AEROSPACE MATERIAL SPECIFICATION

AMS6544™	REV. F

Issued 1975-09
Reaffirmed 2009-06
Revised 2023-05

Superseding AMS6544E

Steel, Plate
2.0Cr - 10Ni - 8.0Co - 1.0Mo (0.10 - 0.14C) (HY-180)
Double Vacuum Melted, Solution Heat Treated
(Composition similar to UNS K91970)

RATIONALE

AMS6544F is the result of a Five-Year Review and update of the specification. The revision adds information on stress corrosion (1.2.1), updates composition reporting (3.1.1), adds pyrometry controls (3.4, 3.5.2), updates macrostructure requirements consistent with the melting practice (Table 2), clarifies applicability of toughness testing (3.5.2.4), and prohibits unauthorized exceptions (3.5.2.5, 8.6).

1. SCOPE

1.1 Form

This specification covers a maraging steel in the form of rolled or forged plate 0.375 inches through 8.000 inches (9.52 mm through 203.20 mm).

1.2 Application

This product has been used typically for heat-treated parts requiring a combination of high strength, toughness, and weldability, but usage is not limited to such applications.

1.2.1 Certain design and processing procedures may cause these products to become susceptible to stress-corrosion cracking after heat treatment. ARP1110 recommends practices to minimize such conditions.

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 cancelled and no superseding document has been specified, the last published issue of that document shall apply.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
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SAE WEB ADDRESS: **http://www.sae.org**

For more information on this standard, visit
https://www.sae.org/standards/content/AMS6544F/

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AMS2242 Tolerances, Corrosion and Heat Resistant Steel, Iron Alloy, Titanium and Titanium Alloy Sheet, Strip, and Plate

AMS2248 Chemical Check Analysis Limits, Corrosion- and Heat-Resistant Steels and Alloys, Maraging and Other Highly Alloyed Steels, and Iron Alloys

AMS2370 Quality Assurance Sampling and Testing, Carbon and Low-Alloy Steel Wrought Products and Forging Stock

AMS2630 Inspection, Ultrasonic, Product Over 0.5 Inch (12.7 mm) Thick

AMS2750 Pyrometry

AMS2807 Identification, Carbon and Low-Alloy Steels, Corrosion and Heat-Resistant Steels and Alloys Sheet, Strip, Plate, and Aircraft Tubing

ARP1110 Minimizing Stress Corrosion Cracking in Wrought Forms of Steels, and Corrosion Resistant Steels and Alloys

AS7766 Terms Used in Aerospace Metals Specifications

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM A370 Mechanical Testing of Steel Products

ASTM A604 Macroetch Testing of Consumable Electrode Remelted Steel Bars and Billets

ASTM A751 Chemical Analysis of Steel Products

ASTM E140 Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, Scleroscope Hardness, and Leeb Hardness

ASTM E399 Plane-Strain Fracture Toughness of Metallic Materials

2.3 Definitions

Terms used in AMS are defined in AS7766.

3. TECHNICAL REQUIREMENTS

3.1 Composition

Shall conform to the percentages by weight shown in Table 1, determined in accordance with ASTM A751 or by other analytical methods acceptable to the purchaser.

Table 1 - Composition

Element	Min	Max
Carbon	0.10	0.14
Manganese	0.05	0.25
Silicon	--	0.10
Phosphorus	--	0.010
Sulfur	--	0.006
Chromium	1.80	2.20
Nickel	9.50	10.50
Cobalt	7.50	8.50
Molybdenum	0.90	1.10
Titanium	--	0.015
Aluminum	--	0.025
Oxygen	--	0.0025 (25 ppm)
Nitrogen	--	0.0075 (75 ppm)

3.1.1 The producer may test for any element not listed in Table 1 and include this analysis in the report of 4.4. Reporting of any element not listed in the composition table is not a basis for rejection unless limits of acceptability are specified by the purchaser.

3.1.2 Check Analysis

Composition variations shall meet the applicable requirements of AMS2248. No variation over maximum is permitted for oxygen and nitrogen.

3.2 Melting Practice

Steel shall be multiple melted using vacuum induction melting plus consumable electrode vacuum remelting.

3.3 Condition

Plate shall be supplied in the following condition:

3.3.1 Rolled Plate

Hot rolled, solution heat treated, and descaled.

3.3.2 Forged Plate

Hot finished, solution heat treated, and descaled.

3.4 Heat Treatment

Plate shall be solution heat treated as in 3.4.1 or 3.4.2, as applicable, holding at heat for sufficient time to ensure complete transformation, and quenching in agitated water sufficiently cool (see 8.2) to develop the properties specified herein. Pyrometry shall be in accordance with AMS2750.

3.4.1 Plate 2.0 Inches (51 mm) and Under in Nominal Thickness

Shall be solution heat treated by heating to 1525 °F ± 25 °F (829 °C ± 14 °C) and quenching.

3.4.2 Plate Over 2.0 Inches (51 mm) in Nominal Thickness

Shall be solution heat treated by heating to 1650 °F ± 25 °F (899 °C ± 14 °C), quenching, reheating to 1525 °F ± 25 °F (829 °C ± 14 °C), and quenching.

3.5 Properties

Plate shall conform to the following requirements; hardness, tensile, and impact testing shall be performed in accordance with ASTM A370:

3.5.1 As Solution Heat Treated

3.5.1.1 Hardness

Shall be not lower than 42 HRC, or equivalent (see 8.3).

3.5.1.2 Macrostructure

Visual examination of transverse full cross sections from slabs, billets, or suitable rerolled product, etched in hot hydrochloric acid in accordance with ASTM A604, shall show no pipe or cracks, porosity, segregation, inclusions, and other imperfections shall be no worse than the macrographs of ASTM A604 shown in Table 2.

Table 2 - Macrostructure Limits

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

3.5.2 Response to Aging Heat Treatment

Specimens from plate shall meet the requirements of the following after being aged by heating to 950 °F ± 10 °F (510 °C ± 6 °C), holding at heat for not less than 5 hours for sections 2.0 inches (51 mm) and under in nominal thickness and for 10 hours +0.5, -0 hours for thicker sections, and cooling at a rate equivalent to air cooling. Pyrometry shall be in accordance with AMS2750.

3.5.2.1 Tensile Properties

Shall be as shown in Table 3.

Table 3A - Minimum tensile properties, inch/pound units

Nominal Thickness Inches	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 4D or 2 Inches %	Reduction of Area %
0.375 to 2.000, incl	190	180	14	62
Over 2.000 to 4.000, incl	190	175	15	60
Over 4.000 to 8.000, incl	190	170	15	50

Table 3B - Minimum tensile properties, SI units

Nominal Thickness Millimeters	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 4D or 50 mm %	Reduction of Area %
9.52 to 50.80, incl	1310	1241	14	62
Over 50.80 to 101.60, incl	1310	1207	15	60
Over 101.60 to 203.20, incl	1310	1172	15	50

3.5.2.1.1 Unless otherwise specified, the strain rate shall be set at 0.005 in/in/min (0.005 mm/mm/min) and maintained within a tolerance of ±0.002 in/in/min (±0.002 mm/mm/min) through 0.2% offset yield strain. After the yield strain, the speed of the testing machine shall be set between 0.05 in/in and 0.5 in/in (0.05 mm/mm and 0.5 mm/mm) of the length of the reduced section (or distance between the grips for specimens not having a reduced section) per minute. Alternatively, an extensometer and strain rate indicator may be used to set the strain rate between 0.05 in/in/min and 0.5 in/in/min (0.05 mm/mm/min and 0.5 mm/mm/min).

3.5.2.2 Impact Strength

Shall be as shown in Table 4 when tested in the longitudinal direction.

Table 4A - Impact strength, inch/pound units

Nominal Thickness Inches	Charpy V-Notch at 0 °F Foot Pounds
0.500 to 2.000, incl	65
Over 2.000 to 4.000, incl	45
Over 4.000 to 8.000, incl	40

Table 4B - Impact strength, SI units

Nominal Thickness Millimeters	Charpy V-Notch at -18 °C J
12.70 to 50.80, incl	81
Over 50.80 to 101.60, incl	61
Over 101.60 to 203.20, incl	54

3.5.2.3 Fracture Toughness

Shall be not lower than 175 ksi $\sqrt{\text{inch}}$ (192 MPa $\sqrt{\text{m}}$), determined in the longitudinal (T-L) and transverse (L-T) direction in accordance with ASTM E399 using the compact tension specimen.

3.5.2.3.1 Fracture toughness testing in the longitudinal direction is not required on plate tested in the transverse direction.

3.5.2.4 Impact and fracture toughness requirements do not apply to plate under 0.500 inch (12.70 mm) in nominal thickness.

3.5.2.5 Mechanical property requirements for product outside the size range covered by 1.1 shall be agreed between the purchaser and producer and reported in 4.4.2.

3.6 Quality

Plate, as received by the purchaser, shall be uniform in quality and condition, sound, and free from foreign materials and from imperfections detrimental to usage of the product.

3.6.1 All plate 0.50 inch (12.7 mm) and over in nominal thickness shall be ultrasonically inspected in accordance with AMS2630 and shall meet Class AA quality requirements as defined therein. Hot-finished surfaces shall be suitably prepared prior to ultrasonic inspection.

3.7 Tolerances

Shall conform to all applicable requirements of AMS2242.

3.8 Any exceptions shall be authorized by the purchaser and reported as in 4.4.2.