AEROSPACE MATERIAL SPECIFICATION

AMS5936™	REV. D

Issued 2001-04
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Superseding AMS5936C

Steel, Corrosion-Resistant, Bars, Wire, and Forgings 12Cr - 11Ni - 1.7Ti - 1Mo Vacuum Induction Plus Vacuum Consumable Electrode Remelted Solution Heat Treated, Precipitation Hardenable (Composition similar to UNS S46500)

RATIONALE

AMS5936D revises chemical analysis standards (3.1), condition (3.3.1.4), prohibits unauthorized exceptions (3.8), revises reports (4.4) and identification (5.2.1.1), 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, and forging stock.

1.2 Application

These products have been used typically for heat-treated parts requiring stress corrosion resistance, along with a combination of high strength and high toughness up to 800 °F (427 °C) with good ductility and strength in the transverse direction, but usage is not limited to such applications.

1.2.1 Certain design, processing procedures, or environmental conditions may cause these products to become susceptible to stress-corrosion cracking; ARP1110 recommends practices to minimize such conditions.

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

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

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 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

ASTM E399 Plane-Strain Fracture Toughness of Metallic 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	--	0.02
Manganese	--	0.25
Silicon	--	0.25
Phosphorus	--	0.015
Sulfur	--	0.010
Chromium	11.00	12.50
Nickel	10.75	11.25
Molybdenum	0.75	1.25
Titanium	1.50	1.80
Nitrogen	--	0.01

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 induction melting followed by vacuum consumable electrode remelt practice.

3.3 Condition

The product shall be supplied in the following condition:

3.3.1 Bars, Wire, and Forgings

3.3.1.1 Rounds

Solution heat treated and turned, centerless ground, and polished.

3.3.1.2 Hexagons

Solution heat treated and descaled.

3.3.1.3 Squares and Flats

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

3.3.1.4 Bars shall not be cut from plate (also see 4.4.2.1).

3.3.1.5 Wire

Cold finished, solution treated and descaled.

3.3.1.6 Forgings

Solution heat treated and descaled.

3.3.2 Forging Stock

As ordered by the forging manufacturer.

3.4 Heat Treatment

Bars, wire, and forgings shall be solution heat treated by heating to 1800 °F ± 25 °F (982 °C ± 14 °C), holding at heat for 60 minutes ± 15 minutes, and quenching in oil or water, cooling to -100 °F (-73 °C) or colder, holding at that temperature for not less than 8 hours, and warming in air to room temperature. Pyrometry shall be in accordance with AMS2750.

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 forging stock, etched in hot hydrochloric acid in accordance with ASTM A604, shall show no pipe or cracks. Porosity, segregation, inclusions, and other imperfections for product 36 in^2 (232 cm^2) and under in nominal cross-sectional area 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

3.5.2 Bars, Wire, and Forgings

3.5.2.1 As Solution Heat Treated

3.5.2.1.1 Tensile Strength

Wire shall have tensile strength not higher than 160 ksi (1103 MPa).

3.5.2.1.2 Hardness

3.5.2.1.2.1 Bars

Not higher than 331 HB, or equivalent (see 8.2), determined at mid-radius or quarter thickness.

3.5.2.1.2.2 Forgings

Not higher than 331 HB, or equivalent (see 8.2).

3.5.2.2 After Precipitation Heat Treatment

The solution heat treated product, 12 inches (305 mm) and under in nominal diameter or maximum cross-sectional dimension, precipitation heat treated to the temperature and time shown in Table 3 and cooled in air, oil, or other suitable liquid quench (see 8.3), shall have the properties specified in 3.5.2.2.1, 3.5.2.2.2, and 3.5.2.2.3. Tensile and hardness tests need only be made in the H1000 condition unless purchaser specifies another heat treated condition for testing.