

BS EN 4632-006:2013



BSI Standards Publication

Aerospace series — Weldability and brazeability of materials in aerospace constructions

Part 006: Homogeneous assemblies of titanium alloys

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National foreword

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A list of organizations represented on this committee can be obtained on request to its secretary.

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**Aerospace series - Weldability and brazeability of materials in
aerospace constructions - Part 006: Homogeneous assemblies
of titanium alloys**

Série aérospatiale - Soudabilité et brasabilité des matériaux
pour constructions aérospatiales - Partie 006 :
Assemblages homogènes des alliages de titane

Luft- und Raumfahrt - Schweißbarkeit und Lötbarkeit von
Werkstoffen im Luft- und Raumfahrzeugbau - Teil 006:
Gleichartige Verbindungen aus Titanbasislegierungen

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Foreword

This document (EN 4632-006:2013) has been prepared by the Aerospace and Defence Industries Association of Europe - Standardization (ASD-STAN).

After enquiries and votes carried out in accordance with the rules of this Association, this Standard has received the approval of the National Associations and the Official Services of the member countries of ASD, prior to its presentation to CEN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2013, and conflicting national standards shall be withdrawn at the latest by September 2013.

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This standard is part 6 of a series of 8 standards, with:

- EN 4632-001, *Aerospace series — Welded and brazed assemblies for aerospace constructions — Weldability and brazeability of materials — Part 001: General requirements*
- EN 4632-002, *Aerospace series — Welded and brazed assemblies for aerospace constructions — Weldability and brazeability of materials — Part 002: Homogeneous assemblies aluminium and aluminium alloys*
- EN 4632-003, *Aerospace series — Weldability and brazeability of materials in aerospace constructions — Part 003: Welding and brazing of homogeneous assemblies of unalloyed and low alloy steels*
- EN 4632-004, *Aerospace series — Welded and brazed assemblies for aerospace constructions — Weldability and brazeability of materials — Part 004: Homogeneous assemblies highly alloyed steels*
- EN 4632-005, *Aerospace series — Weldability and brazeability of materials in aerospace constructions — Part 005: Homogeneous assemblies of heat resisting Ni or Co base alloys*
- EN 4632-007, *Aerospace series — Weldability and brazeability of materials in aerospace constructions — Part 007: Homogeneous assemblies of miscellaneous alloys*

1 Scope

This European Standard defines degrees of weldability and brazeability for materials or families of materials used in the aerospace applications.

It comprises a series of sheets, by materials or by material family, which:

- indicate the main titles, the typical chemical composition and the main characteristics,
- contain recommendations for welding and brazing,
- indicate a degree of weldability or brazeability for a given process under defined conditions.

It is applicable without restriction for the manufacturing of new parts or for repair.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 3120, *Aerospace series — Titanium alloy TI-P64003 — Cold worked and stress relieved — Seamless tube for pressure systems — $4\text{ mm} \leq D \leq 51\text{ mm}$ — $690\text{ MPa} \leq R_m \leq 1\,030\text{ MPa}$*

EN 3310, *Aerospace series — Titanium alloy TI-P64001 (Ti-6Al-4V) — Not heat treated — Forging stock, for annealed forgings — $D_e \leq 360\text{ mm}$*

EN 3311, *Aerospace series — Titanium alloy TI-P64001 (Ti-6Al-4V) — Annealed — Bar for machining — $D < 110\text{ mm}$*

EN 3312, *Aerospace series — Titanium alloy Ti-6Al-4V — Annealed — Forgings — $D_e \leq 150\text{ mm}$*

EN 3313, *Aerospace series — Titanium alloy TI-P64001 — Not heat treated — Grade 2 forging stock, for solution treated and aged forgings — a or $D \leq 360\text{ mm}$ ¹⁾*

EN 3314, *Aerospace series — Titanium alloy TI-P64001 — Solution treated and aged — Bar for machining — $D \leq 75\text{ mm}$ ¹⁾*

EN 3315, *Aerospace series — Titanium alloy TI-P64001 — Solution treated and aged — Forgings — $D_e \leq 75\text{ mm}$ ¹⁾*

EN 3321, *Aerospace series — Titanium alloy TI-P65001 — As forged — Grade 1 forging stock, for solution treated and aged forgings — a or $D \leq 360\text{ mm}$ ¹⁾*

EN 3322, *Aerospace series — Titanium alloy TI-P65001 — Solution treated and aged — Grade 1 — Forgings — $D_e \leq 75\text{ mm}$ ¹⁾*

EN 3354, *Aerospace series — Titanium alloy TI-P64001 (Ti-6Al-4V) — Annealed — Sheet for superplastic forming — $a \leq 6\text{ mm}$ ¹⁾*

1) Published as ASD-STAN Prestandard at the date of publication of this standard (www.asd-stan.org).

EN 3355, Aerospace series — Titanium alloy TI-P64001 (Ti-6Al-4V) — Annealed — Extruded section — $D_e \leq 150 \text{ mm}$ — $900 \text{ MPa} \leq R_m \leq 1\,160 \text{ MPa}$

EN 3442, Aerospace series — Titanium TI-P99002 — Annealed — Sheet and strip, hot rolled — $a \leq 6 \text{ mm}$ — $390 \text{ MPa} \leq R_m \leq 540 \text{ MPa}$ ¹⁾

EN 3443, Aerospace series — Titanium TI-P99003 — Annealed — Sheet and strip, hot rolled — $a \leq 6 \text{ mm}$ — $570 \text{ MPa} \leq R_m \leq 730 \text{ MPa}$ ¹⁾

EN 3451, Aerospace series — Titanium TI-P99002 — Not heat treated — Grade 2 forging stock, for annealed forgings — a or $D \leq 300 \text{ mm}$ ¹⁾

EN 3453, Aerospace series — Titanium TI-P99003 — Not heat treated — Grade 2 forging stock, for annealed forgings — a or $D \leq 300 \text{ mm}$ ¹⁾

EN 3454, Aerospace series — Titanium alloy TI-P19001 — Not heat treated — Grade 2 forging stock, for annealed forgings — a or $D \leq 300 \text{ mm}$ ¹⁾

EN 3455, Aerospace series — Titanium alloy TI-P19001 — Not heat treated — Grade 2 forging stocks, for solution treated and aged forgings — a or $D \leq 300 \text{ mm}$ ¹⁾

EN 3456, Aerospace series — Titanium alloy TI-P64001 (Ti-6Al-4V) — Annealed — Sheet and strip, hot rolled — $a \leq 6 \text{ mm}$

EN 3460, Aerospace series — Titanium TI-P99002 — Annealed — Bar for machining — a or $D \leq 150 \text{ mm}$ — $R_m \geq 390 \text{ MPa}$ ¹⁾

EN 3461, Aerospace series — Titanium TI-P99003 — Annealed — Bar for machining — $D \leq 150 \text{ mm}$ — $540 \text{ MPa} \leq R_m \leq 740 \text{ MPa}$ ¹⁾

EN 3462, Aerospace series — Titanium alloy TI-P19001 — Annealed — Bar for machining — $D \leq 150 \text{ mm}$ ¹⁾

EN 3463, Aerospace series — Titanium alloy TI-P19001 — Solution treated and aged — Bar for machining — $D \leq 75 \text{ mm}$ ¹⁾

EN 3464, Aerospace series — Titanium alloy TI-P64001 (Ti-6Al-4V) — Annealed — Plate — $6 \text{ mm} < a \leq 100 \text{ mm}$

EN 3494, Aerospace series — Titanium alloy TI-P19001 — Grade 2 — Solution treated and aged — Forgings — $D_e \leq 75 \text{ mm}$ ¹⁾

EN 3495, Aerospace series — Titanium alloy TI-P19001 — Grade 2 — Annealed — Forgings — $D_e \leq 150 \text{ mm}$ ¹⁾

EN 3496, Aerospace series — Titanium TI-P99003 — Grade 2 — Annealed — Forgings — $D_e \leq 150 \text{ mm}$ ¹⁾

EN 3498, Aerospace series — Titanium TI-P99002 — Annealed — Sheet and strip, cold rolled — $a \leq 6 \text{ mm}$ — $390 \text{ MPa} \leq R_m \leq 540 \text{ MPa}$ ¹⁾

EN 3499, Aerospace series — Titanium TI-P99003 — Annealed — Sheet and strip, cold rolled — $a \leq 6 \text{ mm}$ — $570 \text{ MPa} \leq R_m \leq 730 \text{ MPa}$ ¹⁾

EN 3735, Aerospace series — Titanium alloy TI-P65002 — Solution treated and aged — Bar for machining — $D \leq 75 \text{ mm}$ ¹⁾

EN 3736, Aerospace series — Titanium alloy TI-P65002 — Grade 2 — Solution treated and aged — Forgings — $D_e \leq 75 \text{ mm}$ ¹⁾

EN 3737, Aerospace series — Titanium alloy TI-P65002 — Not heat treated — Grade 2 forging stock, for solution treated and aged forgings — a or $D \leq 360$ mm ¹⁾

EN 3859, Aerospace series — Titanium alloy TI-P19001 — Annealed — Sheet and strip, hot rolled — $a \leq 6$ mm ¹⁾

EN 3860, Aerospace series — Titanium alloy TI-P19001 — Annealed — Sheet and strip, cold rolled — $a \leq 6$ mm ¹⁾

EN 3870, Aerospace series — Titanium alloy TI-P19001 — Solution treated and aged — Sheet and strip, hot rolled — $a \leq 6$ mm ¹⁾

EN 3871, Aerospace series — Titanium alloy TI-P19001 — Solution treated and aged — Sheet and strip, cold rolled — $a \leq 6$ mm ¹⁾

EN 3892, Aerospace series — Titanium alloy TI-W64001 — Filler metal for welding

EN 3965, Aerospace series — Titanium alloy TI-B17001 — Filler metal for brazing — Rolled foil

EN 4632-001:2008, Aerospace series — Welded and brazed assemblies for aerospace constructions — Weldability and brazeability of materials — Part 001: General requirements

EN 4632-007, Aerospace series — Weldability and brazeability of materials in aerospace constructions — Part 007: Homogeneous assemblies of miscellaneous alloys ²⁾

EN 10052, Vocabulary of heat treatment terms for ferrous products

EN ISO 4063:2009, Welding and allied processes — Nomenclature of processes and reference numbers (ISO 4063:2009)

EN ISO 24034, Welding consumables — Solid wires and rods for fusion welding of titanium and titanium alloys — Classification (ISO 24034:2010)

AMS 4897, Titanium alloy, sheet, strip, and plate 77 Ti — 15Mo - 3.0Al - 2.8Cb - 0.20Si ³⁾

AMS 4911, Titanium alloy, sheet, strip, and plate 6Al - 4V annealed ³⁾

AMS 4920, Titanium alloy, forgings 6Al - 4V alpha-beta or beta processed, annealed ³⁾

AMS 4928, Titanium alloy bars, wire, forgings, rings, and drawn shapes, 6Al - 4V, annealed ³⁾

AMS 4930, Titanium alloy bars, wire, forgings, and rings, 6Al - 4V, extra low interstitial, annealed ³⁾

AMS 4934, Titanium alloy, extrusions and flash welded rings, 6Al - 4V, solution heat treated and aged ³⁾

AMS 4935, Titanium alloy, extrusions and flash welded rings 6Al - 4V annealed beta processed ³⁾

AMS 4965, Titanium alloy, bars, wire, forgings, and rings 6.0Al - 4.0V solution heat treated and aged ³⁾

AMS 4966, Titanium alloy, forgings 5Al - 2.5Sn annealed, 110 ksi (758 MPa) yield strength ³⁾

AMS 4967, Titanium alloy, bars, wire, forgings, and rings, 6.0Al - 4.0V, annealed, heat treatable ³⁾

2) In preparation at the date of publication.

3) Published by: SAE National (US) Society of Automotive Engineers <http://www.sae.org/>.

AMS 4981, *Titanium alloy bars, wire, and forgings — 6.0Al - 2.0Sn - 4.0Zr - 6.0Mo — solution and precipitation heat treated* ³⁾

AMS 4985, *Titanium alloy, investment castings 6Al 4V 130 Uts, 120 Ys, 6 % EI hot isostatically pressed anneal optional or when specified* ³⁾

AMS 4991, *Titanium alloy castings, investment 6Al - 4V hot isostatic pressed, annealed optional* ³⁾

AMS 4995, *Billets and preforms 5Al - 2Sn - 2Zr - 4Cr - 4M - 0.100 premium quality, powder-metallurgy product* ³⁾

ASTM B 265, *Standard specification for titanium and titanium alloy strip, sheet, and plate* ⁴⁾

AWS A5.16, *Specification for titanium and titanium alloy welding electrodes and rods* ⁵⁾

3 Terms, definitions, symbols and abbreviations

For the purposes of this document, the terms, definitions, symbols and abbreviations given in EN 4632-001:2008 and EN ISO 4063:2009 apply.

PJHT	: Post joining (brazing or diffusion brazing) heat treatment
PWHT	: Post welding heat treatment
FSW	: Friction stir welding
15	: Plasma arc welding
21	: Resistance spot welding
22	: Resistance seam welding
24	: Resistance flash welding
42	: Inertia friction welding
45	: Diffusion welding
51	: Electron beam welding
522	: Gas laser welding
91	: Brazing
111	: Shielded metal arc welding
131	: Gas metal arc welding
141	: Gas tungsten arc welding
919	: Diffusion brazing
924	: Vacuum brazing

4) Published by: ASTM National (US) American Society for Testing and Materials <http://www.astm.org/>.

5) Published by: AWS, 550 N.W. LeJeune Road, Miami, Florida 33126.