

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

SAE

AMS 5628E

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Superseding AMS 5628D

STEEL, CORROSION RESISTANT, BARS, WIRE, FORGINGS, AND TUBING
16Cr - 2.5Ni (SAE 51431)

UNS S43100

1. SCOPE:

1.1 Form:

This specification covers a heat-treatable, corrosion-resistant steel in the form of bars, wire, forgings, mechanical tubing, and stock for forging or heading.

1.2 Application:

These products have been used typically for parts and fittings requiring corrosion resistance and high strength at room and elevated [up to 500 °F (260 °C)] temperature, but usage is not limited to such applications.

1.2.1 Certain design and processing procedures may cause these products to become susceptible to stress-corrosion cracking. ARP1110 recommends practices to minimize such conditions.

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.

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2.1 SAE Publications:

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

- AMS 2241 Tolerances, Corrosion and Heat Resistant Steel, Iron Alloy, Titanium, and Titanium Alloy Bars and Wire
- MAM 2241 Tolerances, Metric, Corrosion and Heat Resistant Steel, Iron Alloy, Titanium, and Titanium Alloy Bars and Wire
- AMS 2243 Tolerances, Corrosion and Heat Resistant Steel Tubing
- MAM 2243 Tolerances, Metric, Corrosion and Heat Resistant Steel Tubing
- AMS 2248 Chemical Check Analysis Limits, Corrosion and Heat Resistant Steels and Alloys, Maraging and Other Highly-Alloyed Steels, and Iron Alloys
- AMS 2303 Aircraft-Quality Steel Cleanliness, Martensitic Corrosion-Resistant Steels, Magnetic Particle Inspection Procedure
- MAM 2303 Aircraft-Quality Steel Cleanliness, Martensitic Corrosion-Resistant Steels, Magnetic Particle Inspection Procedure, Metric (SI) Measurement
- 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 2806 Identification, Bars, Wire, Mechanical Tubing, and Extrusions, Carbon and Alloy Steels and Corrosion and Heat Resistant Steels and Alloys
- AMS 2808 Identification Forgings

- ARP1110 Minimizing Stress Corrosion Cracking in Wrought Forms of Steels and Corrosion Resistant Steels and Alloys

2.2 ASTM Publications:

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

- ASTM A 370 Mechanical Testing of Steel Products
- ASTM E 112 Determining the Average Grain Size
- ASTM E 353 Chemical Analysis of Stainless, Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron 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:

(R)

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 the purchaser.

TABLE 1 - Composition

Element	min	max
Carbon	0.12	0.17
Manganese	0.30	0.80
Silicon	0.20	0.60
Phosphorus	--	0.040
Sulfur	--	0.030
Chromium	15.50	16.50
Nickel (See 3.1.1)	2.00	3.00
Molybdenum	--	0.25
Copper	--	0.50
Nitrogen	--	0.10

3.1.1 When stock for heading is ordered, nickel content may be as low as 1.50 for bars and wire
(R) under 0.66 inch (16.8 mm) in nominal diameter.

3.1.2 Check Analysis: Composition variations shall meet the requirements of AMS 2248 except
(R) that no variation over maximum is permitted for nitrogen.

3.2 Condition:

3.2.1 Temper: Forging and heading stock shall be furnished as ordered. Other product shall be
(R) furnished annealed with a maximum hardness of 302 HB or equivalent (See 8.2), determined in accordance with ASTM A 370.

3.2.2 Surface:

3.2.2.1 Round bars and heading stock up to 1/2 inch (12.7 mm), inclusive, in nominal diameter shall
(R) be cold drawn or ground, over 1/2 to 1-1/2 inches (12.7 to 38 mm), inclusive, in nominal diameter shall be ground or smooth turned, and over 1-1/2 inches (38 mm) in nominal diameter shall be ground or turned. Round forging stock shall be ground or turned.

3.2.2.2 Bars other than rounds, 2.75 inches (69.8 mm) and under in nominal distance between
(R) parallel sides, and all hexagons, wire, and mechanical tubing shall be cold finished.

3.2.2.3 Other bars and forging stock shall be hot finished and descaled.

3.2.2.4 Forgings shall be free of scale.
(R)

3.3 Properties:

The product shall conform to the following requirements:

3.3.1 Response to Heat Treatment: Longitudinal tensile specimens, taken from the product, or
(R) from precursor material (for forgings, See 3.3.1.1), having a minimum nominal diameter of 0.250 inches (6.35 mm), which have been heat treated in accordance with 3.3.1.2 and tested in accordance with ASTM A 370 shall meet the requirements shown in Table 2 (See 8.3).

3.3.1.1 To test forgings, specimens may be taken from forgings, forging stock, or stock which has
(R) been forged to simulate the least reduced section of the forgings.

3.3.1.2 Soak at $1875^{\circ}\text{F} \pm 25$ ($1024^{\circ}\text{C} \pm 14$) for not less than 30 minutes, quench in agitated oil at
(R) $125^{\circ}\text{F} \pm 25$ ($52^{\circ}\text{C} \pm 14$), cool to room temperature in water, soak in a liquid at $-100^{\circ}\text{F} \pm 20$ ($-73^{\circ}\text{C} \pm 11$) for not less than 2 hours, temper in air at $550^{\circ}\text{F} \pm 25$ ($288^{\circ}\text{C} \pm 14$) for 2 hours, and retemper in air at $550^{\circ}\text{F} \pm 25$ ($288^{\circ}\text{C} \pm 14$) for 2 hours.

TABLE 2 - Minimum Tensile Properties

Property	Value
Tensile Strength	200 ksi (1379 MPa)
Yield Strength at 0.2% Offset	150 ksi (1034 MPa)
Elongation in 2 Inches or 4D	10%
Reduction of Area	40%

3.3.2 Microstructure: Specimens from product heated to $1875^{\circ}\text{F} \pm 25$ ($1024^{\circ}\text{C} \pm 14$), held at heat
(R) for not less than 30 minutes, quenched in agitated oil at $125^{\circ}\text{F} \pm 25$ ($52^{\circ}\text{C} \pm 14$), cooled to room temperature in water, and tempered in air at $1175^{\circ}\text{F} \pm 25$ ($635^{\circ}\text{C} \pm 14$) for not less than 3 hours shall meet the following requirements. The limits of 3.3.2.1, 3.3.2.2, and 3.3.2.3 apply to all fields in a longitudinal specimen, having a minimum length and width of 0.250 inch (6.35 mm), polished, etched, and examined at 250X.

3.3.2.1 Banded Ferrite (See Figures 1, 2, 3, and 4): The product shall not contain banded free ferrite
(R) in excess of that shown in Figure 3.

3.3.2.2 Blocky Ferrite: The product shall not contain blocky ferrite in excess of 4%.
(R)

3.3.2.3 Banded Austenite (See Figures 1, 5, 6, and 7): The product shall not contain banded
(R) retained austenite in excess of that shown in Figure 5.

3.3.2.4 Blocky Austenite: Shall not be cause for rejection.
(R)

3.3.2.5 Average Grain Size: Shall be ASTM No. 3 or finer, determined by comparison of a heat
(R) treated (as in 3.3.2), specimen, polished, and etched specimen with the chart in ASTM E 112.

3.4 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.

3.4.1 Steel shall be aircraft-quality conforming to AMS 2303 or MAM 2303.

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

3.5 Tolerances:

Shall be as follows:

3.5.1 Bars and Wire: In accordance with AMS 2241 or MAM 2241.

3.5.2 Mechanical Tubing: In accordance with AMS 2243 or MAM 2243.

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: Composition (3.1), condition (3.2), response to heat treatment (3.3.1),
(R) microstructure (3.3.2), and tolerances (3.5) are acceptance tests and shall be performed on each heat or lot as applicable.

4.2.2 Periodic Tests: Frequency-severity cleanliness rating (3.4.1) grain flow of die forgings (3.4.2)
(R) are periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.3 Sampling and Testing:
(R)

Shall be as follows:

4.3.1 Bars, Wire, Mechanical Tubing, and Stock for Forging or Heading: In accordance with AMS 2371.

4.3.2 Forgings: In accordance with AMS 2374.
(R)

4.3.3 Microstructure: A sample shall be taken to represent each 50 pieces in a lot. The plane examined shall be as shown in Figure 8 for constant section products; for forgings, the plane examined shall be at approximately one-third of the thickness in the thinnest section of the forging.

4.4 Reports:
(R)

The vendor of the product shall furnish with each shipment a report showing the results of all tests. The report shall include the purchase order number, heat and lot numbers, AMS 5628E, size, and quantity. 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 Resampling and Retesting:

Shall be as follows:

4.5.1 Bars, Wire, Mechanical Tubing, and Stock for Forging or Heading: In accordance with AMS 2371.

4.5.2 Forgings: In accordance with AMS 2374.
(R)

5. PREPARATION FOR DELIVERY:

5.1 Sizes:

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

5.2 Identification:

Shall be as follows:

5.2.1 Bars, Wire, and Mechanical Tubing: In accordance with AMS 2806.
(R)

5.2.2 Forgings: In accordance with AMS 2808.

5.2.3 Stock for Forging or Heading: As agreed upon by purchaser and vendor.

5.3 Packaging:

5.3.1 The product shall be prepared for shipment in accordance with commercial practice and in (R) compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the product to ensure carrier acceptance and safe delivery.

5.3.2 For direct U.S. Military procurement, packaging shall be in accordance with MIL-STD-163, Level C, unless Level A is specified in the request for procurement.

6. ACKNOWLEDGMENT:

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

7. REJECTIONS:

Product not conforming to this specification, or to modifications authorized by purchaser, will be subject to rejection.

8. NOTES:

8.1 The (R) symbol is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this specification. If the symbol is next to the specification title, it indicates a complete revision of the specification.

8.2 Hardness conversion tables for metals are presented in ASTM E 140.

8.3 The yield strength value in Table 2 is not supported by AMS statistical analysis of currently available test results. However, the value has been used successfully for many years for procurement in accordance with company specifications and MIL-S-18732.

8.4 Clarification of terms used in AMS are presented in ARP1917 and as follows:

8.4.1 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 for the transmission of fluids, and parts made from it are usually machined all over. This product is sometimes known as "hollow bar".

8.5 Dimensions and properties in inch/pound units and the Fahrenheit temperatures are primary; dimensions and properties in SI units and the Celsius temperatures are shown as the approximate equivalents of the primary units and are presented only for information.

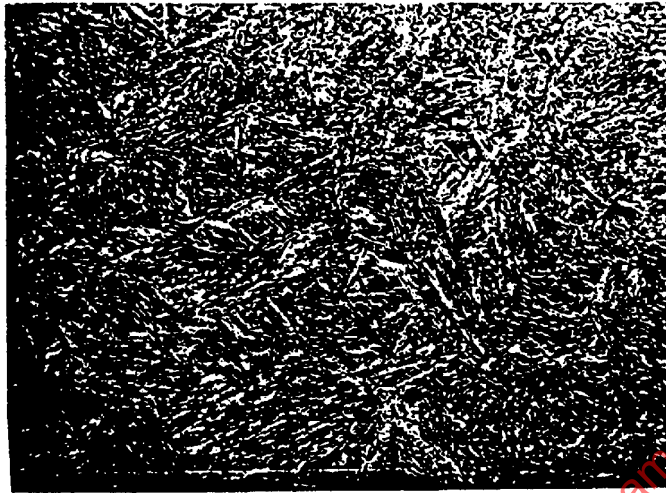
8.6 Purchase documents should specify not less than the following:

Title, number, and date of this specification
Form and size or part number of product desired
Quantity of product desired
Level A packaging, if required (See 5.3.2).

8.7 Products meeting the requirements of this specification have been classified under Federal Supply Classification (FSC) 9510.

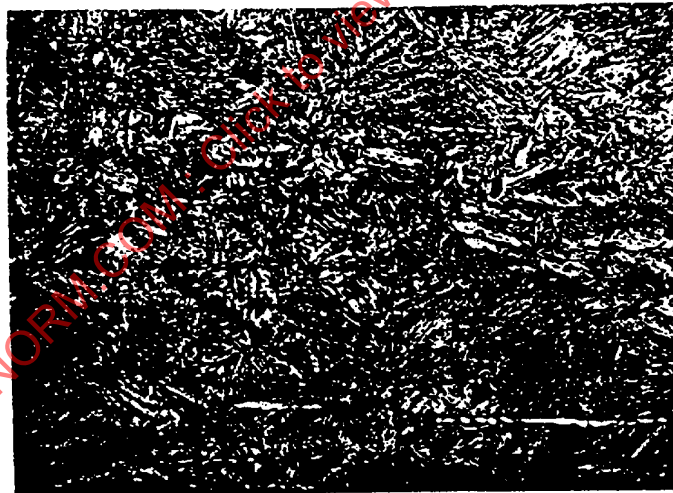
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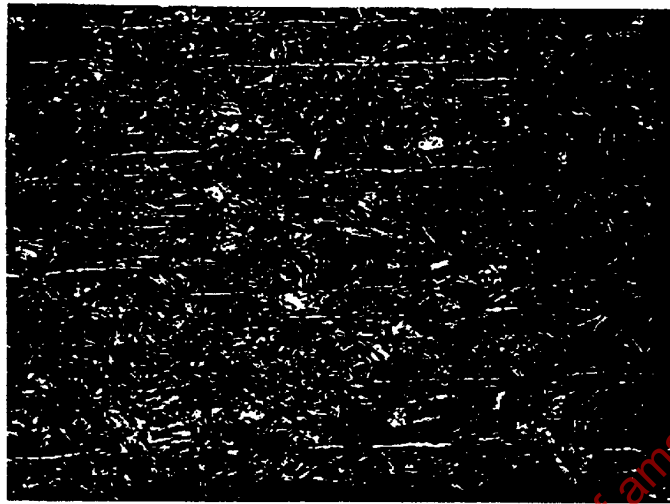
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FIGURE 1 - Desired Microstructure (100% Martensite)



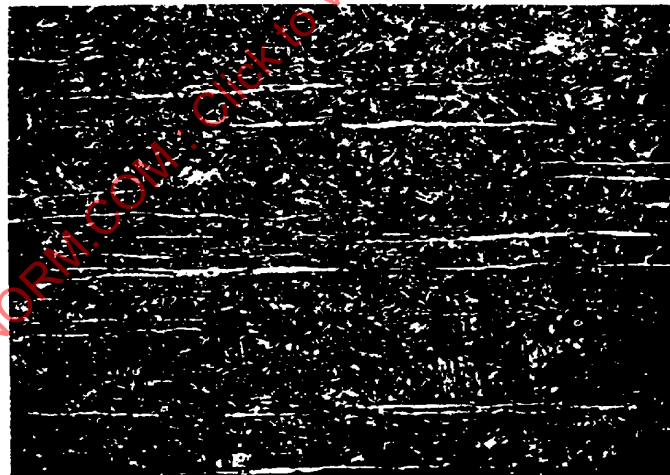
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FIGURE 2 - Acceptable Microstructure Containing Small Amounts of Banded Free Ferrite



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FIGURE 3 - Acceptable Microstructure Containing Maximum Amount of Banded Free Ferrite Permitted in Any Field



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FIGURE 4 - Unacceptable Microstructure Containing Excessive Banded Free Ferrite