AEROSPACE MATERIAL SPECIFICATION

AMS5629	REV. F

Issued 1968-11
Reaffirmed 2006-10
Revised 2014-02

Superseding AMS5629E

Steel, Corrosion-Resistant, Bars, Wire, Forgings, Rings, and Extrusions
13Cr - 8.0Ni - 2.2Mo - 1.1Al
Vacuum Induction Plus Consumable Electrode Melted
Solution Heat Treated, Precipitation Hardenable
(Composition similar to UNS S13800)

RATIONALE

AMS5629F identifies a new procedure for ordering bars in the precipitation heat treated condition (1.1.1, 8.5), adds classes for total delta ferrite allowed (1.3.2), includes a restriction on bar being cut from plate (3.3.1.2.1), revises heat treatment (3.4), adds a default criteria for product over 81 square inches (3.5.1.1), revises microstructure requirements (3.5.1.2), clarifies thickness of bars and altered heat treatment tolerance to agree with AMS2759/3 (3.5.2.1.3, 3.5.2.2), removed the requirement for hardness testing after precipitation heat treatment (3.5.2.2.2, 4.2.1.4, 4.4.2), clarifies tensile orientation for transverse tests (3.5.2.2.1.3), revises reports (4.4.2, 4.4.5, & 4.4.7) and ordering data (8.8).

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.

1.1.1 For purchase of solution treated and aged product, use the applicable AMS slash specification (See 8.5). If a slash sheet description is not specified, solution annealed material shall be supplied. A specific example of a slash specification is:

AMS5629/H1000 – Precipitation Hardened to H1000 condition

1.2 Application

These products have been used typically 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, 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.

1.3 Classification

Steels covered by this specification are classified as follows:

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AMS5629F

1.3.1 Melting Practice

Type 1 - Steel multiple melted using vacuum-arc consumable electrode process in the final melt cycle

Type 2 - Steel multiple melted using electroslag consumable electrode process in the final melt cycle

1.3.1.1 When a type is not specified, Type I shall be supplied.

1.3.2 Maximum Delta Ferrite Content

Class A – 0.5% max., free ferrite

Class B – 1.0% max., free ferrite

Class C – 2.0% max., free ferrite

1.3.2.1 When no class is specified, any class may be supplied.

2. APPLICABLE DOCUMENTS

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AMS2241 Tolerances, Corrosion and Heat-Resistant Steel, Iron Alloy, Titanium, and Titanium Alloy Bars and Wire

AMS2248 Chemical Check Analysis Limits, Corrosion and Heat-Resistant Steels and Alloys, Maraging and Other Highly-Alloyed Steels, and Iron Alloys

AMS2300 Steel Cleanliness, Premium Aircraft-Quality, Magnetic Particle Inspection Procedure

AMS2315 Determination of Delta Ferrite Content

AMS2371 Quality Assurance Sampling and Testing, Corrosion and Heat-Resistant Steels and Alloys, Wrought Products and Forging Stock

AMS2374 Quality Assurance Sampling and Testing, Corrosion and Heat-Resistant Steel and Alloy Forgings

AMS2750 Pyrometry

AMS2806 Identification, Bars, Wire, Mechanical Tubing, and Extrusions, Carbon and Alloy Steels and Corrosion and Heat-Resistant Steels and Alloys

AMS2808 Identification, Forgings

AMS7490 Rings, Flash Welded, Corrosion and Heat-Resistant Austenitic Steels, Austenitic-Type Iron, Nickel, or Cobalt Alloys, or Precipitation-Hardenable Alloys

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

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

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

3. TECHNICAL REQUIREMENTS

3.1 Composition

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 purchaser:

TABLE 1 - COMPOSITION

Element	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 applicable requirements of AMS2248 except that no variation over maximum is permitted for nitrogen.

3.2 Melting Practice

Shall be multiple melted using vacuum induction practice followed by either vacuum or, when specified, electroslag consumable electrode remelting (See 1.3).

3.3 Condition

The product shall be supplied in the following condition:

3.3.1 Bars and Wire

3.3.1.1 Rounds

Centerless ground or turned after solution heat treatment.

3.3.1.2 Hexagons, Squares, and Flats

Cold finished, solution heat treated, straightened, and descaled, or hot finished, solution heat treated, straightened, and descaled, as ordered.

3.3.1.2.1 Bar shall not be cut from plate (Also see 4.4.5).

3.3.2 Forgings and Flash Welded Rings

Solution heat treated and descaled.

3.3.2.1 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 AMS7490.

3.3.3 Extrusions

Solution heat treated, straightened, and descaled.

3.3.4 Stock for Forging, Flash Welded Rings, or Extrusion

As ordered by the forging, flash welded ring, or extrusion manufacturer.

3.4 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 a time commensurate with section thickness, heating equipment, and procedure used, and cooling to below 60 °F (16 °C). Pyrometry shall be in accordance with AMS2750.

3.5 Properties

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

3.5.1 All Products

3.5.1.1 Macrostructure

Visual examination of transverse full cross-sections 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 cm^2) and under in nominal cross-sectional area shall be no worse than the macrographs of ASTM A 604 shown in Table 2. For product greater than 81 square inches (523 cm^2) in cross sectional area, the macrostructure shall meet the requirements for product under 81 square inches (523 cm^2) and under in nominal cross-sectional area or the criteria shall be approved by the cognizant engineering authority.

TABLE 2 - MACROSTRUCTURE LIMITS

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

3.5.1.2 Microstructure

The product shall contain not more than the percent free ferrite as specified in appropriate class (See 1.3.2). The amount of free ferrite shall be determined in accordance with AMS2315.

3.5.2 Bars, Wire, Forgings, Flash Welded Rings, and Extrusions

3.5.2.1 As Solution Treated

3.5.2.1.1 Tensile Strength

Wire shall have tensile strength not higher than 175 ksi (1207 MPa) or equivalent hardness (See 8.2).

3.5.2.1.2 Hardness

3.5.2.1.2.1 Bars

Shall be not higher than 363 HB or equivalent (See 8.3), determined at mid-radius or quarter thickness.

3.5.2.1.2.2 Forgings, Flash Welded Rings, and Extrusions

Shall be not higher than 363 HB, or equivalent (See 8.3).

3.5.2.1.3 Average Grain Size

Shall be ASTM No. 5 or finer for product up to 3.00 inches (76.2 mm) in nominal diameter, thickness or for hexagons, least distance between parallel sides and shall be ASTM No. 4 or finer for product 3.00 inches (76.2 mm) and over in nominal diameter, thickness or for hexagons, least distance between parallel sides, determined in accordance with ASTM E 112 (See 8.4).

3.5.2.2 After Precipitation Heat Treatment

The solution heat treated product 12 inches (305 mm) and under in nominal diameter, thickness or for hexagons, least distance between parallel sides ,when precipitation heat treated for 4 hours + 30 minutes/– 0 minutes to a particular condition at the temperatures shown in Table 2 and cooled at a rate equivalent to air cooling shall have the properties specified in 3.5.2.2.1 for that particular condition. Tensile tests need be made in only the H1000 precipitation heat treated condition unless purchaser specifies a different heat treated condition.

TABLE 3 - PRECIPITATION HARDENING CONDITIONS

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

3.5.2.2.1 Tensile Properties

Shall be as shown in Table 4.

TABLE 4A - MINIMUM TENSILE PROPERTIES AFTER PRECIPITATION HEAT TREATMENT, INCH/POUND UNITS

Condition	Specimen Orientation	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 4D %	Reduction of Area %
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 4B - MINIMUM TENSILE PROPERTIES AFTER PRECIPITATION HEAT TREATMENT, SI UNITS

Condition	Specimen Orientation	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 4D %	Reduction of Area %
H950	Longitudinal	1517	1413	10	45
	Transverse	1517	1413	10	35
H1000	Longitudinal	1413	1310	10	50
	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

3.5.2.2.1.1 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.

3.5.2.2.1.2 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.

3.5.2.2.1.3 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 take. If the cross-sectional dimensions of the product permit, the transverse testing shall be of the short-transverse (ST) direction; otherwise, the orientation shall be in the long transverse (LT) direction.

Products tested in the transverse direction need not be tested in the longitudinal direction.

3.5.3 Forging Stock

When a sample of stock is forged to a test coupon and heat treated as in 3.4, specimens taken from the heat treated coupon shall conform to the requirements of 3.5.2.2.1. If specimens taken from the stock after heat treatment as in 3.4 and 3.5.2.2 conform to the requirements of 3.5.2.2.1, the tests shall be accepted as equivalent to tests of a forged coupon.

3.5.4 Stock for Flash Welded Rings or Extrusion

A sample of stock heat treated as in 3.4 and 3.5.2.2 shall conform to the requirements of 3.5.2.2.1 and 3.5.2.2.2.

3.6 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.

3.6.1 Steel shall be premium aircraft-quality conforming to AMS2300.

3.7 Tolerances

Bars and wire shall conform to all applicable requirements of AMS2241. 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 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

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 (3.5.1.1), and delta ferrite content (Class A & B only) (3.5.1.2) of each heat.

4.2.1.2 Hardness (3.5.2.1.2) as solution heat-treated, and average grain size (3.5.2.1.3 and 4.3.3) of each lot of bars, forgings, flash welded rings, and extrusions.

4.2.1.3 Tensile strength (3.5.2.1.1) of each lot of wire as solution heat-treated.

4.2.1.4 Tensile properties (3.5.2.2.1) of each lot of bars, wire, forgings, flash welded rings, and extrusions after precipitation heat treatment to hardened condition (H1000 or as specified by purchaser) (3.5.2.2).

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

4.2.1.6 Ability of forging stock (3.5.3) and stock for flash welded rings or extruding (3.5.4) to develop required properties (See 4.4.7).

4.2.2 Periodic Tests

Microstructure (3.5.1.2), tensile properties (3.5.2.2.1) and hardness (3.5.2.2.2) of all product forms in other than the specified precipitation hardened condition, and frequency-severity cleanliness rating (3.6.1) 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

Shall be as follows:

4.3.1 Bars, Wire, Flash Welded Rings, Extrusions, and Stock for Forging, Flash Welded Rings or Extrusion

In accordance with AMS2371.

4.3.2 Forgings

In accordance with AMS2374.

4.3.3 Samples for average grain size (3.5.2.1.3) may be hardened to any of the conditions of Table 3 to better define the grain boundaries.

4.4 Reports

The vendor of the product shall furnish with each shipment a report showing the vendor's name and country where the metal was melted (e.g., final melt in the case of metal processed by multiple melting operations) and the following results of tests and relevant information:

4.4.1 For each heat:

Composition
Macrostructure.

4.4.2 For each lot of bars, wire, flash welded rings, extrusions, and forgings:

If wire, tensile strength as solution heat treated
If product form other than wire, hardness and average grain size (See 4.3.3) as solution heat treated
All product forms, tensile properties after precipitation heat treatment

4.4.3 A statement that the product is in the solution heat treated condition, and that it conforms to the other technical requirements.

4.4.4 Purchase order number
Heat and lot numbers
AMS5629F
Size
Quantity.

4.4.5 If the size being shipped is different from the nominal metallurgically-worked cross-sectional size, the size of the larger product and details of how the shipped size was extracted from the larger product shall be reported (See 3.3.1.2.1).

4.4.6 If forgings are supplied, the size and melt source of stock used to make the forgings.

4.4.7 The vendor of stock for forging, flash welded rings, or extrusions shall furnish with each shipment a report showing the vendor's name and country where the metal was melted (e.g., final melt in the case of metal processed by multiple melting operations), composition, macrostructure, and ability to develop required properties of each heat. This report shall include the purchase order number, heat number, AMS5629F, product form, size, and quantity.

4.5 Resampling and Retesting

Shall be as follows:

4.5.1 Bars, Wire, Flash Welded Rings, Extrusions, and Stock for Forging, Flash Welded Rings or Extrusion

In accordance with AMS2371.

4.5.2 Forgings

In accordance with AMS2374.