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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 6351F

Issued DEC 1953
Revised JAN 2001

Superseding AMS 6351E

Steel, Sheet, Strip, and Plate
0.95Cr - 0.20Mo (0.28 - 0.33C) (SAE 4130)
Spheroidized

Composition similar to UNS G41300

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:

These products have been used typically for general use where deep drawing and forming are required, but usage is not limited to such applications. Product may be through-hardened to a minimum tensile strength of 180 ksi (1241 MPa) in sections 0.125 inch (3.18 mm) and under in nominal thickness and proportionately lower strength in heavier section thicknesses.

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 2301	Cleanliness, Aircraft Quality Steel, Magnetic Particle Inspection Procedure
MAM 2301	Cleanliness, Aircraft Quality Steel, Magnetic Particle Inspection Procedure, Metric (SI) Measurement
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

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

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM A 370	Mechanical Testing of Steel Products
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	Microhardness 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	0.28	0.33
Manganese	0.40	0.60
Silicon	0.15	0.35
Phosphorus	--	0.025
Sulfur	--	0.025
Chromium	0.80	1.10
Molybdenum	0.15	0.25
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; hardness shall be not higher than 85 HRB, or equivalent (See 8.2), determined in accordance with ASTM A 370.

3.2.1 Sheet and Strip: Cold rolled or hot rolled, annealed to develop a uniform microstructure of spheroidized cementite in ferrite matrix, and descaled.

3.2.2 Plate: Hot rolled, annealed to develop a uniform microstructure of spheroidized cementite in ferrite matrix, and descaled.

3.3 Properties:

The product shall conform to the following requirements; hardness, tensile, and bend testing shall be performed in accordance with ASTM A 370:

3.3.1 Response to Heat Treatment: Product 0.249 inch (6.32 mm) and under in nominal thickness and thicker product reduced to 0.249 inch ± 0.010 (6.32 mm ± 0.25) in thickness shall have tensile strength not lower than 125 ksi (862 MPa) or hardness not lower than 26 HRC, or equivalent, (See 8.2), after being hardened by quenching in oil from 1600 °F ± 10 (871 °C ± 6), and tempered for not less than 30 minutes at not lower than 900 °F (482 °C).

3.3.2 Average Grain Size: Shall be ASTM No. 5 or finer determined in accordance with ASTM E 112 (See 8.3).

3.3.3 Decarburization: Depending upon 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 3.3.3.4.1), 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.

3.3.3.1 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 3.3.3.4.1 or 3.3.3.5.1, as applicable.).

3.3.3.2 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 inches (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).

3.3.3.3 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.

3.3.3.4 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.

3.3.3.4.1 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 3.3.3.4 shall not be greater than two units on the HRA scale, or equivalent (See 8.2). Also, refer to 3.3.3.1.

3.3.3.5 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.

3.3.3.5.1 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 on the HRA scale, or equivalent (See 8.2). Also, refer to 3.3.3.1.

3.3.3.6 Product 0.375 inch (9.52 mm) and Over in Nominal Thickness:

3.3.3.6.1 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 2. Also, refer to 3.3.3.1. 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 not further increase in hardness.

TABLE 2A - Maximum Decarburization, 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 2B - Maximum Decarburization, SI Units

Nominal Thickness Millimeters	Total Depth of Decarburization Millimeter
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

3.3.4 Bending: Product 0.749 inch (19.02 mm) and under in nominal thickness shall withstand, without cracking, free bending through the angle shown in Table 3 around a diameter equal to the nominal thickness of the product, with axis of bend parallel to the direction of rolling:

TABLE 3 - Bend Angle Requirements

Nominal Thickness Inch	Nominal Thickness Millimeters	Bend Angle Degrees
Up to 0.249, incl	Up to 6.32, incl	180
Over 0.249 to 0.749, incl	Over 6.32 to 19.02, incl	90

3.4 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.

3.4.1 Steel shall be aircraft quality conforming to AMS 2301 or MAM 2301.

3.5 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.

4.2 Classification of Tests:

4.2.1 Ingot Cast Product: All technical requirements are acceptance tests and shall be performed on each heat or lot as applicable.

4.2.2 Continuous Cast Product:

4.2.2.1 Acceptance Tests: Composition (3.1), hardness (3.2), response to heat treatment (3.3.1), average grain size (3.3.2) decarburization (3.3.3), bending (3.3.4), and tolerances (3.5) are classified as acceptance tests and shall be performed on each heat or lot as applicable.

4.2.2.2 Periodic Tests: Frequency and severity (3.4.1) is a periodic test and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.