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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 6435D

Issued JUN 1960
Revised OCT 2001

Superseding AMS 6435C

Steel, Sheet, Strip, and Plate
0.75Mn - 0.78Cr - 1.8Ni - 0.35Mo - 0.20V (0.33 - 0.38C)
Vacuum Consumable Electrode Melted, Annealed

(Composition similar to UNS K33517)

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 used typically for parts, which may be welded during fabrication, requiring through-hardening to high strength levels and which may be used at operational stress levels approaching the yield strength, but usage is not limited to such applications. Steel may become notch sensitive when heat treated to a tensile strength level of 240 ksi (1655 MPa) or higher.

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	Cleanliness, Premium Aircraft-Quality Steel, Magnetic Particle Inspection Procedure
MAM 2300	Cleanliness, Premium Aircraft-Quality Steel, Magnetic Particle Inspection Procedure, Metric (SI) Measurement

QUESTIONS REGARDING THIS DOCUMENT: (724) 772-7161 FAX: (724) 776-0243
TO PLACE A DOCUMENT ORDER: (724) 776-4970 FAX: (724) 776-0790
SAE WEB ADDRESS: http://www.sae.org

2.1 (Continued):

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 255 Determining Hardenability of Steel
ASTM A 370 Mechanical Testing of Steel Products
ASTM E 45 Determining the Inclusion Content of Steel
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	0.33	0.38
Manganese	0.60	0.90
Silicon	0.40	0.60
Phosphorus	--	0.010
Sulfur	--	0.010
Chromium	0.65	0.90
Nickel	1.65	2.00
Molybdenum	0.30	0.40
Vanadium	0.17	0.23
Copper	--	0.35

3.1.1 Check Analysis: Composition variations shall meet the applicable requirements of AMS 2259 except that carbon shall vary not more than 0.01 under min or over max and no variation over max will be permitted for phosphorus and sulfur.

3.2 Melting Practice:

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

3.3 Condition:

The product shall be supplied in the following condition; hardness shall be determined 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, and descaled, unless otherwise ordered, having hardness not higher than 30 HRC or equivalent (See 8.2).

3.3.2 Plate: Hot rolled, annealed, and descaled having hardness not higher than 30 HRC or equivalent (See 8.2).

3.3.3 When product is ordered spheroidize annealed, 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 Micro-Inclusion Rating: No specimen shall exceed the limits shown in Table 2, determined in accordance with ASTM E 45, Method D.

TABLE 2 - Micro-Inclusion Rating Limits

Limits	A Thin	A Heavy	B Thin	B Heavy	C Thin	C Heavy	D Thin	D Heavy
Worst Field Severity	2.0	1.0	1.5	1.0	1.5	1.0	1.5	1.0
Worst Field Frequency, maximum	*	1	*	1	*	1	5	3
Total Rateable Fields Frequency, maximum	**	1	**	1	**	1	***	3

* Combined A+B+C, not more than 3 fields
** Combined A+B+C, not more than 5 fields
*** Any number of lower rateable D-type thin fields per specimen is permitted

3.4.1.1 Thickness of the D-type heavy shall not exceed 0.0005 inch (0.012 mm).

3.4.1.2 A rateable field is defined as one which has a type A, B, C, or D inclusion rating of at least 1.0 thin or heavy in accordance with the Jernkontoret Chart, Plate III, ASTM E 45.

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 Hardenability: Shall be J1/16 inch (1.6 mm) = 58 HRC maximum and J15/16 inch (23.8 mm) = 47 HRC minimum (See 8.4), determined in accordance with ASTM A 255 except that the steel shall be normalized at 1700 °F ± 10 (925 °C ± 5) and the test specimen austenitized at 1625 °F ± 10 (885 °C ± 5).

3.4.4 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 3.4.4.4.1), 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.

3.4.4.1 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 3.4.4.4.1 or 3.4.4.5.1, as applicable).

3.4.4.2 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).

3.4.4.3 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.

3.4.4.4 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.

3.4.4.4.1 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 3.4.4.4 shall not be greater than two units on the HRA scale, or equivalent (See 8.2). Also, refer to 3.4.4.1.

3.4.4.5 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.

3.4.4.5.1 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 in the HRA scale, or equivalent (See 8.2). Also, refer to 3.4.4.1.

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

3.4.4.6.1 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 3. Also, refer to 3.4.4.1. 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 Millimeter
9.50 to 12.50, incl	0.38
Over 12.50 to 25.00, incl	0.62
Over 25.00 to 50.00, incl	0.88

3.4.5 Response to Heat Treatment: Specimens shall meet the requirements shown in Table 4 after being hardened by heating to 1625 °F ± 25 (885 °C ± 15), holding at heat for 60 minutes ± 5, and quenching in oil and tempered by heating to a temperature between 400 and 500 °F (205 and 260 °C), holding at heat for not less than 2 hours, and cooling in air.

TABLE 4A - Minimum Tensile Properties, Inch/Pound Units

Property	Value
Tensile Strength	240 ksi
Yield Strength at 0.2% Offset	210 ksi
Elongation in 2 inches or 4D, min	
Nominal Thickness, Inches	
Up to 0.070, incl	5%
Over 0.070 to 0.249, incl	6%
Over 0.249	8%

TABLE 4B - Minimum Tensile Properties, SI Units

Property	Value
Tensile Strength	1655 MPa
Yield Strength at 0.2% Offset	1450 MPa
Elongation in 50.8 mm or 4D, min	
Nominal Thickness, Millimeters	
Up to 1.75, incl	5%
Over 1.75 to 6.25, incl	6%
Over 6.25	8%

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 except that a maximum average frequency (F) rating of 0.10 and a maximum average severity (S) rating of 0.20 shall apply.

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.