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INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 6546F

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Superseding	AMS 6546E

Steel, Sheet, Strip, and Plate
0.48Cr - 8.0Ni - 4.0Co - 0.48Mo - 0.09V (0.24 - 0.30C)
Consumable Electrode Melted, Annealed

UNS K91122

CANCELLATION NOTICE

This specification has been "CANCELLED" by the Aerospace Materials Division, SAE, as of July 2001. By this action, this document will remain listed in the Numerical Section of the Index of Aerospace Material Specifications.

Cancelled specifications are available from SAE.

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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:

This product has been used typically for heat treated parts, such as pressure vessels, requiring through hardening to high strength levels, and where such parts may require welding, but usage is not limited to such applications.

2. APPLICABLE DOCUMENTS:

The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order.

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 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 2370	Quality Assurance Sampling and Testing of Carbon and Low-Alloy Steels, 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

2.2 ASTM Publications:

Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM A 370	Mechanical Testing of Steel Products
ASTM E 45	Determining the Inclusion Content of Steels
ASTM E 112	Determining Average Grain Size
ASTM E 338	Sharp-Notch Tension Testing of High-Strength Sheet Materials
ASTM E 350	Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron
ASTM E 399	Plane-Strain Fracture Toughness of Metallic Materials

2.3 U.S. Government Publications:

Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-STD-163 Steel Mill Products, Preparation for Shipment and Storage

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	0.24	0.30
Manganese	0.10	0.35
Silicon	--	0.10
Phosphorus	--	0.010
Sulfur	--	0.010
Chromium	0.35	0.60
Nickel	7.00	9.00
Cobalt	3.50	4.50
Molybdenum	0.35	0.60
Vanadium	0.06	0.12
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 A 370:

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 36 HRC, or equivalent.

3.2.2 Plate: Hot rolled, annealed, and descaled, having hardness not higher than 36 HRC, or equivalent.

3.2.3 When the product is ordered normalized and tempered, hardness shall be not higher than 30 HRC, or equivalent.

3.3 Properties:

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

3.3.1 Grain Size: Predominantly 5 or finer with occasional grains as large as 3 permissible, determined in accordance with ASTM E 112.

3.3.2 Micro-Inclusion Rating: Two-thirds of the total number of specimens, selected as in 4.3.1, as well as the averge of all specimens tested shall not exceed the limits of Table 2, determined in accordance with ASTM E 45, Method D, except that the length of any inclusion shall be not greater than 0.015 inch (0.38 mm):

TABLE 2 - Micro-Inclusion Rating Limits

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

3.3.3 Decarburization:

3.3.3.1 Product Under 0.045 Inch (1.14 mm) in Nominal 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 Inch (1.14 to 9.52 mm), Exclusive, in Nominal Thickness:

3.3.3.2.1 Specimens: Shall be the full thickness of the product except that specimens from plate 0.250 inch (6.35 mm) and over in nominal thickness shall be slices approximately 0.250 inch (6.35 mm) thick cut parallel to and preserving one original surface of the plate. Recommended specimen size is 1 x 4 inches (25 x 102 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 inch (1.14 to 6.35 mm), exclusive, in nominal thickness and a portion of the specimen shall be ground to a depth of 0.050 inch (1.27 mm) or one-half thickness, whichever is less. Specimens from product 0.250 to 0.375 inch (6.35 to 9.52 mm), exclusive, in nominal thickness shall be ground to remove 0.020 inch (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 Inch (1.14 to 6.35 mm), Exclusive, 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 3.3.3.2.2 shall be not greater than two units on the Rockwell "A" scale.

3.3.3.2.3.2 Product 0.250 to 0.375 Inch (6.35 to 9.52 mm), Exclusive, 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 three units on the Rockwell "A" scale.

3.3.3.3 Product 0.375 Inch (9.52 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 3.

TABLE 3A - Maximum Depth of Decarburization, Inches

Nominal Thickness	Depth
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 3B - Maximum Depth of Decarburization, Millimeters

Nominal Thickness	Depth
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 Properties After Heat Treatment: Product, heat treated as in 3.3.4.1 except that annealing as in 3.3.4.1.1 is optional, shall meet the requirements of 3.3.4.2 and 3.3.4.3.

3.3.4.1 Heat Treatment:

3.3.4.1.1 Annealing: Heat to 1140 °F ± 25 (616 °C ± 14), hold at heat for 8 - 24 hours, and cool in air to room temperature.

3.3.4.1.2 Normalizing: Heat to a temperature within the range 1600 - 1700 °F (871 - 927 °C), hold at the selected temperature within ±25 °F (±14 °C) for 1 hour per inch (25 mm) of section thickness, and cool in air to room temperature.

3.3.4.1.3 Hardening: Heat to 1550 °F ± 25 (843 °C ± 14), hold at heat for 1 hour per inch (25 mm) of section thickness but not less than 1 hour, and from that temperature quench sections up to 4 inches (102 mm) in nominal thickness into room-temperature oil or water.

3.3.4.1.4 Tempering: Heat to a temperature not higher than 1050 °F (566 °C), hold at heat for 2 hours per inch (25 mm) of thickness but not less than 2 hours, and cool in air to room temperature.

3.3.4.2 Tensile Properties: The product shall conform to the properties specified in Table 4; testing shall be in accordance with ASTM A 370:

TABLE 4A - Minimum Tensile Properties, Inch/Pound Units

Nominal Thickness Inches	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 2 Inches %	Reduction of Area %
0.020 to 0.060, incl	185.0	175.0	5	50
Over 0.060 to 0.100, incl	185.0	175.0	8	50
Over 0.100 to 0.187, incl	185.0	175.0	10	50
Over 0.187 to 4.000, excl	185.0	175.0	13	50

TABLE 4B - Minimum Tensile Properties, SI Units

Nominal Thickness Millimeters	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 50.8 mm %	Reduction of Area %
0.51 to 1.52, incl	1276	1207	5	50
Over 1.52 to 2.54, incl	1276	1207	8	50
Over 2.54 to 4.75, incl	1276	1207	10	50
Over 4.75 to 101.60, excl	1276	1207	13	50

3.3.4.3 Fracture Toughness: When specified, product shall be subjected to fracture toughness testing. The method of test and standards for acceptance shall be as agreed upon by purchaser and vendor. ASTM E 338 is a suggested method of test for sheet and ASTM E 399 is a suggested method of test for plate.

3.4 Quality:

3.4.1 Steel shall be premium aircraft-quality conforming to AMS 2300 or MAM 2300; it shall be multiple melted using consumable electrode practice in the remelt cycle; at least one of the melting cycles shall be under vacuum.

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.

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 performing all required tests. 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 for all technical requirements are acceptance tests and shall be performed on each heat or lot as applicable.

4.3 Sampling and Testing:

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. When permitted by purchaser, a heat may be the consumable electrode remelted product of individual melts of similar composition produced from the same lots of controlled raw materials and having the same average composition as agreed upon by purchaser and vendor.

4.4 Reports:

The vendor of the product shall furnish with each shipment a report showing the results of tests for chemical composition, grain size, micro-inclusion rating, and frequency-severity cleanliness rating of each heat and for tensile properties of each lot after heat treatment. This report shall include the purchase order number, lot number, AMS 6546F, size, and quantity.

4.5 Resampling and Retesting:

Shall be in accordance with AMS 2370.

5. PREPARATION FOR DELIVERY:

5.1 Identification:

Shall be in accordance with AMS 2807.