SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

AMS 6439C

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Superseding AMS 6439B

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

AMS 6439C is a Five Year Review and update of this specification.

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 724-776-4970 (outside USA), or www.sae.org.

AMS 2252	Tolerances, Low-Alloy Steel Sheet, Strip, and Plate
AMS 2259	Chemical Check Analysis Limits, Wrought Low-Alloy and Carbon Steels
AMS 2300	Steel Cleanliness, Premium Aircraft-Quality 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
AMS 2750	Pyrometry

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, or www.astm.org.

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
ASTM E 384	Microindentation Hardness of Materials

3. TECHNICAL REQUIREMENTS

3.1 Composition

Shall conform to the following percentages by weight shown in Table 1, determined by wet chemical methods in accordance with ASTM E 350, by spectrochemical methods, 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 AMS 2259.

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 A 370. Pyrometry shall be in accordance with AMS 2750.

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 °F ± 25 (941 °C ± 14) 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 °F ± 25 (941 °C ± 14) 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).

3.4 Properties

The product shall conform to the following requirements; hardness and tensile testing shall be performed in accordance with ASTM A 370.

3.4.1 Macrostructure

Visual examination of transverse sections as in 4.3.1, etched in accordance with ASTM A 604 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 A 604.

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 E 112 (See 8.3).

3.4.3 Decarburization

Depending upon thickness of the product, decarburization may be measured by a HR30N hardness step test method, or by the microhardness traverse method. Additionally, the metallographic method shall be used, in part (See 3.4.3.4.1), to inspect product 0.025 to 0.250 inch (0.64 to 6.35 mm) thick, and it may be used to inspect product with thickness 0.375 inch (9.52 mm) and over.

3.4.3.1 In the case of dispute, the microhardness method, conducted in accordance with ASTM E 384, shall govern. The allowance for decarburization shall be that which would have been applicable had the step method been used (See 3.4.3.4.1 or 3.4.3.5.1, as applicable.).

3.4.3.2 Specimens

Shall be full thickness of the product except that specimens from plate 0.250 inch (6.35 mm) and over in nominal thickness may be slices approximately 0.250 inch (6.35 mm) thick cut parallel to and preserving one original surface of the plate. Recommended minimum specimen size is 1 × 4 inches (25 × 102 mm). For product 0.025 to 0.250 inch (0.64 to 6.35 mm), a full cross section metallographic sample shall be prepared to inspect for presence of complete decarburization (ferrite).

3.4.3.3 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.

3.4.3.4 Product 0.025 to 0.250 Inch (0.64 to 6.35 mm), Exclusive, in Nominal Thickness

Protective plating, if used to prevent any decarburization during hardening, shall be removed, and a portion of the specimen shall be ground with copious coolant to prevent thermal or mechanical effects to a depth of 0.050 inch (1.27 mm) or one-half thickness, whichever is less.

3.4.3.4.1 Allowance

The product shall show no layer of complete decarburization (ferrite), determined metallographically at a magnification not exceeding 100X. It shall also be free from any partial decarburization to the extent that the difference in hardness between the original surface and the surface (depth) generated by grinding as in 3.4.3.4 shall not be greater than two units on the HRA scale, or equivalent (See 8.2). Also, refer to 3.4.3.1.

3.4.3.5 Product 0.250 to 0.375 Inch (6.35 to 9.52 mm), Exclusive, in Nominal Thickness

Specimens shall be ground to remove 0.010 inch (0.25 mm) of metal to create a test reference surface, and a portion of the specimen shall be further ground to a depth of at least one-third the original thickness of the specimen.

3.4.3.5.1 Allowance

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 HRA scale, or equivalent (See 8.2). Also, refer to 3.4.3.1.

3.4.3.6 Product 0.375 Inch (9.52 mm) and Over in Nominal Thickness

3.4.3.6.1 Allowance

The total depth of the decarburization, determined metallographically at a magnification not exceeding 100X, on the as-supplied plate, shall be not greater than shown in Table 2. Also, refer to 3.4.3.1. The depth of decarburization shall be that which is defined as the perpendicular distance from the surface to the depth under that surface below which there is no further increase in hardness.

TABLE 3A - MAXIMUM DECARBURIZATION, INCH/POUND UNITS

Nominal Thickness Inches	Total 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 2.00	As agreed upon

TABLE 3B - MAXIMUM DECARBURIZATION, SI UNITS

Nominal Thickness Millimeters	Total 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

3.4.4 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 to 1650 °F (871 to 899 °C), holding at the selected temperature within ±10 °F (±5 °C) for a time commensurate with section thickness but not less than 20 minutes, and quenching in oil, stress relieved by heating to 400 °F ± 10 (204 °C ± 5), holding at heat for 60 minutes ± 5, and cooling in air, 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.

3.4.4.1 Tensile Properties

Shall be as specified in Table 4.

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 50.8 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 AMS 2300.

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 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 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.