

ADOPTION NOTICE

SAE-AMS5629, "STEEL, CORROSION RESISTANT, BARS, FORGINGS, RINGS, AND EXTRUSIONS 13CR - 8.0NI - 2.2MO - 1.1AI VACUUM INDUCTION PLUS CONSUMABLE ELECTRODE MELTED SOLUTION HEAT TREATED, PRECIPITATION HARDENABLE", was adopted on 20-DEC-91 for use by the Department of Defense (DoD). Proposed changes by DoD activities must be submitted to the DoD Adopting Activity: Commander, Defense Supply Center Philadelphia, ATTN: DSCP-ILEA, 700 Robbins Avenue, Philadelphia, PA 19111-5096. Copies of this document may be purchased from the Society of Automotive Engineers 400 Commonwealth Drive Warrendale, Pennsylvania, United States, 15096-0001. <http://www.sae.org/>

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AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard



AMS 5629D

Issued NOV 1968
Revised APR 1991
Reaffirmed MAY 1995

Superseding AMS 5629C

Steel, Corrosion Resistant, Bars, Forgings, Rings, and Extrusions

13Cr - 8.0Ni - 2.2Mo - 1.1Al

Vacuum Induction Plus Consumable Electrode Melted

Solution Heat Treated, Precipitation Hardenable

UNS S13800

1. SCOPE:

1.1 Form:

This specification covers a corrosion-resistant steel in the form of bars, wire, forgings, flash welded rings, extrusions, and stock for forging, flash welded rings, or extrusion.

1.2 Application:

Primarily for parts requiring corrosion resistance, stress-corrosion resistance, high strength up to 600 °F (316 °C), and good ductility and strength in the transverse direction in large section sizes.

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.

1.3 Classification:

Product covered by this specification is classified as follows:

Type I - Steel multiple melted using vacuum-arc consumable electrode process in the final melt cycle

Type II - Steel multiple melted using electroslag consumable electrode process in the final melt cycle

1.3.1 When no type is specified, Type I shall be supplied.

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.

2.1.1 Aerospace Material Specifications:

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 2248	Chemical Check Analysis Limits, Wrought Corrosion and Heat Resistant Steels and Alloys, Maraging and Other Highly-Alloyed Steels, and Iron Alloys
AMS 2300	Premium Aircraft-Quality Steel Cleanliness, Magnetic Particle Inspection Procedure
MAM 2300	Premium Aircraft Quality Steel Cleanliness, Magnetic Particle Inspection Procedure, Metric (SI) Measurement
AMS 2315	Determination of Free Ferrite Content
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 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

2.1.2 Aerospace Recommended Practices:

ARP1110	Minimizing Stress Corrosion Cracking in Heat Treatable Wrought Low Alloy and Martensitic Corrosion Resistant Steels
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2.2 ASTM Publications:

Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM A 370	Mechanical Testing of Steel Products
ASTM A 604	Macroetch Testing of Consumable Electrode Remelted Steel Bars and Billets
ASTM E 112	Determining 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 Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

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 E 353, by spectrochemical methods, or by other analytical methods acceptable to purchaser:

	min	max
Carbon	--	0.05
Manganese	--	0.10
Silicon	--	0.10
Phosphorus	--	0.010
Sulfur	--	0.008
Chromium	12.25	13.25
Nickel	7.50	8.50
Molybdenum	2.00	2.50
Aluminum	0.90	1.35
Nitrogen	--	0.010

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

3.2 Condition:

The product shall be supplied in the following condition:

3.2.1 Bars and Wire:

3.2.1.1 Rounds: Centerless ground or turned after solution heat treatment.

3.2.1.2 Hexagons, Squares, and Flats: Cold finished, solution heat treated, straightened, and descaled or hot finished, solution heat treated, and descaled, as ordered.

3.2.2 Forgings and Flash Welded Rings: Solution heat treated and descaled.

3.2.2.1 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.

3.2.3 Extrusions: Solution heat treated, straightened, and descaled.

3.2.4 Stock for Forging, Flash Welded Rings, or Extrusion: As ordered by the forging, flash welded ring, or extrusion manufacturer.

3.3 Heat Treatment:

Bars, wire, forgings, flash welded rings, and extrusions shall be solution heat treated by heating to 1700 °F ± 25 (927 °C ± 14), holding at heat for not less than 30 minutes, and cooling as required to below 60 °F (16 °C). Pyrometry shall be in accordance with AMS 2750.

3.4 Properties:

The product shall conform to the following requirements; hardness and tensile testing shall be performed in accordance with ASTM A 370:

3.4.1 All Products:

3.4.1.1 Macrostructure: Visual examination of transverse sections as in 4.3.3 from bars, billets, extrusions, and stock for forging, flash welded rings, or extrusions, etched in hot hydrochloric acid in accordance with ASTM A 604, shall show no pipe or cracks. Porosity, segregation, inclusions, and other imperfections for product 81 square inches (523 cm²) and under in nominal cross-sectional area shall be no worse than the following macrographs of ASTM A 604; macrostructure standards for product over 81 square inches (523 cm²) in nominal cross-sectional area shall be as agreed upon by purchaser and vendor:

Class	Condition	Severity
1	Freckles	A
2	White Spots	A
3	Radial Segregation	A
4	Ring Pattern	B

3.4.1.2 Microstructure: The product shall contain not more than 2% free ferrite, determined in accordance with AMS 2315.

3.4.2 Bars, Wire, Forgings, Flash Welded Rings, and Extrusions:

3.4.2.1 As Solution Treated:

3.4.2.1.1 Tensile Strength: Wire shall have tensile strength not higher than 175 ksi (1207 MPa).

3.4.2.1.2 Hardness:

- 3.4.2.1.2.1 Bars: Shall be not higher than 363 HB or equivalent, determined at midradius or quarter thickness.
- 3.4.2.1.2.2 Forgings, Flash Welded Rings, and Extrusions: Shall be not higher than 363 HB, or equivalent.
- 3.4.2.1.3 Grain Size: Shall be 5 or finer for product up to 3.00 inches (76.2 mm) in nominal cross-sectional thickness with occasional grains as large as 3, and shall be 4 or finer for product 3.00 inches (76.2 mm) and over in nominal cross-sectional thickness with occasional grains as large as 3; determined by comparison of a polished and etched specimen with the chart in ASTM E 112.
- 3.4.2.2 After Precipitation Heat Treatment: The solution heat treated product 12 inches (305 mm) and under in nominal diameter or maximum cross-section dimension, when precipitation heat treated for 4 hours $\pm$ 0.25 to a particular condition at the temperatures shown in Table I and cooled in air shall have the properties specified in 3.4.2.2.1 and 3.4.2.2.2 for that particular condition. Tensile and hardness tests shall be made in only the H1000 precipitation heat treated condition unless purchaser specifies another heat treated condition.

TABLE I

Condition	Temperature
H950	950 °F $\pm$ 10 (510 °C $\pm$ 6)
H1000	1000 °F $\pm$ 10 (538 °C $\pm$ 6)
H1025	1025 °F $\pm$ 10 (552 °C $\pm$ 6)
H1050	1050 °F $\pm$ 10 (566 °C $\pm$ 6)
H1100	1100 °F $\pm$ 10 (593 °C $\pm$ 6)
H1150	1150 °F $\pm$ 10 (621 °C $\pm$ 6)

- 3.4.2.2.1 Tensile Properties:

TABLE II

Condition	Specimen Orientation	Tensile Strength ksi, min	Yield Strength at 0.2% Offset ksi, min	Elongation in 4D %, min	Reduction of Area %, min
H950	Longitudinal	220	205	10	45
	Transverse	220	205	10	35
H1000	Longitudinal	205	190	10	50
	Transverse	205	190	10	40
H1025	Longitudinal	185	175	11	50
	Transverse	185	175	11	45
H1050	Longitudinal	175	165	12	50
	Transverse	175	165	12	45
H1100	Longitudinal	150	135	14	50
	Transverse	150	135	14	50
H1150	Longitudinal	135	90	14	50
	Transverse	135	90	14	50

TABLE II (SI)

Condition	Specimen Orientation	Tensile Strength MPa, min	Yield Strength at 0.2% Offset MPa, min	Elongation in 4D %, min	Reduction of Area %, min
H950	Longitudinal	1517	1413	10	45
	Transverse	1517	1413	10	35
H1000	Longitudinal	1413	1310	10	60
	Transverse	1413	1310	10	40
H1025	Longitudinal	1276	1207	11	50
	Transverse	1276	1207	11	45
H1050	Longitudinal	1207	1138	12	50
	Transverse	1207	1138	12	45
H1100	Longitudinal	1034	931	14	50
	Transverse	1034	931	14	50
H1150	Longitudinal	931	621	14	50
	Transverse	931	621	14	50

- 3.4.2.2.1.1 Longitudinal tensile property requirements apply to specimens taken in the longitudinal direction from bars, wire, and extrusions, to specimens taken from forgings with axis of specimen in the area of gage length varying not more than 15 degrees from parallel to the forging flow lines, and to specimens taken in the circumferential direction from flash welded rings.
- 3.4.2.2.1.2 Transverse tensile property requirements apply to specimens taken approximately perpendicular to the longitudinal direction of bars and extrusions, to specimens taken from forgings with axis of specimen in the area of gage length varying not more than 15 degrees from perpendicular to the forging flow lines, and to specimens taken in either the radial or axial direction from flash welded rings.
- 3.4.2.2.1.3 Transverse tensile property requirements apply only to products from which a test specimen not less than 2-1/2 inches (63.5 mm) long or 1/2 inch (12.7 mm) x 1/2 inch (12.7 mm) cross-section can be taken.
- 3.4.2.2.1.4 Products tested in the transverse direction need not be tested in the longitudinal direction.
- 3.4.2.2.1.5 Tensile property requirements for product over 12 inches (305 mm) in nominal diameter or maximum cross-section dimension shall be as agreed upon by purchaser and vendor.
- 3.4.2.2.2 Hardness: Should be not lower than shown in Table III, or equivalent, for the corresponding precipitation heat treated condition but the product shall not be rejected on the basis of hardness if the applicable tensile property requirements are met.

TABLE III

Condition	Hardness
H950	45 HRC
H1000	43 HRC
H1025	41 HRC
H1050	40 HRC
H1100	34 HRC
H1150	30 HRC

- 3.4.3 Forging Stock: When a sample of stock is forged to a test coupon and heat treated as in 3.3 and 3.4.2.2, specimens taken from the heat treated coupon shall conform to the requirements of 3.4.2.2.1 and 3.4.2.2.2. If specimens taken from the stock after heat treatment as in 3.3 and 3.4.2.2 conform to the requirements of 3.4.2.2.1 and 3.4.2.2.2, the tests shall be accepted as equivalent to tests of a forged coupon.
- 3.4.4 Stock for Flash Welded Rings or Extrusions: A sample of stock heat treated as in 3.3 and 3.4.2.2 shall conform to the requirements of 3.4.2.2.1 and 3.4.2.2.2.

3.5 Quality:

- 3.5.1 Steel shall be premium aircraft-quality conforming to AMS 2300 or MAM 2300; it shall be multiple melted using vacuum induction practice followed by either vacuum or, when specified, electroslag, consumable electrode remelting.
- 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.

3.6 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 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 and wire shall conform to all applicable requirements of AMS 2241 or MAM 2241. Tolerances for extrusions shall be as specified on the extrusion drawing.

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. 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 for the following requirements are acceptance tests and shall be performed on each heat or lot as applicable.

4.2.1.1 Composition (3.1), macrostructure (3.4.1.1), and grain size (3.4.2.1.3) of each heat.

4.2.1.2 Hardness (3.4.2.1.2) of each lot of bars, forgings, flash welded rings, and extrusions as solution heat-treated.

4.2.1.3 Tensile strength (3.4.2.1.1) of each lot of wire as solution heat-treated.

4.2.1.4 Tensile properties (3.4.2.2.1) and hardness (3.4.2.2.2) of each lot of bars, wire, forgings, flash welded rings, and extrusions after precipitation heat treatment.

4.2.1.5 Tolerances (3.7) of bars, wire, and extrusions.