



AEROSPACE MATERIAL SPECIFICATION

AMS5622™

REV. G

Issued 1969-05
Reaffirmed 2004-12
Revised 2020-08

Superseding AMS5622F

Steel, Corrosion-Resistant, Bars, Wire, Forgings, Mechanical Tubing, and Rings
16Cr - 4.0Ni - 0.30Cb - 4.0Cu
Solution Heat Treated, Precipitation Hardenable
Consumable Electrode Remelted
(Composition similar to UNS S17400)

RATIONALE

AMS5622G results from a Five-Year Review and update of this specification with changes to Title, Composition to update applicable analysis standards (3.1), Melting Practice (3.2), Condition (3.3), Precipitation heat treatments (Table 3), added tensile test strain rates (3.5.2.2.1.1), added product outside of size range (3.5.2.3), prohibits unauthorized exceptions (3.8 and 4.4.6), Reports (4.4), and Identification (5.2.1.1).

1. SCOPE

1.1 Form

This specification covers a premium aircraft-quality corrosion-resistant steel in the form of bars, wire, forgings, mechanical tubing, flash welded rings up to 8.0 inches (203 mm) in 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 heading (see 8.8).

1.1.1 For purchases 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:

AMS5622/H1025 Precipitation Hardened to H1025 Condition

1.2 Application

These products have been used typically for parts requiring corrosion resistance and high strength up to 600 °F (316 °C), but usage is not limited to such applications.

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

1.2.2 For applications, such as bolting, where stress-corrosion is a possibility, the product should be precipitation heat treated for not less than 4 hours at the highest temperature compatible with the strength requirements but in no case lower than 1025 °F (552 °C).

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1.3 Classification

Product covered by this specification is classified as follows:

Type 1- Steel multiple melted using vacuum consumable electrode in the final melt.

Type 2- Steel multiple melted using electroslag process in the final melt.

1.3.1 Unless a specific type is ordered, either type 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
AMS2243	Tolerances, Corrosion and Heat-Resistant Steel Tubing
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
AMS-H-6875	Heat Treatment of Steel Raw Materials
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

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 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 by wet chemical methods in accordance with ASTM A751, by spectrochemical methods, or by other analytical methods acceptable to purchaser.

Table 1 - Composition

Element	Min	Max
Carbon	--	0.07
Manganese	--	1.00
Silicon	--	1.00
Phosphorus	--	0.025
Sulfur	--	0.015
Chromium	15.00	17.50
Nickel	3.00	5.00
Columbium	5xC	0.45
Copper	3.00	5.00
Molybdenum	--	0.50

3.1.1 Check Analysis

Composition variations shall meet the applicable requirements of AMS2248.

3.2 Melting Practice

Product shall be multiple melted using vacuum consumable electrode remelting for Type 1 or using electroslag remelting for Type 2.

3.3 Condition

The product shall be supplied in the following condition:

3.3.1 Bars and Wire

Hot finished or cold finished, solution heat treated, and descaled.

3.3.1.1 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 Mechanical Tubing

Hot finished or cold finished, solution heat treated, and descaled.

3.3.4 Stock for Forging, Flash Welded Rings, or Heading

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

3.4 Heat Treatment

Bars, wire, forgings, mechanical tubing, and flash welded rings shall be solution heat treated in accordance with AMS-H-6875 by heating to 1900 °F ± 25 °F (1038 °C ± 14 °C), holding at heat for a time commensurate with section thickness, heating equipment, and procedure used, and cooling as required to below 90 °F (32 °C). Pyrometry shall be in accordance with AMS2750.

3.4.1 Flash welded rings may be given a homogenization heat treatment prior to solution heat treatment when permitted by purchaser. When such treatment is permitted, the rings shall be heated to 2100 °F ± 25 °F (1149 °C ± 14 °C), held at heat for not less than 90 minutes, and cooled at a rate equivalent to, or faster than, an air cool.

3.5 Properties

Product, 8.0 inches (203 mm) and under in nominal diameter or least distance between parallel sides, shall conform to the following requirements; tensile and hardness testing shall be performed in accordance with ASTM A370:

3.5.1 All Products

Shall be as follows:

3.5.1.1 Macrostructure

Visual examination of full cross section transverse sections from bars, billets, tube rounds, and stock for forging, flash welded rings, or heading, etched in hot hydrochloric acid in accordance with ASTM A604, shall show no pipe or cracks. Porosity, segregation, inclusions, and other imperfections shall be no worse than the macrographs of ASTM A604 shown in Table 2.

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 5% free ferrite, determined in accordance with AMS2315.

3.5.2 Bars, Wire, Forgings, Mechanical Tubing, and Flash Welded Rings

3.5.2.1 As Solution Heat Treated

3.5.2.1.1 Hardness

3.5.2.1.1.1 Bars

Not higher than 363 HB, or equivalent (see 8.2), determined at approximately mid-radius or quarter-thickness.

3.5.2.1.1.2 Forgings, Mechanical Tubing, and Flash Welded Rings

Not higher than 363 HB, or equivalent (see 8.2).

3.5.2.1.2 Tensile Properties

Wire shall have tensile strength not higher than 175 ksi (1207 MPa), or equivalent hardness (see 8.3).

3.5.2.2 After Precipitation Heat Treatment

The solution heat treated product up to 8.0 inches (203 mm) in diameter or least distance between parallel sides, precipitation heat treated to a particular condition in accordance with the corresponding temperatures and times shown in Table 3 and cooled in air, shall have the properties shown in 3.5.2.2.1 for that particular condition. Tensile and hardness tests shall be made in only the H900 precipitation heat treated condition, unless purchaser specifies another heat treated testing condition.

Table 3 - Precipitation heat treatments

Condition	Temperature	Time
H900	900 °F ± 10 °F (482 °C ± 6 °C)	1 hour + 15/-0 minutes
H925	925 °F ± 10 °F (496 °C ± 6 °C)	4 hours + 30/-0 minutes
H1025	1025 °F ± 10 °F (552 °C ± 6 °C)	4 hours + 30/-0 minutes
H1075	1075 °F ± 10 °F (579 °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 Longitudinal and Transverse Tensile Properties

Shall be as specified in Table 4.

Table 4A - Minimum tensile strength properties, inch/pound units

Condition	Specimen Orientation	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 2 Inches or 4D %	Reduction of Area %
H900	Longitudinal	190	170	10	35
	Transverse	190	170	5	15
H925	Longitudinal	170	155	10	38
	Transverse	170	155	6	20
H1025	Longitudinal	155	145	12	45
	Transverse	155	145	7	27
H1075	Longitudinal	145	125	13	45
	Transverse	145	125	8	28
H1100	Longitudinal	140	115	14	45
	Transverse	140	115	9	29
H1150	Longitudinal	135	105	16	50
	Transverse	135	105	10	30

Table 4B - Minimum tensile strength properties, SI units

Condition	Specimen Orientation	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 50.8 Millimeters or 4D %	Reduction of Area %
H900	Longitudinal	1310	1172	10	35
	Transverse	1310	1172	5	15
H925	Longitudinal	1172	1069	10	38
	Transverse	1172	1069	6	20
H1025	Longitudinal	1069	1000	12	45
	Transverse	1069	1000	7	27
H1075	Longitudinal	1000	862	13	45
	Transverse	1000	862	8	28
H1100	Longitudinal	965	793	14	45
	Transverse	965	793	9	29
H1150	Longitudinal	931	724	16	50
	Transverse	931	724	10	30

- 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 min. 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 the radial 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 \times 1/2 inch (12.7 \times 12.7 mm) cross-section can be obtained. If cross-sectional dimensions of the product permit, the transverse testing shall be of the short-transverse (ST) direction; otherwise, the orientation shall be long transverse (LT).
- 3.5.2.2.1.5 Products tested in the transverse direction need not be tested in the longitudinal direction.
- 3.5.2.3 Mechanical properties for product outside 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 and 3.5.2.2, 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 Heading

Specimens taken from the stock after heat treatment 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, 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 Grain flow of die forgings, except in areas which contain flash-line end grain, shall follow the general contour of the forgings showing no evidence of reentrant grain flow.

3.7 Tolerances

Shall conform to all applicable requirements of the following:

3.7.1 Bars and Wire

In accordance with AMS2241.

3.7.2 Mechanical Tubing

In accordance with AMS2243.

3.8 Exceptions

Any exceptions shall be authorized by purchaser and reported as in 4.4.6.

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 (see 3.1) and macrostructure rating (see 3.5.1.1) of each heat.

4.2.1.2 Hardness (see 3.5.2.1.1) of each lot of bars, forgings, mechanical tubing, and flash welded rings as solution heat treated.

4.2.1.3 Tensile strength of each lot of wire (see 3.5.2.1.2) as solution heat treated.

4.2.1.4 Tensile properties (see 3.5.2.2.1) of each lot of bars, wire, forgings, mechanical tubing, and flash welded rings after precipitation heat treatment at $900\text{ }^{\circ}\text{F} \pm 10\text{ }^{\circ}\text{F}$ ($482\text{ }^{\circ}\text{C} \pm 6\text{ }^{\circ}\text{C}$) unless purchaser specifies another precipitation heat treatment temperature.

4.2.1.5 Tolerances (see 3.7) of bars, wire, and mechanical tubing.

4.2.2 Periodic Tests

The ability of forging stock (see 3.5.3) and of stock for flash welded rings or heading (see 3.5.4) to develop required properties, microstructure (see 3.5.1.2), frequency-severity cleanliness rating (see 3.6.1), and grain flow of die forgings (see 3.6.2) 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, Mechanical Tubing, Flash Welded Rings, and Stock for Forging, Flash Welded Rings, or Heading

In accordance with AMS2371.

4.3.2 Forgings

In accordance with AMS2374.

4.4 Reports

The producer of bars, wire, forgings, mechanical tubing, and flash welded rings 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:

Hardness solution heat treated
If wire, tensile strength solution heat treated
Tensile properties and hardness 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.

Purchase order number
Heat and lot numbers
AMS5622G
Product form
Size
Quantity

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

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.

4.4.6 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 AMS5622G(EXC) because of the following exceptions:" and the specific exceptions shall be listed.

4.4.7 The producer of stock for forging, flash welded rings, or extrusions 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 composition and macrostructure. This report shall include the purchase order number, heat number, AMS5622G, product form, and quantity.