SAE Aerospace
An SAE International Group

AEROSPACE MATERIAL SPECIFICATION

SAE MAM 5706C

Issued	OCT 1987
Revised	JUL 1989
Reaffirmed	JUL 1998
Cancelled	MAR 2003

Superseding MAM 5706B

Alloy Bars, Forgings, and Rings, Corrosion and Heat Resistant 57Ni - 19.5Cr - 13.5Co - 4.3Mo - 3.0Ti - 1.4A1 - 0.006B - 0.05Zr Consumable Electrode or Vacuum Induction Melted 995° - 1040 °C Solution Heat Treated

N07001

CANCELLATION NOTICE

This specification has been declared “CANCELLED” by the Aerospace Materials Division, SAE, as of March, 2003. By this action, this document will remain listed in the Numerical Section of the Index of Aerospace Material Specifications.

AMS 5706 covers the same material.

“CANCELLED” specifications are available from SAE.

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

1. SCOPE:

1.1 Form:

This specification covers a corrosion and heat resistant nickel alloy in the form of bars, forgings, flash welded rings, and stock for forging, flash welded rings, or heading procured in SI (metric) units. AMS 5706, specified in inch/pound units, is the equivalent of this MAM.

1.2 Application:

Primarily for parts, such as fasteners, flanges, and rings, requiring high strength up to 815°C and oxidation resistance up to 955°C, particularly those parts which are formed or welded and then heat treated to develop required properties.

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.

2.1 SAE Publications:

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

2.1.1 Aerospace Material Specifications:

MAM 2261 Tolerances, Metric, Nickel, Nickel Alloy, and Cobalt Alloy Bars and Forgings Stock
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
AMS 2374 Quality Assurance Sampling of Corrosion and Heat Resistant Steels and Alloys, Forgings and Forging Stock
AMS 2375 Control of Forgings Requiring First Article Approval
AMS 2750 Pyrometry
AMS 2806 Identification, Bars, Wire, Mechanical Tubing, and Extrusions, Carbon and Alloy Steels and Corrosion and Heat Resistant Steels and Alloys
AMS 2808 Identification, Forgings
AMS 7490 Rings, Flash Welded, Corrosion and Heat Resistant Austenitic Steels, and Austenitic-Type Alloys

2.2 ASTM Publications:

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

ASTM E 8M Tension Testing of Metallic Materials (Metric)
ASTM E 10 Brinell Hardness of Metallic Materials

2.2 (Continued):

ASTM E 112Determining Average Grain Size
ASTM E 139 Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials
ASTM E 292 Conducting Time-of-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 following percentages by weight, determined by wet chemical methods in accordance with ASTM E354, by spectrochemical methods, or by other analytical methods acceptable to purchaser:

	min	max
Carbon	0.02	0.10
Manganese	--	0.10
Silicon	--	0.15
Phosphorus	--	0.015
Sulfur	--	0.015
Chromium	18.00	21.00
Cobalt	12.00	15.00
Molybdenum	3.50	5.00
Titanium	2.75	3.25
Aluminum	1.20	1.60
Boron	0.003	0.010
Zirconium	0.02	0.08
Iron	--	2.00
Copper	--	0.10
Lead	--	0.0005 (5 ppm)
Bismuth	--	0.0003 (0.3 ppm)
Selenium	--	0.0003 (5 ppm)
Nickel	remainder	

3.1.1 Check Analysis: Composition variations shall meet the requirements of AMS 2269; no variation is permitted for lead, bismuth, and selenium.

3.2 Condition:

The product shall be supplied in the following condition:

3.2.1 Bars: Solution heat treated and descaled.

3.2.1.1 Bars shall be hot rolled or extruded; round bars shall be ground or turned.

3.2.2 Forgings and Flash Welded Rings: Solution heat treated.

3.2.2.1 Flash welded rings shall not be supplied unless specified or permitted on purchaser's part drawing. When supplied, rings shall be manufactured in accordance with AMS 7490.

3.2.3 Stock for Forging, Flash Welded Rings, or Heading: As ordered by the forging, flash welded ring, or heading manufacturer.

3.3 Heat Treatment:

Bars, forgings, and flash welded rings shall be solution heat treated by heating to a temperature within the range 995° - 1040°C, holding at the selected temperature within ±15°C for a time commensurate with section thickness, and cooling at a rate equivalent to an air cool or faster; pyrometry shall be in accordance with AMS 2750.

3.4 Properties:

The product shall conform to the following requirements:

3.4.1 Bars, Forgings, and Flash Welded Rings:

3.4.1.1 As Solution Heat Treated:

3.4.1.1.1 Hardness: Shall be not higher than 331 HB, or equivalent, determined in accordance with ASTM E 10.

3.4.1.1.2 Grain Size: Shall be predominantly 3 or finer with occasional grains as large as 1 permissible, determined by comparison of a polished and etched specimen with the chart in ASTM E 112.

3.4.1.2 After Stabilization and Precipitation Heat Treatment: Product 80 mm and under in least nominal diameter or distance between parallel sides shall have the following properties after being stabilization heat treated by heating to 845°C ± 8, holding at heat for 4 hours ± 0.25, and cooling in air and precipitation heat treated by heating to 760°C ± 8, holding at heat for 16 hours ± 1, and cooling in air; properties of product over 80 mm in least nominal diameter or distance between parallel sides shall be as agreed upon by purchaser and vendor:

3.4.1.2.1 Tensile Properties: Shall be as follows, determined in accordance with ASTM E 8M:

Tensile Strength, minimum	1105 MPa
Yield Strength at 0.2% Offset, minimum	760 MPa
Elongation in 4D, minimum	15 %
Reduction of Area, minimum	18 %

3.4.1.2.2 Hardness: Should be 321 - 401 HB, or equivalent, determined in accordance with ASTM E 10, but the product shall not be rejected on the basis of hardness if the tensile property requirements are met.

3.4.1.2.3 Stress-Rupture Properties at 730°C: Shall be as follows; testing of notched specimens 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:

3.4.1.2.3.1 A standard, cylindrical, combination smooth-and-notched specimen conforming to ASTM E 292, maintained at 73O°C ± 2 while a load sufficient to produce an initial axial stress of 515 MPa is applied continuously, shall not rupture in less than 23 hours. The test shall be continued to rupture without change of load. After the 23 hours, if rupture occurs in the notch, the smooth section shall, by suitable means, be continued to rupture or a separate smooth specimen shall be tested to rupture under the above conditions. Elongation of the smooth section after rupture, measured at room temperature, shall be not less than 8% in 4D.

3.4.1.2.3.2 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 3.4.1.2.3.1. The smooth specimen shall not rupture in less than 23 hours and elongation after rupture, measured at room temperature, shall be not less than 8% in 4D. The notched specimen shall not rupture in less than 23 hours but need not be tested to rupture.

3.4.1.2.3.3 The tests of 3.4.1.2.3.1 and 3.4.1.2.3.2 may be conducted using a load higher than required to produce an initial axial stress of 515 MPa but load shall not be changed while test is in progress. Time to rupture, rupture location, and elongation requirements shall be as specified in 3.4.1.2.3.1.

3.4.1.2.3.4 When permitted by purchaser, the tests of 3.4.1.2.3.1 and 3.4.1.2.3.2 may be conducted using incremental loading. In such case, the load required to produce an initial axial stress of 515 MPa shall be used to rupture or for 23 hours, whichever occurs first. After the 23 hours and at intervals of 8 - 16 hours, preferably 8 - 10 hours, thereafter, the stress shall be increased in increments of 35 MPa. Time to rupture, rupture location, and elongation requirements shall be specified in 3.4.1.2.3.1.

3.4.2 Forging Stock: When a sample of stock is forged to a test coupon and heat treated as 3.3 and 3.4.1.2, specimens taken from the heat treated coupon shall conform to the requirements of 3.4.1.2.1, 3.4.1.2.2, and 3.4.1.2.3. If specimens taken from the stock after heat treatment as in 3.3 and 3.4.1.2 conform to the requirements of 3.4.1.2.1, 3.4.1.2.2, and 3.4.1.2.3, the tests shall be accepted as equivalent to tests of a forged coupon.

3.4.3 Stock for Flash Welded Rings or Heading: Specimens taken from the stock after heat treatment as in 3.3 and 3.4.1.2 shall conform to the requirements of 3.4.1.2.1, 3.4.1.2.2, and 3.4.1.2.3.

3.5 Quality:

3.5.1 Alloy shall be produced by multiple melting using consumable electrode practice in the remelt cycle or shall be induction melted under vacuum.

3.5.2 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.

3.5.3 Forgings shall have substantially uniform macrostructure. Standards for acceptance shall be as agreed upon by purchaser and vendor.

3.5.4 Grain flow of die forgings, except in areas which contain flash-line end grain, shall follow the general contour of the forging showing no evidence of re-entrant grain flow.

3.6 Sizes:

Except when exact lengths or multiples of exact lengths are ordered, straight bars will be acceptable in mill lengths of 2 - 7.5 m but not more than 25% of any shipment shall be supplied in lengths of 2 - 3 m except that for bars weighing over 35 kg/m, short lengths down to 600 mm may be supplied.

3.7 Tolerances:

Bars and forging stock shall conform to all applicable requirements of MAM 2261.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

The vendor of the product shall supply all samples for vendor's test and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.5. 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.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests to determine conformance to the following requirements are classified as acceptance tests and shall be performed on each heat or lot as applicable.

4.2.1.1 Composition (3.1) of each heat.

4.2.1.2 Hardness (3.4.1.1.1) and grain size (3.4.1.1.2) of each lot of bars, forgings, and flash welded rings as solution heat treated.

4.2.1.3 Tensile properties (3.4.1.2.1), hardness (3.4.1.2.2), and stress-rupture properties (3.4.1.2.3) of each lot of bars, forgings, and flash welded rings after stabilization and precipitation heat treatment.

4.2.1.4 Tolerances of bars and forging stock (3.7).

4.2.2 Periodic Tests: Tests of forging stock (3.4.2) and stock for flash welded rings and heading (3.4.3) to demonstrate ability to develop required properties are classified as periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.2.3 Preproduction Tests: Tests of forgings to determine conformance to all applicable technical requirements of this specification when AMS 2375 is specified are classified as preproduction tests and shall be performed prior to or on the first-article shipment of a forging to a purchaser, when a change in material and/or processing requires reapproval as in 4.4, and when purchaser deems confirmatory testing to be required.

4.2.3.1 For direct U.S. Military procurement of forgings, substantiating test data and, when requested, preproduction forgings shall be submitted to the cognizant agency as directed by the procuring activity, contracting officer, or request for procurement.

4.3 Sampling:

Shall be in accordance with the following; a heat shall be the consumable electrode remelted ingots produced from alloy originally melted as a single furnace charge or the ingots produced from a single vacuum induction melt.

4.3.1 Bars, Flash Welded Rings, and Stock for Flash Welded Rings or Heading: AMS 2371.

4.3.2 Forgings and Forging Stock: AMS 2374.

4.4 Approval:

When specified, approval and control of forgings shall be in accordance with AMS 2375.

4.5 Reports:

4.5.1 The vendor of bars, forgings, and flash welded rings shall furnish with each shipment a report showing the results of tests for chemical composition of each heat and the results of tests on each lot to determine conformance to the other acceptance test requirements of this specification. This report shall include the purchase order number, lot number, MAM 5706B, size, quantity, and the specific solution heat treatment temperature used. If forgings are supplied, the part number and the size and melt source of stock used to make the forgings shall also be included.

4.5.2 The vendor of stock for forging, flash welded rings, or heading shall furnish with each shipment a report showing the results of tests for chemical composition of each heat. This report shall include the purchase order number, heat number, MAM 5706B, size and quantity.