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

AEROSPACE MATERIAL SPECIFICATION

AMS 6522

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Revised

STEEL PLATE
2.0Cr - 10Ni - 14Co - 1.0Mo
Premium Quality, Vacuum Melted

1. SCOPE:

1.1 Form: This specification covers a premium-quality alloy steel in the form of plate.

1.2 Application: Primarily for heat treated parts requiring high strength, high toughness, and weldability.

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 2248 - Chemical Check Analysis Limits, Wrought Heat and Corrosion Resistant Steels and Alloys
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, PA 19103.

ASTM A604 - Macroetch Testing of Consumable Electrode Remelted Steel Bars and Billets
ASTM E8 - Tension Testing of Metallic Materials
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 E399 - Plain-Strain Fracture Toughness of Metallic Materials

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 Specifications:

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

Printed in U.S.A.

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	0.13	0.17
Manganese	--	0.10
Silicon	--	0.10
Phosphorus	--	0.008
Sulfur	--	0.005
Phosphorus plus Sulfur	--	0.010
Chromium	1.80	2.20
Nickel	9.50	10.50
Cobalt	13.50	14.50
Molybdenum	0.90	1.10
Titanium	--	0.015
Aluminum	--	0.015
Oxygen	--	0.0015 (15 ppm)
Nitrogen	--	0.0015 (15 ppm)

3.1.1 Check Analysis: Composition variations shall meet the requirements of AMS 2248.

3.2 Condition: Normalized and overaged.

3.3 Heat Treatment: Plate shall be normalized by heating to 1650°F ± 25 (900°C ± 15), holding at heat for 60 min. ± 5, and forced-air cooling to room temperature, and overaged by heating to 1250°F ± 25 (675°C ± 15), holding at heat for 8 hr ± 0.25, and forced-air cooling.

3.4 Properties: Plate shall conform to the following requirements:

3.4.1 Macrostructure: Visual examination of transverse sections as in 4.3.1 from slabs, etched in accordance with ASTM A604 in hot hydrochloric acid (1:1) at 160° - 180°F (71° - 82°C) for sufficient time to develop a well-defined macrostructure, shall show no imperfections such as pipe, cracks, porosity, segregation, and inclusions detrimental to usage of the plate. Macrostrucuture shall be no worse than the following macrographs of ASTM 604:

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

3.4.2 Micro-Inclusion Rating: Two-thirds of the total number of specimens, 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):

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

3.4.3 Grain Size: Shall be 10 or finer, determined by comparison of a polished and etched specimen with the chart in ASTM E112.

3.4.4 Response to Heat Treatment: Plate 100 sq in. (645 cm^2) and under in cross-sectional area shall meet the requirements of 3.4.4.1 and 3.4.4.2 after being heated to 1650°F ± 25 (900°C ± 15), held at heat for 60 min. ± 5, forced-air cooled to room temperature, reheated to 1525°F ± 25 (830°C ± 15), held at heat for 60 min. ± 5, forced-air cooled to room temperature, cooled to -100°F ± 15 (-75°C ± 8), held at that temperature for 60 min. ± 5, warmed in air to room temperature, and aged by heating to 950°F ± 10 (510°C ± 5), holding at heat for not less than 5 hr, and forced-air cooling. Property requirements for plate over 100 sq in. (645 cm^2) in cross-sectional area shall be as agreed upon by purchaser and vendor.

3.4.4.1 Tensile Properties: Shall be as follows, determined in accordance with ASTM E8 on specimens taken in the longitudinal direction:

Tensile Strength, min	235,000 psi (1620 MPa)
Yield Strength at 0.2% off-set, min	215,000 psi (1482 MPa)
Elongation in 2 in. (50 mm) or 4D, min	12%
Reduction of Area, min	60%

3.4.4.2 Fracture Toughness: Shall be not lower than 130,000 psi $\sqrt{in.}$ (149 MPa $\sqrt{m}$), determined in accordance with ASTM E399 on specimens taken from plate 1.50 in. (38.1 mm) and over in nominal thickness. Acceptance value and method of test for plate under 1.50 in. (38.1 mm) in nominal thickness shall be as agreed upon by purchaser and vendor. Tests shall be in the T-L orientation, unless otherwise specified by purchaser.

3.5 Quality:

3.5.1 Steel shall be premium aircraft quality conforming to AMS 2300. It shall be multiple melted using vacuum induction melting followed by vacuum arc remelting.

3.5.2 Plate, 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 plate.

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 plate 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 such confirmatory testing as he deems necessary to ensure that the plate conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests to determine conformance to requirements for the following are classified as acceptance tests and shall be performed on each heat or lot as applicable:

4.2.1.1 Composition (3.1), macro-structure (3.4.1), micro-inclusion rating (3.4.2), and grain size (3.4.3) of each heat.

4.2.1.2 Tensile properties (3.4.4.1) of each lot after heat treatment.

4.2.1.3 Tolerances (3.6).

4.2.2 Periodic Test: Tests to determine conformance to requirements for fracture toughness (3.4.4.2) are classified as periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser:

4.3 Sampling: 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:

4.3.1 Samples for macrostructure (3.4.1) shall be cross-sectional specimens obtained from a 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 (3.4.2) shall be obtained from the finished billet or suitable rerolled slab 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 usable ingots from a heat yielding more than 10 ingots.

4.4 Reports:

4.4.1 The vendor of plate shall furnish with each shipment three copies of a report showing the results of tests for chemical composition, macrostructure, micro-inclusion rating, grain size, and AMS 2300 frequency-severity rating of each heat and the results of tests on each lot for tensile properties and, when performed, for fracture toughness after heat treatment. This report shall include the purchase order number, heat number, AMS 6522, 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 6522, contractor or other direct supplier of plate, part number, and quantity. When plate for making parts is produced or purchased by the parts vendor, that vendor shall inspect each lot of plate to determine conformance to the requirements of this specification, and shall include in the report a statement that the plate conforms, or shall include 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: Each plate shall be marked on one face in lengthwise rows of characters recurring at intervals not greater than 3 ft (900 mm), the rows being spaced not more than 6 in. (150 mm) apart and alternately staggered with AMS 6522, 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 plate or its performance and shall be sufficiently stable to withstand normal handling.

5.2 Protective Treatment: Plate shall be oiled prior to shipment.

5.3 Packaging:

5.3.1 Plate shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the plate to ensure carrier acceptance and safe delivery. Packaging shall conform to carrier rules and regulations applicable to the mode of transportation.