Society of Automotive Engineers, Inc.
400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

AEROSPACE MATERIAL SPECIFICATION

AMS 4916C
Superseding AMS 4916B
Issued 3-15-66
Revised 1-15-76

TITANIUM ALLOY SHEET, STRIP, AND PLATE
8Al - 1Mo - 1V
Duplex Annealed

1. SCOPE:

1.1 Form: This specification covers a titanium alloy in the form of sheet, strip, and plate.

1.2 Application: Primarily for parts requiring good strength and fracture toughness up to 800°F (427°C). Certain processing procedures and service conditions may cause this material to be subject to stress-corrosion cracking; ARP 982 recommends practices to minimize such conditions.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS) and Aerospace Recommended Practices (ARP) shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2242 - Tolerances, Corrosion and Heat Resistant Steel and Iron Base Alloy Sheet, Strip, and Plate and Titanuim and Titanium Alloy Sheet, Strip, and Plate
AMS 2249 - Chemical Check Analysis Limits, Titanium and Titanium Alloys
AMS 2350 - Standards and Test Methods
AMS 2631 - Ultrasonic Inspection of Titanium Alloys

2.1.2 Aerospace Recommended Practices:

ARP 982 - Minimizing Stress-Corrosion in Wrought Titanium Alloy Products

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM E8 - Tension Testing of Metallic Materials
ASTM E120 - Chemical Analysis of Titanium and Titanium-Base Alloys
ASTM E290 - Semi-Guided Bend Test for Ductility of Metallic Materials

2.3 Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.3.1 Federal Standards:

Federal Test Method Standard No. 151 - Metals; Test Methods

2.3.2 Military Standards:

MIL-STD-163 - Steel Mill Products, Preparation for Shipment and Storage

3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall conform to the following percentages by weight, determined by wet chemical methods in accordance with ASTM E120, by spectrographic methods in accordance with Federal Test Method Standard No. 151, Method 112, or by other approved analytical methods:

	min	max
Aluminum	7.35	8.35
Molybdenum	0.75	1.25
Vanadium	0.75	1.25
Iron	--	0.30
Oxygen	--	0.12
Carbon	--	0.08
Nitrogen	--	0.05 (500 ppm)
Hydrogen	--	0.15 (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 requirements of AMS 2249.

3.2 Condition: The product shall be supplied in the following condition:

3.2.1 Sheet and Strip: Hot rolled, with or without subsequent cold reduction, duplex annealed, descaled, and leveled, having a surface appearance comparable to a commercial corrosion-resistant steel No. 2D finish.

3.2.2 Plate: Hot rolled, duplex annealed, descaled, and flattened, having a surface appearance comparable to a commercial corrosion-resistant steel No. 1 finish.

3.3 Annealing: The product shall be duplex annealed by heating to 1450°F ± 25 (787.8°C ± 14), holding at heat for 1 - 8 hr, cooling at a rate not faster than 100 F (56 C) deg per hr to below 900°F (482°C), cooling to room temperature, reheating to 1450°F ± 25 (787.8°C ± 14), holding at heat for at least 15 min., and cooling in air to room temperature.

3.4 Properties:

3.4.1 Tensile Properties: Shall be as specified in Table I, determined in accordance with ASTM E8 with the rate of strain maintained at 0.003 - 0.007 in. per in. per min. (0.003 - 0.007 mm/mm/min.) through the yield strength and then increased so as to produce failure in approximately one additional minute. When a dispute occurs between purchaser and vendor over the yield strength values, a referee test shall be performed on a machine having a strain rate pacer, using a rate of 0.005 in. per in. per min. (0.005 mm/mm/min.) through the yield strength and a minimum cross head speed of 0.10 in. (2.5 mm) per min. above the yield strength.

TABLE I

Nominal Thickness Inches	Tensile Strength psi, min	Yield Strength at 0.2% Offset psi, min	Elongation in 2 in. or 4D %, min
0.008 to 0.014, incl	135,000	120,000	6
Over 0.014 to 0.025, incl	135,000	120,000	8
Over 0.025 to 0.187, incl	135,000	120,000	10
Over 0.187 to 1.000, incl	130,000	120,000	10
Over 1.000 to 2.000, incl	125,000	115,000	10
Over 2.000 to 4.000, incl	120,000	110,000	8

TABLE I (SI)

Nominal Thickness Millimetres	Tensile Strength MPa, min	Yield Strength at 0.2% Offset MPa, min.	Elongation in 50.8 mm or 4D %, min
0.20 to 0.36, incl	931	827	6
Over 0.36 to 0.64, incl	931	827	8
Over 0.64 to 4.75, incl	931	827	10
Over 4.75 to 25.40, incl	896	827	10
Over 25.40 to 50.80, incl	862	793	10
Over 50.80 to 101.60, incl	827	758	8

3.4.2 Bending: Product up to 0.1875 in. (4.762 mm), excl, in nominal thickness shall withstand, Ø without evidence of cracking when examined at 20X magnification, bending in accordance with ASTM E290 at room temperature through an angle of 105 deg (1.83 rad) around a diameter equal to the bend factor times the nominal thickness of the product, using either V-block, U-channel, or free bend procedure, with axis of bend parallel to the direction of rolling. Only one of these tests will be required in routine inspection. In case of dispute, results of bend tests using the V-block procedure shall govern:

Nominal Thickness Inch	(Millimetres)	Bend Factor
Up to 0.070, incl	(Up to 1.78, incl)	8
Over 0.070 to 0.1875, excl	(Over 1.78 to 4.762, excl)	9

3.4.2.1 Bending requirements for plate 0.1875 in. (4.762 mm) and over in nominal thickness shall be as agreed upon by purchaser and vendor.

3.4.3 Microstructure: Shall be essentially that resulting from alpha-beta processing. Microstructure Ø shall not be cause for rejection unless standards for acceptance have been agreed upon by purchaser and vendor.

3.4.4 Surface Contamination: The product shall be free of any oxygen-enriched layer, such as alpha Ø case, or other surface contamination, except that isolated local areas of alpha case are acceptable on plate.

3.5 Quality:

3.5.1 Material shall be produced by multiple melting using consumable electrode practice, unless otherwise specified; at least one of the melting cycles shall be under vacuum.

3.5.2 The product shall be uniform in quality and condition, clean, sound, and free from "oil cans" (See 8.2) of depth in excess of the flatness tolerance, ripples, and foreign materials and from internal and external imperfections detrimental to fabrication or to performance of parts.

3.5.2.1 When specified, plate 0.500 to 4.000 in. (12.70 to 101.60 mm) in nominal thickness shall be ø ultrasonically inspected in accordance with AMS 2631. Standards for acceptance shall be as agreed upon by purchaser and vendor.

3.6 Tolerances: Unless otherwise specified, tolerances shall conform to the following:

3.6.1 Thickness, Width, Length, and Straightness: All applicable requirements of AMS 2242.

3.6.2 Flatness: Flatness tolerance for product 36 in. (914 mm) and under in nominal width shall be ø 5% if nominal thickness is less than 0.025 in. (0.64 mm), and 3% if nominal thickness is 0.025 to 0.1875 in. (0.64 to 4.762 mm), exclusive. Flatness tolerance for product under 0.1875 in. (4.762 mm) in nominal thickness and over 36 in. (914 mm) in nominal width and for product 0.1875 in. (4.762 mm) and over in nominal thickness in all widths shall be as agreed upon by purchaser and vendor.

3.6.2.1 Flatness shall be determined from the expression 100H/L where "L" is the distance between contact points of a straight edge laid in any direction on the product and "H" is the distance from the straight edge to the product at the point of greatest separation.

3.6.2.2 Flatness tolerances do not apply to coiled products.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of the product shall supply all samples and shall be responsible for performing all required tests. Results of such tests shall be reported to the ø purchaser as required by 4.4. Purchaser reserves the right to perform such confirmatory testing as he deems necessary to ensure that the product conforms to the requirements of this specification.

4.2 Classification of Tests: Tests to determine conformance to all technical requirements of this ø specification are classified as acceptance or routine control tests.

4.3 Sampling: Shall be in accordance with the following; a lot shall be all material of the same nominal ø size from the same heat processed at the same time.

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

4.3.2 Tensile Property, Bending, Microstructure, and Surface Contamination Requirements: One ø sample from each lot.

4.3.2.1 Tensile test specimens from widths 9 in. (229 mm) and over shall be taken with the axis perpendicular to the direction of rolling; for widths less than 9 in. (229 mm), tensile test specimens shall be taken with the axis parallel to the direction of rolling.

4.3.2.2 For V-block or U-channel bend tests, specimen width shall be not less than 10 times the nominal thickness but not less than 1 in. (25 mm). For free bend tests, minimum specimen width shall, when possible, be not less than 10 times the nominal thickness; maximum width need not be greater than 1 in. (25 mm).

ø 4.3.3 Other Requirements: As agreed upon by purchaser and vendor.

4.4 Reports:

4.4.1 The vendor of the product shall furnish with each shipment three copies of a report showing the results of tests for chemical composition of each heat in the shipment and for the hydrogen content, ø tensile and bending properties, and surface contamination of each lot, and stating that the product conforms to the other technical requirements of this specification. This report shall include the purchase order number, heat number, material specification number and its revision letter, size, and quantity from each heat.