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400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

AMS 5865B

Issued 7-1-76
Revised 1-1-88

Superseding AMS 5865A

NICKEL SHEET AND STRIP, CORROSION AND HEAT RESISTANT
Thoria Dispersion Strengthened
2.2ThO_2

1. SCOPE:

1.1 Form: This specification covers thoria-dispersion-strengthened nickel in the form of sheet and strip.

1.2 Application: Primarily for parts required to operate in the temperature range 1800° - 2400°F (980° - 1315°C) but a protective coating is required for operation at such temperatures. Fusion welding of structural members is not recommended but the product can be brazed and resistance welded satisfactorily. Products covered by this specification are radioactive. Applicable rules and regulations pertaining to handling of radioactive material should be observed.

1.3 Safety - Hazardous Materials: While the materials, methods, applications and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards which may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

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.

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2.1.1 Aerospace Material Specifications:

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, Wrought Nickel Alloys and Cobalt Alloys
AMS 2350 - Standards and Test Methods
AMS 2371 - Quality Assurance Sampling of Corrosion and Heat Resistant Steels and Alloys, 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 E8 - Tension Testing of Metallic Materials
ASTM E21 - Elevated Temperature Tension Tests of Metallic Materials
ASTM E139 - Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials
ASTM E290 - Semi-Guided Bend Test for Ductility of Metallic Materials
ASTM E354 - Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys

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, determined by wet chemical methods in accordance with ASTM E354 or by spectrochemical or other analytical methods approved by purchaser; the method of determining thoria (ThO_2) shall be as agreed upon by purchaser and vendor:

	min	max
Thoria	1.80	2.60
Carbon	--	0.02
Sulfur	--	0.0025
Chromium	--	0.05
Cobalt	--	0.20
Titanium	--	0.05
Iron	--	0.05
Copper	--	0.15
Nickel	remainder	

3.1.1 Check Analysis: Composition variations shall meet the requirements of AMS 2269 except that chromium, titanium, and iron shall each vary not more than 0.001 over max; permissible variation for thoria shall be 0.01 under min or over maximum.

3.2 Condition: Cold-rolled, stress-releived, descaled, and leveled.

3.3 Stress-Relieving: The product shall be stress-relieved by heating in Ø vacuum, argon, or hydrogen, to a temperature not lower than 2000°F (1095°C) holding at heat for not less than 20 min. and cooling to below 500°F (260°C) in vacuum, argon, or hydrogen.

3.4 Properties: The product shall conform to the following requirements:

3.4.1 Tensile Properties:

3.4.1.1 At Room Temperature: Shall be as follows, determined in accordance with ASTM E8 using a strain rate of 0.003 - 0.007 in./in. per min. (0.003 - 0.007 mm/mm per min.) through the 0.6% offset and a crosshead speed of 0.03 - 0.07 in. per min. (0.8 - 1.8 mm/min.) from the 0.6% offset to rupture:

Tensile Strength, min	60,000 psi (415 MPa)
Yield Strength at 0.2% Offset, min	40,000 psi (275 MPa)
Elongation in 1 in. (25 mm), min	10%

3.4.1.2 At 2000°F (1095°C): Shall be as follows, determined in accordance with ASTM E21 on specimens heated to 2000°F + 10 (1095°C + 5), held at heat for 10 - 30 min. before testing, and tested at 2000°F + 10 (1095°C + 5), using a crosshead speed of 0.03 - 0.07 in. per min (0.8 - 1.8 mm/min.):

Tensile Strength, min	12,000 psi (85 MPa)
Yield Strength at 0.2% Offset, min	9,500 psi (65 MPa)
Elongation in 1 in. (25 mm), min	2%

3.4.2 Bending: Product 0.020 to 0.250 in. (0.50 to 6.25 mm), incl, in nominal thickness shall withstand, without cracking when examined at 10X magnification, bending in accordance with ASTM E290 through an angle of 105 deg around a diameter equal to the bend factor times the nominal thickness of the product with axis of bend parallel to the direction of rolling.

Nominal Thickness		
Inch	Millimetres	Bend Factor
0.020 to 0.125, incl	0.50 to 3.12, incl	2
Over 0.125 to 0.250, incl	Over 3.12 to 6.25, incl	3

3.4.2.1 Bending requirements for product under 0.020 in. (0.50 mm) in nominal thickness shall be as agreed upon by purchaser and vendor.

3.4.3 Stress-Rupture Properties at 2000°F (1095°C): A tensile specimen, maintained at 2000°F + 10 (1095°C + 5) while a load sufficient to produce an initial axial stress of 5,500 psi (38 MPa) is applied continuously, shall not rupture in less than 20 hours. The test shall be continued to rupture without change of load. The elongation in 1 in. (25 mm) after rupture, measured at room temperature, shall be reported. Test shall be conducted in accordance with ASTM E139.

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 5,500 psi (38 MPa) but load shall not be changed while test is in progress. Time to rupture requirement shall be as specified in 3.4.3. The elongation in 1 in. (25 mm) after rupture, measured at room temperature, shall be reported.

3.4.3.2 When permitted by purchaser, 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 5,500 psi (38 MPa) shall be maintained to rupture or for 20 hr, whichever occurs first. After the 20 hr and at intervals of 1 hr thereafter, the stress shall be increased in increments of 1000 psi (7 MPa). Time to rupture requirement shall be as specified in 3.4.3. The elongation in 1 in. (25 mm), measured at room temperature, shall be reported.

3.4.4 Structure: The product shall have a substantially uniform structure essentially free from porosity, determined by macroscopic or microscopic examination. Standards for acceptance shall be as agreed upon by purchaser and vendor.

3.5 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.

3.5.1 Surface Condition: Mars, gouges, scratches, pits, and similar imperfections which reduce the thickness of the product below the minimum allowable by the thickness tolerance will not be permitted; such imperfections, if more than 0.0005 in. (0.012 mm) deep but not of such depth that their removal would reduce thickness below the minimum, will be permitted provided the number is not more than 5 per sq ft (55/m^2). Superficial scratches, individual pits, and roughened areas which appear under magnification as a scattering of pits will be acceptable if they are less than 0.0005 in. (0.012 mm) deep; the number of such imperfections is not restricted. The product shall be free of contamination, determined by visual inspection; differences in reflectivity will not be considered evidence of contamination.

3.6 Tolerances: Shall conform to all applicable requirements of AMS 2262 or MAM 2262 except that the deviation from flat shall not exceed 6%, determined as in 3.6.1.

3.6.1 The deviation from flat shall be determined from the expression 100 H/L where H is equal to the maximum distance between a flat surface and the highest surface of the product and L is the distance between the highest point of the product and the nearest point of contact of the product with the flat surface. A general bow in the product which can be eliminated by slight pressure without the ends coiling or an "oil-can" effect resulting will be acceptable.

4. QUALITY ASSURANCE PROVISIONS: