AEROSPACE MATERIAL SPECIFICATION

AMS5746™	REV. G

Issued 1960-06
Reaffirmed 2000-11
Revised 2005-08
Stabilized 2022-06

Superseding AMS5746F

Alloy, Corrosion- and Heat-Resistant, Bars and Forgings
15Cr - 45Ni - 4.1Mo - 4.1W - 3.0Ti - 1.0Al - 31Fe (D979)
Consumable Electrode Vacuum Melted
Solution and Precipitation Heat Treated
(Composition similar to UNS N09979)

RATIONALE

This document will no longer be updated and may no longer represent standard industry practice. This document was stabilized because it contains mature technology that is not expected to change and thus no further revisions are anticipated.

NOTE: Previously, this document was reaffirmed. The last technical update of this document occurred in August, 2005. Users of this document should refer to the cognizant engineering organization for disposition of any issues with reports/certifications to this specification, including exceptions listed on the certification. In many cases, the purchaser may represent a sub-tier supplier and not the cognizant engineering organization.

STABILIZED NOTICE

AMS5746G has been declared “STABILIZED” by SAE AMS Committee F Corrosion and Heat Resistant Alloys and will no longer be subjected to periodic reviews for currency. Users are responsible for verifying references and continued suitability of technical requirements. Newer technology may exist.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
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For more information on this standard, visit
https://www.sae.org/standards/content/AMS5746G/

1. SCOPE:

1.1 Form:

This specification covers a corrosion and heat-resistant nickel alloy in the form of bars, forgings, and stock for forging or heading.

1.2 Application:

These products have been used typically for parts, such as turbine rotors, shafts, blades, bolts, dowels, and fittings, requiring high strength up to 1600 °F (871 °C) and oxidation resistance up to 1800 °F (982 °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, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or www.sae.org.

AMS 2241	Tolerances, Corrosion and Heat-Resistant Steel, Iron Alloy, Titanium, and Titanium Alloy Bars and Wire
AMS 2248	Chemical Check Analysis Limits, Corrosion and Heat-Resistant Steels and Alloys, Maraging and Other Highly-Alloyed Steels, and Iron Alloys

2.1 (Continued):

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 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

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959 or www.astm.org.

ASTM E 8	Tension Testing of Metallic Materials
ASTM E 8M	Tension Testing of Metallic Materials (Metric)
ASTM E 10	Brinell Hardness 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 353	Chemical Analysis of Stainless, Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron 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 353, by spectrochemical methods, or by other analytical methods acceptable to purchaser.

TABLE 1 - Composition

Element	min	max
Carbon	--	0.08
Manganese	--	0.75
Silicon	--	0.75
Phosphorus	--	0.015
Sulfur	--	0.015
Chromium	14.00	16.00
Nickel	42.00	48.00
Molybdenum	3.75	4.50
Tungsten	3.75	4.50
Titanium	2.70	3.30
Aluminum	0.75	1.30
Boron	0.008	0.016
Zirconium	--	0.050
Lead	--	0.0005 (5 ppm)
Bismuth	--	0.00003 (0.3 ppm)
Selenium	--	0.0003 (3 ppm)
Iron	remainder	

3.1.1 Check Analysis: Composition variations shall meet the applicable requirements of AMS 2248; no variations for lead, bismuth, and selenium are permitted.

3.2 Condition:

The product shall be supplied in the following condition:

3.2.1 Bars and Forgings: Solution and precipitation heat treated.

3.2.2 Stock for Forging or Heading: As ordered by the forging or heading manufacturer.

3.3 Heat Treatment:

Bars and forgings shall be solution and precipitation heat treated as follows; pyrometry shall be in accordance with AMS 2750.

3.3.1 Solution: Heat to a temperature within the range 1850 to 1900 °F (1010 to 1038 °C), hold at the selected temperature within ±25 °F (±14 °C) for a time commensurate with cross-sectional thickness, and quench as required.

3.3.2 Precipitation: Heat to 1550 °F ± 15 (843 °C ± 8), hold at heat for 6 to 12 hours, cool at a rate equivalent to an air cool, heat to 1300 °F ± 15 (704 °C ± 8), hold at heat for 16 hours ± 1, and cool at the rate equivalent to an air cool.

3.4 Properties:

The product shall conform to the following requirements:

3.4.1 Bars and Forgings:

3.4.1.1 Tensile Properties: Shall be as shown in Table 2 and 3.4.1.1.2, determined in accordance with ASTM E 8 or ASTM E 8M.

3.4.1.1.1 Bars:

TABLE 2A - Minimum Tensile Properties, Inch/Pound Units

Nominal Diameter or Equivalent Cross Section Inches	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 4D %	Reduction of Area %
Up to 0.75, incl	190	125	12	15
Over 0.75	190	125	10	12

TABLE 2B - Minimum Tensile Properties, SI Units

Nominal Diameter or Equivalent Cross Section Millimeters	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 4D %	Reduction of Area %
Up to 19.0, incl	1310	862	12	15
Over 19.0	1310	862	10	12

3.4.1.1.2 Forgings:

Tensile Strength, minimum	175 ksi (1207 MPa)
Yield Strength at 0.2% Offset, minimum	125 ksi (862 MPa)
Elongation in 4D, minimum	8%
Reduction of Area, minimum	10%

3.4.1.2 Hardness: Shall be 340 to 418 HB, or equivalent, (See 8.2) determined in accordance with ASTM E 10.

3.4.1.3 Stress-Rupture Properties at 1200 °F (649 °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:

3.4.1.3.1 A standard, cylindrical, combination smooth-and-notched specimen conforming to ASTM E 292, maintained at 1200 °F ± 3 (649 °C ± 2) while a load sufficient to produce an initial axial stress of 95 ksi (655 MPa) is applied continuously, shall not rupture in less than 23 hours. The test shall be continued to rupture without change of load. Rupture shall occur in the smooth section and elongation of this section after rupture, measured at room temperature, shall be not less than 5% in 4D if the specimen ruptures in 48 hours or less and not less than 3% in 4D if the specimen ruptures in more than 48 hours.

3.4.1.3.2 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 3.4.1.3.1. The smooth specimen shall not rupture in less than 23 hours and elongation after rupture, measured at room temperature, shall be as specified in 3.4.1.3.1. The notched specimen shall not rupture in less time than the companion smooth specimen but need not be tested to rupture.

3.4.1.3.3 The tests of 3.4.1.3.1 and 3.4.1.3.2 may be conducted using a load higher than required to produce an initial axial stress of 95 ksi (655 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 3.4.1.3.1.

3.4.1.3.4 When permitted by purchaser, the tests of 3.4.1.3.1 and 3.4.1.3.2 may be conducted using incremental loading. In such case, the load required to produce an initial axial stress of 95 ksi (655 MPa) shall be used to rupture, or for 48 hours, whichever occurs first. After the 48 hours and at intervals of 8 hours minimum, preferably 8 to 10 hours, thereafter, the stress shall be increased in increments of 5 ksi (34.5 MPa). Time to rupture, rupture location, and elongation requirements shall be as specified in 3.4.1.3.1.

3.4.2 Forging Stock: When a sample of stock is forged to a test coupon and heat treated as in 3.3, specimens taken from the heat treated coupon shall conform to the requirements of 3.4.1.1.2, 3.4.1.2, and 3.4.1.3. If specimens taken from the stock after heat treatment as in 3.3 conform to the requirements of 3.4.1.1.2, 3.4.1.2, and 3.4.1.3, the tests shall be accepted as equivalent to tests of a forged coupon.

3.4.3 Heading Stock: Specimens taken from the stock after heat treatment as in 3.3 shall conform to the requirements of 3.4.1.1.1, 3.4.1.2, and 3.4.1.3.

3.5 Quality:

3.5.1 The alloy shall be produced by multiple melting using vacuum consumable electrode practice in the remelt cycle.

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.

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

3.5.2.2 Grain flow of die forgings, except in areas which contain flash-line end grain, shall follow the general contour of the forgings, showing no evidence of reentrant 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 6 to 24 feet (1.8 to 7.3 m) but not more than 25% of any shipment shall be supplied in lengths of 6 to 9 feet (1.8 to 2.7 m) except that for bars weighing over 25 pounds per foot (37 kg/m), short lengths down to 2 feet (610 mm) may be supplied.

3.7 Tolerances:

Bars shall conform to all applicable requirements of AMS 2241.

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:

4.2.1 Acceptance Tests: The following requirements are 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 Tensile properties (3.4.1.1), hardness (3.4.1.2), and stress-rupture properties (3.4.1.3) of each lot of bars and forgings.

4.2.1.3 Tolerances (3.7) of bars.

4.2.2 Periodic Tests: Test of forging stock (3.4.2) and of heading stock (3.4.3) to demonstrate ability to develop required properties and grain flow of die forgings (3.5.2.2) are 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 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.

4.3 Sampling and Testing:

Shall be as follows:

4.3.1 Bars and Forging Stock: In accordance with AMS 2371.

4.3.2 Forgings: In accordance with AMS 2374 and the following:

4.3.2.1 Size, location, and number of specimens for tensile tests of disc forgings shall be as agreed upon by purchaser and vendor.

4.4 Approval:

Approval and control of forgings shall be in accordance with AMS 2375.

4.5 Reports:

4.5.1 The vendor of bars and forgings shall furnish with each shipment a report showing the results of tests for composition of each heat and for tensile properties, hardness and stress-rupture properties of each lot, and stating that the product conforms to the other technical requirements. This report shall include the purchase order number, heat and lot numbers, AMS 5746G, size, and quantity. If forgings are supplied, 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 or heading shall furnish with each shipment a report showing the results of tests for composition of each heat. This report shall include the purchase order number, heat number, AMS 5746G, size, and quantity.

4.6 Resampling and Retesting:

Shall be as follows:

4.6.1 Bars, Forging Stock, and Heading Stock: In accordance with AMS 2371.

4.6.2 Forgings: In accordance with AMS 2374.