SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS 6438 | REV. F

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Superseding AMS 6438E

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

(Composition similar to UNS K24728)

RATIONALE

This document has been reaffirmed to comply with the SAE five-year review policy.

NONCURRENT NOTICE

This specification has been declared “NONCURRENT” by the Aerospace Materials Division, SAE, as of May, 2006. It is recommended, therefore, that this specification not be specified for new designs.

“NONCURRENT” refers to those specifications which have previously been widely used and which may be required for production or processing of existing designs in the future. The Aerospace Materials Division, however, does not recommend these specifications for future use in new designs. “NONCURRENT” specifications are available from SAE upon request.

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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:

This product has been used typically 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), 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 canceled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

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	Steel Cleanliness, Premium Aircraft-Quality Magnetic Particle Inspection Procedure
MAM 2300	Steel Cleanliness, Premium Aircraft-Quality Magnetic Particle Inspection Procedure, Metric (SI) Measurement
AMS 2370	Quality Assurance Sampling and Testing, Carbon and Low-Alloy Steel Wrought Products and Forging Stock
AMS 2807	Identification, Carbon and Low-Alloy Steels, Corrosion and Heat Resistant Steels and Alloys, Sheet, Strip, Plate, and Aircraft Tubing

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

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 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	0.45	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 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:

3.3.1 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 (See 8.2). When spheroidize anneal is specified, hardness shall be not higher than 100 HRB, or equivalent.

3.3.2 Plate: Hot rolled, annealed or normalized 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.

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 full cross sections etched in hot hydrochloric acid in accordance with ASTM A 604, shall show no pipe or cracks. Porosity, segregation, inclusions, and other imperfections shall be no worse than the macrographs of ASTM a 604 shown in Table 2.

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 No. 5 or finer determined in accordance with ASTM E 112 (See 8.3).

3.4.3 Decarburization: Depending on 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 x 4 inch (25 x 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 not be greater than that shown in Table 3. 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 Limits, 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

TABLE 3B - Maximum Decarburization Limits, 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

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 (±6 °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 ± 6), holding at heat for 60 minutes ± 5, and cooling at a rate equivalent to air cooling; and tempered by heating to not lower than 1000 °F (538 °C) for not less than 4 hours, and cooling at a rate equivalent to air cooling.

3.4.4.1 Tensile Properties: Shall be as shown in Table 4.

TABLE 4 - Minimum Tensile Properties

Property	Value
Tensile Strength	224 ksi (1544 MPa)
Yield Strength at 0.2% Offset	195 ksi (1344 MPa)
Elongation in 2 inches (50.8 mm) or 4D	7%

3.4.4.2 Hardness: Shall be not lower than 47 HRC, but product shall not be rejected on the basis of hardness if the tensile properties of 3.4.4.1 are acceptable, determined on specimens taken from the same sample as that with nonconforming hardness or from another sample with similar nonconforming hardness.

3.5 Quality:

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.

3.5.1 Steel shall be premium aircraft-quality conforming to AMS 2300 or MAM 2300.

3.6 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 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.