Society of Automotive Engineers, Inc.
400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

AEROSPACE MATERIAL SPECIFICATION

AMS 6439

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Revised

STEEL SHEET, STRIP, AND PLATE
1.05Cr - 0.55Ni - 1.0Mo - 0.12V (0.42 - 0.48C)
Premium Quality, Consumable Electrode Melted

1. SCOPE:

1.1 Form: This specification covers a premium-quality, low-alloy steel in the form of sheet, strip and plate.

1.2 Application: Primarily for heat-treated parts which may be welded during fabrication and which require through-hardening to high strength levels, for use at temperatures up to 600° F (316° C).

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

2.1 SAE Publications: Available from Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, Pennsylvania 15096.

2.1.1 Aerospace Material Specifications:

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

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.

ASTM A370 - Mechanical Testing of Steel Products
ASTM A604 - Macroetch Testing of Consumable Electrode Vacuum Arc Remelted Steel Bars and Billets
ASTM E112 - Estimating the Average Grain Size of Metals
ASTM E350 - Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron

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

2.3.1 Federal Standards:

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

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 approved analytical methods:

	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 Condition: The product shall be supplied in the following condition; hardness tests shall be conducted 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 if necessary, and descaled; having hardness not higher than 30 HRC or equivalent. When spheroidize anneal is specified, hardness shall be not higher than 100 HRB or equivalent.

3.2.2 Plate: Hot rolled, annealed if necessary, and descaled, having hardness not higher than 30 HRC or equivalent. When spheroidize anneal is specified, hardness shall be not higher than 100 HRB or equivalent.

3.3 Properties: The product shall confrom to the following requirements; hardness and tensile testing shall be performed in accordance with ASTM A370:

3.3.1 Grain Size: Predominantly 5 or finer with occasional grains as large as 3 permissible, ASTM E112, McQuaid-Ehn test.

3.3.2 Macrostructure: Visual examination of transverse sections from slabs, billets, or suitable rerolled product, etched in accordance with ASTM A604 in hot hydrochloric acid (1:1) at 160° - 180° F (71.1° - 82.2° C) for sufficient time to develop a well-defined macrostructure, shall show no injurious imperfections such as pipe, cracks, porosity, segregation, and inclusions detrimental to fabrication or to performance of parts. Macrostructure shall be equal to or better than the following macrographs of ASTM A604:

Class	Condition	Severity
1	Freckles	B
2	White Spots	C
3	Radial Segregation	C
4	Ring Pattern	As agreed upon

3.3.3 Decarburization:

3.3.3.1 Product Under 0.045 In. (1.14 mm) in Thickness: The method of test and the allowance shall be as agreed upon by purchaser and vendor.

3.3.3.2 Product 0.045 to 0.375 In. (1.14 to 9.52 mm), Excl, in Thickness:

3.3.3.2.1 Specimens: Shall be the full thickness of the product except that specimens from plate over 0.249 in. (6.32 mm) thick shall be slices approximately 0.250 in. (6.35 mm) thick cut parallel to and preserving one original surface of the plate. Recommended specimen size is 1 x 4 in. or 25 x 100 mm.

3.3.3.2.2 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 (149° 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. (1.14 to 6.35 mm), excl, in thickness and a portion of the specimen shall be ground to a depth of 0.050 in. (1.27 mm) or one-half thickness, whichever is less. Specimens from product 0.250 to 0.375 in. (6.35 to 9.52 mm), excl, in thickness shall be ground to remove 0.020 in. (0.51 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.

3.3.3.2.3 Allowance:

3.3.3.2.3.1 Product 0.045 to 0.250 In. (1.14 to 6.35 mm), Excl, in Thickness: The product shall show no layer of complete decarburization as 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 3.3.3.2.2 shall be not greater than 2 units on the Rockwell "A" scale.

3.3.3.2.3.2 Product 0.250 to 0.375 In. (6.35 to 9.52 mm), Excl, in 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.

3.3.3.3 Product 0.375 In. (9.52 mm) and Over in 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 Millimetres
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

3.3.4 Response to Heat Treatment: Product hardened by heating in a protective atmosphere to a temperature within the range 1600° - 1650° F (871.1° - 898.9° C), holding at the selected temperature within ± 10° F (± 5.6° C) for a time commensurate with section thickness but not less than 20 min., and quenched in oil, stress relieved at 400° F ± 10 (204.4° C ± 5.6) for 60 min. ± 5, cooled in air, and tempered at not lower than 1000° F (538° C) for not less than 4 hr, and cooled in air shall conform to the following requirements:

3.3.4.1 Tensile Properties: Shall be as specified in Table II.

TABLE II

Tensile Strength, min	
Nominal Thickness, in.	
Up to 0.250, incl	215,000 psi
Over 0.250	224,000 psi
Yield Strength at 0.2% Offset, min	
Nominal Thickness, in.	
Up to 0.250, incl	190,000 psi
Over 0.250	195,000 psi
Elongation in 2 in. or 4D, min	7%

TABLE II (SI)

Tensile Strength, min	
Nominal Thickness, mm	
Up to 6.35, incl	1482 MPa
Over 6.35	1544 MPa
Yield Strength at 0.2% Offset, min	
Nominal Thickness, mm	
Up to 6.35, incl	1310 MPa
Over 6.35	1345 MPa
Elongation in 50.8 mm or 4D, min	7%

3.3.4.2 Hardness: Product should have hardness not lower than 44 HRC or equivalent but the product shall not be rejected on the basis of hardness if the tensile property requirements are met.

3.4 Quality:

3.4.1 Steel shall be premium quality conforming to AMS 2300; it shall be multiple melted using vacuum consumable electrode process in the remelt cycle.

3.4.2 The product shall be uniform in quality and condition, clean, sound, and free from foreign materials and from internal and external imperfections detrimental to fabrication or to performance of parts.

3.5 Tolerances: Unless otherwise specified, 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 and shall be responsible for performing all required tests. Results of such shall be reported to the purchaser as required by 4.4. Purchaser reserves the right to perform such confirmatory testing as he deems necessary to assure that the product conforms to the requirements of this specification.