AEROSPACE MATERIAL SPECIFICATION

AMS2801	REV. B

Issued 1990-07
Revised 2003-03
Reaffirmed 2014-02

Superseding AMS2801A

Heat Treatment of Titanium Alloy Parts

RATIONALE

AMS2801B has been reaffirmed to comply with the SAE five-year review policy.

1. SCOPE:

1.1 Purpose:

This specification covers the engineering requirements for heat treatment by part fabricators (users) or their vendors or subcontractors, of parts (See 1.1.2) made from the following titanium alloys:

Commercially Pure	6Al-4V(ELI)	3Al-8V-6Cr-4Mo-4Zr
3Al-2.5V	6Al-6V-2Sn	13V-11Cr-3Al
5Al-2.5Sn	6Al-2Sn-4Zr-2Mo	10V-2Fe-3Al
8Al-1Mo-1V	6Al-2Sn-4Zr-6Mo	15V-3Cr-3Al-3Sn
6Al-4V		

1.1.1 Other Alloys and Heat Treatments: This specification may be used for heat treatment of parts made from alloys other than the above, provided temperatures, times, and quenchants are specified by the cognizant engineering organization. It is permissible, for specific parts, to use equipment, practices, and test methods which conformed to AMS-H-81200 or MIL-H-81200 and were previously acceptable to the purchaser.

1.1.2 Parts: Finished and semi-finished parts, including raw material, heat treated by the parts fabricators, or their vendors or subcontractors, during the fabrication process. (See 8.2.2.)

1.2 Qualification of Raw Material:

The temperature, soaking time, and cooling rate requirements specified herein are applicable to testing of raw material by material producers, warehouses/distributors, and forge shops for capability to respond to heat treatment when some or all of these requirements are not included in the procurement specification.

1.3 Raw Material:

Heat treatment by material producers, forge shops, and warehouses/distributors, or their vendors, of products listed below should be performed in accordance with the procurement specification. (See 8.2.1.)

Sheet, Plate, Foil, Bar, Rod, Wire, Tubing, Extruded Shapes, Forgings, and Castings.

1.4 Heat Treatments:

Heat treatments and their abbreviations covered by this specification are as follows:

Anneal (ANN)	Beta Solution Treated and Overaged (BSTOA)
Stress Relief (SR)	Solution Treat (ST)
Age (AGE)	Beta Solution Treat (BST)
Overage (OA)	Solution Treat and Age (STA)
Cold Worked and Aged (CWA)	Solution Treat and Over Age (STOA)

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, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or www.sae.org.

AMS 2750	Pyrometry
AMS 4901	Titanium Sheet, Strip, and Plate, Annealed, 70.0 ksi (483 MPa) Yield Strength
ARP1962	Certification of Heat Treating Personnel

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959 or www.astm.org.

ASTM B 600	Descaling and Cleaning Titanium and Titanium Alloy Surfaces
ASTM E 1447	Determination of Hydrogen in Titanium and Titanium Alloys by the Inert Gas Fusion Thermal Conductivity Method

2.3 U.S. Government Publications:

Available from DODSSP Subscription Services Desk, Building 40, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

BB-H-1168	Helium, Technical
MIL-A-18455	Argon, Technical
MIL-PRF-27407	Propellant Pressurizing Agent, Helium

3. TECHNICAL REQUIREMENTS:

3.1 Equipment:

3.1.1 Pyrometry: Shall conform to AMS 2750.

3.1.2 Furnaces:

3.1.2.1 Temperature Uniformity: Shall be as shown in Table 1.

TABLE 1 - Temperature Tolerance

Heat Treatment	Temperature Tolerance °F	Temperature Tolerance °C
Aging	±15(1)	±8
Solution	±25	±14
Stress Relief	±25	±14
Anneal	±25	±14

(1) ±10 °F (t6 °C) for parts made from the following five alloys if temperature is 1025 °F (552 °C) or lower: 6Al-6V-2Sn, 13V-11Cr-3Al, 15V-3Cr-3Al-3Sn, 10V-2Fe-3Al, and 3Al-8V-6Cr-4Mo-4Zr.

3.1.2.2 Heating Media:

3.1.2.2.1 Air and Non-Inert Atmospheres: Shall be free of reducing gases and other contaminants which may produce surface contamination in excess of that to be removed (see 3.2.10) or which may result in excess hydrogen pick-up (see 3.1.2.2.5). Direct fired furnaces shall be controlled so that the flame is slightly oxidizing and there is no flame impingement on the parts. A coupon (See 3.1.2.2.5) shall accompany one load each week, heated above 1200 °F (649 °C), and be subsequently tested for excess hydrogen pick-up and for surface contamination in excess of that to be removed. Parts with net dimensions shall not be heated above 1000 °F (538 °C) in air or non-inert atmosphere furnaces unless coated with a protective coating (See 3.1.2.2.1.2).

3.1.2.2.1.1 Furnaces to be used above 1200 °F (649 °C which have contained a contaminating atmosphere (e.g., endothermic, dissociated ammonia) shall be equipped so as to prevent leakage of the contaminating atmosphere into the working zone. Such furnaces shall be purged and tested for hydrogen pick-up before heat treating the first load of titanium parts.

3.1.2.2.1.2 Protective coatings may be used to avoid or minimize the detrimental effects of heating media when approved by the cognizant engineering organization.

3.1.2.2.2 Inert Atmospheres (Helium and Argon): Shall meet the composition requirements of MIL-PRF-27407, Type I, MIL-A-18455, or BB-H-1168 as applicable. The dew point of the gas shall be -65 °F (-54 °C) or lower as it enters the furnace. For loads to be heated above 1000 °F (538 °C), containing parts having surfaces from which no material will be removed, one coupon (see 3.1.2.2.5) shall accompany each load and be subsequently tested for alpha case (See 8.5). Test coupons are not needed for heat treatments under 1000 °F (538 °C).

3.1.2.2.3 Vacuum: Vacuum pressure and leak rate shall be determined at room temperature before heating each load. Vacuum pressure shall be lower than 0.1 µm of mercury and leak rate shall be lower than 3 µm of mercury per one-quarter hour with the vacuum pump isolated from the furnace chamber. Cooling may be accelerated by back-filling with inert gas conforming to 3.1.2.2.2. For loads to be heated above 1000 °F (538 °C) containing parts having surfaces from which no material will be removed, one coupon (see 3.1.2.2.5) shall accompany each load and be subsequently tested for alpha case (see 8.5). Test coupons are not needed for heat treatments under 1000 °F (538 °C).

3.1.2.2.4 Molten Salt and Fluidized Bed: Prohibited.

3.1.2.2.5 Tests: Coupons of AMS 4901 composition, nominally 0.020 inch (0.51 mm) thick by 1 inch (25 mm) wide shall be used to confirm conformance with heating media requirements. Hydrogen pick-up by coupons heated in air and other non-inert atmosphere furnaces shall not exceed 25 ppm when analyzed in accordance with ASTM E 1447. Coupons heat treated in vacuum or inert gas atmosphere furnaces shall be free from surface contamination determined in accordance with either the microhardness or bend test of AMS 4901 or a metallographic technique approved by the cognizant quality assurance organization.

3.1.2.2.5.1 For heat treat loads containing small parts (e.g., fastener components) such parts may be substituted for the coupons specified in 3.1.2.2.5.

3.1.3 Auxiliary Equipment: Fixtures, jigs, hangers, trays, racks, etc. shall be employed as necessary. The equipment shall not reduce the heating, cooling, or quenching rates below those required for proper heat treatment.

3.1.4 Quench Tanks: Shall be of sufficient size to permit complete immersion of parts and free movement of the quench medium adjacent to all surfaces of parts. Equipment shall be provided for agitation or circulation of the quench medium and/or the parts. The volume of quenchant, and any auxiliary cooling equipment, shall be sufficient to maintain (1) a water quench below 100 °F (38 °C) during the quench, (2) a polymer quench below 120 °F (49 °C), and (3) an oil quench between 60 and 160 °F (16 and 71 °C) at the start of the quench and below 200 °F (93 °C) during a quench. In addition, quench oils shall be used within the temperature range recommended by the oil manufacturer.