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SAE-AMS6435, "STEEL SHEET, STRIP, AND PLATE 0.78CR - 1.8NI - 0.35MO - 0.20V (0.33 - 0.38C) VACUUM CONSUMABLE ELECTRODE MELTED, ANNEALED", was adopted on 08-JUL-77 for use by the Department of Defense (DoD). Proposed changes by DoD activities must be submitted to the DoD Adopting Activity: Commander, Defense Supply Center Philadelphia, ATTN: DSCP-ILEA, 700 Robbins Avenue, Philadelphia, PA 19111-5096. Copies of this document may be purchased from the Society of Automotive Engineers 400 Commonwealth Drive Warrendale, Pennsylvania, United States, 15096-0001. <http://www.sae.org/>

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**AEROSPACE  
MATERIAL  
SPECIFICATION**

**AMS 6435C**

Superseding AMS 6435B

Issued 6-30-60

Revised 10-1-84

STEEL SHEET, STRIP, AND PLATE  
0.78Cr - 1.8Ni - 0.35Mo - 0.20V (0.33 - 0.38C)  
Vacuum Consumable Electrode Melted, Annealed

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: Primarily 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. Steel may become notch sensitive when heat treated to a tensile strength level of 240,000 psi (1655 MPa) or higher.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

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

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 2350 - Standards and Test Methods

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 American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM A255 - End-Quench Test for Hardenability of Steel  
ASTM A370 - Mechanical Testing of Steel Products  
ASTM E45 - Determining the Inclusion Content of Steel  
ASTM E112 - Determining Average Grain Size  
ASTM E350 - Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron

2.3 U.S. Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.3.1 Federal Standards:

Federal Test Method Standard No. 151 - Metals: Test Methods

2.3.2 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 E350, by spectrographic methods in accordance with Federal Test Method Standard No. 151, Method 112, or by other analytical methods approved by purchaser:

	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 Condition: The product shall be supplied in the following condition: hardness shall be determined in accordance with ASTM A370:

- 3.2.1 Sheet and Strip: Cold finished, bright or atmosphere annealed, and descaled if necessary; or hot rolled, annealed, and descaled; having hardness not higher than 30 HRC or equivalent.
- 3.2.2 Plate: Hot rolled, annealed, and descaled having hardness not higher than 30 HRC or equivalent.
- 3.2.3 When product is ordered spheroidize annealed, 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 A370:

3.3.1 Micro-Inclusion Rating: No specimen as in 4.3.1 shall exceed the  $\phi$  following limits, determined in accordance with ASTM E45, Method D:

Type	Inclusion Rating			
	A	B	C	D
Thin	2.0	1.5	1.5	1.5
Heavy	1.0	1.0	1.0	1.0

- 3.3.1.1 For types A, B, and C thin combined, there shall be not more than three  $\phi$  fields of No. 2.0 A type or No. 1.5 B and C types and not more than five other lower rateable A, B, and C type thin fields per specimen. For type D thin, there shall be not more than five No. 1.5 thin fields. Any number of lower rateable D type thin fields per specimen is permitted. There shall be not more than one field each of No. 1.0 type A, B, or C or three fields of type D heavy per specimen. In addition, the thickness of the D-type heavy shall not exceed 0.0005 in. (0.012 mm).
- 3.3.1.2 A rateable field is defined as one which has a type A, B, C, or D  $\phi$  inclusion rating of at least 1.0 thin or heavy in accordance with the Jernkontoret Chart, Plate III, ASTM E45.
- 3.3.2 Grain Size: Predominantly 5 or finer with occasional grains as large as 3 permissible, determined in accordance with ASTM E112.
- 3.3.3 Hardenability: Shall be J58=1 max and J47=15 min, determined in accordance with ASTM A255 except that a laminated end-quench test specimen (Fig. 1) shall be used and the steel shall be normalized at 1700°F ± 10 (925°C ± 5) and the test specimen austenitized at 1625°F ± 10 (885°C ± 5).
- 3.3.4 Decarburization:
  - 3.3.4.1 Product Under 0.045 In. (1.15 mm) in Nominal Thickness: The method of test and the allowance shall be as agreed upon by purchaser and vendor.

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3.3.4.2 Product 0.045 to 0.375 In. (1.15 to 9.50 mm), Excl, in Nominal Thickness:

3.3.4.2.1 Specimens: Shall be the full thickness of the product except that specimens from plate 0.250 in. (6.25 mm) and over in nominal thickness shall be slices approximately 0.250 in. (6.25 mm) thick cut parallel to and preserving one original surface of the plate. Recommended specimen size is 1 x 4 in. (25 x 100 mm).

3.3.4.2.2 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 (150°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 in. (1.15 - 6.25 mm), excl, in nominal thickness and a portion of the specimen shall be ground to a depth of 0.050 in. (1.25 mm) or one-half thickness, whichever is less. Specimens from product 0.250 to 0.375 in. (6.25 - 9.50 mm), excl, in nominal thickness shall be ground to remove 0.020 in. (0.50 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.

3.3.4.2.3 Allowance:

3.3.4.2.3.1 Product 0.045 to 0.250 In. (1.15 to 6.25 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 3.3.4.2.2 shall be not greater than 2 units on the Rockwell "A" Scale.

3.3.4.2.3.2 Product 0.250 to 0.375 In. (6.25 to 9.50 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 3 units on the Rockwell "A" Scale.

3.3.4.3 Product 0.375 In. (9.50 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
9.50 to 12.50, incl	0.38
Over 12.50 to 25.00, incl	0.62
Over 25.00 to 50.00, incl	0.88
Over 50.00	As agreed upon

3.3.5 Response to Heat Treatment: Specimens as in 4.3.2 shall meet the following requirements after being hardened by heating to 1625°F ± 25 (885°C ± 15), holding at heat for 60 min. ± 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 hr, and cooling in air:

Tensile Strength, min	240,000 psi (1655 MPa)
Yield Strength at 0.2% Offset, min	210,000 psi (1450 MPa)
Elongation in 2 in. (50 mm) or 4D, min	

Nominal Thickness		
Inches	Millimetres	
Up to 0.070, incl	Up to 1.75, incl	5%
Over 0.070 to 0.249, incl	Over 1.75 to 6.25, incl	6%
Over 0.249	Over 6.25	8%

### 3.4 Quality:

- 3.4.1 Steel shall be premium aircraft-quality conforming to AMS 2300 or MAM 2300  $\phi$  except that a maximum average frequency (F) rating of 0.10 and a maximum average severity (S) rating of 0.20 shall apply. Steel shall be multiple melted using vacuum consumable electrode practice 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.

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3.5 Tolerances: Unless otherwise specified, 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  $\phi$  samples for vendor's tests and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.4. 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 to determine conformance to requirements for  $\phi$  composition (3.1), condition (3.2), micro-inclusion rating (3.3.1), grain size (3.3.2), hardenability (3.3.3), decarburization (3.3.4), frequency-severity cleanliness rating (3.4), and tolerances (3.5) are classified as acceptance tests and shall be performed on each heat or lot as applicable.

4.2.2 Periodic Tests: Tests to determine conformance to requirements for  $\phi$  response to heat treatment (3.3.5) are classified as periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.3 Sampling: Shall be in accordance with AMS 2370 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 micro-inclusion rating (3.3.3) shall be obtained from the finished slab or billet or suitable rerolled product and shall consist of not less than four specimens representing the top and bottom of the first and last ingots from a heat yielding 10 or fewer ingots or not less than six specimens representing the top and bottom of the first, middle, and last usable ingots from a heat yielding more than 10 ingots.

## 4.4 Reports:

4.4.1 The vendor of the product shall furnish with each shipment a report showing the results of tests for chemical composition, micro-inclusion rating, grain size, hardenability, and frequency-severity cleanliness rating of each heat and the results of tests on each lot to determine conformance to the hardness and decarburization requirements and, when performed, to the periodic test requirements. This report shall include the purchase order number, heat number, AMS 6435C, size, and quantity from each heat.

- 4.4.2 The vendor of finished or semi-finished parts shall furnish with each shipment a report showing the purchase order number, AMS 6435C, contractor or other direct supplier of material, part number, and quantity. When material for making parts is produced or purchased by the parts vendor, that vendor shall inspect each lot of material to determine conformance to the requirements of this specification and shall include in the report either a statement that the material conforms or copies of laboratory reports showing the results of tests to determine conformance.
- 4.5 Resampling and Retesting: Shall be in accordance with AMS 2370.
5. PREPARATION FOR DELIVERY:
- 5.1 Identification: The product shall be identified as in 5.1.1 unless purchaser permits a method from 5.1.2.
- 5.1.1 Each sheet, strip, and plate shall be marked on one face, in the respective location indicated below, with AMS6435C, heat number, manufacturer's identification, and nominal thickness. The characters shall be of such size as to be legible, shall be applied using a suitable marking fluid, and shall be removable in hot alkaline cleaning solution without rubbing. The markings shall have no deleterious effect on the product or its performance and shall be sufficiently stable to withstand normal handling. The specification number, manufacturer's identification, and nominal thickness shall be continuously line marked; the heat number may be included in the line marking or may be marked at one location on each piece.
- 5.1.1.1 Flat Strip 6 In. (150 mm) and Under in Width: Shall be marked in one or more lengthwise rows of characters recurring at intervals not greater than 3 ft (900 mm).
- 5.1.1.2 Flat Sheet, Flat Strip Over 6 In. (150 mm) in Width, and Plate: Shall be marked in lengthwise rows of characters recurring at intervals not greater than 3 ft (900 mm), the rows being spaced not more than 6 in. (150 mm) apart and alternately staggered.
- 5.1.1.3 Coiled Sheet and Strip: Shall be marked near both the outside and inside ends of the coil; the markings shall be applied as in 5.1.1 or shall appear on a durable tag or label attached to the coil and marked with the information of 5.1.1. When the product is wound on cores, the tag or label may be attached to the core.
- 5.1.2 When purchaser permits, each sheet, strip, and plate may be marked near one end, coils being marked near the outside, end with AMS 6435C, heat number, manufacturer's identification, and nominal thickness, using any suitable marking fluid. As an alternate method, individual pieces and bundles shall have attached a durable tag marked with the above information or shall be boxed and the box marked with the same information.