

Submitted for recognition as an American National Standard

ALLOY BARS, FORGINGS, AND RINGS, CORROSION AND HEAT RESISTANT
29Fe - 22Cr - 21Ni - 18.5Co - 3.2Mo - 2.8W - 0.78Ta -
0.30Al - 0.05Zr - 0.05La - 0.20N
Solution Heat Treated

UNS R30556

1. SCOPE:

1.1 Form: This specification covers a corrosion and heat resistant alloy in the form of bars, forgings, flash welded rings, and stock for forging, flash welded rings, or heading.

1.2 Application: Primarily for parts, such as turbine rotors, shafts, blades, and bolts, requiring high strength and oxidation resistance up to 2000°F (1093°C).

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 documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

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2.1.1 Aerospace Material Specifications:

- AMS 2248 - Chemical Check Analysis Limits, Wrought Corrosion and Heat Resistant Steels and Alloys, Maraging and Other Highly-Alloyed Steels, and Iron Alloys
- AMS 2261 - Tolerances, Nickel, Nickel Alloy, and Cobalt Alloy Bars and Forging Stock
- MAM 2261 - Tolerances, Metric, Nickel, Nickel Alloy, and Cobalt Alloy Bars and Forging Stock
- 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, 1916 Race Street, Philadelphia, PA 19103.

- ASTM E8 - Tension Testing of Metallic Materials
- ASTM E8M - Tension Testing of Metallic Materials (Metric)
- ASTM E10 - Brinell Hardness of Metallic Materials
- ASTM E139 - Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials
- ASTM E353 - Chemical Analysis of Stainless, Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron 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 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 E353, by spectrochemical methods, or by other analytical methods acceptable to purchaser:

| | min | max |
|------------|-----------|-------|
| Carbon | 0.05 | 0.15 |
| Manganese | 0.50 | 2.00 |
| Silicon | 0.20 | 0.80 |
| Phosphorus | -- | 0.04 |
| Sulfur | -- | 0.015 |
| Chromium | 21.00 | 23.00 |
| Nickel | 19.00 | 22.50 |
| Cobalt | 16.00 | 21.00 |
| Molybdenum | 2.50 | 4.00 |
| Tungsten | 2.00 | 3.50 |
| Tantalum | 0.30 | 1.25 |
| Aluminum | 0.10 | 0.50 |
| Zirconium | 0.001 | 0.10 |
| Lanthanum | 0.005 | 0.10 |
| Nitrogen | 0.10 | 0.30 |
| Columbium | -- | 0.30 |
| Boron | -- | 0.02 |
| Iron | remainder | |

3.1.1 Check Analysis: Composition variations shall meet the requirements of AMS 2248; check analysis limits for lanthanum shall be 0.002 under minimum and 0.01 over maximum.

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

3.2.1 Bars, Forgings, and Flash Welded Rings: Solution heat treated. Forgings shall be descaled.

3.2.1.1 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.

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

3.3 Heat Treatment: The product shall be solution heat treated by heating to a temperature within the range 2100° - 2225°F (1149° - 1218°C), holding at the selected temperature within +25°F (+14°C) for a time commensurate with section thickness but not less than 20 minutes, and quenching in water. 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 Tensile Properties: Shall be as follows, determined in accordance with ASTM E8 or ASTM E8M:

| | |
|--|-----------------------|
| Tensile Strength, minimum | 100,000 psi (689 MPa) |
| Yield Strength at 0.2% Offset, minimum | 47,000 psi (324 MPa) |
| Elongation in 4D, minimum | 40% |

3.4.1.2 Hardness: Should be not higher than 241 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 are met.

3.4.1.3 Stress-Rupture Properties at 1500°F (816°C): A tensile specimen, maintained at 1500°F ± 3 (816°C ± 2) while a load sufficient to produce an initial axial stress of 19,000 psi (131 MPa) is applied continuously, shall not rupture in less than 24 hours. Elongation after rupture, measured at room temperature, shall be not less than 25% in 4D. Tests shall be conducted in accordance with ASTM E139.

3.4.1.3.1 The test of 3.4.1.3 may be conducted using a load higher than required to produce an initial axial stress of 19,000 psi (131 MPa). Time to rupture and elongation requirements shall be as specified in 3.4.1.3.

3.4.1.3.2 When permitted by purchaser, the test of 3.4.1.3 may be conducted using incremental loading. In such case, the load required to produce an initial axial stress of 19,000 psi (131 MPa) shall be used to rupture or for 24 hours, whichever occurs first. After the 24 hours and at intervals of 8 - 16 hours, preferably 8 - 10 hours, thereafter, the stress shall be increased in increments of 2,000 psi (13.8 MPa). Time to rupture and elongation requirements shall be as specified in 3.4.1.3.

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, 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, 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 Stock for Flash Welded Rings or Heading: Specimens taken from the stock after heat treatment as in 3.3 shall conform to the requirements of 3.4.1.1, 3.4.1.2, and 3.4.1.3.

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 Forgings shall have substantially uniform macrostructure. Standards for acceptance shall be as agreed upon by purchaser and vendor.
- 3.5.2 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 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 6 - 20 feet (1.8 - 6.1 m) but not more than 10% of any shipment shall be supplied in lengths shorter than 10 feet (3 m).
- 3.7 Tolerances: Bars shall conform to all applicable requirements of AMS 2261 or MAM 2261.
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 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 Tensile (3.4.1.1), hardness (3.4.1.2), and stress-rupture (3.4.1.3) properties of each lot of bars, forgings, and flash welded rings.
- 4.2.1.3 Tolerances (3.7) of bars.
- 4.2.2 Periodic Tests: Tests of forging stock (3.4.2), and of stock for flash welded rings or 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.