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400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

AMS 6518A

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Superseding AMS 6518

STEEL SHEET, STRIP, AND PLATE, MARAGING
19Ni - 3.0Mo - 1.4Ti - 0.10Al
Double Vacuum Melted, Solution Heat Treated

1. SCOPE:

1.1 Form: This specification covers a premium aircraft-quality maraging steel in the form of sheet, strip, and plate.

1.2 Application: Primarily for parts such as pressure vessels, and other components requiring through-hardening, without quenching, to a yield strength of 245,000 psi (1690 MPa) or higher.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications 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 2248 - Chemical Check Analysis Limits, Wrought Corrosion and Heat Resistant Steels and Alloys, Maraging and Other Highly-Alloyed Steels, and Iron Alloys
AMS 2252 - Tolerances, Low-Alloy Steel Sheet, Strip, and Plate
MAM 2252 - Tolerances, Metric, Low-Alloy Steel Sheet, Strip, and Plate
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 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 A604 - Macroetch Testing of Consumable Electrode Remelted Steel Bars and Billets
ASTM E45 - Determining the Inclusion Content of Steel
ASTM E112 - Determining Average Grain Size
ASTM E338 - Sharp-Notch Tension Testing of High-Strength Sheet Materials
ASTM E353 - Chemical Analysis of Stainless, Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron Alloys
ASTM E399 - Plane-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 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, Ø determined by wet chemical methods in accordance with ASTM E353 or by spectrographic or other analytical methods approved by purchaser:

	min	max
Carbon	--	0.03
Manganese	--	0.10
Silicon	--	0.10
Phosphorus	--	0.010
Sulfur	--	0.010
Nickel	18.00	20.00
Molybdenum	2.75	3.25
Titanium	1.30	1.45
Aluminum	0.05	0.15
Chromium	--	0.50
Cobalt	--	0.50
Copper	--	0.50

3.1.1 Prior to pouring, up to 0.05% calcium shall be added to the melt but analysis for this element need not be performed.

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

3.2 Condition: Hot rolled, solution heat treated, and descaled.

3.3 Heat Treatment: The product shall be solution heat treated by heating to 1500°F ± 25 (815°C ± 15) in air, holding at heat for a time commensurate with the thickness and the heating procedure used, and cooling in air. Continuously-rolled product may be solution heat treated at temperatures higher than 1500°F (815°C) provided the product is re-solution heat treated at 1500°F ± 25 (815°C ± 15).

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 As Solution Heat Treated:

3.4.1.1 Macrostructure: Visual examination of transverse sections as in 4.3.1, etched in accordance with ASTM A604 in hot hydrochloric acid (1:1) at 160° - 180°F (70° - 80°C) for sufficient time to develop a well-defined macrostructure, shall show no pipe or cracks. Porosity, segregation, inclusions, and other imperfections shall be no worse than the following macrographs of ASTM A604:

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

3.4.1.2 Micro-Inclusion Rating: No specimen as in 4.3.2 shall exceed the following limits, determined in accordance with ASTM E45, Method D:

	Inclusion Rating, Worst Field				
Type	A	B	C	D	E
Thin	1.5	1.5	1.5	2.0	3.0
Heavy	1.0	1.0	1.0	1.5	2.0

3.4.1.2.1 Type E is titanium nitrides and shall be rated in the same manner as Type B.

3.4.1.3 Grain Size:

3.4.1.3.1 Product 0.625 In. (15.50 mm) and Under in Nominal Thickness: Shall be predominantly 5 or finer with occasional grains as large as 3 permissible, determined by comparison of a polished and etched specimen with the chart in ASTM E112.

3.4.1.3.2 Product Over 0.625 In. (15.50 mm) in Nominal Thickness: Shall be as agreed upon by purchaser and vendor.

3.4.1.4 Hardness: Shall be not higher than 34 HRC, or equivalent.

3.4.2 After Maraging: Product, solution heat treated as in 3.3, shall have the following properties after being maraged by heating to 900°F ± 10 (480°C ± 5), holding at heat for 4 - 6 hr, and cooling in air:

3.4.2.1 Tensile Properties: Shall be as specified in Table I.

TABLE I

Tensile Strength, min 255,000 psi
Yield Strength at 0.2% Offset, min 245,000 psi
Elongation, % in gage length specified

Nominal Thickness Inch	Gage Length 2 in. or 4D	1 in.	0.5 in.
Up to 0.030, excl	-	-	1.0
0.030 to 0.045, incl	-	-	2.0
Over 0.045 to 0.065, incl	-	2.0	-
Over 0.065 to 0.090, incl	2.5	5.0	-
Over 0.090 to 0.125, incl	3.0	6.0	-
Over 0.125 to 0.250, incl	4.0	8.0	-
Over 0.250 to 0.375, incl	5.0	-	-
Over 0.375	6.0	-	-

TABLE I (SI)

Tensile Strength, min 1760 MPa
Yield Strength at 0.2% Offset, min 1690 MPa
Elongation, % in gage length specified

Nominal Thickness Millimetres	Gage Length 50 mm or 4D	25 mm	12.5 mm
Up to 0.75, excl	-	-	1.0
0.75 to 1.10, incl	-	-	2.0
Over 1.10 to 1.60, incl	-	2.0	-
Over 1.60 to 2.25, incl	2.5	5.0	-
Over 2.25 to 3.10, incl	3.0	6.0	-
Over 3.10 to 6.25, incl	4.0	8.0	-
Over 6.25 to 9.50, incl	5.0	-	-
Over 9.50	6.0	-	-

3.4.2.2 Hardness: Should be not lower than 48 HRC, or equivalent, but the product shall not be rejected on the basis of hardness if the tensile property requirements of 3.4.2.1 are met.

3.4.2.3 Fracture Toughness: When specified, product shall be subjected to fracture toughness testing. Method of test and standards for acceptance shall be as agreed upon by purchaser and vendor. ASTM E338 is a suggested method of test for sheet. ASTM 399 is a suggested method of test for plate.

3.5 Quality:

3.5.1 Steel shall be premium aircraft-quality conforming to AMS 2300 or MAM 2300. It shall be multiple melted using vacuum induction process in the initial melt and vacuum consumable electrode practice in the final melt.

3.5.2 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.

3.6 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. 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; 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 (3.4.1.1) testing shall be full cross-sectional specimens obtained from the finished slab or billet or suitable rerolled product representing the top and bottom of each ingot.

4.3.2 Samples for micro-inclusion rating (3.4.1.2) shall be obtained from the finished slab or billet or suitable rerolled product and shall consist of not less than 4 specimens representing the top and bottom of the first and last ingots from a heat yielding 10 or fewer ingots or not less than 6 specimens representing the top and bottom of the first, middle, and last usable ingot from a heat yielding more than 10 ingots.

4.4 Reports:

4.4.1 The vendor of the product shall furnish with each shipment a report showing the results of tests for chemical composition, macrostructure, micro-inclusion rating, grain size, and frequency-severity cleanliness rating of each heat and the results of tests on each lot for tensile properties, hardness, and, when specified, fracture toughness after maraging. This report shall include the purchase order number, heat number, AMS 6518A, size, and quantity.

4.4.2 The vendor of finished or semi-finished parts shall furnish with each shipment a report showing the purchase order number, AMS 6518A, 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 6518A, 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).

5.1.1.2 Flat Sheet, Flat Strip Over 6 In. (150 mm) in Width, and Plate: Shall be marked 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.