temper at 350° - 450°F (177° - 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 AMS 2759.

3.3.5.1 Tensile Properties: Shall be as specified in Table II.

TABLE II

Nominal Thickness Inches	Tensile Strength psi, min	Yield Strength at 0.2% Offset psi, minimum	Elongation in 2 inches or 4D %, minimum	Reduction of Area %, minimum
Up to 0.250, excl	190,000	175,000	5	45
0.250 and over	190,000	175,000	10	45

TABLE II (SI)

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

3.3.5.2 Ø Hardness: Should be 41 - 46 HRC, or equivalent, but the product shall not be rejected on the basis of hardness if the tensile property requirements of 3.3.5.1 are met.

3.3.5.3 Ø Fracture Toughness: When specified, product shall be subjected to fracture toughness testing. Sheet and strip shall be tested in accordance with ASTM E338 and plate shall be tested in accordance with ASTM E399. Results of tests on sheet and strip over 4 inches (102 mm) wide and plate under 1.50 inch (38.1 mm) in thickness shall be reported. Plate over 1.50 inch (38.1 mm) in thickness shall have fracture toughness in the longitudinal direction (L-T) not less than 120,000 psi $\sqrt{\text{inch}}$ (132 MPa $\sqrt{\text{m}}$) and 110,000 psi $\sqrt{\text{inch}}$ (121 MPa $\sqrt{\text{m}}$) in the long-transverse (T-L) direction.

3.4 Quality:

3.4.1 Steel shall be premium aircraft-quality conforming to AMS 2300 or MAM 2300. It shall be multiple melted using vacuum consumable electrode practice in the remelt cycle.

3.4.2 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 Tolerances: Shall conform to all applicable requirements of AMS 2252 or MAM 2252.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of the product shall supply all samples for vendor's tests and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.4. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to the requirements of this specification.

4.2 Classification of Tests: Tests to determine conformance to all technical requirements of this specification are classified as acceptance tests and shall be performed on each heat or lot as applicable.

4.3 Sampling: Shall be in accordance with AMS 2370 and the following; a heat shall be the consumable electrode remelted ingots produced from steel originally melted as a single furnace charge:

4.3.1 Samples for macrostructure rating (3.3.1) shall be full cross-sectional Ø specimens obtained from the finished slab or billet or suitable rerolled product representing the top and bottom of at least the first, middle, and last usable ingot of each heat. When ingot location is not available, the lot shall be sampled on at least one end of 10% of the slabs or billets.

4.3.2 Samples for micro-inclusion rating (3.3.2) shall be obtained from the finished slab or billet or suitable rerolled product and shall consist of not less than four specimens representing the top and bottom of the first and last ingot from a heat yielding 10 or fewer ingots or not less than six specimens representing the top and bottom of the first, middle, and last usable ingot from a heat yielding more than 10 ingots.

4.4 Reports:

4.4.1 The vendor of the product shall furnish with each shipment a report showing the results of tests for chemical composition, macrostructure, micro-inclusion rating, grain size, and frequency-severity cleanliness rating of each heat and for tensile properties, hardness, and, when specified, fracture toughness of each lot after normalizing, hardening, sub-zero cooling, and double tempering. This report shall include the purchase order number, heat number, AMS 6523C, size, and quantity.