

AMS 5890

ADOPTION NOTICE

AMS 5890, "Nickel, Corrosion and Heat Resistant, Bars, Forgings, and Extrusions Thoria Dispersion Strengthened 2.2ThO₂ Stressed-Relieved" was adopted on 8 August 1994 for use by the Department of Defense (DoD). Proposed changes by DoD activities must be submitted to the DoD Adopting Activity: Air Force, ASC/ENOSD, Building 125, 2335 Seventh Street, Suite 6, Wright-Patterson AFB OH 45433-7809. DoD activities may obtain copies of this standard from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094. The private sector and other Government agencies may purchase copies from the Society of Automotive Engineers Inc., 400 Commonwealth Drive, Warrendale, PA 15096-0001.

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400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

SAE

AMS 5890C

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Superseding AMS 5890B

NICKEL, CORROSION AND HEAT RESISTANT, BARS, FORGINGS, AND EXTRUSIONS Thoria Dispersion Strengthened 2.2ThO₂ Stress-Relieved

UNS N03260

1. SCOPE:

1.1 Form:

This specification covers thoria-dispersion-strengthened nickel in the form of bars, forgings, extrusions, and stock for forging or extruding.

1.2 Application:

These products have been used typically for parts required to operate in the 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 following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order.

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

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2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

- AMS 2261 Tolerances, Nickel, Nickel Alloy, and Cobalt Alloy Bars, Rods, and Wire
- MAM 2261 Tolerances, Metric, Nickel, Nickel Alloy, and Cobalt Alloy Bars, Rods, and Wire
- AMS 2269 Chemical Check Analysis Limits, Wrought 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 2374 Quality Assurance Sampling and Testing, Corrosion and Heat Resistant Steel and Alloy Forgings
- AMS 2806 Identification, Bars, Wire, Mechanical Tubing, and Extrusions, Carbon and Alloy Steels, Corrosion and Heat Resistant Steels and Alloys
- AMS 2808 Identification, Forgings

2.2 ASTM Publications:

Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

- 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 292 Conducting Time-for-Rupture Notch Tension Tests of Materials
- ASTM E 354 Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys

2.3 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-STD-163 Steel Mill Products, Preparation for Shipment and Storage

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 agreed upon by purchaser and vendor.

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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 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:

The product shall be supplied in the following condition:

3.2.1 Bars: Hot and/or cold worked and stress-relieved.

3.2.2 Forgings and Extrusions: Stress-relieved.

3.2.3 Stock for Forging or Extruding: As ordered by the forging or extrusion manufacturer.

3.3 Stress-Relieving:

Bars, forgings, and extrusions shall be stress-relieved by heating in vacuum, argon, or hydrogen to a temperature within the range 2000 to 2200 °F (1093 to 1204 °C), holding at the selected temperature within ± 25 °F (± 14 °C) for not less than one hour, and cooling in vacuum, argon, or hydrogen to 500 °F (260 °C) or lower.

3.4 Properties:

The product shall conform to the following requirements:

3.4.1 Bars, Forgings, and Extrusions:

3.4.1.1 Tensile Properties: Shall be as follows, determined in either the longitudinal or transverse direction except that testing in the transverse direction applies only to product from which a tensile specimen not less than 2.50 inches (63.5 mm) in length can be obtained. Testing in the longitudinal direction is not required on product tested in the transverse direction.

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- 3.4.1.1.1 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/minute (0.003 to 0.007 mm/mm/minute) through the 0.6% offset and a cross-head speed of 0.03 to 0.07 inch per minute (0.013 to 0.030 mm/s) from the 0.6% offset to rupture:

TABLE 2 - Minimum Room Temperature Tensile Properties

Tensile Strength	57.0 ksi (393 MPa)
Yield Strength at 0.2% Offset	42.0 ksi (290 MPa)
Elongation in 4D	15%
Reduction of Area	50%

- 3.4.1.1.2 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 $\pm$ 10 (1093 °C $\pm$ 6), held at heat for 10 to 30 minutes before testing, and tested at 2000 °F $\pm$ 10 (1093 °C $\pm$ 6) using a crosshead speed of 0.03 to 0.07 inch per minute (0.013 to 0.030 mm/s).

TABLE 3 - Minimum Elevated Temperature Tensile Properties

TABLE 3A - Minimum Elevated Temperature Tensile Properties, Inch/Pound Units

Nominal Diameter or Distance Between Parallel Sides Inches	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 4D %	Reduction of Area %
0.500 to 0.750, incl	15.0	13.5	2	5
Over 0.750 to 1.250, incl	12.0	11.5	2	5

TABLE 3B - Minimum Elevated Temperature Tensile Properties, SI Units

Nominal Diameter or Distance Between Parallel Sides mm	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 4D %	Reduction of Area %
12.70 to 19.05, incl	103	93	2	5
Over 19.05 to 31.75, incl	83	79	2	5

- 3.4.1.1.2.1 Tensile property requirements at 2000 °F (1093 °C) for product under 0.500 inch (12.70 mm) or over 1.250 inches (31.75 mm) in nominal diameter or distance between parallel sides shall be agreed upon by purchaser and vendor.

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3.4.1.2 Stress-Rupture Properties at 2000 °F (1093 °C): Shall be as shown in Table 4; testing of notched and of combination smooth-and-notched specimens shall be performed in accordance with ASTM E 292 and of smooth specimens in accordance with ASTM E 139:

3.4.1.2.1 A standard cylindrical combination smooth-and-notched specimen conforming to ASTM E 292, maintained at 2000 °F $\pm$ 10 (1093 °C $\pm$ 6) while a load sufficient to produce the initial axial stress specified in Table 4 is applied continuously, shall not rupture in less than 20 hours. The test shall be continued to rupture without change of load. Rupture shall occur in the smooth section and elongation and reduction of area of this section, measured at room temperature, shall be reported.

TABLE 4 - Stress Rupture Properties

Nominal Diameter or Distance Between Parallel Sides Inches	Nominal Diameter or Distance Between Parallel Sides mm	Initial Axial Stress ksi	Initial Axial Stress MPa
0.500 to 0.750, incl	12.70 to 19.05, incl	8.0	55
Over 0.750 to 1.250, incl	Over 19.05 to 31.75, incl	7.0	48

3.4.1.2.1.1 Initial axial stress for product under 0.500 inch (12.70 mm) or over 1.250 inches (31.75 mm) in nominal diameter or distance between parallel sides shall be agreed upon by purchaser and vendor.

3.4.1.2.2 As an alternate procedure, separate smooth and notched specimens, machined from adjacent sections of the same piece, with gage sections conforming to the respective dimensions shown in ASTM E 292, may be tested individually under the conditions of 3.4.1.2.1. The smooth specimen shall not rupture in less than 20 hours and elongation and reduction of area, measured at room temperature, shall be reported. The notched specimen shall not rupture in less time than the companion smooth specimen but need not be tested to rupture.

3.4.1.2.3 The tests of 3.4.1.2.1 and 3.4.1.2.2 may be conducted using a load higher than required to produce the applicable initial stress specified in 3.4.1.2.1 but load shall not be changed while test is in progress. Time to rupture and rupture location requirements shall be as specified in 3.4.1.2.1. The elongation and reduction of area after rupture, measured at room temperature, shall be reported.

3.4.1.2.4 (R) The tests of 3.4.1.2.1 and 3.4.1.2.2 may be conducted using incremental loading. In such case, the load required to produce the applicable initial stress specified in 3.4.1.2.1 shall be maintained to rupture or for 20 hours, whichever occurs first. After the 20 hours and at intervals of 8 to 16 hours, preferably 8 to 10 hours, thereafter, the stress shall be increased in increments of 1.0 ksi (7 MPa). Time to rupture and rupture location shall be as specified in 3.4.1.2.1 and 3.4.1.2.2. The elongation and reduction of area, measured at room temperature, shall be reported.

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- 3.4.2 Structure: The product shall have a substantially uniform structure essentially free from porosity, determined by macroscopic or microscopic examination. Standards for acceptance shall be agreed upon by purchaser and vendor.
- 3.4.3 Stock for Forging or Extruding: When a sample of stock is forged or extruded to a test coupon and stress-relieved as in 3.3, specimens taken from the stress-relieved coupon shall conform to the requirements of 3.4.1.1 and 3.4.1.2. If specimens taken from the stock after stress-relieving as in 3.3 conform to the requirements of 3.4.1.1 and 3.4.1.2, the tests shall be accepted as equivalent to tests of a forged or extruded coupon.

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 dimensions of the product below the minimum allowable by the specified tolerances are not acceptable; such imperfections, if more than 0.005 inch (0.13 mm) deep but not of such depth that their removal would reduce dimensions below the minimum, will be permitted provided the number is not more than five per square foot (0.093 m²). 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 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 shall not be considered evidence of contamination.

3.6 Tolerances:

Shall conform to the following:

- 3.6.1 Bars: All applicable requirements of AMS 2261 or MAM 2261.
- 3.6.2 Extrusions: As specified on the extrusion drawing or agreed upon by purchaser and vendor.
- 3.6.3 Stock for Forging or Extruding: As agreed upon by purchaser and vendor.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

(R)

The vendor of the product shall supply all samples for vendor's tests and shall be responsible for performing all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to the requirements of this specification.

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4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests for the following requirements are acceptance tests and shall be performed on each powder lot or product lot as applicable.

4.2.1.1 Composition (3.1) of each powder lot.

4.2.1.2 Structure (3.4.2) and surface condition (3.5.1) of the product.

4.2.1.3 Tensile properties (3.4.1.1) and stress-rupture properties (3.4.1.2) of each lot of bars, forgings, and extrusions.

4.2.1.4 Tolerances (3.6) of bars and extrusions.

4.2.2 Periodic Tests: Tests of stock for forging or extruding (3.4.3) to determine ability to develop required properties are periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.3 Sampling and Testing:

(R)

Shall be as follows:

4.3.1 Bars, Extrusions, and Stock For Forging or Extruding: In accordance with AMS 2371.

4.3.2 Forgings: In accordance with AMS 2374.

4.4 Reports:

4.4.1 The vendor of bars, forgings, and extrusions shall furnish with each shipment a report showing the results of tests for chemical composition of each powder lot and the results of tests on each product lot to determine conformance to the other acceptance test requirements. This report shall include the purchase order number, powder lot number, AMS 5890C, size, and quantity. If forgings are supplied, the part number and the size and manufacturing source of stock used to make the forgings shall also be included.

4.4.2 The vendor of stock for forging or extruding shall furnish with each shipment a report showing the results of tests for chemical composition of each powder lot. This report shall include the purchase order number, powder lot number, AMS 5890C, size, and quantity.

4.5 Resampling and Retesting:

Shall be as follows:

4.5.1 Bars, Extrusions, and Stock for Forging or Extruding: In accordance with AMS 2371.

4.5.2 Forgings: In accordance with AMS 2374.