

BS EN 4800-007:2010



BSI Standards Publication

Aerospace series — Titanium and titanium alloys — Technical specification

Part 007: Remelting stock

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National foreword

This British Standard is the UK implementation of EN 4800-007:2010.

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

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Luft- und Raumfahrt - Titan und Titanlegierungen
Knetzeugnisse - Technische Lieferbedingungen - Teil
007: Vormaterial

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Foreword

This document (EN 4800-007:2010) 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of an identical text or by endorsement, at the latest by May 2011, and conflicting national standards shall be withdrawn at the latest by May 2011.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

This standard is part of the series of EN metallic material standards for aerospace applications. The general organization of this series is described in EN 4258.

1 Scope

This standard defines the requirements for the ordering, manufacture, testing, inspection and delivery of titanium and titanium alloy remelting stock. It shall be applied when referred to and in conjunction with the EN material standard unless otherwise specified on the drawing, order or inspection schedule.

2 Normative references

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

EN 2002-001, *Aerospace series — Metallic materials — Test methods — Part 001: Tensile testing at ambient temperature*

EN 2002-002, *Aerospace series — Metallic materials — Test methods — Part 002: Tensile testing at elevated temperature*

EN 2002-005, *Aerospace series — Test methods for metallic materials — Part 005: Uninterrupted creep and stress-rupture testing*

EN 2032-1, *Aerospace series — Metallic materials — Part 1: Conventional designation*

EN 2032-2, *Aerospace series — Metallic materials — Part 2: Coding of metallurgical condition in delivery condition*

EN 2078, *Aerospace series — Metallic materials — Manufacturing schedule, inspection schedule, inspection and test report — Definition, general principles, preparation and approval*

EN 2955, *Aerospace series — Recycling of titanium and titanium alloy scrap*

EN 3238, *Aerospace series — Metallic materials — Test method — Shear test for wires and rivets*

EN 3976, *Aerospace series — Titanium and titanium alloys — Test method — Chemical analysis for the determination of hydrogen content*

EN 4258, *Aerospace series — Metallic materials — General organization of standardization — Links between types of EN standards and their use*

EN 4259, *Aerospace series — Metallic materials — Definition of general terms*¹⁾

EN 9100, *Quality Management Systems — Requirements for Aviation, Space and Defense Organizations*

EN 9133, *Aerospace series — Quality management systems — Qualification procedure for aerospace standard parts*

EN ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature (ISO 6892-1:2009)*

prEN ISO 6892-2, *Metallic materials — Tensile testing — Part 2: Method of test at elevated temperature (ISO/DIS 6892-2:2009)*

1) Published as ASD-STAN Prestandard at the date of publication of this standard.

TR 2410, *Aerospace series — Metallic materials — Relationship between dimensional standards and material standards* ²⁾

AMS 2750, *Pyrometry* ³⁾

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 4259 and the following apply.

- 3.1
melt**
mass of homogeneous liquid metal from a single charge
- 3.2
remelt**
solid metal resulting from a single melt
- 3.3
parent cast**
cast of remelting stock to be used for the production of castings
- 3.4
remelting stock**
metal supplied in cast or wrought form, the composition of which has been established by chemical analysis

4 Wording of order

The order shall clearly indicate:

- quantities to be supplied;
- dates of delivery;
- material standard number;
- delivery condition and metallurgical code of products;
- dimensions and tolerances or reference to an appropriate dimensional standard;
- product designation, when required;
- forwarding address;
- nature and type of packing, if required;
- definition and frequency of any special tests and their retest procedures, if required.

2) Published as ASD-STAN Technical Report at the date of publication of this standard.

3) Published by: American Society for Testing and Materials (ASTM), 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA, 19428-2959 USA.

5 Health and safety

Products in the delivery condition shall fulfil the health and safety laws of the area of the country when and where it is to be delivered.

A product safety data sheet shall be available.

6 Technical requirements

6.1 General

The product shall be manufactured in accordance with the requirements of the relevant material standard and the applicable requirements of this specification. A manufacturing schedule shall be established and applied in accordance with EN 2078.

The product shall satisfy the requirements of the material standard and/or order and shall be free from irregularities prejudicial to the subsequent manufacture or use of this product.

Notwithstanding previous acceptance complying with this material standard, any product that is found, at a later stage, to contain such defects shall be rejected.

Unless otherwise specified, the requirements in Tables 1 and 2 shall apply in conjunction with those of the relevant material standard. Table 1 relates to lines 1 to 29 (inclusive) of the material standard and Table 2 relates to lines 30 onwards in which the sub-line format is also used. Lines 2 to 98 may also be opened in line 100 if the material standard details specific qualification requirements. If a specific line number is not shown in Tables 1 and 2, the requirement is stated in the material standard and/or order.

The requirements of the order and/or material standard shall over-ride the requirements of the technical specification.

6.2 Qualification requirements

Qualification requirements when invoked by the material standard and/or order are detailed in Tables 1 and 2. Unless otherwise agreed between the manufacturer and purchaser the qualification phase shall be run on the first three batches.

6.3 Release requirements

6.3.1 Release tests

Release testing shall be the responsibility of the manufacturer.

The purchaser reserves the right to perform any of the inspections and/or tests required by the material standard and/or order.

The test samples shall be representative of the product.

When required the manufacturer shall inform the purchaser of the planned dates for extraction of samples and release testing in order that these operations may be witnessed.

Tables 1 and 2 detail the requirements for each line of the material standard. Unless otherwise specifically requested by the purchaser, a particular inspection and/or test for release shall be carried out if corresponding acceptance criteria and/or values are stated in the applicable material standard, but see also in 6.3.5.

6.3.2 Retests

If the test procedure or test piece preparation is faulty, testing shall be re-applied at the original frequency after rectification of the original cause of failure.

When failure cannot be attributed to faulty testing, or test piece preparation, further test samples shall be selected at twice the original frequency from the product, one of which shall be that on which the original results were obtained unless already withdrawn by the manufacturer after suitable identification of the cause of failure. If all retest results are satisfactory, the batch shall be accepted. If one or more tests are unsatisfactory, the batch shall be:

- rejected; or
- 100 % retested and the conforming products accepted; or
- partially or fully re-heat treated if heat treatment can rectify the cause of the failure and tested as a completely new batch except for chemical composition, for which redetermination of hydrogen content is required. No product or test sample shall be re-heat treated more than twice.

6.3.3 Rejection

Any failure to meet the requirements of the material standard shall be cause for rejection.

6.3.4 Special tests

Special tests may be required by the purchaser. In such cases, the nature of the test, method, frequency and technical requirements shall be specified on the order or inspection schedule and shall be mutually agreed by the manufacturer and purchaser.

6.3.5 Capability clause

Where capability clause is invoked and where sufficient statistical evidence exists, the test need not be carried out (unless specifically requested by the purchaser).

However, this in no way reduces the obligations of the manufacturer to fulfil the requirements. If subsequent testing indicates that the product does not comply with the requirements, the batch shall be rejected.

If sufficient statistical evidence does not exist, the test shall be carried out at a frequency agreed between the manufacturer and the purchaser.

6.3.6 Statistical process control

Reduction in the extent of release testing, other than that defined in 6.3.5 above, may be negotiated with the purchaser on the basis of appropriate statistical process control and/or statistical data.

6.3.7 Inspection and test report

The manufacturer shall furnish, with each delivery, a report conforming to the requirements of EN 2078 stating the following:

- manufacturer's name and address and, if appropriate, identification of the plant;
- order number;
- material standard number;
- delivery condition and metallurgical code of the product;

- quantity and dimensions;
- manufacturing and inspection schedule reference;
- cast and batch number;
- batch and/or test samples heat treatment conditions;
- results of the tests and retests if any.

6.4 Traceability

Each product shall be traceable to the cast, production batch and/or heat treatment batch at all stages of manufacture, testing and delivery.

Table 1 — Technical requirements for lines 1 to 29, where appropriate

| Material standard line reference | | Requirements | Frequency of testing | |
|----------------------------------|----------------------|---|----------------------|------------|
| | | | Qualification | Release |
| No | Title | | | |
| 1 | Material designation | See EN 2032-1. | — | — |
| 2 | Chemical composition | The test samples used for chemical analysis shall be representative of the product and shall be taken from each melt or cast. The method of chemical analysis shall be at the discretion of the manufacturer unless otherwise stated in the material standard or order. In cases of dispute, the method of chemical analysis shall be agreed between the manufacturer and purchaser preferably using existing chemical analysis standards. The measured chemical composition shall be stated on the inspection certificate. | 2 per cast | 2 per cast |
| | | Specific requirements for hydrogen content: The hydrogen content shall be determined on each batch in the delivery condition in accordance with EN 3976. | 1 per cast | 1 per cast |
| 3 | Method of melting | <p>Method of melting shall consist of Cold Hearth (Electron Beam or Plasma Arc) and/or Consumable Electrode Vacuum Arc Melting. An initial non-consumable electrode melt is allowed provided a water-cooled copper electrode is used. Some of the following requirements depend on whether the melting method includes Cold Hearth.</p> <p>1 <u>Raw material:</u></p> <p>Raw materials shall be purchased only from suppliers approved by the manufacturer and registered in his list of approved suppliers.</p> <p>Approval of suppliers shall be made in accordance with written procedures contained within the quality assurance system of the manufacturer.</p> <p><u>Titanium sponge and alloying elements:</u></p> <p>The requirements shall be specified by the manufacturer who shall also establish the following procedures for the evaluation and acceptance testing of each batch:</p> <ul style="list-style-type: none"> — titanium sponge: manufacturing method, level of impurities, particle size, freedom from surface contamination; — alloying elements: chemical composition including level of impurities, particle size, freedom from foreign particles. | — | — |

continued

Table 1 — Technical requirements for lines 1 to 29, where appropriate (continued)

| Material standard line reference | | Requirements | Frequency of testing | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--|---|---|--|---|----------------------|---|---------|---------|---|---------|---------|---|---------|---------|-----|----------------------|----------------------|-------|------------------------|----------------------|-------|------------------------|--------------------------|-------|------------------------|----------------------|-------|------------------------|--------------------------|-----|---------|---------|-----|-------------|-------------|---|-------------|-------------|---|---|
| | | | Qualification | Release | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| No. | Title | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | Method of melting (continued) | <p><u>Recycling of scrap:</u> See EN 2955.</p> <p>The categories and sub-categories of scrap which may be used by the manufacturer are given in the following table:</p> <table border="1"> <thead> <tr> <th>Scrap categories and sub-categories (See EN 2955)</th> <th>Melting method which includes cold hearth</th> <th>VAR-only melt method</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>allowed</td> <td>allowed</td> </tr> <tr> <td>2</td> <td>allowed</td> <td>Allowed</td> </tr> <tr> <td>3</td> <td>allowed</td> <td>allowed</td> </tr> <tr> <td>4.1</td> <td>allowed^a</td> <td>allowed^a</td> </tr> <tr> <td>4.2.1</td> <td>allowed^{a b}</td> <td>allowed^a</td> </tr> <tr> <td>4.2.2</td> <td>allowed^{a b}</td> <td>not allowed^a</td> </tr> <tr> <td>4.3.1</td> <td>allowed^{a b}</td> <td>allowed^a</td> </tr> <tr> <td>4.3.2</td> <td>allowed^{a b}</td> <td>not allowed^a</td> </tr> <tr> <td>5.1</td> <td>allowed</td> <td>allowed</td> </tr> <tr> <td>5.2</td> <td>not allowed</td> <td>not allowed</td> </tr> <tr> <td>6</td> <td>not allowed</td> <td>not allowed</td> </tr> </tbody> </table> <p>^a Only turnings produced by the melter shall be used, unless otherwise agreed by the purchaser. ^b X-ray inspection not required.</p> <p>Bolts or used components shall not be used.</p> <p>The manufacturer shall maintain a list of his approved scrap processors. The list shall indicate the categories of scrap for which the processors are approved.</p> <p>Each order for scrap shall refer to EN 2955, specify the category and, if necessary, the sub-category of the scrap. In the case of turnings the limits for O₂, C and H₂ shall also be specified.</p> | Scrap categories and sub-categories (See EN 2955) | Melting method which includes cold hearth | VAR-only melt method | 1 | allowed | allowed | 2 | allowed | Allowed | 3 | allowed | allowed | 4.1 | allowed ^a | allowed ^a | 4.2.1 | allowed ^{a b} | allowed ^a | 4.2.2 | allowed ^{a b} | not allowed ^a | 4.3.1 | allowed ^{a b} | allowed ^a | 4.3.2 | allowed ^{a b} | not allowed ^a | 5.1 | allowed | allowed | 5.2 | not allowed | not allowed | 6 | not allowed | not allowed | — | — |
| Scrap categories and sub-categories (See EN 2955) | Melting method which includes cold hearth | VAR-only melt method | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | allowed | allowed | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | allowed | Allowed | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | allowed | allowed | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4.1 | allowed ^a | allowed ^a | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4.2.1 | allowed ^{a b} | allowed ^a | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4.2.2 | allowed ^{a b} | not allowed ^a | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4.3.1 | allowed ^{a b} | allowed ^a | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4.3.2 | allowed ^{a b} | not allowed ^a | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5.1 | allowed | allowed | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5.2 | not allowed | not allowed | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | not allowed | not allowed | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

continued

Table 1 — Technical requirements for lines 1 to 29, where appropriate (continued)

| Material standard line reference | | Requirements | Frequency of testing | |
|----------------------------------|----------------------------------|--|----------------------|---------|
| | | | Qualification | Release |
| No. | Title | | | |
| 3 | Method of melting (continued) | <p>2 <u>Charge preparation:</u></p> <p>The melter shall establish procedures for the charge make up which shall include, if appropriate:</p> <ul style="list-style-type: none"> — scrap categories and sub-categories to be used; — amount of recycled scrap; — charge composition; — requirements for recording the constitution of each charge; — compaction. <p>The scrap shall be of the same alloy, or compatible with the final alloy composition.</p> <p>3 <u>Electrode constitution (if appropriate):</u></p> <p>Build up of electrodes and attachment of their stubs shall be carried out under a vacuum or inert gas atmosphere or in accordance with the procedure defined by the manufacturer.</p> <p>4 <u>Welding:</u></p> <p>Welds produced outside the melting furnace shall be visually examined for unacceptable discolouration in accordance with the standard defined by the manufacturer.</p> <p>The welding method to be used for fabricating electrodes, joining electrodes and joining stubs to the electrode shall be Metal Inert Gas (MIG) or Plasma in an inert gas atmosphere or Electron Beam (EB) under vacuum. In addition, stubs may be attached to electrodes by electric arc in a VAR furnace.</p> <p>5 <u>Melting:</u></p> <p>Melting process consist of:</p> <ul style="list-style-type: none"> – a first melt using a consumable electrode, a non consumable electrode or a cold hearth process; – at least one consumable electrode remelting, except where a cold heart melting route is used for commercially pure titanium. <p>Scrap may only be used during the first melt, except for striking the arc.</p> <p>The stub weld interface shall not be melted during the second or subsequent melts. The stub weld interface may be melted during the first melting operation if the stub is of the same alloy and the weld has been made without filler metal, in a vacuum or inert gas atmosphere.</p> <p>Arc breaks during the final melting operation shall not exceed 60 s.</p> | — | — |

continued

Table 1 — Technical requirements for lines 1 to 29, where appropriate (continued)

| Material standard line reference | | Requirements | Frequency of testing | |
|----------------------------------|----------------------------------|---|----------------------|---------|
| | | | Qualification | Release |
| No. | Title | | | |
| 3 | Method of melting (concluded) | An appropriate system shall be provided for the control, checking and verification of the voltage, pressure, and either current or melting rate. The manufacturer shall establish written procedures which define (if appropriate): — the cleaning of furnace and ingot-moulds; — the purity of inert gas used; — the current, the voltage and the maximum allowed pressure during melting; — the maximum allowed leak rate in the furnace; — the hot topping cycle at the end of the final melt; — the inspection of the stub weld interface after melting. | — | — |
| 4.1 | Form | Remelting stock | — | — |
| 4.2 | Method of production | Remelt stock may be wrought or cast. The manufacturer shall establish a procedure for casting and mechanical working if product is wrought. This procedure shall define: — the method of melting; — the method of casting; — the method of mechanical working; if product is wrought. | — | — |
| 4.3 | Limit dimension(s) | Minimum and/or maximum size of the product expressed as the nominal thickness a , or as a nominal diameter, D , of round bar or as equivalent diameter D_e of non circular or non rectangular section products. | — | — |
| 5 | Technical specification | Reference to this technical specification EN 4800-007. In cases of conflict, the requirements of the material standard shall take precedence over those of this technical specification. | — | — |

continued

Table 1 — Technical requirements for lines 1 to 29, where appropriate (continued)

| Material standard line reference | | Requirements | Frequency of testing | |
|----------------------------------|--------------------|---|----------------------|---------|
| | | | Qualification | Release |
| No. | Title | | | |
| 6.1 | Delivery condition | <p>Product shall be supplied in the delivery condition specified in this line in the material standard and/or as stated on the order.</p> <p>Marking:</p> <p>The method of marking used is at the discretion of the manufacturer but shall not cause corrosion, crack initiation, contamination or unacceptable deformation. The marking shall remain permanently visible after handling and contact with protective products.</p> <p>Each remelting stock shall bear the following identification marking:</p> <ul style="list-style-type: none"> — material standard number; — cast/ingot number; — identification of manufacturer, and where appropriate, of plant; — inspection stamp. <p>Packing:</p> <p>All necessary precautions shall be taken to prevent damage to the product, especially where the delivered surface finish shall be maintained.</p> <p>The packing shall be suitable for the type of transportation used.</p> <p>The exterior of the packing shall bear the following information:</p> <ul style="list-style-type: none"> — name and address of recipient; — mass; — order number and sufficient information to enable the contents to be related to the relevant documentation. <p>Shipment:</p> <p>The responsibility for shipping shall be detailed in a transport contract.</p> | — | — |

continued

Table 1 — Technical requirements for lines 1 to 29, where appropriate (continued)

| Material standard line reference | | Requirements | Frequency of testing | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|----------------------------------|-------------------------------------|--|----------------------|---------|---------------------|------|---------------------|-------------|----------|--------------|----|------|---|------------|----|------|---|-------------------|----|--------|-----|----------|----|--------------|----|----------------------------|-----------------|----------------|---------|-------------------------|----------|---|---|
| | | | Qualification | Release | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| No. | Title | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6.1 | Heat treatment (Delivery condition) | <p>Thermal and/or thermomechanical operations shall be applied to the product as specified in the material standard and are listed in the same order as they are to be applied. No product shall be re-solution heat treated more than once without the agreement of the purchaser. Abbreviations and symbols used in the material standard are shown in the following table: all other terms are written in full.</p> <table border="1"> <thead> <tr> <th>Term</th> <th>Abbreviation/Symbol</th> <th>Term</th> <th>Abbreviation/Symbol</th> </tr> </thead> <tbody> <tr> <td>temperature</td> <td>θ</td> <td>water quench</td> <td>WQ</td> </tr> <tr> <td>time</td> <td>t</td> <td>oil quench</td> <td>OQ</td> </tr> <tr> <td>hour</td> <td>h</td> <td>forced air quench</td> <td>AQ</td> </tr> <tr> <td rowspan="2">minute</td> <td rowspan="2">min</td> <td>air cool</td> <td>AC</td> </tr> <tr> <td>furnace cool</td> <td>FC</td> </tr> </tbody> </table> <p>AMS 2750 to be used unless otherwise agreed between customer and supplier.</p> <p>If a specific temperature (value and tolerance) is stated in the material standard or order, that temperature shall be mandatory. If a temperature range is stated, a temperature within that range, reduced by the tolerances of the furnace, shall be selected. The charge shall be maintained at the temperature selected, subject to the furnace tolerances in the following table, for the period stated in the material standard:</p> <table border="1"> <thead> <tr> <th>Selected temperature °C</th> <th>Tolerance °C</th> </tr> </thead> <tbody> <tr> <td>$\theta < 750$</td> <td>± 5</td> </tr> <tr> <td>$750 < \theta < 1\ 000$</td> <td>± 10</td> </tr> </tbody> </table> <p>When the duration of the heat treatment is stated as a fixed value, the tolerance shall be: $(\begin{smallmatrix} +20 \\ 0 \end{smallmatrix})\%$.</p> <p>When the duration of the heat treatment stage is stated as a range, a time within that range shall be selected. When the duration is not specified, it shall be at the discretion of the manufacturer.</p> | | Term | Abbreviation/Symbol | Term | Abbreviation/Symbol | temperature | θ | water quench | WQ | time | t | oil quench | OQ | hour | h | forced air quench | AQ | minute | min | air cool | AC | furnace cool | FC | Selected temperature °C | Tolerance °C | $\theta < 750$ | ± 5 | $750 < \theta < 1\ 000$ | ± 10 | — | — |
| Term | Abbreviation/Symbol | Term | Abbreviation/Symbol | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| temperature | θ | water quench | WQ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| time | t | oil quench | OQ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| hour | h | forced air quench | AQ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| minute | min | air cool | AC | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | furnace cool | FC | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Selected temperature °C | Tolerance °C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| $\theta < 750$ | ± 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| $750 < \theta < 1\ 000$ | ± 10 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

continued

Table 1 — Technical requirements for lines 1 to 29, where appropriate (continued)

| Material standard line reference | | Requirements | Frequency of testing | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|----------------------------------|-------------------------|--|----------------------|---------------------|------|---------------------|-------------|----------|--------------|----|------|---|------------|----|------|---|-------------------|----|--------|-----|----------|----|--------------|----|----------------------------|-----------------|----------------|---------|-------------------------|----------|---|
| | | | Qualification | Release | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| No. | Title | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6.2 | Delivery condition code | See EN 2032-2. | — | — | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | Use condition | The use condition treatment of the product is stated in the material standard. | — | — | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Heat treatment | <p>If the delivery condition is the use condition, no further heat treatment shall be applied to the product.</p> <p>If the delivery condition is not the use condition, the product shall be subject to heat treatment(s) in the same order as those specified in the material standard. Abbreviations and symbols used in the material standard are shown in the following table: all other terms are written in full.</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Term</th> <th>Abbreviation/Symbol</th> <th>Term</th> <th>Abbreviation/Symbol</th> </tr> </thead> <tbody> <tr> <td>temperature</td> <td>θ</td> <td>water quench</td> <td>WQ</td> </tr> <tr> <td>time</td> <td>t</td> <td>oil quench</td> <td>OQ</td> </tr> <tr> <td>hour</td> <td>h</td> <td>forced air quench</td> <td>AQ</td> </tr> <tr> <td rowspan="2">minute</td> <td rowspan="2">min</td> <td>air cool</td> <td>AC</td> </tr> <tr> <td>furnace cool</td> <td>FC</td> </tr> </tbody> </table> <p>AMS 2750 to be used unless otherwise agreed between customer and supplier.</p> <p>If a specific temperature (value and tolerance) is stated in the material standard or order, that temperature shall be mandatory. If a temperature range is stated, a temperature within that range, reduced by the tolerances of the furnace, shall be selected. The charge shall be maintained at the temperature selected, subject to the furnace tolerances in the following table, for the period stated in the material standard:</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Selected temperature °C</th> <th>Tolerance °C</th> </tr> </thead> <tbody> <tr> <td>$\theta < 750$</td> <td>± 5</td> </tr> <tr> <td>$750 < \theta < 1\ 000$</td> <td>± 10</td> </tr> </tbody> </table> <p>When the duration of the heat treatment is stated as a fixed value, the tolerance shall be: $(\begin{smallmatrix} +20 \\ 0 \end{smallmatrix})\%$.</p> <p>When the duration of the heat treatment stage is stated as a range, a time within that range shall be selected. When the duration is not specified, it shall be at the discretion of the manufacturer.</p> | Term | Abbreviation/Symbol | Term | Abbreviation/Symbol | temperature | θ | water quench | WQ | time | t | oil quench | OQ | hour | h | forced air quench | AQ | minute | min | air cool | AC | furnace cool | FC | Selected temperature °C | Tolerance °C | $\theta < 750$ | ± 5 | $750 < \theta < 1\ 000$ | ± 10 | — |
| Term | Abbreviation/Symbol | Term | Abbreviation/Symbol | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| temperature | θ | water quench | WQ | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| time | t | oil quench | OQ | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| hour | h | forced air quench | AQ | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| minute | min | air cool | AC | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | furnace cool | FC | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Selected temperature °C | Tolerance °C | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| $\theta < 750$ | ± 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| $750 < \theta < 1\ 000$ | ± 10 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

continued

Table 1 — Technical requirements for lines 1 to 29, where appropriate (continued)

| Material standard line reference | | | | Requirements | Frequency of testing | |
|----------------------------------|------------------------------------|------------|-----|--|----------------------|----------------------|
| | | | | | Qualification | Release |
| No. | Title | | | | | |
| 8.1 | Test sample(s) | | | This line relates to test samples for the test defines in lines 12 to 26. Test samples shall not be worked after removal from the product they represent. Test samples and associated test pieces shall be marked in such a manner that their identity, location and orientation with respect to the product and batch are maintained. | — | — |
| 8.2 | Test piece(s) | | | This line relates to test pieces for the test defines in lines 12 to 26. Test pieces shall be machined from the test samples taken in accordance with the requirements of line 8.1 of this technical specification. Test piece type and dimensions shall be as specified for the appropriate test/line number in the material standard and/or this technical specification and/or test method. | — | — |
| 8.3 | Heat treatment | | | The heat treatment shall be as specified in the material standard. If the delivery condition is the use condition, further heat treatment shall not be applied. | — | — |
| 9 | Dimensions concerned | | | Nominal thickness, a , or nominal diameter D , of the product to which the properties, in lines 11 to 26 of the material standard, relate. | — | — |
| 10 | Thickness of cladding on each face | | | Not used for titanium alloys. | | |
| 11 | Direction of test piece | | | As specified in the material standard and relates to the direction of the test piece used for tensile and creep testing. | — | — |
| Tensile test | | | | Lines 12 to 16 | — | — |
| 12 | Temperature | θ | °C | As specified in the material standard and relates to the temperature at which the tensile tests are carried out. | — | — |
| 13 | Proof stress | $R_{p0,2}$ | MPa | Tensile testing shall be carried out in accordance with EN 2002-001 for testing at ambient temperature and EN 2002-002 for testing at elevated temperature. EN ISO 6892-1 and prEN ISO 6892-2 are also applicable subject to agreement between customer and supplier on the test method (A or B method) The tensile test specimen direction and position within the product shall be in accordance with the following table: | 1 specimen per batch | 1 specimen per batch |
| 14 | Strength | R_m | MPa | | | |
| 15 | Elongation | A | % | | | |

continued

Table 1 — Technical requirements for lines 1 to 29, where appropriate (continued)

| Material standard line reference | | | | Requirements | | | Frequency of testing | |
|----------------------------------|-----------------------|------------|-----|---|----------------------------|-----------------------------|----------------------|----------------------|
| | | | | | | | Qualification | Release |
| No. | Title | | | | | | | |
| 16 | Reduction of area | Z | % | Minor transverse dimension of product mm | Direction of test piece | Location of test piece | 1 specimen per batch | 1 specimen per batch |
| | | | | ≤ 25 | Longitudinal | Centre | | |
| | | | | 25 < D < 75 | Longitudinal | At 12,5 mm from the surface | | |
| | | | | > 75 | Longitudinal or transverse | Mid radius | | |
| 17 | Hardness | | | Not normally used for titanium alloys. | | | – | – |
| 18 | Shear strength | | | Test in accordance with EN 3238. | | | 1 specimen per batch | 1 specimen per batch |
| 19 | Bending | | | Not used for this type of product. | | | – | – |
| 20 | Impact strength | | | Not normally used for titanium alloys. | | | – | – |
| Creep parameters | | | | Lines 21-26 | | | – | – |
| 21 | Temperature | θ | °C | As specified in the material standard and relates to the temperature at which the creep and/or stress rupture tests are carried out. | | | – | – |
| 22 | Time | | h | | | | | |
| 23 | Stress | σ_a | MPa | Test in accordance with EN 2002-005. The test piece definition and position within the product shall be agreed between the manufacturer and purchaser. | | | 1 specimen per batch | 1 specimen per batch |
| 24 | Elongation | a | % | | | | | |
| 25 | Rupture stress | σ_R | MPa | The test specimen orientation shall be in accordance with the following table/ | | | | |
| 26 | Elongation at rupture | A | % | | | | | |
| | | | | Minor transverse dimension of product mm | Direction of test piece | Location of test piece | | |
| | | | | ≤ 25 | Longitudinal | Centre | | |
| | | | | 25 < D ≤ 75 | Longitudinal | At 12,5 mm from the surface | | |
| | | | | > 75 | Longitudinal or transverse | Mid radius | | |

continued

Table 1 — Technical requirements for lines 1 to 29, where appropriate (concluded)

| Material standard line reference | | Requirements | Frequency of testing | |
|----------------------------------|--------------------------|--|----------------------|---------|
| | | | Qualification | Release |
| No. | Title | | | |
| 27 | Notes | List of indices appearing on page 4 of the material standard which relate to normative and/or interpretative notes which are subsequently explained in line 98 of the material standard. | — | — |
| 29 | Reference heat treatment | When required, reference heat treatment is applied to the test samples, see line 8.3. | — | — |

Table 2 — Technical requirements for lines 30 onwards, where appropriate

| 44 | | External defects | |
|--|---|---|--------------------|
| Test method | 1 | Visual inspection. | |
| Frequency of testing | 2 | Qualification | Release testing |
| | | Each product 100 % | Each product 100 % |
| Sample type | 3 | - | |
| Test piece definition | 4 | Delivery condition | |
| Heat treatment condition of test piece | 5 | Delivery condition | |
| Testing condition | 6 | - | |
| Acceptance criteria | 7 | There shall be no surface contamination or any other foreign matter, including paint, other than that approved for marking. | |

| 61 | | Internal defects | |
|--|---|--|---|
| Test method | 1 | At option of manufacturer | |
| Frequency of testing | 2 | Qualification | Release testing |
| | | Each product 100 % | Sufficient to permit manufacturer to certify compliance with the requirements |
| Sample type | 3 | - | |
| Test piece definition | 4 | - | |
| Heat treatment condition of test piece | 5 | Delivery condition | |
| Testing condition | 6 | - | |
| Acceptance criteria | 7 | There shall be no defects prejudicial to the intended use. | |

continued

Table 2 — Technical requirements for lines 30 onwards, where appropriate (continued)

| 82 | | Batch uniformity | |
|--|---|---|--------------------|
| Test method | 1 | The method used shall be at the discretion of the manufacturer. | |
| Frequency of testing | 2 | Qualification | Release testing |
| | | Each product 100 % | Each product 100 % |
| Sample type | 3 | See sub-line 1. | |
| Test piece definition | 4 | — | |
| Heat treatment condition of test piece | 5 | Delivery condition | |
| Testing condition | 6 | The product shall be tested at final inspection. | |
| Acceptance criteria | 7 | The manufacturer has to guarantee that all the products belong to the same batch. | |

| 95 | | Marking inspection | |
|--|---|--|--|
| Test method | 1 | Visual inspection | |
| Frequency of testing | 2 | Qualification | Release testing |
| | | Each product | The frequency adopted by the manufacturer shall be sufficient to permit him to certify compliance with the requirements. |
| Sample type | 3 | — | |
| Test piece definition | 4 | — | |
| Heat treatment condition of test piece | 5 | — | |
| Testing condition | 6 | — | |
| Acceptance criteria | 7 | The requirements of line 6.1 shall be met. | |

continued

Table 2 — Technical requirements for lines 30 onwards, where appropriate (concluded)

| 96 | | Dimensional inspection | |
|--|---------------|---|---|
| Test method | 1 | Measuring equipment and procedures suitable for the tolerances shall be used. | |
| Frequency of testing | 2 | Qualification | Release testing |
| | | Each product | The frequency of the examination adopted by the manufacturer shall be sufficient to enable him to certify compliance with the requirements. |
| Sample type | 3 | — | |
| Test piece definition | 4 | — | |
| Heat treatment condition of test piece | 5 | — | |
| Testing condition | 6 | — | |
| Acceptance criteria | 7 | Dimensions and tolerances shall conform to the requirements of the dimensional standard stated on the order, or the relevant standard given in TR 2410. | |
| 98 | Notes | — | Normative and/or interpretive notes appearing on pages 4 and 5 of the material standard. |
| 99 | Typical use | — | This line is not normally completed for titanium alloys. |
| 100 | Qualification | — | For approval of the manufacturer's quality systems, see EN 9100. For product qualification, see EN 9133. |

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