AEROSPACE MATERIAL SPECIFICATION

AMS5536™	REV. R

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Superseding AMS5536P

(R) Nickel Alloy, Corrosion- and Heat-Resistant, Sheet, Strip, and Plate 47.5Ni - 22Cr - 1.5Co - 9.0Mo - 0.60W - 18.5Fe (Alloy X or HX) Solution Heat Treated

(Composition similar to UNS N06002)

RATIONALE

AMS5536R is the result of a Five-Year Review and update of the specification. The revision adds the common name to the Title, adds SI units (see 1.1 and throughout the document), updates composition testing and reporting (see 3.1 and 3.1.1), revises finish (see 3.2.1), adds strain rate requirements to tensile tests (see 3.4.1.1), clarifies test procedure (see 3.4.2), and updates the prohibition on exceptions to this standard (see 4.4.1 and 8.4).

1. SCOPE

1.1 Form

This specification covers a corrosion- and heat-resistant nickel alloy in the form of sheet, strip, and plate.

1.2 Application

These products have been used typically for parts requiring oxidation resistance up to 2200 °F (1204 °C) and relatively high strength up to 1500 °F (816 °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 cancelled and no superseding document has been specified, the last published issue of that document shall apply.

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.

AMS2262 Tolerances, Nickel, Nickel Alloy, and Cobalt Alloy Sheet, Strip, and Plate

AMS2269 Chemical Check Analysis Limits, Nickel, Nickel Alloys, and Cobalt Alloys

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

For more information on this standard, visit
https://www.sae.org/standards/content/AMS5536R

AMS2283 Composition Testing Methods for Nickel- and Cobalt-Based Alloys

AMS2371 Quality Assurance Sampling and Testing, Corrosion and Heat-Resistant Steels and Alloys, Wrought Products and Forging Stock

AMS2750 Pyrometry

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

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 E8/E8M Tension Testing of Metallic Materials

ASTM E112 Determining Average Grain Size

ASTM E139 Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials

ASTM E290 Bend Testing of Material for Ductility

2.3 Definitions

Terms used in AMS are defined in AS7766.

3. TECHNICAL REQUIREMENTS

3.1 Composition

Composition shall conform to the percentages by weight shown in Table 1, determined in accordance with AMS2283 or by other analytical methods acceptable to the purchaser.

Table 1 - Composition

Element	Min	Max
Carbon	0.05	0.15
Manganese	--	1.00
Silicon	--	1.00
Phosphorus	--	0.040
Sulfur	--	0.030
Chromium	20.50	23.00
Cobalt	0.50	2.50
Molybdenum	8.00	10.00
Tungsten	0.20	1.00
Iron	17.00	20.00
Aluminum	--	0.50
Titanium	--	0.15
Boron	--	0.010
Copper	--	0.50
Nickel	remainder	

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 AMS2269.

3.2 Condition

The product shall be supplied in the following condition:

3.2.1 Sheet and Strip

Sheet and strip shall be hot or cold rolled, solution heat treated, and, unless solution heat treatment is performed in an atmosphere yielding a bright finish, descaled producing a uniform finish.

3.2.2 Plate

Plate shall be hot rolled, solution heat treated, and descaled.

3.3 Heat Treatment

The product shall be solution heat treated by heating in a suitable atmosphere within the range 2100 to 2150 °F (1149 to 1177 °C), holding at the selected temperature within ±25 °F (±14 °C) for a time commensurate with product thickness, and rapidly cooling. Pyrometry shall be in accordance with AMS2750.

3.3.1 Continuous Heat Treating

When continuous heat treating is used, process parameters (e.g., furnace temperature set points, heat input, travel rate, etc.) for continuous heat-treating lines shall be established by the material producer and validated by testing of product to the requirements of 3.4.

3.4 Properties

The product shall conform to the following requirements:

3.4.1 Tensile Properties

Shall be as specified in Table 2, determined in accordance with ASTM E8/E8M.

Table 2A - Minimum tensile properties, inch/pound units

Nominal Thickness Inches	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 2 Inches or 4D %
Up to 0.010, excl	105	45.0	--
0.010 to 0.020, excl	105	45.0	29
0.020 to 0.1874, incl	105	45.0	35
Over 0.1874 to 2.000, incl	100	40.0	35
Over 2.000	95	40.0	35

Table 2B - Tensile properties, SI units

Nominal Thickness Millimeters	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 50mm or 4D %
Up to 0.25, excl	724	310.3	--
0.25 to 0.51, excl	724	310.3	29
0.51 to 4.760, incl	724	310.3	35
Over 4.760 to 50.80, incl	689	275.8	35
Over 50.80	655	275.8	35

3.4.1.1 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 parallel 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). The requirement for compliance becomes effective for material produced 1 year after the publication date of this specification.

3.4.2 Bending

Product 0.1874 inch (4.760 mm) and under in nominal thickness shall be tested in accordance with ASTM E290 using a sample prepared nominally 0.75 inch (19.0 mm) in width with its axis of bending parallel to the direction of rolling. Testing shall be performed at room temperature through an angle of 180 degrees around a diameter equal to the bend factor multiplied by the nominal thickness of the product. The specimen shall exhibit no cracking when visually examined. In case of dispute, the results of tests using the guided bend test of ASTM E290 shall govern.

Table 3 - Bending parameters

Nominal Thickness Inch	Nominal Thickness Millimeters	Bend Factor
Up to 0.050, incl	Up to 1.27, incl	1.5
Over 0.050 to 0.1874, incl	Over 1.27 to 4.760, incl	2

3.4.3 Stress-Rupture Properties at 1500 °F (816 °C)

A tensile specimen, maintained at 1500 °F ± 3 °F (816 °C ± 2 °C) while a load sufficient to produce an initial axial stress of 16.0 ksi (110.3 MPa) is applied continuously, shall not rupture in less than the time indicated in Table 4. 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 4. Tests shall be conducted in accordance with ASTM E139.

Table 4 - Stress-rupture parameters

Nominal Thickness Inch	Nominal Thickness Millimeters	Time to Rupture Hours, minimum	Elongation % in 4D
0.010 to 0.020, excl	0.25 to 0.51, excl	15	3
0.020 and over	0.51 and over	24	8

3.4.3.1 The test of 3.4.3 may be conducted using a load higher than required to produce an initial axial stress of 16.0 ksi (110.3 MPa), but the load shall not be changed while the test is in progress. Time to rupture and elongation requirements shall be as specified in Table 4.

3.4.3.2 The test of 3.4.3 may be conducted using incremental loading. In such case, the load required to produce an initial axial stress of 16.0 ksi (110.3 MPa) shall be used to rupture or for 24 hours, whichever occurs first. After the 24 hours and at intervals of 8 hours minimum thereafter, the stress shall be increased in increments of 2.0 ksi (13.8 MPa). Time to rupture and elongation requirements shall be as specified in Table 4.

3.4.3.2.1 The test of 3.4.3.2 applies only to product 0.020 inch (0.51 mm) and over in nominal thickness.