Society of Automotive Engineers, Inc.
400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

# AEROSPACE MATERIAL SPECIFICATION

AMS 5616F
Superseding AMS 5616E

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## STEEL BARS, FORGINGS, TUBING, AND RINGS, CORROSION AND MODERATE HEAT RESISTANT 13Cr - 2.0Ni - 3.0W



1. SCOPE:

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

1.2 Application: Primarily for parts and assemblies, such as compressor wheels and blades, requiring oxidation resistance up to 1000°F (538°C). Strength at the higher temperature is superior to that of the standard 12Cr type.

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 Bars and Wire and Titanium and Titanium Alloy Bars and Wire
AMS 2243 - Tolerances, Corrosion and Heat Resistant Steel Tubing
AMS 2248 - Chemical Check Analysis Limits, Wrought Heat and Corrosion Resistant Steels and Alloys
AMS 2303 - Aircraft Quality Steel Cleanliness, Martensitic Corrosion Resistant Steels, Magnetic Particle Inspection Procedure
AMS 2350 - Standards and Test Methods
AMS 2371 - Quality Assurance Sampling of Corrosion and Heat Resistant Alloys, Wrought Products Except Forgings
AMS 2375 - Approval and Control of Critical Forgings
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
AMS 7493 - Rings, Flash Welded, Non-Austenitic Corrosion Resistant Steels

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM A370 - Mechanical Testing of Steel Products
ASTM E353 - Chemical Analysis of Stainless, Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron Alloys

2.3 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





Printed in U.S.A.

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 E353, by spectrographic methods in accordance with Federal Test Method Standard No. 151, Method 112, or by other approved analytical methods:

| | min | max |
|---|---|---|
| Carbon | 0.15 | 0.20 |
| Manganese | -- | 0.50 |
| Silicon | -- | 0.50 |
| Phosphorus | -- | 0.040 |
| Sulfur | -- | 0.030 |
| Chromium | 12.00 | 14.00 |
| Nickel | 1.80 | 2.20 |
| Tungsten | 2.50 | 3.50 |
| Molybdenum | -- | 0.50 |
| Aluminum | -- | 0.15 |
| Nitrogen (3.1.1) | -- | 0.08 |
| Copper | -- | 0.50 |
| Tin | -- | 0.05 |

3.1.1 Determination not required for routine acceptance.

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

3.2 Condition: The product shall be supplied in the following condition; hardness and tensile strength shall be determined in accordance with ASTM A370:

3.2.1 Bars: Annealed having hardness not higher than 311 HB or equivalent.

3.2.1.1 Bars over 0.500 to 2.750 in. (12.70 to 69.85 mm), incl, in nominal diameter or distance between parallel sides, and all hexagons shall be cold finished.

3.2.1.2 Bars, other than hexagons, over 2.750 in. (69.85 mm) in nominal diameter or distance between parallel sides shall be hot finished.

3.2.2 Wire: Annealed and cold finished having tensile strength not higher than 155,000 psi (1069 MPa) or equivalent hardness.

3.2.3 Forgings: As ordered.

3.2.4 Mechanical Tubing: Annealed and cold finished having hardness not higher than 311 HB or equivalent.

3.2.5 Flash Welded Rings: Annealed having hardness not higher than 311 HB or equivalent.

3.2.5.1 Flash welded rings shall not be supplied unless specified or permitted on purchaser's part drawing. When supplied, they shall be manufactured in accordance with AMS 7493.

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

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

3.3.1 Response to Heat Treatment: Product 0.375 in. (9.52 mm) and under in nominal thickness and specimens 0.375 in. ± 0.010 (9.52 mm ± 0.25) thick cut from larger product shall have hardness not lower than 45 HRC or equivalent, determined in accordance with ASTM A370, after being heated to 1750°F ± 10 (954.4°C ± 5.6), held at heat for 25 - 30 min., and quenched in commercial paraffin oil (approximately 100 SUS at 100°F (37.8°C)) at room temperature.

3.4 Quality:

3.4.1 Steel shall be aircraft quality and, when specified, shall conform to AMS 2303.

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

3.5 Sizes: Except when exact lengths or multiples of exact lengths are ordered, straight bars, wire, and Ø tubing 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).

3.6 Tolerances: Unless otherwise specified, tolerances shall conform to all applicable requirements of the following:

3.6.1 Bars and Wire: AMS 2241.

3.6.2 Mechanical Tubing: AMS 2243.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of the product shall supply all samples and shall be responsible Ø 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 perform such confirmatory testing as he deems necessary to ensure that the product conforms to the requirements of this specification.

4.2 Classification of Tests: Tests to determine conformance to all technical requirements of this specifica- Ø tion are classified as acceptance tests.

4.2.1 For direct U.S. Military procurement of forgings, test data and, when requested, preproduction Ø 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:

4.3.1 Bars, Wire, Mechanical Tubing, Flash Welded Rings, and Stock for Flash Welded Rings or Headings: Ø AMS 2371.

Ø 4.3.2 Forgings and Forging Stock: As agreed upon by purchaser and vendor.

Ø 4.4 Approval: When specified, approval and control of forgings shall be in accordance with AMS 2375.

4.5 Reports:

4.5.1 Ø The vendor of the product shall furnish with each shipment three copies of a report showing the results of tests for chemical composition, and for AMS 2303 frequency-severity rating when specified, of each heat and the results of tests for the response to heat treatment requirements of each size from each heat. This report shall include the purchase order number, heat number, material specification number and its revision letter, 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, material specification number and its revision letter, 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 Ø Resampling and Retesting: If any specimen used in the above tests fails to meet the specified requirements, disposition of the product may be based on the results of testing three additional specimens for each original nonconforming specimen. Failure of any retest specimen to meet the specified requirements shall be cause for rejection of the product represented and no additional testing shall be permitted. Results of all tests shall be reported.

5. PREPARATION FOR DELIVERY:

5.1 Identification: The product shall be identified as follows:

Ø 5.1.1 Bars, Wire, and Tubing: In accordance with AMS 2806.

5.1.2 Forgings: In accordance with AMS 2808.

5.1.3 Flash Welded Rings and Stock for Forging, Flash Welded Rings, or Heading: As agreed upon by purchaser and vendor.

5.2 Packaging:

5.2.1 Ø The product shall be prepared for shipment in accordance with commercial practice to ensure carrier acceptance and safe transportation to the point of delivery. Packaging shall conform to carrier rules and regulations applicable to the mode of transportation.

5.2.2 Ø For direct U.S. Military procurement, packaging shall be in accordance with MIL-STD-163, Level A or Level C, as specified in the request for procurement. Commercial packaging as in 5.2.1 will be acceptable if it meets the requirements of Level C.

6. ACKNOWLEDGMENT: A vendor shall mention this specification number and its revision letter in all quotations and when acknowledging purchase orders.

7. REJECTIONS: Material not conforming to this specification or to authorized modifications will be subject to rejection.

8. NOTES:

8.1 Marginal Indicia: The phi (Ø) symbol is used to indicate technical changes from the previous issue of this specification.

8.2 Definitition of "Mechanical Tubing": The term "mechanical tubing" as used in AMS means a heavy-walled cylindrical tubing intended primarily for the machining of circular rings, flanges, shafts, etc, having a wall thickness which is a substantial proportion of the outer diameter; such tubing is not normally used as pipe for the transmission of fluids and parts made from it are usually machined all over. This product is sometimes known as "hollow bar."