SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS5865 REV. E

Issued 1976-07
Revised 2001-07
Reaffirmed 2006-04
Cancelled 2010-11

Superseding AMS5865D

Nickel, Corrosion and Heat Resistant, Sheet and Strip
Thoria Dispersion Strengthened
2.2ThO_2

(Composition similar to UNS N03260)

RATIONALE

AMS5865E cancels this document. Because of the radioactive nature of this commodity, it is no longer in use in aerospace applications.

CANCELLATION NOTICE

This document has been declared “CANCELLED” by the Aerospace Materials Division, SAE, as of November 2010. By this action, this document will remain listed in the Numerical Section of the Index of Aerospace Material Specifications indicating that it has been “CANCELLED”.

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1. SCOPE:

1.1 Form:

This specification covers thoria-dispersion-strengthened nickel powder metallurgy product in the form of sheet and strip.

1.2 Application:

These products have been used typically for parts required to operate in the temperature range 1800 to 2400 °F (982 to 1316 °C), but usage is not limited to such applications. 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.

1.3 Products covered by this specification are radioactive. Applicable rules and regulations pertaining to handling of radioactive material should be observed.

1.4 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 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

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 21	Elevated Temperature Tension Tests of Metallic Materials
ASTM E 139	Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials
ASTM E 290	Bend Testing for Ductility of Metallic Materials
ASTM E 354	Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys

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; the method of determining thoria (ThO_2) shall be acceptable to purchaser.

TABLE 1 - Composition

Element	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 applicable requirements of AMS 2269 except that chromium, titanium, and iron shall each vary not more than 0.001 over maximum; permissible variation for thoria shall be 0.01 under minimum or over maximum.

3.2 Condition:

Cold-rolled, stress-relieved, descaled, and leveled.

3.3 Stress-Relieving:

The product shall be stress-relieved by heating, in vacuum, argon, or hydrogen, to a temperature not lower than 2000 °F (1093 °C) holding at heat for not less than 20 minutes, 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 shown in Table 2, determined in accordance with ASTM E 8 or ASTM E 8M using a strain rate of 0.003 to 0.007 inch/inch per minute (0.003 to 0.007 mm/mm per minute) through the 0.6% offset and a crosshead speed of 0.03 to 0.07 inch per minute (0.8 to 1.8 mm/minute) from the 0.6% offset to rupture.

TABLE 2 - Minimum Room Temperature Tensile Properties

Property	Value
Tensile Strength	60 ksi (414 MPa)
Yield Strength at 0.2% Offset	40.0 ksi (276 MPa)
Elongation in 1 Inch (25 mm)	10%

3.4.1.2 At 2000 °F (1093 °C): Shall be as shown in Table 3, determined in accordance with ASTM E 21 on specimens heated to 2000 °F ± 10 (1093 °C ± 6), held at heat for 10 to 30 minutes before testing, and tested at 2000 °F ± 10 (1093 °C ± 6) using a crosshead speed of 0.03 to 0.07 inch per minute (0.8 to 1.8 mm/minute).

TABLE 3 - Minimum Elevated Temperature Tensile Properties

Property	Value
Tensile Strength	12.0 ksi (83 MPa)
Yield Strength at 0.2% Offset	9.5 ksi (66 MPa)
Elongation in 1 Inch (25 mm)	2%

3.4.2 Bending: Product 0.020 to 0.250 inch (0.51 to 6.35 mm), inclusive, in nominal thickness shall withstand, without cracking when examined at 10X magnification, bending in accordance with ASTM E 290 through an angle of 105 degrees 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.

TABLE 4 - Bending Parameters

Nominal Thickness Inch	Nominal Thickness Millimeters	Bend Factor
0.020 to 0.125, incl	0.51 to 3.18, incl	2
Over 0.125 to 0.250, incl	Over 3.18 to 6.35, incl	3

3.4.3 Stress-Rupture Properties at 2000 °F (1093 °C): A tensile specimen, maintained at 2000 °F ± 10 (1093 °C ± 6) while a load sufficient to produce an initial axial stress of 5.5 ksi (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 inch (25 mm) after rupture, measured at room temperature, shall be reported. Testing shall be conducted in accordance with ASTM E 139.

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 5.5 ksi (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 inch (25 mm) after rupture, measured at room temperature, shall be reported.

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 5.5 ksi (38 MPa) shall be maintained to rupture or for 20 hours, whichever occurs first. After the 20 hours and at intervals of 1 hour thereafter, the stress shall be increased in increments of 1.0 ksi (7 MPa). Time to rupture requirement shall be as specified in 3.4.3. The elongation in 1 inch (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 acceptable to purchaser.

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 Mars, gouges, scratches, pits, and similar imperfections which reduce the thickness of the product below the minimum allowable by the thickness tolerance are not acceptable. Imperfections, if more than 0.0005 inch (0.013 mm) deep but not of such depth that their removal would reduce thickness below the minimum, are acceptable provided the number is not more than five per square foot (0.09 m^2). Superficial scratches, individual pits, and roughened areas which appear under magnification as a scattering of pits will be acceptable if they are under 0.0005 inch (0.013 mm) in depth; 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 is acceptable.

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 the performance of all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to specified requirements.

4.2 Classification of Tests:

All technical requirements are acceptance tests and, except for composition, shall be performed on each product lot.

4.2.1 Composition (3.1) of each powder lot is an acceptance test and shall be performed on each product lot.

4.3 Sampling and Testing:

Shall be in accordance with AMS 2371.