AEROSPACE MATERIAL SPECIFICATION

AMS4914	REV. F

Issued 1984-04
Revised 2014-04

Superseding AMS4914E

Titanium Alloy Cold Rolled Sheet and Strip
15V - 3Al - 3Cr - 3Sn
Solution Heat Treated
(Composition similar to UNS R58153)

RATIONALE

AMS4914F results from a Five Year Review and update of this specification that that restricts material to the sizes of the mechanical property tables (1.1), includes removing the allowance for additional sample weight for hydrogen (Table 1) (See AMS2368), revises melting to require all remelting under vacuum (3.2.1), requires agreement on mechanical property values for material outside the size range of 1.1, revises flatness tolerance requirements (3.7), adds AS6279 (3.8) and AMS2368 (4.3) and revises the report paragraph (4.4).

1. SCOPE

1.1 Form

This specification covers a titanium alloy in the form of sheet and strip up to and including 0.125 inches (3.18 mm) in thickness.

1.2 Application

These products have been used typically in applications requiring high strength-to-weight ratio and stability up to 550 °F (288 °C), but usage is not limited to such applications. Parts are typically formed in the solution heat treated condition and subsequently precipitation heat treated to final condition.

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 724-776-4970 (outside USA), www.sae.org.

AMS2242 Tolerances, Corrosion and Heat-Resistant Steel, Iron Alloy, Titanium, and Titanium Alloy Sheet, Strip, and Plate

AMS2249 Chemical Check Analysis Limits, Titanium and Titanium Alloys

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**

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AMS4914F

AMS2368 Sampling and Testing of Wrought Titanium Raw Materials, Except Forgings and Forging Stock

AMS2750 Pyrometry

AMS2801 Heat Treatment of Titanium Alloy Parts

AMS2809 Identification, Titanium and Titanium Alloy Wrought Products

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 E 8 / E 8M Tension Testing of Metallic Materials

ASTM E 112 Determining Average Grain Size

ASTM E 290 Bend Testing of Material for Ductility

ASTM E 1409 Determination of Oxygen and Nitrogen in Titanium and Titanium Alloys by the Inert Gas Fusion Technique

ASTM E 1447 Determination of Hydrogen in Titanium and Titanium Alloys by the Inert Gas Fusion Thermal Conductivity/Infrared Detection Method

ASTM E 1941 Determination of Carbon in Refractory and Reactive Metals and Their Alloys by Combustion Analysis

ASTM E 2371 Analysis of Titanium and Titanium Alloys by Direct Current Plasma and Inductively Coupled Plasma Atomic Emission Spectrometry

3. TECHNICAL REQUIREMENTS

3.1 Composition

Shall conform to the percentages by weight shown in Table 1; carbon shall be determined in accordance with ASTM E 1941, hydrogen in accordance with ASTM E 1447, oxygen and nitrogen in accordance with ASTM E 1409, and other elements in accordance with ASTM E 2371. Other analytical methods may be used if acceptable to the purchaser.

TABLE 1 - COMPOSITION

Element	min	max	
Vanadium	14.0	16.0	
Chromium	2.5	3.5	
Tin	2.5	3.5	
Aluminum	2.5	3.5	
Iron	--	0.25	
Oxygen	--	0.13	
Carbon	--	0.05	
Nitrogen	--	0.05	(500 ppm)
Hydrogen	--	0.015	(150 ppm)
Other Elements, each (3.1.1)	--	0.10	
Other Elements, total (3.1.1)	--	0.40	
Titanium	remainder		

3.1.1 Determination not required for routine acceptance.

3.1.2 Check Analysis

Composition variations shall meet the applicable requirements of AMS2249.

3.2 Melting Practice

Alloy shall be multiple melted. The first melt shall be made by vacuum consumable electrode, nonconsumable electrode, electron beam cold hearth, or plasma arc cold hearth melting practice. The subsequent melt or melts shall be made under vacuum using vacuum arc remelting (VAR) practice. Alloy additions are not permitted in the final melt cycle.

3.2.1 The atmosphere for nonconsumable electrode melting shall be vacuum or shall be argon and/or helium at an absolute pressure not higher than 1000 mm of mercury.

3.2.2 The electrode tip for nonconsumable electrode melting shall be water-cooled copper.

3.3 Condition

Hot rolled with subsequent cold reduction, solution heat treated, descaled, and leveled, having a surface appearance comparable to a commercial corrosion-resistant steel ASTM No. 2D finish (See 8.2).

3.4 Heat Treatment

Product shall be solution heat treated by heating to a temperature within the range 1450 to 1500 °F (788 to 816 °C), holding at the selected temperature within ±25 °F (±14 °C) for 3 to 30 minutes, and cooling at a rate that will produce product meeting the requirements of 3.5 (See 8.3). Pyrometry shall be in accordance with AMS2750.

3.5 Properties

The product shall conform to the following requirements:

3.5.1 As Solution Heat Treated

3.5.1.1 Tensile Properties

Shall be as shown in Table 2 for product 0.125 inch (3.18 mm) and under in nominal thickness, determined in accordance with ASTM E 8 / E 8M with the rate of strain set at 0.005 inch/inch/minute (0.005 mm/mm/minute) and maintained within a tolerance of ±0.002 inch/inch/minute (0.002 mm/mm/minute) through the 0.2% offset yield strain.

TABLE 2 - TENSILE PROPERTIES

Property	Value
Tensile Strength	102 to 137 ksi (703 to 945 MPa)
Yield Strength at 0.2% Offset	100 to 126 ksi (689 to 869 MPa)
Elongation in 2 Inches (50.8 mm)	12% minimum

3.5.1.1.1 Mechanical property requirements for product outside the range covered by 3.5.1.1 shall be agreed upon between purchaser and producer.

3.5.1.2 Bending

Product 0.125 inch (3.18 mm) and under in nominal thickness, shall have a test sample prepared nominally 0.750 inch (19.06 mm) in width, with its axis of bending parallel to the direction of rolling. The sample shall be bend tested in accordance with the guided bend test defined in ASTM E 290 through an angle of 105 degrees. The test fixture supports shall have a contact radius 0.010 inch (0.25 mm) minimum, and the plunger shall have a radius equal to the bend factor shown in Table 3 times the nominal thickness. Examination of the bent sample shall not show evidence of cracking when examined at 15 to 25X magnification.

TABLE 3 - BENDING

Nominal Thickness Inch	Nominal Thickness Millimeters	Bend Factor
Up tc	Up to 1.78, inc	4
Over 0.070 to 0.125, i	Over 1.78 to 3.18, inc	5

3.5.1.2.1 Mechanical property requirements for product outside the range covered by 3.5.1.2 shall be agreed upon between purchaser and producer.

3.5.1.3 Surface Contamination

The product shall be free of any oxygen-rich layer, such as alpha case, or other surface contamination, determined by the bend test of 3.5.1.2 or other method acceptable to purchaser.

3.5.2 After Precipitation Heat Treatment (Capability Test)

Precipitation heat treat in accordance with AMS2801 using the parameters of Tables 4 and 5.

3.5.2.1 Tensile Properties

Shall be as shown in Tables 4 and 5 for product 0.125 inch (0.32 mm) and under in nominal thickness, determined in accordance with ASTM E 8 / E 8M with the rate of strain set at 0.005 inch/inch/minute (0.005 mm/mm/minute) and maintained within a tolerance of ±0.002 inch/inch/minute (0.002 mm/mm/minute) through the 0.2% offset yield strain. Properties shall be verified for both precipitation heat treatment conditions (See Tables 4 and 5).

TABLE 4 - MINIMUM TENSILE PROPERTIES AFTER PRECIPITATION HEAT TREATMENT OF HEATING TO 950 °F ± 10 (510 °C ± 6), HOLDING AT HEAT FOR 8 HOURS ± 0.5, AND COOLING IN AIR OR FASTER

Property	Value
Tensile Strength	145 ksi (1000 MPa)
Yield Strength at 0.2% Offset	140 ksi (965 MPa)
Elongation in 2 Inches (50.8 mm)	7%

TABLE 5 - MINIMUM TENSILE PROPERTIES AFTER PRECIPITATION HEAT TREATMENT OF HEATING TO 900 °F ± 10 (482 °C ± 6), HOLDING AT HEAT FOR 16 HOURS ± 0.5, AND COOLING IN AIR

Property	Value
Tensile Strength	180 ksi (1241 MPa)
Yield Strength at 0.2% Offset	170 ksi (1172 MPa)
Elongation in 2 Inches (50.8 mm)	5%

3.5.2.1.1 Mechanical property requirements for product outside the range covered by 3.5.2.1 shall be agreed upon between purchaser and producer.

3.5.2.2 Average Grain Size

Shall be ASTM No. 6 or finer, determined by comparison of a polished and etched specimen with the chart in ASTM E 112.

3.6 Quality

The product, as received by purchaser, shall be uniform in quality and condition, sound, and free from “oil cans” (See 8.4) of depth in excess of the flatness tolerances, ripples, and foreign materials and from imperfections detrimental to usage of the product.

3.7 Tolerances

Except for flatness, shall conform to all applicable requirements of AMS2242.

3.7.1 Flatness shall be as shown in Table 6

TABLE 6 – MAXIMUM DEVIATION FROM A HORIZONTAL FLAT SURFACE

Specified Thickness		Variation from Flat	
Inch	Millimeters	Inch	Millimeters
Up to 0.062, excl	Up to 1.57, excl	2	51
0.062 to 0.1875, excl	1.57 to 4.762, excl	1	25

3.8 Production, distribution, and procurement of metal stock shall comply with AS6279. This requirement becomes effective October 1, 2015.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The vendor of the product shall supply all samples for vendor'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

All technical requirements are acceptance tests and shall be performed on each heat or lot as applicable.

4.3 Sampling and Testing

Shall be in accordance with AMS2368 and the following; a lot shall be all product of the same nominal size from the same heat processed at the same time and in the same heat treatment batch.

4.3.1 Composition

One sample from each heat, except that for hydrogen determinations one sample from each lot obtained after thermal and chemical processing is completed.

4.3.2 Tensile Properties, Bending, Grain Size, and Surface Contamination

Not less than one sample from each lot.

4.3.2.1 Specimens for tensile tests of widths 9 inches (229 mm) and over shall be taken and tested in both the longitudinal and long transverse directions; for widths under 9 inches (229 mm), specimens shall be taken in longitudinal direction.

4.4 Reports

4.4.1 The producer shall furnish with each shipment a report showing the producer identity, country where the metal was melted (i.e., final melt in the case of metal processed by multiple melting operations) and the results of tests for composition of each heat, for the hydrogen content and tensile and bending properties of each lot, tensile properties and average grain size after precipitation heat treatment of each lot, and stating that the product conforms to the other technical requirements. This report shall include the purchase order number, heat and lot numbers, AMS4914F, specific precipitation hardening temperature used to develop properties, product form, size, and quantity.

4.4.2 When product size is outside the range designated in 1.1, the report shall contain a statement to that effect.

4.5 Resampling and Retesting

If any specimen used in the above tests fails to meet the specified requirements, disposition of the product may be based on the results of testing three additional specimens for each original nonconforming specimen. Failure of any retest specimen to meet the specified requirements shall be cause for rejection of the product represented. Results of all tests shall be reported.

5. PREPARATION FOR DELIVERY

5.1 Identification

Shall be in accordance with AMS2809.

5.2 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 vendor shall include 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 A change bar (|) 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 Commercial corrosion-resistant steel finishes are defined in ASTM A 480/A 480M.

8.3 For nominal thicknesses under 0.1875 inch (4.762 mm), air cooling from the solution heat treatment temperature is usually satisfactory

8.4 Terms used in AMS are clarified in ARP1917 and as follows:

8.4.1 “Oil Can”

An excess of material in a localized area of a sheet which causes the sheet to buckle in that area. When the sheet is placed on a flat surface and hand pressure applied to the buckle, the buckle will spring through to the opposite surface or spring up in another area of the sheet.

8.5 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.

8.6 Purchase documents should specify not less than the following:

AMS4914F
Product form and size of product desired
Quantity of product desired
Property and acceptance requirements from the cognizant engineering organization applicable to sizes outside the size range listed in 1.1.

PREPARED BY AMS COMMITTEE “G”