

STEEL SHEET, STRIP, AND PLATE

1.8Ni - 0.80Cr - 0.25Mo (0.38 - 0.43C) (SAE 4340)  
Premium Aircraft-Quality, Consumable Electrode Melted UNS G43400

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 heat treated parts requiring good tensile and endurance strengths in combination with good ductility. The product may be through-hardened to tensile strength ranges of 260,000 - 280,000 psi (1795 - 1930 MPa) in sections of 1.5 in. (38 mm) and under in nominal thickness and 180,000 - 220,000 psi (1240 - 1515 MPa) in nominal section thicknesses up to 3 in. (75 mm).

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 SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2252 - Tolerances, 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

AMS 2350 - Standards and Test Methods

AMS 2370 - Quality Assurance Sampling of Carbon and Low-Alloy Steels, Wrought Products Except Forgings and Forging Stock

SAE Technical Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

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

- ASTM E45 - Determining the Inclusion Content of Steel
- ASTM A255 - End-Quench Test for Hardenability of Steel
- ASTM A370 - Mechanical Testing of Steel Products
- 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 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	0.38	0.43
Manganese	0.60	0.90
Silicon	0.15	0.35
Phosphorus	--	0.015
Sulfur	--	0.015
Chromium	0.70	0.90
Nickel	1.65	2.00
Molybdenum	0.20	0.30
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 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 if necessary, and descaled, having hardness not higher than 98 HRB or equivalent.

3.2.2 Plate: Hot rolled, annealed if necessary, and descaled, having hardness not higher than 25 HRC or equivalent.

3.2.3 If product is ordered spheroidize annealed, the degree of spheroidization shall be as agreed upon by purchaser and vendor.

3.3 Properties: The product shall conform to the following requirements; hardness and bend 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, determined in accordance with ASTM E112.

3.3.2 Hardenability: Shall be J53=6 min and J50=20 min, determined on the standard end-quench test specimen in accordance with ASTM A255 except that the steel shall be normalized at  $1700^{\circ}\text{F} \pm 10$  ( $925^{\circ}\text{C} \pm 5$ ) and the test specimen austenitized at  $1525^{\circ}\text{F} \pm 10$  ( $830^{\circ}\text{C} \pm 5$ ). The hardenability test is not required on a product which will not yield a suitable specimen but the steel from which the product is made shall conform to the hardenability specified.

3.3.3 Micro-Inclusion Rating: Two-thirds of the total number of specimens as in 4.3.1, as well as the average of all specimens, shall not exceed the following limits, determined in accordance with ASTM E45, Method D, except that the length of any inclusion shall be not greater than 0.015 in. (0.38 mm):

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

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.

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 over 0.250 in. (6.25 mm) thick 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. (1.12 - 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 - 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 Millimetres
Over 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 Bending: Product 0.749 in. (18.72 mm) and under in nominal thickness shall withstand, without cracking, bending through the angle indicated below around a diameter equal to three times the nominal thickness of the product with axis of bend parallel to the direction of rolling:

Nominal Thickness		Angle deg, min
Inch	Millimetres	
Up to 0.249, incl	Up to 6.22, incl	180
Over 0.249 to 0.749, incl	Over 6.22 to 18.72, incl	90

3.3.5.1 Bending requirements for plate over 0.749 in. (18.72 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.

#### 3.4 Quality:

3.4.1 Steel shall be premium aircraft-quality conforming to AMS 2300. Steel shall be multiple melted using vacuum consumable electrode or electro-slag process 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 internal and external imperfections detrimental to usage of the product.

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 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: 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.

4.3 Sampling: Shall be in accordance with AMS 2370 and the following:

4.3.1 Samples for micro-inclusion rating (3.3.3) shall be obtained from the finished billet or slab 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 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 three copies of a report showing the results of tests for chemical composition, grain size, and AMS 2300 frequency-severity rating of each heat and the results of tests on each lot to determine conformance to the decarburization and bending requirements. This report shall include the purchase order number, heat number, AMS 6454, size, and quantity from each heat.

4.4.2 The vendor of finished or semi-finished parts shall furnish with each shipment three copies of a report showing the purchase order number, AMS 6454, 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 AMS 6454, 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).