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400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

AMS 6406C

Issued 6-30-60
Revised 7-I-88

Superseding AMS 6406B

STEEL SHEET, STRIP, AND PLATE
1.6Si - 2.1Cr - 0.58Mo - 0.05V (0.41-0.46C)
Annealed

UNS K34378

This specification has been declared "NONCURRENT" by the Aerospace Materials Division, SAE, as of April 1, 1987. It is recommended that this specification not be specified for new designs.

This cover sheet should be attached to the "C" Revision of the subject specification.

Noncurrent refers to those materials which have previously been widely used and which may be required on some existing designs in the future. The Aerospace Materials Division does not recommend these as standard materials for future use in new designs. Each of these "Noncurrent" specifications is available on request.

REAFFIRMED
APR 94

This specification is under the jurisdiction of the AMS Committee "E".

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AMS 6406C
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STEEL SHEET, STRIP, AND PLATE
1.6Si - 2.1Cr - 0.58Mo - 0.05V (0.41 - 0.46C)

1. SCOPE:

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

1.2 Application: Primarily for heat treated parts and structures that may require welding during fabrication and may be through-hardened to a minimum tensile strength of 270,000 psi (1862 MPa) in sections of 2 in. (50 mm) or lees in nominal thickness.

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, 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 2301 - Aircraft Quality Steel Cleanliness, Magnetic Paticle 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, PA 19103.

ASTM A370 - Mechanical Testing of Steel Products
ASTM E45 - Determining the Inclusion Content of Steel
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
ASTM E381 - Rating Macroetched Steel

2.3 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	0.41	0.46
Manganese	0.75	1.00
Silicon	1.40	1.75
Phosphorus	--	0.015
Sulfur	--	0.015
Chromium	1.90	2.25
Molybdenum	0.45	0.60
Vanadium	0.03	0.08
Nickel	--	0.25
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:

3.2.1 Sheet and Strip: Cold finished, annealed, and descaled.

3.2.2 Plate: Hot rolled, annealed, and descaled.

3.3 Annealing: The product shall be annealed by heating to 13S5°F ± 25 (735°C ± 15), holding at heat for not less than 40 hr, and cooling in air to room temperature.

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

3.4.1 Macrostructure: Visual examination of specimens as in 4.3.1, etched in accordance with ASTM E381 in hot hydrochloric acid (1:1) at 160° - 180°F (71° - 82°C) for sufficient time to develop a well-defined Ø macrostructure, shall show no pipe or cracks. Porosity, segregation, inclusions, and other imperfections shall be no worse than the following macrographs of ASTM E381:

Section Size		
Square inches	(Square Centimetres)	Macrographs
Up to 36, incl	(Up to 232, incl)	S2 - R1 - C2
Over 36 to 100, incl	(Over 232 to 645, incl)	S2- R2- C3
Over 100	(Over 645)	As agreed upon

3.4.2 Grain Size: Predominantly 5 or finer with occasional grains as large as 3 permissible, determined Ø in accordance with ASTM E112.

3.4.3 Micro-Inclusion Rating: At least one specimen from each ingot tested, as well as two-thirds of the total number of specimens and the average of all specimens, shall not exceed the following limits, determined Ø in accordance with ASTM E45, Method A, except that the length of any inclusion shall be not greater than 0.025 in. (0.65 mm):

	Inclusion Rating			
Type	A	B	C	D
Thin	2.0	2.0	3.0	2.5
Heavy	2.0	2.0	2.0	2.0

3.4.4 Decarburization:

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

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

3.4.4.2.1 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. (25 x 100 mm).

3.4.4.2.2 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. (1.14 to 6.35 mm), excl, in nominal 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 9.50 mm), excl, in nominal thickness shall be ground to remove 0.020 in. (0.50 mm) of metal from 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 thicknees of the specimen. At least three Rockwell hardness readings shall be taken on each prepared step and each group of readings averaged.

3.4.4.2.3 Allowance:

3.4.4.2.3.1 Product 0.045 to 0.250 In. (1.14 to 6.35 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 3.4.4.2.2 shall be not greater than 2 units on the Rockwell "A" scale.

3.4.4.2.3.2 Product 0.250 to 0.375 In. (6.35 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.

3.4.4.3 Product 0.375 In. (9.5 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
9.50 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

3.4.5 Properties As Annealed:

3.4.5.1 Tensile Properties:

3.4.5.1.1 Product 0.020 - 2.000 In. (0.50 - 50 mm), Incl, in Nominal Thickness:

Tensile Strength, max	120,000 psi (827 MPa)
Yield Strength at 0.2% Offset, max	95,000 psi (655 MPa)
Elongation in 2 in. (50 mm) or 4D, min	15%

3.4.5.1.2 Tensile property requirements for product under 0.020 in. (0.50 mm) or over 2.000 in. (50 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.

3.4.5.2 Hardness: Shall be not higher than 97 HRB or equivalent.

3.4.6 Properties After Hardening and Tempering: The product shall have the following properties after being heated to 1725°F ± 25 (940°C ± 15), held at heat for not less than 15 min. , cooled as required, and tempered at 600° - 750°F (315° 400°C) for not less than 30 minutes:

3.4.6.1 Tensile Properties:

3.4.6.1.1 Product 0.020 - 2.000 In. (0.50 - 50 mm), Incl, in Nominal Thickness:

Tensile Strength, min	270,000 psi (1862 MPa)
Yield Strength at 0.2% Offset, min	230,000 psi (1586 MPa)
Elongation in 2 in. (50 mm) or 4D, min	5%

3.4.6.1.2 Tensile property requirements for product under 0.020 in. (0.50 mm) or over 2.000 in. (50 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.

3.4.6.2 Hardness: Shall be not lower than 53 HRC or equivalent.

3.5 Quality:

3.5.1 Steel shall be aircraft quality conforming to AMS 2301.

3.5.2 Ø 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.

3.6 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 tests 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 ensure that the product conforms to the requirements of this specification.

4.2 Ø 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 lot.

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

4.3.1 Ø Samples for macrostructure (3.4.1) testing shall be full cross-sectional specimens obtained from the finished slab or billet or suitable rerolled product representing the top and bottom of at least the first, middle, and last usable ingots of each heat.

4.3.2 Samples for micro-inclusion rating (3.4.3) shall consist of not less than six specimens from each heat, selected so that the surface examined will be approximately parallel to the direction of rolling. The method of selection of specimens shall be such that a representative rating is ensured for the heat of steel being evaluated.

4.3.3 Specimens for tensile tests of widths 9 in. (230 mm) and over shall be taken with the axis of the specimen perpendicular to the direction of rolling; for widths less than 9 in. (230 mm), specimens shall be taken with the axis parallel to the direction of rolling.

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, macrostructure, grain size, micro-inclusion rating, and AMS 2301 frequency-severity rating of each heat and the results of tests on each size from each heat to determine conformance to the other technical requirements of this specification. This report shall include the purchase order number, heat number, material specification number and its revision letter, 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, material specification number and its revision letter, 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 a statement that the material conforms, or shall include copies of laboratory reports showing the results of tests to determine conformance.

Ø 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 6406C, heat number, manufacturer's identification, and nominal thickness. The characters shall be of such size as to be clearly 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. (152 mm) and Under in Width: Shall be marked in one or more lengthwise rows of characters recurring at intervals not greater than 3 A (914 mm).

5.1.1.2 Flat Sheet, Flat Strip Over 6 In. (152 mm) in Width, and Plate: Shall be marked in lengthwise rows of characters recurring at intervals not greater than 3 ft (914 mm), the rows being spaced not more than 6 in. (152 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
Ø and marked with the information of 5.1.1. When the inside end of the coil is inaccessible, as 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 6406C, 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.