

NOTICE OF
ADOPTION

ADOPTION NOTICE
20 December 1991
AMS 6438D
1 October 1990
SUPERSEDING
AMS 6438C
30 October 1981

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Title of Document: Steel Sheet, Strip, and Plate
1.05Cr - 0.55Ni - 1.0Mo - 0.12V (0.45 - 0.50C)
Consumable Electrode Vacuum Melted

Date of Specific Issue Adopted: 1 October 1990

Releasing Non-Government Standards Body: SAE

Custodians:

Air Force - 11
Army - MR
Navy - AS

Military Coordinating Activity

Air Force - 11

(Project No: 95150914)

FSC 9515

DISTRIBUTION STATEMENT A: Approved for public release; distribution is unlimited.

Submitted for recognition as an American National Standard

Issued 1964-06-30
Revised 1990-10-01

Superseding AMS - 6438C

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UNS K24728

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 heat treated parts, which may be welded during fabrication and which require through-hardening to high strength levels, for use up to 600°F (316°C).

2. **APPLICABLE DOCUMENTS:** The following publications form a part of this specification 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.

- 2.1 **SAE Publications:** Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

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-2370 - Quality Assurance Sampling of Carbon and Low-Alloy Steels, Wrought Products Except Forgings and Forging Stock

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2.2 ASTM Publications: Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

- ASTM A 370 - Mechanical Testing of Steel Products
- ASTM A 604 - Macroetch Testing of Consumable Electrode Remelted Steel Bars and Billets
- 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

2.3 U.S. Government Publications: Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

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, determined by wet chemical methods in accordance with ASTM E 350, by spectrochemical methods, or by other analytical methods acceptable to purchaser:

	min	max
Carbon	0.45	0.50
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 A 370:

- 3.2.1 Sheet and Strip:** Cold finished, bright or atmosphere annealed, and descaled if necessary; or hot rolled, annealed or normalized and tempered, 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, 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 A 370:

3.3.1 Grain Size: Predominantly 5 or finer with occasional grains as large as 3 permissible, determined in accordance with ASTM E 112.

3.3.2 Macrostructure: Visual examination of transverse sections as in 4.3.1, etched in accordance with ASTM A 604, shall show no pipe or cracks. Porosity, segregation, inclusions, and other imperfections shall be no worse than the following macrographs of ASTM A 604:

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

3.3.3 Decarburization:

3.3.3.1 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.

3.3.3.2 Product 0.045 to 0.375 Inch (1.14 to 9.52 mm), Incl, in Nominal Thickness:

3.3.3.2.1 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).

3.3.3.2.2 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 (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.

3.3.3.2.3 Allowance:**3.3.3.2.3.1 Product 0.045 to 0.250 Inch (1.14 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 3.3.3.2.2 shall be not greater than two units on the Rockwell "A" scale.

3.3.3.2.3.2 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 three units on the Rockwell "A" scale.

3.3.3.3 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

3.3.4 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 (871° - 899°C), holding at the selected temperature within $\pm 10^\circ\text{F}$ ($\pm 6^\circ\text{C}$) for a time commensurate with section thickness but not less than 20 minutes, and quenching in oil; stress relieved by heating to $400^\circ\text{F} \pm 10$ ($204^\circ\text{C} \pm 6$), holding at heat for 60 minutes ± 5 , and cooling in air; and tempered by heating to not lower than 1000°F (538°C) for not less than 4 hours, and cooling in air:

3.3.4.1 Tensile Properties:

Tensile Strength, minimum	224,000 psi (1544 MPa)
Yield Strength at 0.2% Offset, minimum	195,000 psi (1344 MPa)
Elongation in 2 inches (50.8 mm) or 4D, minimum	7%

3.3.4.2 Hardness: Product should have hardness not lower than 47 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 or MAM-2300; it shall be multiple melted using consumable electrode vacuum process 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. 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:

4.2.1 Acceptance Tests: Tests for composition (3.1), hardness (3.2), grain size (3.3.1), macrostructure (3.3.2), decarburization) (3.3.3), response to heat treatment (3.3.4) and tolerances (3.5) are acceptance tests and shall be performed on each heat or lot as applicable.

4.2.2 Periodic Tests: Tests for frequency-severity cleanliness rating (3.4.1) are periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

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

4.3.1 Samples for macrostructure rating (3.3.2) 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 ingot of each heat.