The Engineering Society For Advancing Mobility Land Sea Air and Space

400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

AMS 5634B

Issued 3-15-66
Revised 7-1-87

Superseding AMS 5634A

ALLOY BARS AND FORGINGS, CORROSION AND HEAT RESISTANT
38Fe - 13.2Cr - 38Ni - 5.5Mo - 0.85Cb - 2.5Ti - 1.6Al - 0.009B
Consumable Electrode Melted, Solution and Precipitation Heat Treated
UNS N09027

This specification has been declared "NONCURRENT" by the Aerospace Materials Division, SAE, as of 15 October 1986. It is recommended that this specification not be specified for new designs.

This cover sheet should be attached to the "B" revision of the subject specification.

"Noncurrent" refers to those materials which have previously been widely used and which may be required on some existing designs in the future. The Aerospace Materials Division, SAE, does not recommend these as standard materials for future use in new designs. Each of these "Noncurrent" specifications is available on request from SAE.

This specification is under the jurisdiction of AMS Committee "F".

SAE The Engineering Resource For Advancing Mobility

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1. SCOPE:

1.1 Form: This specification covers a corrosion and heat resistant iron-nickel alloy in the form of bars, wire, forgings, and forging stock.

1.2 Application: Primarily for parts, such as turbine discs, shafts, spacers, dowels, and fittings requiring high strength up to 1400°F (760°C) and oxidation resistance up to 1600°F (870°C).

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS) shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2241 - Tolerances, Corrosion and Heat Resistant Steel, Iron Alloy, Titanium, and Titanium Alloy Bars and Wire
AMS 2248 - Chemical Check Analysis Limits, Wrought Heat and Corrosion Resistant Steels and 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 2806 - Identification, Bars, Wire, Mechanical Tubing, and Extrusions, Carbon and Alloy Steels and Heat and Corrosion Resistant Steels and Alloys
AMS 2808 - Identification, Forgings

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 E10 - Brinell Hardness of Metallic Materials
ASTM E21 - Elevated Temperature Tension Tests of Metallic Materials
ASTM E112 - Estimating the Average Grain Size of Metals
ASTM B139 - Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials
ASTM E292 - Conducting Time-for-Rupture Notch Tension Tests of 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 Federal Standards:

Federal Test Method Standard No. 151 - Metals; Test Methods

2.3.2 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, by spectrographic methods in accordance with Federal Test Method Standard No. 151, Method 112, or by other analytical methods approved by purchaser:

	min	max
Carbon	0.02	0.08
Manganese	--	0.25
Silicon	--	0.25
Phosphorus	--	0.015
Sulfur	--	0.015
Chromium	12.50	14.00
Nickel	36.50	39.50
Molybdenum	5.00	6.00
Columbium	0.60	1.10
Titanium	2.30	2.70
Aluminum	1.45	1.75
Boron	0.003	0.015
Iron	remainder	

3.1.1 Check Analysis: Composition variations shall meet the requirements of AMS 2248.

3.2 Condition: The product shall be supplied in the following condition:

3.2.1 Bars, Wire, and Forgings: Solution and precipitation heat treated.

3.2.1.1 Bars and wire 2.75 in. (70.0 mm) and under in nominal diameter or distance between parallel sides shall be cold finished. Larger size bars shall be hot finished and descaled.

3.2.1.2 Forgings: Shall be descaled.

3.2.2 Forging Stock: As ordered by the forging manufacturer.

3.3 Heat Treatment: Bars, wire, and forgings shall be solution treated by heating to 1875°F ± 25 (1025°C ± 15), holding at heat for 60 min. ± 5, and quenching in oil or water and precipitation heat treated by heating to 1450°F ± 25 (790°C ± 15), holding at heat for 8 to 16 hr, cooling in air, reheating to 1200°F ± 25 (650°C ± 15), holding at heat for 16 hr ± 1, and cooling in air. Furnace cooling from 1450°F (790°C) to 1200°F (650°C) may be substituted for cooling in air and subsequent reheating.

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

3.4.1 Bars, Wire, and Forgings:

3.4.1.1 Grain Size: Predominantly 4 or finer with no grains larger than 2, determined by comparison of a polished and etched specimen with the chart in ASTM E112 or, in case of disagreement, by the intercept (Heyn) method.

3.4.1.2 Tensile Properties:

3.4.1.2.1 At Room Temperature: Shall be as follows, determined in accordance with ASTM E8:

Tensile Strength, min	183,000 psi (1262 MPa)
Yield Strength at 0.2% Offset, min	127,000 psi (876 MPa)
Elongation in 4D, min	11%
Reduction of Area, min	15%

3.4.1.2.2 At 1200°F (649°C): Shall be as follows, determined in accordance with ASTM E21 on specimens heated to 1200°F ± 5 (649°C ± 3), held at heat for 20 to 30 min. before testing, and tested at 1200°F ± 5 (649°C ± 3):

Tensile Strength, min	155,000 psi (1069 MPa)
Yield Strength at 0.2% Offset, min	127,000 psi (876 MPa)
Elongation in 4D, min	11%
Reduction of Area, min	15%

3.4.1.3 Hardness: Should be 320 - 403 HB or equivalent, determined in accordance with ASTM E10, but the product shall not be rejected on the basis of hardness if the tensile property requirements of 3.4.1.2.1 are met.

3.4.1.4 Stress Rupture Properties at 1400°F (760°C): Shall be as follows; testing of notched specimens and of combination smooth-and-notched specimens shall be performed in accordance with ASTM E292 and of smooth specimens in accordance with ASTM E139:

3.4.1.4.1 A combination smooth and notched test specimen machined to the dimensions shown in Fig. 1 and Table I, maintained at 1400°F ± 3 (760°C ± 2) while a load sufficient to produce an initial axial stress of 55,000 psi (379 MPa) is applied continuously, shall not rupture in less than 25 hours. The test shall be continued to rupture, without change of load, with rupture occurring in the smooth section.

3.4.1.4.2 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 of Table I may be tested individually under the conditions of 3.4.1.4.1. The smooth specimen shall not rupture in less than 25 hours. The notched specimen shall not rupture in less time than the companion smooth specimen but need not be tested to rupture.

3.4.1.4.3 The tests of 3.4.1.4.1 and 3.4.1.4.2 may be conducted using a load higher than required to produce an initial axial stress of 55,000 psi (379 MPa) but load shall not be changed while test is in progress. Time to rupture and rupture location shall be as specified in 3.4.1.4.1.

3.4.1.4.4 When permitted by purchaser, the tests of 3.4.1.4.1 and 3.4.1.4.2 may be conducted using incremental loading. In such case, the load required to produce an initial axial stress of 55,000 psi (379 MPa) shall be used to rupture or for 25 hr, whichever occurs first. After 25 hr and at intervals of 8 - 16 hr, preferably 8 - 10 hr, thereafter, the stress shall be increased in increments of 5,000 psi (34.5 MPa). Time to rupture and rupture location requirements shall be as specified in 3.4.1.4.1.

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, 3.4.1.2, 3.4.1.3, and 3.4.1.4. If specimens taken from stock after heat treatment as in 3.3 conform to the requirements of 3.4.1.1, 3.4.1.2, 3.4.1.3, and 3.4.1.4, the tests shall be accepted as equivalent to tests of a forged coupon.

3.5 Quality:

3.5.1 Alloy shall be produced by multiple melting using consumable electrode practice in the remelt cycle, unless otherwise permitted by purchaser. If consumable electrode remelting is not performed in vacuum, electrodes which have been produced by vacuum induction melting shall be used.

3.5.2 The product, as received by purchaser, shall be uniform in quality and condition, sound, Ø and free from foreign materials and from internal and external imperfections detrimental to usage of the product.

3.5.2.1 Forgings shall have substantially uniform macrostructure and grain flow. Standards for Ø acceptance shall be as agreed upon by purchaser and vendor.

3.6 Sizes: Except when exact lengths or multiples of exact lengths are ordered, straight bars and wire will be acceptable in mill lengths of 6 - 20 ft (1.8 - 6.1 m) but not more than 10% of any shipment shall be supplied in lengths shorter than 10 ft (3 m).

3.7 Tolerances: Unless otherwise specified, tolerances for bars and wire 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 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 such confirmatory testing as 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 classi- Ø fied 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 Grain size (3.4.1.1), room temperature tensile properties (3.4.1.2.1), hardness (3.4.1.3), and stress-rupture properties (3.4.1.4) of each lot of bars, wire, and forgings.

4.2.1.3 Tolerances (3.7) of bars and wire.

4.2.2 Periodic Tests: Tests to determine conformance to the following requirements are classified Ø as periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.2.2.1 Elevated temperature tensile properties (3.4.1.2.2) of bars, wire, and forgings.

4.2.2.2 Ability of forging stock to develop required properties (3.4.2).

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 on the first-article shipment of a forging to a purchaser, when a change in material 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, the contracting officer, or the 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 and Wire: 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 the product shall furnish with each shipment three copies of 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, heat number, AMS 5634B, size, and quantity from each heat. 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 finished or semi-finished parts shall furnish with each shipment three copies of a report showing the purchase order number, AMS 5634B, contractor or other direct supplier of material, part number, and quantity. When material for making parts is produced or purchased by the parts vendor, that vendor shall inspect each lot of material to determine conformance to the requirements of this specification, and shall include in the report a statement that the material conforms, or shall include copies of laboratory reports showing the results of tests to determine conformance.

4.6 Resampling and Retesting: Shall be in accordance with the following:

4.6.1 Bars and Wire: AMS 2371.

4.6.2 Forgings and Forging Stock: AMS 2374.

5. PREPARATION FOR DELIVERY:

5.1 Identification: The product shall be identified as follows:

5.1.1 Bars and Wire: In accordance with AMS 2806.

5.1.2 Forgings: In accordance with AMS 2808.

5.1.3 Forging Stock: As agreed upon by purchaser and vendor.

5.2 Packaging: