AEROSPACE MATERIAL SPECIFICATION

AMS5643™	REV. W

Issued 1951-10
Reaffirmed 2007-08
Revised 2021-12

Superseding AMS5643V

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

RATIONALE

AMS5643W prohibits unauthorized exceptions (3.8, 3.4.3.2.1,8.9, 8.10), revises composition (3.1) to replace obsolete chemical analysis standards, updates finish categories (3.2.1.1, 8.10), updates heat treatment specification (3.3.1), deletes requirement for CEO approval of heat treatment test (3.4.3.2), adds strain rate for tensile tests (3.4.3.2.1.1), updates requirements for product stock testing (3.4.3.2.2, 3.4.3.2.3), adds quality requirements of AS1182 (3.5.2, 8.8), changes microstructure from acceptance to periodic (4.2.1.3, 4.2.2, 4.4.1), and results from a Five-Year Review and update of this specification.

1. SCOPE

1.1 Form

This specification covers a corrosion-resistant steel in the form of bars, wire, forgings, mechanical tubing, flash welded rings in the solution heat treated condition up to 8.0 inches (203 mm) in diameter or least distance between parallel sides, and stock of any size for forging, flash welded rings, or heading (see 8.4).

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:

AMS5643/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 susceptible 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).

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**

For more information on this standard, visit
https://www.sae.org/standards/content/AMS5643W

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
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
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
AMS5643/H1025	Steel, Corrosion-Resistant, Bars, Wire, Forgings, Tubing and Rings, 16Cr – 4.0Ni - 0.30Cb (Nb) – 4.0Cu, Solution and Precipitation Heat Treated (H1025)
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	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 A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products

ASTM E340 Macroetching Metals and Alloys

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	--	0.07
Manganese	--	1.00
Silicon	--	1.00
Phosphorus	--	0.040
Sulfur	--	0.030
Chromium	15.00	17.50
Nickel	3.00	5.00
Columbium (Niobium)	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 Condition

The product shall be supplied in the following condition:

3.2.1 Bars and Wire

3.2.1.1 Rounds

Solution heat treated and descaled Bars 2.00 inch (50.8mm) and under in nominal diameter shall be cold finished (see 3.5.2). Bars over 2.0 inches (50.8 mm) in nominal diameter shall be hot or cold finished (see 3.5.2). When a specific finish is required, it must be ordered (see 8.10).

3.2.1.2 Hexagons

Cold drawn, solution heat treated, and descaled.

3.2.1.3 Squares and Flats

Hot finished, solution heat treated, and descaled.

3.2.1.4 Bar shall not be cut from plate (see also 4.4.6).

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 AMS7490.

3.2.3 Mechanical Tubing

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

3.2.4 Stock for Forging, Flash Welded Rings, or Heading

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

3.3 Solution Heat Treatment

3.3.1 Bars, wire, forgings, flash welded rings, and extrusions shall be solution heat treated in accordance with AMS2761 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).

3.3.2 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.

3.4 Properties

The product shall conform to the following requirements; tensile and hardness testing shall be performed in accordance with ASTM A370:

3.4.1 Macrostructure

Visual examination of transverse sections etched in hot hydrochloric acid in accordance with ASTM E340 shall show no pipe or cracks. Porosity, segregation, inclusions, and other imperfections may be specified by macrostructure standards established by the cognizant engineering organization.

3.4.2 Microstructure

The product shall contain no more than 5% ferrite, determined in accordance with AMS2315.

3.4.3 Mechanical Properties

3.4.3.1 As Solution Heat Treated

Hardness shall conform to Table 2.

3.4.3.2 Response to Precipitation Heat Treatment

Samples from 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 2, and cooled in air, shall have the properties shown in Table 2 for that particular condition. Tensile tests and hardness tests shall be performed in the H900 precipitation heat treated condition, unless purchaser specifies another heat treated condition.

3.4.3.2.1 Mechanical property requirements for product outside of the range covered by 1.1 shall be agreed upon between purchaser and producer and reported per 4.4.7.

Table 2 - Hardness and minimum tensile properties

Condition	Tensile Strength ksi (MPa)	Yield Strength at 0.2% Offset ksi (MPa)	Elongation in 4D %	Reduction of Area %	Hardness (1) HB	Hardness (1) HRC	Temperature/ Time °F (°C)/Hours
H900	190 (1310)	170 (1172)	10	40 (2)	388-444	40-47	900 (482)/1 (3)
H925	170 (1172)	155 (1069)	10	44 (2)	375-429	38-45	925 (496)/4 (4)
H1025	155 (1069)	145 (1000)	12	45	331-401	34-42	1025 (552)/4 (4)
H1075	145 (1000)	125 (862)	13	45	311-375	31-38	1075 (579)/4 (4)
H1100	140 (965)	115 (793)	14	45	302-363	30-37	1100 (593)/4 (4)
H1150	135 (931)	105 (724)	16	50	277-352	28-37	1150 (621)/4 (4)
Solution Heat Treated					363 (5)	39 (5)	1900 (1038) (6)

NOTES:
1. Hardness shall not be the basis for rejection if tensile properties are acceptable, determined on specimens taken from the same sample as that with nonconforming hardness or from another sample with similar nonconforming hardness.
2. For sizes over 3 inches (76 mm), 35% for H900 condition and 38% for H925 condition.
3. Temperature tolerance ±10 °F (±6 °C); time tolerance +15 / -0 minutes; cool in air.
4. Temperature tolerance ±10 °F (±6 °C); time tolerance +30 / -0 minutes; cool in air.
5. Maximum; alternate for wire: 175 ksi (1207 MPa) or equivalent hardness (see 8.3).
6. Temperature tolerance ±25 °F (±14 °C); time commensurate with thickness, heating equipment, and procedure used, and cooling as required to below 90 °F (32 °C).

3.4.3.2.1.1 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).

3.4.3.2.2 Forging Stock

Specimens extracted from a forged test coupon and heat treated as in 3.3 and 3.4.3.2 shall conform to the requirements of Table 2. If specimens extracted directly from the stock and heat treated as in 3.3 and 3.4.3.2 conform to the requirements of Table 2, the test results shall be accepted in lieu of tests of a forged coupon.

3.4.3.2.3 Stock for Flash Welded Rings or Extruding

A sample of stock heat treated as in 3.3 and 3.4.3.2 shall conform to the requirements of Table 2.

3.5 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.

3.5.1 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.

3.5.2 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.

3.6 Tolerances

Shall conform to all applicable requirements of the following:

3.6.1 Bars and Wire

In accordance with AMS2241.

3.6.2 Mechanical Tubing

In accordance with AMS2243.

3.7 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.

3.8 Exceptions

Any exception shall be authorized by purchaser and reported as in 4.4.7.

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) and macrostructure (3.4.1) of each heat.

4.2.1.2 Hardness (Table 2) of each lot of bars, wire, forgings, mechanical tubing, and flash welded rings as solution heat treated.

4.2.1.3 Mechanical properties (Table 2) of each lot of bars, wire, forgings, mechanical tubing, and flash welded rings after precipitation heat treatment to the specified condition (3.4.3.2).

4.2.1.4 Tolerances (3.6) of bars, wire, and mechanical tubing.

4.2.2 Periodic Tests

Microstructure (3.4.2), the ability of forging stock (3.4.3.2.2) to develop required properties, the ability of other products to develop required properties in conditions other than that tested in accordance with 3.4.3.2, and grain flow of die forgings (3.5.1) 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, 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.

4.3.3 Stock for Forging, Flash Welded Rings, or Extruding

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

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 results of the following tests:

4.4.1 For each heat:

Composition
Macrostructure

4.4.2 For each lot of product as solution heat treated:

Hardness

4.4.3 For each lot of product after precipitation heat treatment:

Hardness
Tensile properties

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

4.4.5 Purchase order number.

Heat and lot numbers
AMS5643W
Product form
Size
Quantity

4.4.6 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 (also see 3.2.1.4).

4.4.7 When material produced to this specification is beyond the sizes allowed in the scope or tables, or other exceptions are 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 AMS5643W(EXC) because of the following exceptions." and the specific exceptions shall be listed.

4.4.8 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 of each heat. This report shall include the purchase order number, heat number, AMS5643W, product form, size, and quantity. The producer shall provide a copy of the original material manufacturer's (producer's) report (material certification), including: producer's name and country where the metal was melted (e.g., the final melt in the case of metal processed by multiple melting operations).

4.5 Resampling and Retesting

Shall be as follows:

4.5.1 Bars, Wire, Mechanical Tubing, Flash Welded Rings, and Stock for Forging, Flash Welded Rings, or Heading

In accordance with AMS2371.

4.5.2 Forgings

In accordance with AMS2374.

5. PREPARATION FOR DELIVERY

5.1 Sizes

Except when exact length or multiples of exact lengths are ordered, straight bars, 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 AMS2806.

5.2.1.1 When technical exceptions are taken (see 4.4.7), the material shall be marked with AMS5643W(EXC).

5.2.2 Forgings

In accordance with AMS2808.

5.2.3 Flash Welded Rings and Stock for Forging, Flash Welded Rings, or Heading

As agreed upon by purchaser and producer.

5.3 Packaging

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

6. ACKNOWLEDGMENT

A producer 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 Revision Indicator

A change bar (l) located in the left margin 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 document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

8.2 The MMPDS values are lower than specification tensile strength values for some heat treat conditions.

8.3 Tensile strengths to hardness conversions are presented in ASTM A370.

8.4 Except for forging stock (see 3.2.4), product supplied to this document will be in the solution heat treated condition. AMS slash documents (see 1.1.1) cover product in a specific solution treated and aged condition.

8.5 Terms used in AMS are clarified in ARP1917.

8.6 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.

8.7 Unless otherwise specified, the material producer shall work to the revision of this specification (AMS5643) in effect on the date of order placement. Unless otherwise specified, material manufactured and certified to the immediately previous revision of this specification (AMS5643) may be procured and used until inventory is depleted.

8.8 Purchasers should consider stock removal requirements of 3.5.2 when selecting the appropriate size and condition including surface finish to specify in ordering information.

8.9 It is the purchaser's obligation to ensure that product they procure or resell as AMS5643W has any exceptions approved by their subsequent purchaser.

8.10 Purchase documents should specify not less than the following:

AMS5643W
Product form and size or part number of product desired
Quantity of product desired
Acceptance standards for macrostructure (see 3.4.1)
Precipitation heat treated condition for test if other than H900 (see 3.4.3.2)
Specific finish when required

PREPARED BY SAE AMS F CORROSION HEAT RESISTANT ALLOYS COMMITTEE