



AEROSPACE MATERIAL SPECIFICATION	AMS5629™	REV. J
	Issued 1968-11 Reaffirmed 2006-10 Revised 2021-04	
Superseding AMS5629H		
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

AMS5629J prohibits unauthorized exceptions (3.9, 4.4.4, 5.2.1.1), revises composition (3.1) to replace obsolete chemical analysis standards, updates bar condition (3.3.1), updates heat treatment (3.4) adds strain rate control (3.5.2.2.1.1), adds machining allowance (3.6.2, 8.7), and results from a Five-Year Review and update of this specification.

1. SCOPE

1.1 Form

This specification covers a premium aircraft-quality corrosion-resistant steel in the form of bars, wire, forgings, flash welded rings, and extrusions up to 12 inches (305 mm) in nominal diameter, or least distance between parallel sides in the solution heat treated condition (see 8.4), and stock of any size for forging, flash welded rings, or extrusion (see 8.8).

1.1.1 For purchase of solution treated and aged product, use the applicable AMS slash specification (see 8.4). 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.

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1.3 Classification

Product covered by this specification is classified as follows:

1.3.1 Melting Practice

Type 1 - Steel multiple melted using vacuum consumable electrode remelting.

Type 2 - Steel multiple melted using electroslag remelting.

1.3.1.1 When a type is not specified, Type 1 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 +1 724-776-4970 (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
AMS2761	Heat Treatment of Steel Raw Materials
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
- ARP1917 Clarification of Terms Used in Aerospace Metals Specifications
- AS1182 Standard Stock Removal Allowance Aircraft-Quality and Premium Aircraft-Quality Steel Bars and Mechanical Tubing
- AS6279 Industry Standard Practices for Production, Distribution, and Procurement of Metal Stock

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 A370 Mechanical Testing of Steel Products
- ASTM A604 Macroetch Testing of Consumable Electrode Remelted Steel Bars and Billets
- ASTM A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products
- ASTM E112 Determining Average Grain Size
- ASTM E140 Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, Scleroscope Hardness, and Leeb Hardness

3. TECHNICAL REQUIREMENTS

3.1 Composition

Shall conform to the percentages by weight shown in Table 1, determined in accordance with ASTM A751, 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

Product shall be multiple melted using vacuum induction primary melting followed by either vacuum consumable electrode remelting for Type 1 or, when specified, electroslag remelting for Type 2.

3.3 Condition

The product shall be supplied in the following condition:

3.3.1 Bars and Wire

Solution heat treated and descaled, to hot finished or cold finished tolerances (see 3.7).

3.3.1.1.1 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 in accordance with AMS2761, by heating to 1700 °F ± 25 °F (927 °C ± 14 °C), holding at heat for a time commensurate with section thickness, heating equipment, and procedure used, and cooling to below 60 °F (16 °C).

3.5 Properties

Product, 12.0 inches (305 mm) and under in nominal diameter or least distance between parallel sides, shall conform to the following requirements; hardness and tensile testing shall be performed in accordance with ASTM A370.

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 A604, 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 macrographs of ASTM A604 shown in Table 2. For product greater than 81 square inches (523 cm²) in cross sectional area, the macrostructure shall meet the requirements for product under 81 square inches (523 cm²) 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 no 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 HBW 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 HBW, 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, 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, or least distance between parallel sides, determined in accordance with ASTM E112.

3.5.2.2 After Precipitation Heat Treatment

The solution heat treated product 12 inches (305 mm) and under in nominal diameter, or least distance between parallel sides, when precipitation heat treated to a particular condition at the times and temperatures shown in Table 3 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	Time
H950	950 °F ± 10 °F (510 °C ± 6 °C)	4 hours + 30 / -0 minutes
H1000	1000 °F ± 10 °F (538 °C ± 6 °C)	4 hours + 30 / -0 minutes
H1025	1025 °F ± 10 °F (552 °C ± 6 °C)	4 hours + 30 / -0 minutes
H1050	1050 °F ± 10 °F (566 °C ± 6 °C)	4 hours + 30 / -0 minutes
H1100	1100 °F ± 10 °F (593 °C ± 6 °C)	4 hours + 30 / -0 minutes
H1150	1150 °F ± 10 °F (621 °C ± 6 °C)	4 hours + 30 / -0 minutes

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 Unless otherwise specified, the strain rate shall be set at 0.005 in/in/min (0.005 mm/mm/min) and maintained within a tolerance of ± 0.002 in/in/min (0.002 mm/mm/min) through 0.2% offset yield strain. After the yield strain, the speed of the testing machine shall be set between 0.05 and 0.5 in/in (0.05 and 0.5 mm/mm) of the length of the reduced section (or distance between the grips for specimens not having a reduced section) per minute. Alternatively, an extensometer and strain rate indicator may be used to set the strain rate between 0.05 and 0.5 in/in/min (0.05 and 0.5 mm/mm/min).

3.5.2.2.1.2 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.

3.5.2.2.1.3 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.

3.5.2.2.1.4 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. 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.

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

3.5.2.2.2 Mechanical property requirements for product outside of the range covered by 1.1 shall be agreed upon between purchaser and producer.

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.

3.6 Quality

The product, as received by purchaser, shall be uniform in quality and condition, sound, consistent with the type of steel involved, 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.

3.6.2 Bars shall be free from seams, laps, tears, and cracks after removal of the standard stock removal allowance in accordance with AS1182. Superficial surface imperfections such as scratches or pits shall not exceed applicable tolerances.

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.

3.8 Production, distribution, and procurement of metal stock shall comply with AS6279. After production and certification to the specified requirements, cutting in a plane perpendicular to the short transverse dimension is permitted.

3.9 Exceptions

Any exception shall be authorized by purchaser and reported as in 4.4.4.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The producer of the product shall supply all samples for producer'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 and 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), and tensile properties (3.5.2.2.1) 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 producer 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 producer of the product shall furnish with each shipment a report showing the producer'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 When material produced to this specification has exceptions authorized by purchaser taken to the technical requirements listed in Section 3 (see 5.2.1.1), the report shall contain a statement "This material is certified as AMS5629J(EXC) because of the following exceptions:" and the specific exceptions shall be listed.