



AEROSPACE MATERIAL SPECIFICATION

AMS6439™**REV. F**Issued 1974-12
Revised 2021-12

Superseding AMS6439E

Steel Sheet, Strip, and Plate
1.05Cr - 0.55Ni - 1.0Mo - 0.12V (0.42 - 0.48C) (D6AC)
Consumable Electrode Vacuum Melted, Annealed
(Composition similar to UNS K24728)

RATIONALE

AMS6439 is the result of a Five-Year Review and update of the specification. The revision prohibits unauthorized exceptions (3.7, 4.4.1, 5.1.1, 8.5), updates the composition testing (3.1), adds continuous heat treatment (3.3.3), updates decarburization methods (3.4.3), allows alternate cooling methods (3.4.4), limits tensile testing strain rate (3.4.4.1.1), and allows prior revisions (8.6).

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 typically used for parts that may be welded during fabrication and require through-hardening to high strength levels, for use up to 600 °F (316 °C), 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 +1 724-776-4970 (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

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For more information on this standard, visit
<https://www.sae.org/standards/content/AMS6439F>

- AMS2750 Pyrometry
- AMS2807 Identification Carbon and Low-Alloy Steels, Corrosion and Heat-Resistant Steels and Alloys Sheet, Strip, Plate, and Aircraft Tubing
- AS7766 Terms Used in Aerospace Metals Specifications

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 A370 Mechanical Testing of Steel Products
- ASTM A604 Macroetch Testing of Consumable Electrode Remelted Steel Bars and Billets
- ASTM A751 Chemical Analysis of Steel Products
- ASTM E112 Determining Average Grain Size
- ASTM E140 Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, Scleroscope Hardness, and Leeb Hardness
- ASTM E1077 Estimating the Depth of Decarburization of Steel Specimens

3. TECHNICAL REQUIREMENTS

3.1 Composition

Shall conform to the following percentages by weight shown in Table 1, determined in accordance with ASTM A751, or by other analytical methods acceptable to purchaser.

Table 1 - Composition

Element	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 AMS2259.

3.2 Melting Practice

Steel shall be multiple melted using consumable electrode vacuum process in the remelt cycle.

3.3 Condition

The product shall be supplied in the following condition; hardness tests shall be conducted in accordance with ASTM A370. Pyrometry shall be in accordance with AMS2750.

3.3.1 Sheet and Strip

Cold finished, bright or atmosphere annealed, and descaled if necessary; or hot rolled, annealed or normalized at a temperature of $1725^{\circ}\text{F} \pm 25^{\circ}\text{F}$ ($941^{\circ}\text{C} \pm 14^{\circ}\text{C}$) and tempered, and descaled; having hardness not higher than 30 HRC, or equivalent (see 8.2). When spheroidize anneal is specified, hardness shall be not higher than 100 HRB, or equivalent (see 8.2).

3.3.2 Plate

Hot rolled, annealed or normalized at a temperature of $1725^{\circ}\text{F} \pm 25^{\circ}\text{F}$ ($941^{\circ}\text{C} \pm 14^{\circ}\text{C}$) and tempered, and descaled having hardness not higher than 30 HRC, or equivalent (see 8.2). When spheroidize anneal is specified, hardness shall be not higher than 100 HRB, or equivalent (see 8.2).

3.3.3 Continuous Heat Treatment

When continuous heat treating is used process parameters (e.g., furnace temperature set points, heat input, travel rate, etc.) for continuous heat treating lines shall be established by the material producer and validated by testing of product to the requirements of 3.3 and 3.4.

3.4 Properties

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

3.4.1 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 to 180 °F (71 to 82 °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.

Table 2 - Macrostructure limits

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

3.4.2 Average Grain Size

Shall be ASTM 5 or finer, determined in accordance with ASTM E112.

3.4.3 Decarburization

Decarburization shall be evaluated by one of the two methods of 3.4.3.1 or 3.4.3.2.

3.4.3.1 Metallographic (Microscopic) Method

A cross section taken perpendicular to the surface shall be prepared in accordance with ASTM E1077, etched, and examined metallographically at a magnification not to exceed 100X. The product shall not show a layer of complete (ferrite) or partial decarburization exceeding the limits of Table 3.

3.4.3.2 Hardness Traverse (Microindentation) Method

The total depth of decarburization shall be determined by a traverse method using microindentation hardness testing in accordance with ASTM E1077. Samples shall be hardened but untempered and protected during heat treatment to prevent changes in surface carbon content. Measurements shall be far enough away from any adjacent surface to be uninfluenced by any decarburization on the adjacent surface. Acceptance shall be as listed in Table 3.

- 3.4.3.3 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.
- 3.4.3.4 In case of dispute, the total depth of decarburization determined using the microindentation hardness traverse method shall govern.

Table 3A - Maximum total depth of decarburization, inch/pound units

Nominal Thickness Inches	Total Depth of Decarburization Inches
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 2.00	As agreed upon

Table 3B - Maximum total depth of decarburization, SI units

Nominal Thickness Millimeters	Total Depth of Decarburization Millimeters
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

3.4.4 Response to Heat Treatment

Samples from product shall have the following properties after being hardened by heating in a protective atmosphere to a temperature at 1625 °F ± 25 °F (885 °C ± 14 °C), holding at the selected temperature for a time commensurate with section thickness, but not less than 20 minutes, and quenching in oil or at an equivalent rate, stress relieved by heating to 400 °F ± 10 °F (204 °C ± 6 °C), holding at heat for 60 minutes ± 5 minutes, and cooling in air or at an equivalent rate, and tempered by heating to not lower than 1000 °F (538 °C), holding at heat for not less than 4 hours, and cooling in air or at an equivalent rate.

3.4.4.1 Tensile Properties

Shall be as specified in Table 4.

- 3.4.4.1.1 Unless otherwise specified, the strain rate shall be set at 0.005 in/in/min (0.005 mm/mm/min) and maintained within a tolerance of ±0.002 in/in/min (0.002 mm/mm/min) through 0.2% offset yield strain. After the yield strain, the speed of the testing machine shall be set between 0.05 and 0.5 in/in (0.05 and 0.5 mm/mm) of the length of the reduced section (or distance between the grips for specimens not having a reduced section) per minute. Alternatively, an extensometer and strain rate indicator may be used to set the strain rate between 0.05 and 0.5 in/in/min (0.05 and 0.5 mm/mm/min).

Table 4A - Minimum tensile properties - inch/pound units

Property	Value
Tensile Strength	
Nominal Thickness, Inches	
Up to 0.250, incl	215 ksi
Over 0.250	224 ksi
Yield Strength at 0.2% Offset	
Nominal Thickness, Inches	
Up to 0.250, incl	190 ksi
Over 0.250	195 ksi
Elongation in 2 Inches or 4D	7%

Table 4B - Minimum tensile properties - SI units

Property	Value
Tensile Strength	
Nominal Thickness, mm	
Up to 6.35, incl	1482 MPa
Over 6.35	1544 MPa
Yield Strength at 0.2% Offset	
Nominal Thickness, mm	
Up to 6.35, incl	1310 MPa
Over 6.35	1345 MPa
Elongation in 50 mm or 4D	7%

3.4.4.2 Hardness

Should be not lower than 44 HRC, or equivalent (see 8.2), but the product shall not be rejected on the basis of hardness if the tensile property requirements are met.

3.5 Quality

3.5.1 Steel shall be premium-aircraft-quality conforming to AMS2300.

3.5.2 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.

3.6 Tolerances

Shall conform to all applicable requirements of AMS2252.

3.7 Exceptions

Any exceptions shall be authorized by the purchaser and reported as in 4.4.1.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The producer of the product shall supply all samples for producer's tests and shall be responsible for the performance of all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to specified requirements.

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 AMS2370 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 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.