



AEROSPACE MATERIAL SPECIFICATION	AMS5895™	REV. F
	Issued 1979-10 Reaffirmed 2015-04 Revised 2021-08	
Superseding AMS5895E		
Steel, Corrosion and Heat-Resistant, Bars, Wire, Forgings, Mechanical Tubing, Rings and Forging Stock, 15Cr - 25.5Ni - 1.2Mo - 2.1Ti - 0.006B - 0.30V Consumable Electrode Melted, 1750 °F (954 °C) Solution Heat Treated, Welding Grade Precipitation Hardenable (Composition similar to UNS S66286)		

RATIONALE

AMS5895E updates title, revises composition test (3.1), adds strain rate to tensile testing (3.5.1.2.1), introduces option for grain size on large products 3.5.1.1.3.1, prohibits unauthorized exceptions (3.6.2, 3.8, 4.4.3, 4.4.4, 5.2.1.1, 8.7), samples clarified (3.5.1.2), combines forging stock with stock for flash welded rings or heading (3.5.2, 4.2.2, 5.2.3), adds AS1182 requirements (3.6.3, 8.8), adds country of origin and standard requirements for Reports (4.4), allows prior revisions (8.6), and results from a Five-Year Review and update of this specification.

1. SCOPE

1.1 Form

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

1.2 Application

These products have been used typically for parts requiring high strength up to 1300 °F (704 °C) and oxidation resistance up to 1500 °F (816 °C), particularly those which are welded and then heat treated to develop required properties, but usage is not limited to such applications.

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.

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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
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
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

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	Chemical Analysis of Steel Products
ASTM E112	Determining Average Grain Size
ASTM E139	Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials
ASTM E140	Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, Scleroscope Hardness, and Leeb Hardness
ASTM E292	Conducting Time-for-Rupture Notch Tension Tests of Materials

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	--	0.08
Manganese	--	0.35
Silicon	--	0.30
Phosphorus	--	0.020
Sulfur	--	0.010
Chromium	13.50	16.00
Nickel	24.00	27.00
Molybdenum	1.00	1.50
Titanium	1.90	2.35
Boron	0.0030	0.010
Vanadium	0.10	0.50
Cobalt	--	1.00
Aluminum	--	0.35
Copper	--	0.50

3.1.1 Check Analysis

Composition variations shall meet the applicable requirements of AMS2248.

3.2 Melting Practice

Steel shall be produced by multiple melting using consumable electrode practice in the remelt cycle.

3.3 Condition

The product shall be supplied in the following condition:

3.3.1 Bars, Wire, Forgings, and Flash Welded Rings

Solution heat treated.

3.3.1.1 Bars and Wire

3.3.1.1.1 All hexagons, other bars 2.750 inches (69.85 mm) and under in nominal diameter or least distance between parallel sides, and wire shall be cold finished.

3.3.1.1.2 Bars, other than hexagons, over 2.750 inches (69.85 mm) in nominal diameter or least distance between parallel sides shall be hot finished and descaled, or cold finished.

3.3.1.2 Forgings

Shall be descaled.

3.3.1.3 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.

3.3.1.4 Mechanical Tubing

Cold finished.

3.3.2 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 except as specified in 3.4.1, forgings, mechanical tubing, and flash welded rings shall be solution heat treated by heating to 1750 °F ± 25 °F (954 °C ± 14 °C), holding at heat for not less than 1 hour, and quenching in oil or water. Pyrometry shall be in accordance with AMS2750.

3.4.1 Wire 0.1874 inch (4.760 mm) and under in nominal diameter shall be solution heat treated by heating to 1750 °F ± 25 °F (954 °C ± 14 °C), holding at heat for a time commensurate with wire diameter, and cooling rapidly.

3.5 Properties

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

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

3.5.1.1 As Solution Heat Treated

3.5.1.1.1 Tensile Properties

Wire shall have tensile strength not higher than 105 ksi (724 MPa) or equivalent hardness (see 8.2).

3.5.1.1.2 Hardness

3.5.1.1.2.1 Bars and Mechanical Tubing

Not higher than 201 HB, or equivalent, (see 8.3) determined approximately midway between outer surface and center or inner surface as applicable.

3.5.1.1.2.2 Forgings and Flash Welded Rings

Not higher than 201 HB, or equivalent (see 8.3).

3.5.1.1.3 Average Grain Size

Shall be ASTM No. 5 or finer, determined in accordance with ASTM E112.

3.5.1.1.3.1 For product sizes greater than 5.0 inches (127 mm) grain size shall be as agreed upon with producer and purchaser.

3.5.1.2 Response to Precipitation Heat Treatment

Samples from product, 5.0 inches (127 mm) and under in nominal diameter or least distance between parallel sides, shall have the following properties after being precipitation heat treated by heating to 1325 °F ± 15 °F (718 °C ± 8 °C), holding at heat for not less than 16 hours, and cooling in air.

3.5.1.2.1 Longitudinal Tensile Properties

Shall be as shown in Table 2.

Table 2 - Minimum tensile properties

Property	Value
Tensile Strength	130 ksi (896 MPa)
Yield Strength at 0.2% Offset	85 ksi (586 MPa)
Elongation in 4D	15%
Reduction of Area	20%

- 3.5.1.2.1.1 The requirements of 3.5.1.2.1 apply to specimens taken with the axis approximately parallel to the grain flow and to specimens taken in the radial direction and in the tangential direction at the rim of disc forgings.
- 3.5.1.2.1.2 Specific locations of specimens from forgings and flash welded rings shall be as agreed upon by purchaser and producer.
- 3.5.1.2.1.3 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. The strain rate after yield may be increased to any value up to 0.5 inch/inch/min (or mm/mm/min) or equivalent crosshead speed as a function of gage length.

3.5.1.2.2 Hardness

Should be 248 to 341 HB, or equivalent (see 8.3). The product shall not be rejected on the basis of hardness if the tensile property requirements of 3.5.1.2.1 are acceptable, determined on specimens taken from the same sample as that with nonconforming hardness, or from another sample with similar nonconforming hardness.

3.5.1.2.3 Stress-Rupture Properties at 1200 °F (649 °C)

Shall be as follows; testing of notched specimens and of combination smooth-and-notched specimens shall be performed in accordance with ASTM E292 and of smooth specimens in accordance with ASTM E139:

- 3.5.1.2.3.1 A standard cylindrical combination smooth-and-notched specimen conforming to ASTM E292, maintained at $1200\text{ °F} \pm 3\text{ °F}$ ($649\text{ °C} \pm 2\text{ °C}$) while a load sufficient to produce an initial axial stress of 65.0 ksi (448 MPa) is applied continuously, shall not rupture in less than 23 hours. The test shall be continued to rupture without change of load. Rupture shall occur in the smooth section and elongation of this section after rupture, measured at room temperature, shall be not less than 5% in 4D if the specimen ruptures in 48 hours or less and not less than 3% in 4D if the specimen ruptures in more than 48 hours.
- 3.5.1.2.3.2 As an alternate procedure, separate smooth and notched specimens, machined from adjacent sections of the same piece with gage sections conforming to the applicable dimensions shown in ASTM E292, may be tested individually under the conditions of 3.5.1.2.3.1. The smooth specimen shall not rupture in less than 23 hours and elongation after rupture, measured at room temperature, shall be as specified in 3.5.1.2.3.1. The notched specimen shall not rupture in less time than the companion smooth specimen but need not be tested to rupture.
- 3.5.1.2.3.3 The tests of 3.5.1.2.3.1 and 3.5.1.2.3.2 may be conducted using a load higher than required to produce an initial axial stress of 65.0 ksi (448 MPa) but the load shall not be changed while test is in progress. Time to rupture, rupture location, and elongation requirements shall be as specified in 3.5.1.2.3.1.
- 3.5.1.2.3.4 The tests of 3.5.1.2.3.1 and 3.5.1.2.3.2 may be conducted using incremental loading. In such case, the load required to produce an initial axial stress of 65.0 ksi (448 MPa) shall be used to rupture or for 23 hours, whichever occurs first. After the 23 hours and at interval of 8 hours minimum, thereafter, the stress shall be increased in increments of 5.0 ksi (34.5 MPa). Time to rupture, rupture location, and elongation requirements shall be as specified in 3.5.1.2.3.1.
- 3.5.1.2.3.5 For tubing from which a solid round specimen cannot be cut, a full section of tubing shall be tested and shall meet the smooth bar requirements of 3.5.1.2.3.1.

3.5.2 Stock for Forging, Flash Welded Rings or Heading

When a sample of stock is heat treated as in 3.4 and 3.5.1.2, specimens taken from the heat treated sample shall conform to the requirements of 3.5.1.2.1, 3.5.1.2.2, and 3.5.1.2.3.

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 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.
- 3.6.2 Bars shall not be cut from plate (see 4.4.3).
- 3.6.3 Bars and mechanical tubing shall be free from seams, laps, tears, and cracks after removal of the standard stock removal allowance in accordance with AS1182.

3.7 Tolerances

3.7.1 Bars and Wire

In conformance with AMS2241.

3.7.2 Mechanical Tubing

In conformance with AMS2243.

3.8 Exceptions

Any exceptions shall be authorized by the 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) of each heat.
- 4.2.1.2 Tensile properties (3.5.1.1.1) of each lot of wire as solution heat treated.
- 4.2.1.3 Hardness (3.5.1.1.2) of each lot of bars, forgings, mechanical tubing, and flash welded rings as solution heat treated.
- 4.2.1.4 Tensile properties (3.5.1.2.1), hardness (3.5.1.2.2), and stress-rupture properties (3.5.1.2.3) of response to heat treatment samples each lot of bars, wire, forgings, mechanical tubing, and flash welded rings after precipitation heat treatment.
- 4.2.1.5 Tolerances (3.7) of bars, wire, and mechanical tubing.

4.2.2 Periodic Tests

Tests for stock for forging, flash welded rings or heading (3.5.2) to demonstrate ability to develop required properties, and grain flow of die forgings (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

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