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400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

AEROSPACE MATERIAL SPECIFICATION

AMS 6439A
Superseding AMS 6439

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STEEL SHEET, STRIP, AND PLATE UNS K24729
1.05Cr - 0.55Ni - 1.0Mo - 0.12V (0.42 - 0.48C)
Premium-Aircraft-Quality, Consumable Electrode Melted
Annealed

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 which may be welded during fabrication and which require through-hardening to high strength levels, for use up to 600°F (315°C).

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 SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2252 - Tolerances, 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
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, PA 19103.

ASTM A370 - Mechanical Testing of Steel Products
ASTM A604 - Macroetch Testing of Consumable Electrode Remelted Steel Bars and Billets
ASTM E112 - Estimating the Average Grain Size of Metals
ASTM E350 - Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron

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

2.3.1 Federal Standards:

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

2.3.2 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, 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 analytical methods approved by purchaser:

	min	max
Carbon	0.42	0.48
Manganese	0.60	0.90
Silicon	0.15	0.30
Phosphorus	--	0.015
Sulfur	--	0.015
Chromium	0.90	1.20
Nickel	0.40	0.70
Molybdenum	0.90	1.10
Vanadium	0.08	0.15
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; hardness tests shall be conducted 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 or normalized and tempered, Ø and descaled; having hardness not higher than 30 HRC or equivalent. When spheroidize anneal is specified, hardness shall be not higher than 100 HRB or equivalent.

3.2.2 Plate: Hot rolled, annealed or normalized and tempered, and descaled Ø having hardness not higher than 30 HRC or equivalent. When spheroidize anneal is specified, hardness shall be not higher than 100 HRB 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, determined in accordance with ASTM E112.

3.3.2 Macrostructure: Visual examination of transverse sections as in 4.3.1, etched in accordance with ASTM A604 in hot hydrochloric acid (1:1) at 160° - 180°F (70° - 80°C) for sufficient time to develop a well-defined macrostructure 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	B
2	White Spots	C
3	Radial Segregation	C
4	Ring Pattern	As agreed upon

3.3.3 Decarburization:

3.3.3.1 Product Under 0.045 In. (1.15 mm) in Nominal Thickness: The method of test and the allowance shall be as agreed upon by purchaser and vendor.

3.3.3.2 Product 0.045 to 0.375 In. (1.15 to 9.50 mm), Excl, in Nominal Thickness:

3.3.3.2.1 Specimens: Shall be the full thickness of the product except that specimens from plate 0.250 in. (6.25 mm) and over in nominal thickness shall be slices approximately 0.250 in. (6.25 mm) thick cut parallel to and preserving one original surface of the plate. Recommended specimen size is 1 x 4 in. (25 x 100 mm).

3.3.3.2.2 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 (150°C). During heat treatment, specimens shall be protected by suitable atmosphere or medium or by suitable plating to prevent carburization

3.3.3.2.2 (Continued):

or further decarburization. Protective plating, if used, shall then be removed from specimens of product 0.045 to 0.250 in. (1.15 to 6.25 mm), excl, in nominal thickness and a portion of the specimen shall be ground to a depth of 0.050 in. (1.25 mm) or one-half thickness, whichever is less. Specimens from product 0.250 to 0.375 in. (6.25 to 9.50 mm), excl, in nominal thickness shall be ground to remove 0.020 in. (0.50 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.

3.3.3.2.3 Allowance:

3.3.3.2.3.1 Product 0.045 to 0.250 In. (1.15 to 6.25 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 3.3.3.2.2 shall be not greater than 2 units on the Rockwell "A" scale.

3.3.3.2.3.2 Product 0.250 to 0.375 In. (6.25 to 9.50 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.

3.3.3.3 Product 0.375 In. (9.50 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
9.50 to 12.50, incl	0.38
Over 12.50 to 25.00, incl	0.64
Over 25.00 to 50.00, incl	0.89
Over 50.00	As agreed upon

3.3.4 Response to Heat Treatment: Product shall have the following properties after being hardened by heating in a protective atmosphere to a temperature within the range 1600° - 1650°F (870° - 900°C), holding at the selected temperature within ±10°F (±5°C) for a time commensurate with section thickness but not less than 20 min., and quenching in oil, stress relieved by heating to 400°F ± 10 (205°C ± 5), holding at heat for 60 min. ± 5, and cooling in air, and tempered by heating to not lower than 1000°F (540°C), holding at heat for not less than 4 hr, and cooling in air.

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

TABLE II

Tensile Strength, min	
Nominal Thickness, in.	
Up to 0.250, incl	215,000 psi
Over 0.250	224,000 psi
Yield Strength at 0.2% Offset, min	
Nominal Thickness, in.	
Up to 0.250, incl	190,000 psi
Over 0.250	195,000 psi
Elongation in 2 in. or 4D, min	7%

TABLE II (SI)

Tensile Strength, min	
Nominal Thickness, mm	
Up to 6.25, incl	1480 MPa
Over 6.25	1545 MPa
Yield Strength at 0.2% Offset, min	
Nominal Thickness, mm	
Up to 6.25, incl	1310 MPa
Over 6.25	1345 MPa
Elongation in 50 mm or 4D, min	7%

3.3.4.2 Hardness: Should be not lower than 44 HRC or equivalent but the product shall not be rejected on the basis of hardness if the tensile property requirements are met.

3.4 Quality:

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

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

3.5 Tolerances: Unless otherwise specified, tolerances shall conform to all applicable requirements of AMS 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 Ø 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 (3.3.2) testing shall be full cross-sectional specimens obtained from the finished billet, slab, or suitable rerolled product representing the top and bottom of at least the first, middle, and last usable ingots of each heat.

4.3.2 Tensile test specimens from widths 9 in. (225 mm) and over shall be taken with the axis of the specimen perpendicular to the direction of rolling; for widths less than 9 in. (225 mm), tensile test specimens shall be taken with the axis parallel to the direction of rolling.

4.4 Reports:

4.4.1 The vendor of the product shall furnish with each shipment three copies of a report showing the results of tests for chemical composition, grain size, macrostructure, and AMS 2300 frequency-severity rating for each heat and to determine tensile properties and hardness of each lot after heat treatment. This report shall include the purchase order number, heat number, AMS 6439A, size, and quantity from each heat.