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AEROSPACE MATERIAL SPECIFICATION

SAE AMS 5892A

Issued APR 1992
Revised SEP 2000
Reaffirmed APR 2006

Superseding AMS 5892

Alloy, Sheet and Strip
42Fe - 37.5Ni - 14Co - 4.8(Cb + Ta) - 1.6Ti
Solution Heat Treated, Precipitation Hardenable
Multiple Melted, High Temperature, Low Expansion

UNS N19909

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1. SCOPE:

1.1 Form:

This specification covers a low expansion iron alloy in the form of sheet or strip.

1.2 Application:

These products have been used typically for parts requiring a combination of high strength and low expansion properties up to 1200 °F (649 °C), but usage is not limited to such applications.

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 2262	Tolerances, Nickel, Nickel Alloy, and Cobalt Alloy Sheet, Strip, and Plate
MAM 2262	Tolerances, Metric, Nickel, Nickel Alloy, and Cobalt Alloy Sheet, Strip, and Plate
AMS 2269	Chemical Check Analysis Limits, Nickel, Nickel Alloys and Cobalt Alloys
AMS 2371	Quality Assurance Sampling and Testing, Corrosion and Heat Resistant Steels and Alloys, 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

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2.2 ASTM Publications:

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

ASTM E 8	Tension Testing of Metallic Materials
ASTM E 8M	Tension Testing of Metallic Materials (Metric)
ASTM E 18	Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials
ASTM E 21	Elevated Temperature Tension Tests of Metallic Materials
ASTM E 112	Determining the Average Grain Size
ASTM E 139	Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials
ASTM E 228	Linear Thermal Expansion of Solid Materials with a Vitreous Silica Dilatometer
ASTM E 290	Semi-Guided Bend Test for Ductility of Metallic Materials
ASTM E 354	Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys
ASTM E 384	Microhardness of Materials
ASTM E 1181	Characterizing Duplex Grain Sizes

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 354, by spectrochemical methods, or by other analytical methods acceptable to purchaser.

TABLE 1 - Composition

Element	min	max
Carbon	--	0.06
Manganese	--	1.0
Silicon	0.25	0.50
Phosphorus	--	0.015
Sulfur	--	0.015
Nickel	35.0	40.0
Cobalt	12.0	16.0
Columbium + Tantalum	4.3	5.2
Titanium	1.3	1.8
Chromium	--	1.0
Aluminum	--	0.15
Boron	--	0.012
Copper	--	0.5
Iron	remainder	

3.1.1 Check Analysis: Composition variations shall meet the applicable requirements of AMS 2269.

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3.2 Melting Practice:

Alloy shall be multiple melted using consumable electrode practice in the remelt cycle. If consumable electrode remelting is not performed in vacuum, electrodes which have been produced by vacuum induction melting shall be used for remelting.

3.3 Condition:

Hot rolled or cold rolled, solution heat treated, and, unless solution heat treatment is performed in an atmosphere yielding a bright finish, descaled having a surface appearance comparable to the following commercial corrosion-resistant steel finishes as applicable (See 8.4).

3.3.1 Sheet: No. 2D finish.

3.3.2 Strip: No. 1 strip finish.

3.4 Solution Heat Treatment:

The product shall be solution heat treated by heating to 1800 °F ± 25 (982 °C ± 14), holding at heat for a time commensurate with section thickness, and cooling at a rate equivalent to an air cool.

3.5 Properties:

Product 0.250 inch (6.35 mm) and under in nominal thickness shall conform to the following requirements:

3.5.1 As Solution Heat Treated:

3.5.1.1 Tensile Properties: Shall be as shown in Table 2, determined in accordance with ASTM E 8 or ASTM E 8M.

TABLE 2 - Tensile Properties

Property	Value
Tensile Strength, maximum	140.0 ksi (965 MPa)
Yield Strength at 0.2% Offset, maximum	80.0 ksi (552 MPa)
Elongation in 2 Inches (50.8 mm), minimum	30%

3.5.1.2 Hardness: Shall be not higher than 100 HRB, or equivalent (See 8.2), determined in accordance with ASTM E 18 or by microhardness test in accordance with ASTM E 384. Product shall not be rejected on the basis of hardness if the tensile property requirements of 3.5.1.1 are acceptable. Tensile properties shall be determined on material taken from the same sample as that with nonconforming hardness or from another sample with similar nonconforming hardness.

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3.5.1.3 Bending: The product shall withstand, without cracking, bending in accordance with ASTM E 290 at room temperature through an angle of 180 degrees around a diameter equal to the bend factor shown in Table 3 times the nominal thickness of the product with axis of bend parallel to the direction of rolling.

TABLE 3 - Bending Factor

Nominal Thickness Inch	Nominal Thickness Millimeters	Bend Factor
0.018 to 0.050	0.46 to 1.27, incl	1
0.051 to 0.250	1.28 to 6.35, incl	2

3.5.1.4 Grain Size Uniformity: As determined in accordance with ASTM E 112, shall be ASTM No. 5 or finer with no more than 20% of the specimen area as large as ASTM No. 2. No single grain shall be larger than 0.014 inch (0.36 mm).

3.5.1.4.1 Limitations on duplex grain structures as defined by ASTM E 1181 shall be as agreed upon by purchaser and vendor.

3.5.2 After Re-Solution and Precipitation Heat Treatment: The product shall have the following properties after being re-solution heat treated (See 8.5) by heating to 1800 °F ± 25 (982 °C ± 14) holding at heat for 60 minutes ± 15, and cooling at a rate equivalent to an air cool and precipitation heat treated by heating to 1375 °F ± 15 (746 °C ± 8), holding at heat for four hours ± 0.5, and cooling at a maximum rate of 100 F (56 C) degrees per hour to 1150 °F ± 15 (621 °C ± 8), holding at heat for four hours ± 0.5, and cooling at a rate equivalent to air cool.

3.5.2.1 Tensile Properties:

3.5.2.1.1 At Room Temperature: Shall be as shown in Table 4, determined in accordance with ASTM E 8 or ASTM E 8M.

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TABLE 4 - Minimum Tensile Properties

Property	Value
Tensile Strength	170.0 ksi (1172 MPa)
Yield Strength at 0.2% Offset	125.0 ksi (862 MPa)
Elongation in 2 Inches (50.8 mm)	10%

3.5.2.1.2 At 1200 °F (649 °C): Shall be as shown in Table 5, determined in accordance with ASTM E 21 on specimens heated to 1200 °F ± 5 (649 °C ± 3), held at heat for 20 to 30 minutes before testing, and tested at 1200 °F ± 5 (649 °C ± 3).

TABLE 5A - Minimum Tensile Properties at 1200 °F, Inch/Pound Units

	Nominal Thickness Inch	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 2 Inches %
	0.018 to 0.030, incl	120.0	90.0	5
Over	0.030 to 0.250, incl	120.0	90.0	8

TABLE 5B - Minimum Tensile Properties at 649 °C, SI Units

	Nominal Thickness Millimeters	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 50.8 mm %
	0.46 to 0.76, incl	827	621	5
Over	0.79 to 6.35, incl	827	621	8

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3.5.2.1.2.1 Elevated temperature tensile properties for product 0.025 inch (0.64 mm) and under in nominal thickness may be established using a sample up to 0.025 inch (0.64 mm) in nominal thickness from the same master coil and heat.

3.5.2.2 Hardness: Shall be not lower than 35 HRC, or equivalent (See 8.2), determined in accordance with ASTM E 18. Product shall not be rejected on the basis of hardness if the tensile property requirements of 3.5.2.1.1 are acceptable. Tensile properties shall be determined on material taken from the same sample as that with nonconforming hardness, or from another sample with similar nonconforming hardness.

3.5.2.3 Stress-Rupture Properties at 1200 °F (649 °C): A tensile specimen, maintained at 1200 °F ± 5 (649 °C ± 3) while a load sufficient to produce the initial axial stress specified in Table 6 is applied continuously, shall not rupture in less than 23 hours. The test shall be continued to rupture without change of load. Elongation after rupture, measured at room temperature, shall be not less than shown in Table 6. Tests shall be conducted in accordance with ASTM E 139.

TABLE 6A - Minimum Stress-Rupture Properties, Inch/Pound Units

	Nominal Thickness Inch	Initial Axial Stress, ksi	Elongation in 2 Inches %
	0.018 to 0.030, incl	70.0	--
Over	0.030 to 0.250, incl	70.0	4

TABLE 6B - Minimum Stress-Rupture Properties, SI Units

Nominal Thickness Millimeters	Initial Axial Stress, MPa	Elongation in 50.8 mm %
0.46 to 0.76, incl	483	--
Over 0.79 to 6.35, incl	483	4

3.5.2.3.1 The test of 3.5.2.3 may be conducted using a load higher than required to produce the initial axial stress specified in Table 6 but the load shall not be changed while test is in progress. Time to rupture and elongation requirements shall be as specified in 3.5.2.3.

3.5.2.3.2 When permitted by purchaser, the test of 3.5.2.3 may be conducted using incremental loading. In such case, the load required to produce the initial axial stress shown in Table 6 shall be used to rupture or for 23 hours whichever occurs first. After the 23 hours and at intervals of 8 to 16 hours, preferably 8 to 10 hours, thereafter, the stress shall be increased in increments of 5.0 ksi (34.5 MPa). Time to rupture and elongation requirements shall be as specified in 3.5.2.3.

3.5.2.3.3 Stress-rupture properties, for product 0.025 inch (0.64 mm) and under in nominal thickness, may be established using a sample up to 0.025 inch (0.64 mm) in nominal thickness from the same master coil and heat.

3.5.2.4 Thermal Expansion: Shall be determined in accordance with ASTM E 228 on each heat of alloy.

3.5.2.4.1 Coefficient of Expansion: Shall be 4.00 to 4.50 x 10^{-6} inch/inch/°F (7.2 to 8.1 x 10^{-6} mm/mm/°C) at 780 °F (416 °C) using 77 °F (25 °C) as a reference.

3.5.2.4.2 Inflection Temperature: Shall be 750 to 850 °F (399 to 454 °C), determined by establishing the intersection of the tangents of the upper and lower portions of the dilatometric expansion curve.

3.6 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.

3.7 Tolerances:

Shall conform to all applicable requirements of AMS 2262 or MAM 2262.

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