



AEROSPACE MATERIAL SPECIFICATION

AMS5659™**REV. T**Issued 1965-09
Revised 2021-10

Superseding AMS5659S

Steel, Corrosion Resistant, Bars, Wire, Forgings, Rings, and Extrusions

15Cr - 4.5Ni - 0.30Cb (Nb) - 3.5Cu

Consumable Electrode Remelted

Solution Heat Treated, Precipitation Hardenable

(Composition similar to UNS S15500)

RATIONALE

AMS5659T prohibits unauthorized exceptions (3.9, 4.4.6, 5.2.1.1, 8.7), revises composition (3.1) to replace obsolete chemical analysis standards, updates condition (3.3.1.1, 8.9), introduces AMS2761 replacing legacy controls (3.4), adds strain rate control (3.5.2.2.1), deletes redundant requirements with AMS2371 (prior 3.5.2.2.1.2, 3.5.2.2.1.3), adds AS1182 (3.6.3, 8.6), updates title, allows prior revisions (8.8), 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, flash welded rings, and extrusions in the solution heat treated condition (see 8.3), 12 inches (305 mm) and under in nominal diameter, thickness or for hexagons, least distance between parallel sides, and having a maximum cross-sectional area of 144 in² (930 cm²), and stock of any size for forging, flash welded rings, or extruding.

1.1.1 For purchase of solution treated and aged product, use the applicable AMS slash specification (see 8.3). If a slash sheet description is not specified, solution annealed material shall be supplied. A specific example of a slash specification is:

AMS5659/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) with 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

Products covered by this specification are classified as follows:

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

Type 2 - Steel multiple melted using electroslag remelting.

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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
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
AMS 2761	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 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	--	0.07
Manganese	--	1.00
Silicon	--	1.00
Phosphorus	--	0.030
Sulfur	--	0.015
Chromium	14.00	15.50
Nickel	3.50	5.50
Columbium (Niobium)	5xC	0.45
Copper	2.50	4.50
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 electroslog remelting for Type 2.

3.3 Condition

The product shall be supplied in the following condition:

3.3.1 Bars, Wire, Forgings, and Flash Welded Rings

3.3.1.1 Rounds

Solution heat treated and descaled. Bars 2.00 inch (50.8 mm) and under in nominal diameter shall be cold finished. Bars over 2.0 inches (50.8 mm) in nominal diameter shall be hot or cold finished (see 3.6.3). When a specific finish is required, it must be ordered (see 8.8).

3.3.1.2 Hexagons

Solution heat treated, cold drawn, and descaled.

3.3.1.3 Squares and Flats

Hot finished, solution heat treated, and descaled.

3.3.1.4 Bar shall not be cut from plate (also see 4.4.5).

3.3.1.5 Wire and Forgings

Solution heat treated and descaled.

3.3.1.6 Flash Welded Rings

Solution heat treated and descaled. 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.

3.3.2 Extrusions

Solution heat treated, straightened, and descaled.

3.3.3 Stock for Forging, Flash Welded Rings, or Extruding

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

3.4 Solution Heat Treatment

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).

3.5 Properties

The product shall conform to the following requirements; tensile and hardness 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, 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 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 no more than 2% free ferrite, determined in accordance with AMS2315.

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

3.5.2.1 As Solution Heat Treated

3.5.2.1.1 Tensile Strength

Wire shall have tensile strength not higher than 175 ksi (1207 MPa).