

Specification for

# Unfired fusion welded pressure vessels

ICS 23.020.30

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## Foreword

This Published Document has been prepared by Technical Committee PVE/1, Pressure vessels. It superseded BS 5500 : 1997, which was withdrawn when PD 5500:2000 was published. It provides a specification for the design, manufacture, inspection and testing of pressure vessels manufactured from carbon, ferritic alloy and austenitic steels, nickel and aluminium.

The form and content of the original issue of PD 5500 was derived, without technical amendment, from the 1997 edition of BS 5500, *Specification for unfired fusion welded pressure vessels*, and all amendments issued thereto, up to and including No. 6 (September 1999). Then PD 5500 differed from BS 5500 only insofar as it does not retain the latter's status as a national standard. This specification was, thus, founded on the experience derived from the application of BS 5500 and provides an integrated set of rules which have been shown to provide vessels of suitable integrity for a wide range of duties and risk environments.

BS 5500 : 1997 was withdrawn because its status as a national standard was incompatible with BSI's obligations to CEN consequent to the development of the European Standard EN 13445, *Unfired pressure vessels*. That European Standard was published in May 2002.

The process of development of EN 13445 by CEN and its reference in the Official Journal of the European Communities creates, for equipment which conforms to that standard, a presumption of conformity with the essential safety requirements of the EU's pressure equipment directive, 97/23/EC (see article 5 of that directive). This Published Document does not provide that presumption of conformity. However, this Published Document can be used, for vessels within the scope of the directive, subject to:

- adherence to the directive's conformity assessment requirements;
- the manufacturer satisfying himself that this PD covers all the technical requirements of the Directive relevant to the vessel in question.

This use may be to cover the full range of applicable vessel requirements or to cover an issue not, at the time, appropriately supported in EN 13445.

The normative form of wording is retained in this Published Document, even though this does not have the status of a national standard, in order to ensure clarity in the definition of its requirements and recommendations.

Reference is made in the text to a number of standards which have been withdrawn. Such standards are identified in the list of references (see page V). Consideration is currently being given as to whether replacement standards are available or are being developed, for example, in the European programme, and to the implications for PD 5500 of such replacement standards. When a decision is made about any replacement standards, these will be identified by the issue of an amendment.

The British Standards Institution will be pleased to receive constructive proposals based on experience or research that may lead to improvements in this Published Document. PVE/1 intends to keep the content and technical status of this specification under review along with the need to publish appropriate supplements covering other types of pressure vessels. If there is sufficient demand from industry, this Published Document will be extended to cover other non-ferrous materials.

The requirements for materials not listed in Section 2 Materials, are given in supplements to the main text, which are to be read in conjunction with the main text so as to provide comprehensive requirements for pressure vessels produced in the relevant material. Annexes to the main text are provided which can be either normative (i.e. requirements) or informative (i.e. recommendations). These annexes can include additional requirements to the main text or informative guidance or recommendations or can provide worked examples. Enquiry cases are published primarily to give guidance and clarification of possible ambiguities in the main text and will be incorporated into the main text or into an annex at an appropriate stage. Some Enquiry cases are published to provide new information and are identified as 'preliminary rules'.

It should be noted that the effective date of amendments to this Published Document will be later than the publication date to allow users time to amend their own working procedures and documentation. See the introduction to the summary of pages table.

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This document may be referred to by the UK Health and Safety Executive (HSE) when giving guidance.

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**Compliance with a Published Document does not of itself confer immunity from legal obligations.**

## Summary of pages

This specification is kept up to date by the issue, from time to time, of replacement or additional pages. Each replacement or added page will carry a copyright date indicating its date of issue/publication.

Sidelining on replacement pages will indicate that changes of technical or reference significance have been made at that point.

The following table identifies for each page of the specification the issue date which forms the authorized version of the document when assembled to include the original pages and amendments identified on the inside front page. Each amended page becomes part of the authorized version at the implementation date given for each amendment on the inside front cover.

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# Section 1. General

## 1.1 Scope

**1.1.1** This Published Document specifies requirements for the design, construction, inspection, testing and verification of compliance of unfired fusion welded pressure vessels. The materials of construction are specified in section 2. The term 'pressure vessel' as used in this specification includes branches up to the point of connection to the connecting piping by bolting, screwing or welding, and supports, brackets or other attachments directly welded to the pressure containing shell. The term 'unfired' excludes vessels that are subject to direct generated heat or flame impingement from a fired process. It does not exclude vessels subject to electrical heating or heated process streams.

**1.1.2** In addition to the definitive requirements this specification also requires the items detailed in 1.5 to be documented. For compliance with this specification, both the definitive requirements and the documented items have to be satisfied.

**1.1.3** This specification applies only to pressure vessels manufactured under the survey of a competent engineering Inspecting Authority or Organization. The competent engineering Inspection Authority or Organization shall either be:

- a) a notified body appointed by a member state of the European Union for the Pressure Equipment Directive 97/23/EC for the range of activities covered by this specification; or

NOTE. Within the UK the United Kingdom Accreditation Service (UKAS) acts on behalf of the regulating authority in accrediting inspection bodies.

- b) accredited to BS EN 45004, to Type A independence criteria, for inspection in the subject matter of this specification; or

- c) accredited by an organization authorized by the local Regulatory Authority in countries outside the EU and in circumstances where the Pressure Equipment Directive 97/23/EC does not apply.

The intent of this requirement is regarded as satisfied where inspection is carried out by competent personnel of a separate engineering inspection department maintained by the purchaser of the vessel (in which case Type B independence criteria shall be met). An inspection department maintained by the manufacturer does not satisfy this requirement except:

- a) that specific responsibilities may be delegated at the discretion of the Inspecting Authority or Organization; or
- b) in the case of vessels for the manufacturer's own use and not for resale.

This specification applies only to vessels made by manufacturers who can satisfy the Inspecting Authority or Organization that they are competent and suitably equipped to fulfil the appropriate requirements of this specification.

The requirements for testing and inspecting serially manufactured pressure vessels are given in annex V. In all other respects the appropriate requirements in the specification apply.

Glass lined steel vessels require special design considerations subject to the limits imposed by the method of construction which should have the agreement of the Inspecting Authority.

**1.1.4** This specification does not cover the following.

- a) Storage tanks designed for the storage of liquids at near atmospheric pressures, i.e. where the pressure additional to that due to the hydrostatic head does not exceed 140 mbar<sup>1)</sup> above or 6 mbar below atmospheric pressure in accordance with such standards as BS 799, BS 2594, BS 2654, BS 7777.
- b) Low pressure, above ground storage tanks which have a single vertical axis of revolution designed for the storage of liquids at a pressure not exceeding 1 bar<sup>1)</sup>.
- c) Vessels in which the stresses calculated in accordance with the equations given in section 3 are less than 10 % of the design stress permitted by section 3.
- d) Multilayered, autofrettaged, prestressed vessels or other special designs of vessels which may be appropriate for very high pressures.
- e) Transport vessels, i.e. vessels used for transport of contents under pressure.
- f) Vessels for specific applications which are covered by standards listed in the *BSI Catalogue*.

NOTE 1. PD 5500 may be used for the design and manufacture of liquid and bulk powder road tankers, provided consideration is given to the following:

- dynamic loads imposed upon the shell, its supports and fittings (see chapter 6.8.2.1.2 of the European Agreement concerning International Carriage of Dangerous Goods by Road (ADR));
- stability (see chapter 9.7.5.1 of ADR);
- protection of the shell, its supports and fittings in the case of accident (see chapter 6.8.2.1, 6.8.2.1.28, 6.8.2.2.1 and 6.8.2.2.2 of ADR).

BS 3441 gives guidance on the design and construction of tanks for the transport of milk and liquid milk products.

Road tankers used to transport non-hazardous substances in the UK and which operate at a pressure above 0.5 bar g are subject to the Pressure Systems Safety Regulations, 2000 (SI 128).

NOTE 2. The titles of the publications referred to in this specification are listed on the last page.

<sup>1)</sup> 1 mbar = 10<sup>2</sup> N/m<sup>2</sup> = 100 Pa.

1 bar = 10<sup>5</sup> N/m<sup>2</sup> = 0.1 N/mm<sup>2</sup> = 100 kPa.

**1.1.5** This specification does not address the nature or consequences of a fire in the vicinity of a pressure vessel. Any consideration of the effect of a fire hazard in the design of a pressure vessel would have to be under the direction of the plant owner or his responsible agent such as the plant architect/engineer, with analysis of the consequences of a fire adjacent to a pressure vessel being undertaken in accordance with a comprehensive specification of the fire conditions, impingement parameters, analytical methods and assessment criteria.

**1.1.6** This specification addresses materials in various ways:

- a) The main text gives requirements for steels.
- b) Certain other materials are covered by supplements which identify either where the main text is applicable or where specific requirements of the supplement apply.

**1.1.7** When another standard or specification calls for the provisions of PD 5500 to be applied, the responsibility for defining the manner in which the provisions are applied and their appropriateness for the intended duty, is defined in that other document.

**1.1.8** Guidance on the application of PD 5500 to pressure vessels that fall within the scope of the European Pressure Equipment Directive is given in annex Z.

## 1.2 Interpretation

If any ambiguity be found or doubt arise as to the meaning or effect of any part of this specification or as to whether anything ought to be done or omitted to be done in order that this specification should be complied with in full, the question shall be referred to the Pressure Vessels Technical Committee (PVE/1) of the British Standards Institution, whose interpretation of the requirements of this specification upon the matter at issue shall be given free of charge and shall be final and conclusive. Parties adopting this specification for the purposes of any contract shall be deemed to adopt this provision unless they expressly exclude it or else import an arbitration provision in terms extending to interpretation of this specification. However, this provision is limited to questions of interpretation and does not confer upon the committee any power, duty or authority to adjudicate upon the contractual rights or duties of any person under a contract except in so far as they may necessarily be affected by the interpretation arrived at by the committee.

Findings or rulings of the committee upon all enquiries, including matters of interpretation, which are of sufficient importance that both enquiries and replies be made public as soon as possible will be published in an enquiry reply form for inclusion in the PD 5500 ring binder as Enquiry Cases. Their availability will be notified in *BSI News*.

After taking into account any public comment thereon, Enquiry Cases may be incorporated, as appropriate, into this specification as amendments which will form part of the next convenient annual updating.

## 1.3 Definitions

For the purposes of this specification the following definitions apply.

### 1.3.1 Purchaser

The organization or individual who buys the finished pressure vessel for its own use or as an agent for the owner.

### 1.3.2 Manufacturer

The organization that designs, constructs and tests the pressure vessel in accordance with the purchaser's order. The design function may be carried out by the purchaser or his agent, independently from the organization that constructs and tests the vessel (see 1.4.2).

### 1.3.3 Inspecting Authority

The body or organization that verifies that the vessel has been designed, constructed and tested in accordance with this specification.

### 1.3.4 Regulating Authority

The authority in the country of installation that is legally charged with the enforcement of the requirements of the law and regulations of that country relating to pressure vessels.

## 1.4 Responsibilities

NOTE. Reference should be made to annex Z when this specification is being used to satisfy the EU's pressure equipment directive, 97/23/EC, or any national implementation thereof.

### 1.4.1 Responsibilities of the purchaser

The purchaser shall be responsible for furnishing the manufacturer and the Inspecting Authority with the information required by 1.5.1.

The purchaser shall detail in a purchase specification any requirements additional to those of this specification. Table 1.4-1 summarizes where this specification identifies additional purchase specification options.

Where the Inspecting Authority is nominated by the purchaser, the purchaser shall be responsible for ensuring that any information which the manufacturer is required to supply, as specified in this specification, is made available to the Inspecting Authority.

Where necessary, it shall be the responsibility of the purchaser to ensure that the Inspecting Authority is acceptable to the Regulating Authority.

Where the purchaser elects to perform the design function for the vessel, the purchaser shall be responsible for maintaining a complete design dossier for the vessel (see 1.5.1) and for ensuring that all the information contained in it, or agreed modifications to it, comply with this specification; the purchaser shall also be responsible for the accuracy of all design calculations for the vessel.



### 1.4.2 Responsibilities of the manufacturer

The manufacturer shall be responsible for the completeness and accuracy of all design calculations and for compliance with all applicable requirements of this specification for the whole vessel. The manufacturer shall, as required at various points in this specification, obtain the agreement of the purchaser and/or Inspecting Authority for aspects of vessel design, material choice, manufacture and testing (summarized in Table 1.4-2). These agreements shall be documented for inclusion in the vessel records (see 1.5.2.2e)).

If during fabrication unexpected deviations from the requirements of this specification arise, that the manufacturer can justify will not impair the intended functionality or integrity of the vessel, the manufacturer may submit a justification to the purchaser and Inspecting Authority for their approval. Such approved deviations shall be documented for inclusion in the vessel records (see 1.5.2.2e)) and require the application of suffix XX to Form X (see 1.4.4 and NOTE 1 to Form X).

Where the Inspecting Authority is not nominated by the purchaser, the manufacturer shall appoint an Inspecting Authority. The manufacturer shall be responsible for ensuring that the Inspecting Authority is provided with any information the manufacturer is required to supply, as specified in this specification.

The organization which discharges the manufacturer's responsibilities for construction and testing shall assume overall responsibility for compliance with this specification during all related activities including part manufacture and subsequent fabrication to completion at works and/or site. It shall satisfy the Inspecting Authority, as necessary, under the general provisions of 1.1 that it is competent to ensure by appropriate control or surveillance of such activities, whether carried out by itself or by subcontractors, that all the relevant requirements of this specification are met.

Examinations carried out by the Inspecting Authority do not absolve the manufacturer from his responsibility for compliance with the applicable requirements of this specification.

Where the purchaser elects to perform the design function for the vessel, the manufacturer shall be responsible for ensuring that all the design information he requires to construct and test the vessel is provided by the purchaser and for ensuring that all construction and testing is carried out in compliance with this specification. The manufacturer shall also be responsible for the accuracy of any information he provides to enable the purchaser to fulfil the design function.

### 1.4.3 Responsibilities of the Inspecting Authority

The Inspecting Authority shall be responsible for verifying:

- a) that all parts of the vessel have been designed in accordance with the requirements of this specification as are applicable for the conditions specified by the purchaser according to 1.5.1;
- b) that the vessel has been constructed and tested in accordance with this specification and any additional requirements in respect of purchaser options covered in the purchase specification (see 1.4.1).

### 1.4.4 Certificate of Conformance

On completion of the vessel the manufacturer shall issue Form X to certify that the vessel has been designed, constructed and tested in every respect in accordance with this specification and with any additional requirements in respect of purchaser's options covered by this specification. Form X shall be countersigned by the Inspecting Authority as required.

Where some of the activities covered by this specification are performed under the surveillance of a second Inspecting Authority, each Inspecting Authority shall attach a statement to Form X, countersigned as required thereon, confirming which part of the total works has been carried out under its surveillance.

The countersigned Certificate and its attachments (if any) shall be furnished to the purchaser with a copy of the Regulating Authority if required.

Where the purchaser or his appointed design consultant/contractor elects to perform the design function for the vessel, the purchaser or his appointed design consultant/contractor shall complete the section of Form X which certifies that the design of the vessel complies with this specification.

If a vessel is subject to deviations from the requirements of this specification the vessel serial number on Form X shall have the suffix XX added (see 1.4.2).

NOTE. Form X may be reproduced as hard copy or by electronic means provided that such reproductions are fair copies of the original. All copies should state 'Reproduced from PD 5500' with a reference to the current issue.

| <b>Table 1.4-1 Purchase specification options</b> |                                                                      |
|---------------------------------------------------|----------------------------------------------------------------------|
| <b>Clause</b>                                     | <b>Item</b>                                                          |
| <b>1.4.1</b>                                      | Table 1.4-1, identification of purchase specification options        |
| <b>1.4.3b</b>                                     | Responsibility of IIA regarding purchase specification               |
| <b>1.5.1b</b>                                     | Information supplied by purchaser regarding purchase specification   |
| <b>2.1.1.2</b>                                    | Any special material limits                                          |
| <b>2.1.2.1</b>                                    | Use of casting for pressure parts                                    |
| <b>2.2.4</b>                                      | Requirements for material bands M5 and M7 to M10                     |
| <b>3.1.5 Note</b>                                 | Zero negative thickness tolerance                                    |
| <b>3.2.2</b>                                      | Service life and design margin for fatigue vessels                   |
| <b>3.2.4</b>                                      | Design lifetime for time dependant stress                            |
| <b>3.3.1</b>                                      | Identification of the risk of stress corrosion cracking              |
| <b>3.3.2</b>                                      | Required corrosion allowance                                         |
| <b>3.3.3</b>                                      | Surface finish for coating vessels                                   |
| <b>3.4.1</b>                                      | Choice of construction category                                      |
| <b>3.4.2.1</b>                                    | Reduced design stress for operational reasons                        |
| <b>3.4.2.1a</b>                                   | Any special material tests                                           |
| <b>3.8.1 Note 5</b>                               | Special requirements for leak tight flanges                          |
| <b>3.9.4.1 Note</b>                               | Tubesheet design for as-new condition                                |
| <b>3.9.4.3.4</b>                                  | Tubesheet design for simultaneous shellside and tubeside pressures   |
| <b>3.13.2.1 Note</b>                              | Additional relief capacity for the event of fire                     |
| <b>4.2.1.2</b>                                    | Supplementary NDT in addition to visual inspection                   |
| <b>4.2.6</b>                                      | Supplementary structural tolerances                                  |
| <b>4.3.1c)</b>                                    | Production control test plates                                       |
| <b>4.4.3.1d)</b>                                  | PWHT                                                                 |
| <b>4.5.2</b>                                      | Special finish                                                       |
| <b>Table 5.1-1</b>                                | Material examination etc.                                            |
| <b>5.4.1</b>                                      | Requirements for production control test plates for non 9 % Ni       |
| <b>5.6.2</b>                                      | NDT or parent plates                                                 |
| <b>5.6.6.6</b>                                    | Specific method of marking                                           |
| <b>5.8.2.6</b>                                    | Use of differential pressure in testing or multi-compartment vessels |
| <b>5.8.8.1</b>                                    | Gas leak test before Hydraulic or pneumatic tests                    |
| <b>C.1.2.3</b>                                    | Design conditions for cyclic operation in creep range                |
| <b>D.7.2.2</b>                                    | Heat treatment of production test plates with the vessel             |
| <b>D.7.2.2a)</b>                                  | Use of previous results of production test plates                    |
| <b>D.7.2.2b)</b>                                  | Requirements for production weld test plates                         |
| <b>D.7.2.2</b>                                    | Additional tests on test plates                                      |
| <b>N.1.1</b>                                      | Use of annex N for non-UK applications                               |
| <b>N.1.3</b>                                      | Definition of information for purchase specification                 |
| <b>N.2.2</b>                                      | Extent information to be provided by manufacturer                    |
| <b>N.2.3</b>                                      | Requirement for manufacturer to recommend periodic examination       |
| <b>S</b>                                          | Optional documentation                                               |
| <b>T.5.1</b>                                      | Optional tube-end joint tests                                        |
| <b>V.7</b>                                        | Records for serially produced vessels                                |

**Table 1.4-1 Purchase specification options** *(continued)*

| Clause            | Item                                          |
|-------------------|-----------------------------------------------|
| <b>Al.5.4.1</b>   | Need for production control test plates       |
| <b>Al.5.5.3</b>   | Transverse tensile tests for welder approval  |
| <b>Al.5.6.6.6</b> | Specific marking for NDT                      |
| <b>Cu.3.4.1</b>   | Choice of construction category               |
| <b>Cu.5.4.1</b>   | Production control test pieces for C106 alloy |

| <b>Table 1.4-2 Items for manufacturer, purchaser and/or Inspecting Authority agreement</b> |                                                                                     |
|--------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| <b>Clause</b>                                                                              | <b>Item</b>                                                                         |
| <b>2.2.2.1c</b>                                                                            | Use of non BS, BS EN or European approved materials                                 |
| <b>2.3.1.1a</b>                                                                            | Procedure of determination of design strength                                       |
| <b>2.1.2.2.1</b>                                                                           | Choice of equivalent M band                                                         |
| <b>2.2.1</b>                                                                               | Consideration of materials for low temperature testing                              |
| <b>2.2.4</b>                                                                               | Requirements for material in bands M5 and M7 to M10                                 |
| <b>2.1.2.2.2.1</b>                                                                         | Use of steels with C content > 0.25 %                                               |
| <b>2.1.2.2.2.7 Note 2</b>                                                                  | Use of rolling process to achieve normalized properties                             |
| <b>Table 2.1.3 Note 5</b>                                                                  | Additional procedure for correction of minor defects in category 3 components       |
| <b>3.2.2b)</b>                                                                             | Alternative design methods                                                          |
| <b>3.2.2b) 4)</b>                                                                          | Alternative design by comparison with similar vessels                               |
| <b>3.2.3</b>                                                                               | Design vacuum with break valve                                                      |
| <b>3.3.3</b>                                                                               | Cladding thickness included in calculation in thickness                             |
| <b>3.4.2.1b) 2)</b>                                                                        | Alloy design stresses with PWHT not to table 4.4.1                                  |
| <b>3.8.1.4</b>                                                                             | Bolt design stresses higher than table 3.8-1                                        |
| <b>3.8.1.5</b>                                                                             | Use of plate material for hubbed flanges                                            |
| <b>3.9.2.1 Note</b>                                                                        | Ligament efficiency of non-standard tube end fixing                                 |
| <b>4.1.1</b>                                                                               | Commencement of manufacture before drawing approval                                 |
| <b>4.1.1</b>                                                                               | Modification of approved drawings                                                   |
| <b>4.1.6</b>                                                                               | Additional NDT after rectification of departure from tolerance                      |
| <b>4.2.1.1</b>                                                                             | Dressing of cut edges of ferritic steels                                            |
| <b>4.2.1.2</b>                                                                             | Major defect notification and rectification                                         |
| <b>4.2.2.2</b>                                                                             | NDT method on butt welded plates prior to forming                                   |
| <b>4.2.2.4.1</b>                                                                           | Ferritic steel: forming procedure involving plate heating; possible supporting data |
| <b>4.2.2.4.2</b>                                                                           | Austenitic steel: forming procedure involving plate heating                         |
| <b>4.2.2.5</b>                                                                             | Sectional flanging for dished ends                                                  |
| <b>4.2.3.1a)</b>                                                                           | Assembly tolerance of longitudinal joints $e > 200$ mm                              |
| <b>4.2.3.1b)</b>                                                                           | Assembly tolerance of circumferential joints $e > 200$ mm                           |
| <b>4.2.4.2.3</b>                                                                           | Circularity tolerance at nozzle                                                     |
| <b>4.3.2.2</b>                                                                             | Weld metal properties for 9 % Ni                                                    |
| <b>4.3.2.4</b>                                                                             | Austenitic stainless steel consumables for 9 % Ni below $-101$ °C                   |
| <b>4.3.6.2</b>                                                                             | Permanent backing strips for inaccessible second side                               |
| <b>4.3.6.2</b>                                                                             | Backing strips for tubes                                                            |
| <b>4.4.3.1a)</b>                                                                           | PWHT ferritic steel thicker than table 4.4-1                                        |
| <b>4.4.3.1</b>                                                                             | Welding of lightly loaded parts after heat treatment                                |
| <b>4.4.3.5</b>                                                                             | PWHT for austenitic stainless steel                                                 |
| <b>4.4.4.4b)</b>                                                                           | Requirements for local heat treatment of branches                                   |
| <b>4.4.5.1</b>                                                                             | Alternative PWHT to tables 4.4-1 and 4.4-2                                          |
| <b>4.4.5.1</b>                                                                             | PWHT for non-M0 or M1 materials                                                     |
| <b>Table 4.4-1</b>                                                                         | Thickness limits for PWHT of 3½ Ni                                                  |
| <b>Table 4.4-1 Note 3</b>                                                                  | PWHT of 9 % Ni                                                                      |
| <b>5.2.5</b>                                                                               | Criteria for all weld test                                                          |
| <b>5.3.3</b>                                                                               | Retake whole or part of welder approval test                                        |

**Table 1.4-2 Items for manufacturer, purchaser and/or Inspecting Authority agreement** *(continued)*

| Clause          | Item                                                                      |
|-----------------|---------------------------------------------------------------------------|
| 5.4.1           | Number and details of production control test plates for non-9 % Ni       |
| 5.4.2           | Number and details of production control test plates for 9 % Ni           |
| 5.6.2           | Acceptance standards for flaws in parent plates and NDT of repairs        |
| 5.6.4.1.2       | Method of examination for surface flaws in type A welds                   |
| 5.6.4.3         | Additional testing for visual examination for category 3 components       |
| 5.6.5.1         | Choice of NDT method                                                      |
| 5.6.5.2         | Alternative NDT methods to assess depth surface defects                   |
| 5.6.6.1         | Alternative radiographic techniques                                       |
| 5.7.2.2         | Deviation from acceptance criteria of tables 5.7-1 to 5.7-3               |
| 5.7.2           | Assessment of defects to annex U                                          |
| 5.7.3           | Repair of welds                                                           |
| 5.8.2.2         | Pressure test procedure                                                   |
| 5.8.2.4         | Elevation of test temperature to avoid brittle fracture                   |
| 5.8.2.5         | Pressure test procedure for large vessels                                 |
| 5.8.4.1         | Consultation for pneumatic testing                                        |
| 5.8.5.5         | Testing vacuum vessels with anti-vacuum valves                            |
| 5.8.6.1         | Proof test procedure                                                      |
| 5.8.6.2         | Strain indicating coating proof test                                      |
| 5.9.1           | Quality specification for castings                                        |
| 5.9.2           | Examination and heat treatment of weld repair of cast components          |
| C.3.4.3.1       | Raising the weld class for cyclic loading                                 |
| C.3.4.6.4       | Stress factor for machined weld toes                                      |
| D.1             | Alternative to annex D requirements                                       |
| D.7.2.2         | Waiving of impact tests on production weld test plates                    |
| D.7.2.3 Note    | Position of impact test specimen                                          |
| D.7.1 Note      | Alternative toughness requirements using annex U                          |
| H.3.2           | PWHT of different material grades with differences in temperature > 10 °C |
| H.5.3           | Time at PWHT                                                              |
| J               | Fitting of additional pressure relief valve(s)                            |
| K.1.4.1.2       | Extrapolation of upper temperature stress values                          |
| K.1.4.2 Note 1d | Design strengths at higher temperatures                                   |
| K.1.4.2 Note 17 | Design strengths for slit rimming tubes                                   |
| Q.1.3           | Selection of test specimen                                                |
| Q.2.3.2         | Maximum strength of all-weld tensiles                                     |
| Q.2.6           | Micro-examination of production control test plates                       |
| T.4.3a)         | Alternative leak test method for tube-end joints                          |
| T.5.3           | Tracer gas test of tube-end joints                                        |
| T.5.4           | Radiography for back-face tube to tubesheet welds                         |
| T.5.5           | Testing production control test pieces                                    |
| T.5.5           | Frequency of production control test pieces for tube-end joints           |
| U.1             | Fracture mechanics approach                                               |
| V.4.4           | Reduction in extent of weld examination for serially produced vessels     |

**Table 1.4-2 Items for manufacturer, purchaser and/or Inspecting Authority agreement** *(continued)*

| Clause                | Item                                                                          |
|-----------------------|-------------------------------------------------------------------------------|
| Al table 2.3-1 Note 1 | Tube produced by the porthole/bridge method                                   |
| Al.4.2.2.1            | Use of local heating and hammering for forming                                |
| Al.4.2.2.4.2          | Softening for cold worked aluminium                                           |
| Al.4.3.6.2            | Use of backing rings in circumferential butt joints in tubing                 |
| Al.4.3.7.7            | Alternative of two layers of weld metal at branches etc.                      |
| Al.4.4.3.1            | Details of any post weld heat treatment                                       |
| Al.5.4.1              | Number and detail of production control test plates                           |
| Al.5.4.4              | Selection of test specimen                                                    |
| Al.5.5.5              | Optional micro examination of production, welder and production control tests |
| Al.5.6.2              | Acceptance standards and techniques for defects in parent materials           |
| Al.5.6.4.1.2          | Need for surface flaw examination of full penetration butt welds              |
| Al.5.6.5.2            | Alternative method for surface flaw detection                                 |
| Al.5.7.3.2            | Alternative acceptance levels for assessment defects                          |
| Al.5.7.4              | Repair of welds                                                               |
| Ni.4.4.1              | Heat treatment procedure for PWHT                                             |
| Cu.4.2.2.3            | Heat treatment after cold forming                                             |
| Cu.4.3.2              | Non-matching filler rod metals                                                |
| Cu.4.3.6              | Temporary/consumable backing strips for circumferential tube welds            |
| Cu.4.4.1              | Preheat requirements for each type of weld                                    |
| Cu.5.4.1              | Details of production control testing of C106 sheet                           |
| Cu.5.4.2              | Details of production control testing of non-C106 alloys                      |
| Cu.5.5.4              | Macro- and micro-examination of test specimen                                 |
| Cu.5.6.2              | Acceptance standards for defects in parent material                           |
| Cu.5.6.6.1            | Alternative to radiographic techniques                                        |

## Form X Certificate of Conformance

### Vessel description

Type.....  
 Approx. overall dimensions.....  
 Approved drawing number(s).....  
 .....  
 .....  
 .....  
 .....

Year of manufacture ..... Relevant PD 5500 edition including Amd. No(s).....

Purchaser ..... Purchaser's serial no. ....

### Manufacture

Name of manufacturer.....  
 Manufacturer's serial number..... (see note 1)  
 Name of Design Organization (if not above manufacturer) .....  
 Name of Inspecting Authority.....

### Design

| Design conditions of principal components<br>(see notes 2 and 3) | Design pressure<br>bar | Design temp.<br>°C | Construction category | Corrosion allowance<br>mm |
|------------------------------------------------------------------|------------------------|--------------------|-----------------------|---------------------------|
| .....                                                            | .....                  | .....              | .....                 | .....                     |
| .....                                                            | .....                  | .....              | .....                 | .....                     |
| .....                                                            | .....                  | .....              | .....                 | .....                     |
| .....                                                            | .....                  | .....              | .....                 | .....                     |
| .....                                                            | .....                  | .....              | .....                 | .....                     |

Other factors affecting design (e.g. weight, nature of contents, environment)  
 (see notes 3 and 4)

.....  
 .....  
 .....  
 .....  
 .....

### Post-weld heat treatment

| Component | Temperature<br>°C | Holding time<br>h |
|-----------|-------------------|-------------------|
| .....     | .....             | .....             |
| .....     | .....             | .....             |
| .....     | .....             | .....             |
| .....     | .....             | .....             |
| .....     | .....             | .....             |
| .....     | .....             | .....             |
| .....     | .....             | .....             |

### Pressure test

| Location<br>(see note 5) | Test pressure<br>bar | Test medium and temperature | Date  |
|--------------------------|----------------------|-----------------------------|-------|
| .....                    | .....                | .....                       | ..... |
| .....                    | .....                | .....                       | ..... |
| .....                    | .....                | .....                       | ..... |
| .....                    | .....                | .....                       | ..... |

Form X (continued)

Certificate of Conformance (design)

We hereby certify that the design of this vessel conforms to PD 5500

Date:

For manufacturer (see note 6):

Position: Name of company:

We hereby confirm that we have checked the design of the above vessel and that this conforms to PD 5500.

Date:

For Inspecting Authority:

Position: Name of company:

Certificate of Conformance (construction and testing)

We hereby certify that this vessel has been constructed and tested in conformance with PD 5500.

Date:

For manufacturer:

Position: Name of company:

We hereby confirm that the construction and testing of the above vessel has been carried out under our surveillance and that to the best of our knowledge and belief all aspects to this work conforms to PD 5500.

Date:

For Inspecting Authority:

Position: Name of company:

To this certificate shall be attached, where appropriate, the records of any items that caused an XX designation along with the records of the decisions arrived at on any items from table 1.4-2 that were subject to agreement.

NOTE 1. The suffix 'XX' is to be added to the serial number of each vessel for which any deviations or concessions have been authorized (see 1.4.2 and 1.4.4).

NOTE 2. The design conditions associated with the operational duties specified by the purchaser should be given.

If a purchaser wishes to change the operational duty of a vessel, revised design conditions, consistent with the vessel scantlings, will be established separately, as appropriate.

NOTE 3. Where the design covers operation below 0 °C the various combinations of temperature, pressure and calculated membrane stresses considered in determining the minimum design temperature (see 3.2.5 and annex D) should be stated.

NOTE 4. Where appropriate, cross reference to drawings or specifications will suffice.

NOTE 5. Where a vessel is tested in a different orientation to that in which it will normally operate, this should be stated.

NOTE 6. This part of the Certificate to be signed by the purchaser in cases where the purchaser elects to perform the design function (see 1.4.4).

## 1.5 Information and requirements to be agreed and to be documented

### 1.5.1 Information to be supplied by the purchaser

The following information shall be supplied by the purchaser and shall be fully documented.

- a) The normal working conditions of the required vessel, together with details of any transient cyclic and/or adverse conditions in which the vessel is required to operate and any special requirements for in-service inspection.
- b) Any requirements relating to the various options covered by the purchase specification (see 1.4.1).
- c) Any special statutory or other regulations with which the finished vessel is required to comply.
- d) The name of the Inspecting Authority to be commissioned by the purchaser.
- e) The name of the Regulating Authority (if any).
- f) The requirement to obtain copies for record purposes of any documents other than those listed in 1.5.2.2a to g (see table 1.5-1). (To facilitate the identification of such documents, a check list of optional documents is given in annex S.)

Where the purchaser elects to perform the design function for the vessel, the purchaser shall supply any additional design information required by the manufacturer in accordance with 1.4.2. The design dossier maintained by the purchaser in accordance with 1.4.1 shall cover all the information (whether supplied by the purchaser or by the manufacturer) which the manufacturer would otherwise be required by 4.1.1 to submit before commencing manufacture.

The fulfilment of specified requirements and the availability of documentation/records identified shall both be satisfied before a claim of conformance with the specification can be made and verified.

### 1.5.2 Information to be supplied by the manufacturer

The information in 1.5.2.1 and 1.5.2.2 shall be supplied by the manufacturer and shall be fully documented.

The fulfilment of specified requirements and the availability of documentation/records identified shall both be satisfied before a claim of conformance with the specification can be made and verified.

#### 1.5.2.1 Before commencement of manufacture

The manufacturer shall submit the information specified in 4.1.1 for approval before commencement of manufacture. In submitting this information, the manufacturer shall identify, in an appropriate manner, any features of the proposed design and/or in the proposed manufacturing, inspection or test procedures which by the terms of this specification require to be approved by the purchaser.

NOTE. Table 1.4-2 lists such features. The features should be identified in an appropriate document such as purchase order, approved drawing or an approved working procedure (e.g. weld preparation procedure, heat treatment procedure, welding procedure etc.).

#### 1.5.2.2 On completion of construction

The manufacturer shall supply to the purchaser for record purposes a copy of the following documentation, as finally approved, for each vessel or batch of vessels.

- a) A fully dimensioned drawing of the vessel, as built, together with any relevant supporting information as specified in 4.1.1 and which is not covered by items b) to g) as follows.
- b) A list of materials (including welding consumables) used in the construction of the vessel with details of any special heat treatments carried out by the material supplier.

NOTE 1. For materials specified to a British Standard the date of the standard is to be given. Where other materials are used (see 2.1.2.1b) the full specification is to be supplied.

- c) Factors effecting the equipment operation or design life - safe operating limits and design basis (which may be on the drawings).
- d) Factors effecting the design life i.e.:

- 1) Creep - design hours of operation at specified temperature.
- 2) Fatigue - design number of cycles at specified stress levels.
- 3) Corrosion - design corrosion allowance.
- 4) Residual hazards not prevented by design or protective measures that might arise from foreseeable misuse.
- 5) Information about replaceable parts (liners, wear plates etc.).

- e) The welding procedures used during vessel manufacture (see 5.2.2).

- f) The procedures used for radiography, ultrasonic inspection and/or crack detection of welds (see 5.6.6.1 to 5.6.6.4).

- g) Records detailing all deviations from this specification and the decisions made on all matters subject to agreement (see 1.4.2).

- h) A Certificate of Conformance (Form X) for each vessel (see 1.4.4).

- i) A facsimile of the vessel nameplate (see 5.8.9).

- j) Details of any statutory required marking (e.g. CE marking).

- k) Operating instructions for mounting, putting into service its use and maintenance (as far as is relevant).

NOTE 2. The duration for which a manufacturer will retain all records produced during the manufacture of a vessel is influenced by a number of factors that are outside the scope of this standard.

1.6 Thicknesses

Thicknesses are referred to in several ways in this specification in accordance with the following definitions.

- a) Minimum thickness; the thickness calculated in section 3 and some design annexes, to satisfy the relevant design requirement.
- b) Nominal thickness; the thickness as specified on the construction drawing which includes all allowances and tolerances.
- c) Analysis thickness; the thickness used in design calculations and assessments, which equals the nominal thickness less corrosion allowances and less any other allowances and tolerances.

The nominal thickness, less any negative tolerance permitted by the specification to which the material is ordered, shall not be less than the minimum thickness plus any allowances specified for corrosion, erosion etc.

The relationships between the defined thicknesses are shown in Figure 1.6-1. This figure indicates:

- a) on the left hand side, that the thickness calculated from the rules is increased by the amount of the specified allowances (for effects such as corrosion) and possibly by an unspecified margin (in consideration, for example, of materials availability);
- b) on the right hand side, that the nominal thickness should be reduced by any negative supply (i.e. negative plate thickness) tolerance and any manufacturing (i.e. dishing) allowances as well as by the specified design allowances, to arrive at the analysis thickness.

NOTE. Following the replacement of BS 1501 by BS EN 10028, it should be noted that plate conforming to this latter specification is normally supplied in accordance with BS EN 10029 class B which permits a negative tolerance of 0.3 mm for all nominal thicknesses. However, the purchaser may specify a zero negative tolerance.

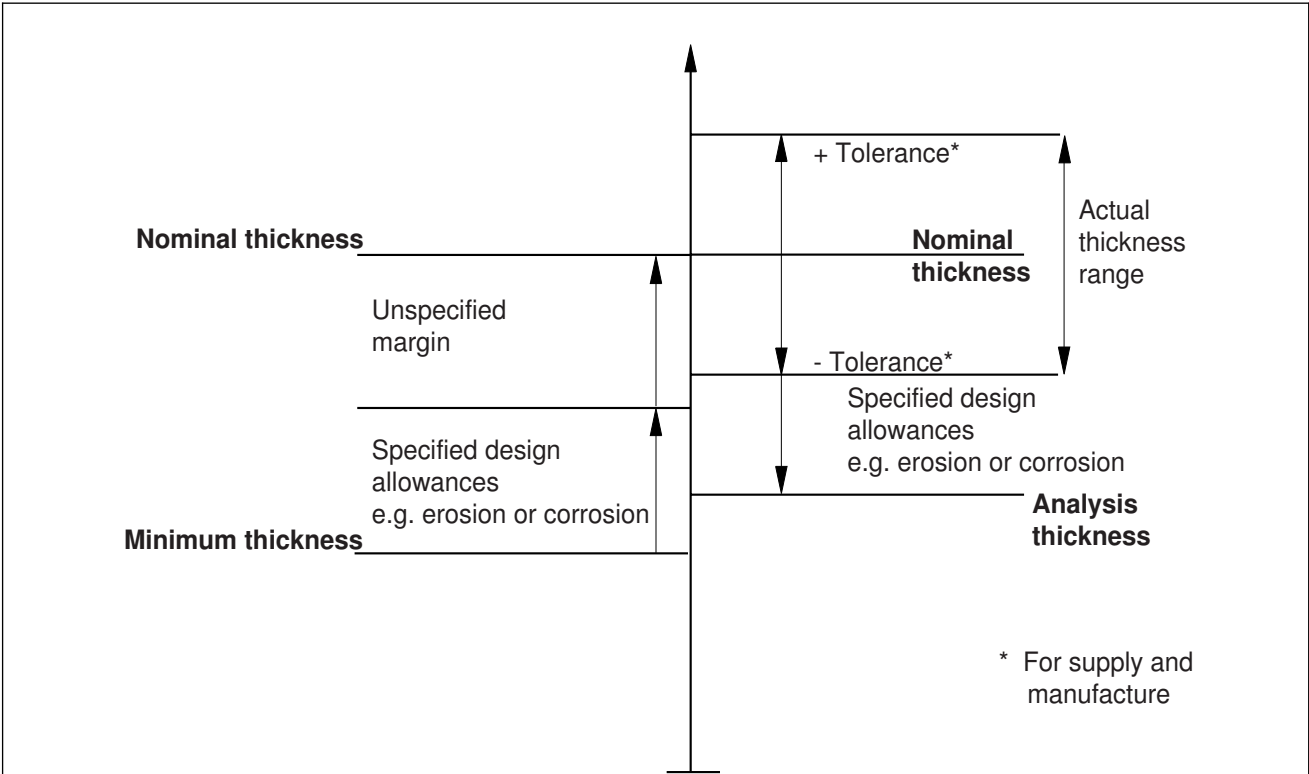


Figure 1.6-1 Relationship of thickness definitions

## Section 2. Materials

### 2.1 Selection of materials

#### 2.1.1 General

**2.1.1.1** The selection of the materials of construction for pressure containing parts and their integral attachments shall take into account the suitability of the material with regard to fabrication<sup>2)</sup> and to the conditions under which they will eventually operate.

**2.1.1.2** Any special limits for the materials of construction, e.g. composition, heat treatment and non-destructive testing (NDT), which are different to those given in this specification shall be specified in the purchase specification.

**2.1.1.3** For the ease of reference throughout this specification, ferritic materials, with the exception of the following, have been grouped into “M” bands as summarized in table 2.1-1 (which also indicates the equivalent material group, as used by CEN, derived from PD CR ISO 15608 : 2000):

- 1½Ni;
- martensitic stainless steel;
- ferritic stainless steel;
- austenitic stainless steel;
- clad material;
- duplex austenitic-ferritic stainless steel;
- quenched and tempered fine grain steel.

#### 2.1.2 Materials for pressure parts

##### 2.1.2.1 General

All the materials used in the manufacture of pressure parts shall:

- a) conform to BS EN steels given in table 2.1-2; or
- b) conform to BS steels given in table K.1-2 to K.1-12; or
- c) be agreed between purchaser, Inspecting Authority and manufacturer, be documented [see 1.5.2.2b)] and shall conform to 2.1.2.2; or

d) be the subject of a “European approval for material” in accordance with the EU directive 97/23/EC; or

e) be detailed in supplements, annexes or enquiry cases to this specification.

Welding material shall conform to sections 4 and 5.

The option to be able to use castings for pressure parts shall be specified in the purchase specification. An appropriate “quality specification” for such castings shall be agreed between the manufacturer and material supplier at the time of enquiry, specifying the standards of inspection to be applied and of acceptance for defects. As a minimum, all accessible fillets and changes of section, etc., shall be subject to magnetic particle or penetrant inspection.

Bolts and nuts shall conform to the material specifications listed in tables 3 and 4 of BS 4882 or table 3 of BS 1473.

##### 2.1.2.2 Materials covered by 2.1.2.1c)

###### 2.1.2.2.1 General

The material shall be covered by a written specification at least as comprehensive as the nearest equivalent British Standard listed in table 2.1-2. The written specification shall as a minimum specify the manufacturing process, compositional limits for all constituents, deoxidation practice, heat treatment and appropriate mechanical properties for acceptance and other purposes.

An equivalent “M” band for the material shall be chosen and agreed between manufacturer, inspection authority and purchaser. This “M” banding shall be used to assist in the selection of manufacturing and inspection requirements of sections 4 and 5.

**Table 2.1-1 Material banding**

| PD 5500 Band | Material type                                          | EN material group       |
|--------------|--------------------------------------------------------|-------------------------|
| M0, M1       | Carbon and carbon manganese steel                      | 1.1, 1.2, 1.3, 1.5, 2.1 |
| M2           | Carbon molybdenum steel                                | 1.4                     |
| M4           | Low alloy magnesium chromium molybdenum vanadium steel | 4.1, 4.2                |
| M5           | 3½Ni                                                   | 9.1, 9.2                |
| M6           | 9Ni                                                    | 9.3                     |
| M7           | 1 to 1½Cr ½Mo                                          | 5.1                     |
| M8           | ½Cr ½Mo ¼V                                             | 6.1                     |
| M9           | 2¼Cr1Mo                                                | 5.2                     |
| M10          | 5Cr½Mo                                                 | 5.3                     |
| M11          | 9Cr1Mo                                                 | 5.4                     |
| M12          | 12Cr1Mo1V                                              | 6.4                     |

<sup>2)</sup> See BS EN 1011 for general guidance on the susceptibility of materials to lamellar tearing during fabrication

| Table 2.1-2 List of materials covered by BS EN material standards |                 |               |                                 |            |                 |                              |              |      |                                   |       |
|-------------------------------------------------------------------|-----------------|---------------|---------------------------------|------------|-----------------|------------------------------|--------------|------|-----------------------------------|-------|
| 1                                                                 | 2               | 3             | 4                               | 5          | 6               | 7                            | 8            |      | 9                                 | 10    |
| No.                                                               | Product form    | EN standard   | Material description            | Grade      | Material number | Heat treatment <sup>1)</sup> | Thickness mm |      | Material Group to PD CR ISO 15608 | Notes |
|                                                                   |                 |               |                                 |            |                 |                              | min.         | max. |                                   |       |
| 1                                                                 | Plate and strip | BS EN 10028-2 | Elevated temperature properties | P235GH     | 1.0345          | N                            | 0            | 150  | 1.1                               | a)    |
| 2                                                                 | Plate and strip | BS EN 10028-2 | Elevated temperature properties | P265GH     | 1.0425          | N                            | 0            | 150  | 1.1                               | a)    |
| 3                                                                 | Plate and strip | BS EN 10028-2 | Elevated temperature properties | P295GH     | 1.0481          | N                            | 0            | 150  | 1.2                               | a)    |
| 4                                                                 | Plate and strip | BS EN 10028-2 | Elevated temperature properties | P355GH     | 1.0473          | N                            | 0            | 150  | 1.2                               | a)    |
| 5                                                                 | Plate and strip | BS EN 10028-2 | Elevated temperature properties | 16Mo3      | 1.5415          | N                            | 0            | 150  | 1.1                               | a) f) |
| 6                                                                 | Plate and strip | BS EN 10028-2 | Elevated temperature properties | 13CrMo4-5  | 1.7335          | NT                           | 0            | 60   | 5.1                               | a)    |
| 7                                                                 | Plate and strip | BS EN 10028-2 | Elevated temperature properties | 13CrMo4-5  | 1.7335          | NT QT                        | 60           | 100  | 5.1                               | a)    |
| 8                                                                 | Plate and strip | BS EN 10028-2 | Elevated temperature properties | 13CrMo4-5  | 1.7335          | QT                           | 100          | 150  | 5.1                               | a)    |
| 9                                                                 | Plate and strip | BS EN 10028-2 | Elevated temperature properties | 10CrMo9-10 | 1.7380          | NT                           | 0            | 60   | 5.2                               | a)    |
| 10                                                                | Plate and strip | BS EN 10028-2 | Elevated temperature properties | 10CrMo9-10 | 1.7380          | NT QT                        | 60           | 100  | 5.2                               | a)    |
| 11                                                                | Plate and strip | BS EN 10028-2 | Elevated temperature properties | 10CrMo9-10 | 1.7380          | QT                           | 100          | 150  | 5.2                               | a)    |
| 12                                                                | Plate and strip | BS EN 10028-2 | Elevated temperature properties | 11CrMo9-10 | 1.7383          | NT QT                        | 0            | 60   | 5.2                               | a)    |
| 13                                                                | Plate and strip | BS EN 10028-2 | Elevated temperature properties | 11CrMo9-10 | 1.7383          | QT                           | 60           | 100  | 5.2                               | a)    |
| 14                                                                | Plate and strip | BS EN 10028-3 | Fine grain steel normalized     | P275N      | 1.0486          | N                            | 0            | 150  | 1.1                               | a)    |
| 15                                                                | Plate and strip | BS EN 10028-3 | Fine grain steel normalized     | P275NH     | 1.0487          | N                            | 0            | 150  | 1.1                               | a)    |
| 16                                                                | Plate and strip | BS EN 10028-3 | Fine grain steel normalized     | P275NL1    | 1.0488          | N                            | 0            | 150  | 1.1                               | a)    |
| 17                                                                | Plate and strip | BS EN 10028-3 | Fine grain steel normalized     | P275NL2    | 1.1104          | N                            | 0            | 150  | 1.1                               | a)    |
| 18                                                                | Plate and strip | BS EN 10028-3 | Fine grain steel normalized     | P355N      | 1.0562          | N                            | 0            | 150  | 1.2                               | a)    |
| 19                                                                | Plate and strip | BS EN 10028-3 | Fine grain steel normalized     | P355NH     | 1.0565          | N                            | 0            | 150  | 1.2                               | a)    |
| 20                                                                | Plate and strip | BS EN 10028-3 | Fine grain steel normalized     | P355NL1    | 1.0566          | N                            | 0            | 150  | 1.2                               | a)    |
| 21                                                                | Plate and strip | BS EN 10028-3 | Fine grain steel normalized     | P355NL2    | 1.1106          | N                            | 0            | 150  | 1.2                               | a)    |
| 22                                                                | Plate and strip | BS EN 10028-4 | Low temperature properties      | 11MnNi5-3  | 1.6212          | N NT                         | 0            | 50   | 9.1                               | a)    |
| 23                                                                | Plate and strip | BS EN 10028-4 | Low temperature properties      | 13MnNi6-3  | 1.6217          | N NT                         | 0            | 50   | 9.1                               | a)    |
| 24                                                                | Plate and strip | BS EN 10028-4 | Low temperature properties      | 15NiMn6    | 1.6228          | N NT QT                      | 0            | 50   | 9.1                               | a)    |
| 25                                                                | Plate and strip | BS EN 10028-4 | Low temperature properties      | 12Ni14     | 1.5637          | N NT QT                      | 0            | 50   | 9.2                               | a)    |
| 26                                                                | Plate and strip | BS EN 10028-4 | Low temperature properties      | 12Ni19     | 1.5680          | N NT QT                      | 0            | 50   | 9.2                               | a)    |

**Table 2.1-2 List of materials covered by BS EN material standards** *(continued)*

| 1<br>No. | 2<br>Product form | 3<br>EN standard | 4<br>Material description           | 5<br>Grade           | 6<br>Material number | 7<br>Heat treatment <sup>1)</sup> | 8<br>Thickness<br>mm |      | 9<br>Material Group to PD CR ISO 15608 | 10<br>Notes |
|----------|-------------------|------------------|-------------------------------------|----------------------|----------------------|-----------------------------------|----------------------|------|----------------------------------------|-------------|
|          |                   |                  |                                     |                      |                      |                                   | min.                 | max. |                                        |             |
| 27       | Plate and strip   | BS EN 10028-4    | Low temperature properties          | X8Ni9                | 1.5662               | N NT QT                           | 0                    | 50   | 9.3                                    | a)          |
| 28       | Plate and strip   | BS EN 10028-4    | Low temperature properties          | X7Ni9                | 1.5663               | QT                                | 0                    | 50   | 9.3                                    | a)          |
| 29       | Plate and strip   | BS EN 10028-6    | Fine grain steel, quenched/tempered | P355Q                | 1.8866               | QT                                | 0                    | 150  | 1.2                                    | a)          |
| 30       | Plate and strip   | BS EN 10028-6    | Fine grain steel, quenched/tempered | P355QH               | 1.8867               | QT                                | 0                    | 150  | 1.2                                    | a)          |
| 31       | Plate and strip   | BS EN 10028-6    | Fine grain steel, quenched/tempered | P355QL1              | 1.8868               | QT                                | 0                    | 150  | 1.2                                    | a)          |
| 32       | Plate and strip   | BS EN 10028-6    | Fine grain steel, quenched/tempered | P355QL2              | 1.8869               | QT                                | 0                    | 150  | 1.2                                    | a)          |
| 33       | Plate and strip   | BS EN 10028-7    | Stainless steel, austenitic         | X2CrNiN18-7          | 1.4318               | AT                                | 0                    | 75   | 8.1                                    | a)          |
| 34       | Plate and strip   | BS EN 10028-7    | Stainless steel, austenitic         | X2CrNi18-9           | 1.4307               | AT                                | 0                    | 75   | 8.1                                    | a)          |
| 35       | Plate and strip   | BS EN 10028-7    | Stainless steel, austenitic         | X2CrNi19-11          | 1.4306               | AT                                | 0                    | 75   | 8.1                                    | a)          |
| 36       | Plate and strip   | BS EN 10028-7    | Stainless steel, austenitic         | X2CrNi18-10          | 1.4311               | AT                                | 0                    | 75   | 8.1                                    | a)          |
| 37       | Plate and strip   | BS EN 10028-7    | Stainless steel, austenitic         | X5CrNi18-10          | 1.4301               | AT                                | 0                    | 75   | 8.1                                    | a)          |
| 38       | Plate and strip   | BS EN 10028-7    | Stainless steel, austenitic         | X5CrNi19-9           | 1.4315               | AT                                | 0                    | 75   | 8.1                                    | a)          |
| 39       | Plate and strip   | BS EN 10028-7    | Stainless steel, austenitic         | X6CrNi18-10          | 1.4948               | AT                                | 0                    | 75   | 8.1                                    | a)          |
| 40       | Plate and strip   | BS EN 10028-7    | Stainless steel, austenitic         | X6CrNi23-13          | 1.4950               | AT                                | 0                    | 75   | 8.2                                    | a)          |
| 41       | Plate and strip   | BS EN 10028-7    | Stainless steel, austenitic         | X6CrNi25-20          | 1.4951               | AT                                | 0                    | 75   | 8.2                                    | a)          |
| 42       | Plate and strip   | BS EN 10028-7    | Stainless steel, austenitic         | X6CrNiTi18-10        | 1.4541               | AT                                | 0                    | 75   | 8.1                                    | a)          |
| 43       | Plate and strip   | BS EN 10028-7    | Stainless steel, austenitic         | X6CrNiTiB18-10       | 1.4941               | AT                                | 0                    | 75   | 8.1                                    | a)          |
| 44       | Plate and strip   | BS EN 10028-7    | Stainless steel, austenitic         | X2CrNiMo17-12-2      | 1.4404               | AT                                | 0                    | 75   | 8.1                                    | a)          |
| 45       | Plate and strip   | BS EN 10028-7    | Stainless steel, austenitic         | X2CrNiMoN17-11-2     | 1.4406               | AT                                | 0                    | 75   | 8.1                                    | a)          |
| 46       | Plate and strip   | BS EN 10028-7    | Stainless steel, austenitic         | X5CrNiMo17-12-2      | 1.4401               | AT                                | 0                    | 75   | 8.1                                    | a)          |
| 47       | Plate and strip   | BS EN 10028-7    | Stainless steel, austenitic         | X6CrNiMoTi17-12-2    | 1.4571               | AT                                | 0                    | 75   | 8.1                                    | a)          |
| 48       | Plate and strip   | BS EN 10028-7    | Stainless steel, austenitic         | X2CrNiMo17-12-3      | 1.4432               | AT                                | 0                    | 75   | 8.1                                    | a)          |
| 49       | Plate and strip   | BS EN 10028-7    | Stainless steel, austenitic         | X2CrNiMo18-14-3      | 1.4435               | AT                                | 0                    | 75   | 8.1                                    | a)          |
| 50       | Plate and strip   | BS EN 10028-7    | Stainless steel, austenitic         | X2CrNiMoN17-13-5     | 1.4439               | AT                                | 0                    | 75   | 8.1                                    | a)          |
| 51       | Plate and strip   | BS EN 10028-7    | Stainless steel, austenitic         | X1NiCrMoCu25-20-5    | 1.4539               | AT                                | 0                    | 75   | 8.2                                    | a)          |
| 52       | Plate and strip   | BS EN 10028-7    | Stainless steel, austenitic         | X5NiCrAlTi31-20      | 1.4958               | AT                                | 0                    | 75   | 8.2                                    | a)          |
| 53       | Plate and strip   | BS EN 10028-7    | Stainless steel, austenitic         | X5NiCrAlTi31-20 + RA | 1.4958+RA            | AT                                | 0                    | 75   | 8.2                                    | a)          |

| Table 2.1-2 List of materials covered by BS EN material standards (continued) |                   |                  |                                      |                    |                      |                                   |                      |      |                                              |             |
|-------------------------------------------------------------------------------|-------------------|------------------|--------------------------------------|--------------------|----------------------|-----------------------------------|----------------------|------|----------------------------------------------|-------------|
| 1<br>No.                                                                      | 2<br>Product form | 3<br>EN standard | 4<br>Material description            | 5<br>Grade         | 6<br>Material number | 7<br>Heat treatment <sup>1)</sup> | 8<br>Thickness<br>mm |      | 9<br>Material Group to<br>PD CR ISO<br>15608 | 10<br>Notes |
|                                                                               |                   |                  |                                      |                    |                      |                                   | min.                 | max. |                                              |             |
| 54                                                                            | Plate and strip   | BS EN 10028-7    | Stainless steel, austenitic          | X8NiCrAlTi32-21    | 1.4959               | AT                                | 0                    | 75   | 8.2                                          | a)          |
| 55                                                                            | Plate and strip   | BS EN 10028-7    | Stainless steel, austenitic          | X3CrNiMoBN17-13-3  | 1.4910               | AT                                | 0                    | 75   | 8.1                                          | a)          |
| 56                                                                            | Plate and strip   | BS EN 10028-7    | Stainless steel, austenitic, special | X1CrNi25-21        | 1.4335               | AT                                | 0                    | 75   | 8.2                                          | a)          |
| 57                                                                            | Plate and strip   | BS EN 10028-7    | Stainless steel, austenitic, special | X6CrNiNb18-10      | 1.4550               | AT                                | 0                    | 75   | 8.1                                          | a)          |
| 58                                                                            | Plate and strip   | BS EN 10028-7    | Stainless steel, austenitic, special | X8CrNiNb16-13      | 1.4961               | AT                                | 0                    | 75   | 8.1                                          | a)          |
| 59                                                                            | Plate and strip   | BS EN 10028-7    | Stainless steel, austenitic, special | X1CrNiMoN25-22-2   | 1.4466               | AT                                | 0                    | 75   | 8.2                                          | a)          |
| 60                                                                            | Plate and strip   | BS EN 10028-7    | Stainless steel, austenitic, special | X6CrNiMoNb17-12-2  | 1.4580               | AT                                | 0                    | 75   | 8.1                                          | a)          |
| 61                                                                            | Plate and strip   | BS EN 10028-7    | Stainless steel, austenitic, special | X2CrNiMoN17-13-3   | 1.4429               | AT                                | 0                    | 75   | 8.1                                          | a)          |
| 62                                                                            | Plate and strip   | BS EN 10028-7    | Stainless steel, austenitic, special | X3CrNiMoN17-13-3   | 1.4436               | AT                                | 0                    | 75   | 8.1                                          | a)          |
| 63                                                                            | Plate and strip   | BS EN 10028-7    | Stainless steel, austenitic, special | X2CrNiMoN18-12-4   | 1.4434               | AT                                | 0                    | 75   | 8.1                                          | a)          |
| 64                                                                            | Plate and strip   | BS EN 10028-7    | Stainless steel, austenitic, special | X2CrNiMo18-15-4    | 1.4438               | AT                                | 0                    | 75   | 8.1                                          | a)          |
| 65                                                                            | Plate and strip   | BS EN 10028-7    | Stainless steel, austenitic, special | X1NiCrMoCu31-27-4  | 1.4563               | AT                                | 0                    | 75   | 8.2                                          | a)          |
| 66                                                                            | Plate and strip   | BS EN 10028-7    | Stainless steel, austenitic, special | X1CrNiMoCuN25-25-5 | 1.4537               | AT                                | 0                    | 75   | 8.2                                          | a)          |
| 67                                                                            | Plate and strip   | BS EN 10028-7    | Stainless steel, austenitic, special | X1CrNiMoCuN20-18-7 | 1.4547               | AT                                | 0                    | 75   | 8.2                                          | a)          |
| 68                                                                            | Plate and strip   | BS EN 10028-7    | Stainless steel, austenitic, special | X1NiCrMoCuN25-20-7 | 1.4529               | AT                                | 0                    | 75   | 8.2                                          | a)          |
| 69                                                                            | Bar               | BS EN 10272      | Stainless steel, austenitic          | X2CrNi18-9         | 1.4307               | AT                                | 0                    | 250  | 8.1                                          | a)          |
| 70                                                                            | Bar               | BS EN 10272      | Stainless steel, austenitic          | X2CrNi19-11        | 1.4306               | AT                                | 0                    | 250  | 8.1                                          | a)          |
| 71                                                                            | Bar               | BS EN 10272      | Stainless steel, austenitic          | X2CrNi18-10        | 1.4311               | AT                                | 0                    | 250  | 8.1                                          | a)          |
| 72                                                                            | Bar               | BS EN 10272      | Stainless steel, austenitic          | X5CrNi18-10        | 1.4301               | AT                                | 0                    | 250  | 8.1                                          | a)          |
| 73                                                                            | Bar               | BS EN 10272      | Stainless steel, austenitic          | X6CrNiTi18-10      | 1.4541               | AT                                | 0                    | 250  | 8.1                                          | a)          |
| 74                                                                            | Bar               | BS EN 10272      | Stainless steel, austenitic          | X2CrNiMo17-12-2    | 1.4404               | AT                                | 0                    | 250  | 8.1                                          | a)          |
| 75                                                                            | Bar               | BS EN 10272      | Stainless steel, austenitic          | X2CrNiMoN17-11-2   | 1.4406               | AT                                | 0                    | 250  | 8.1                                          | a)          |
| 76                                                                            | Bar               | BS EN 10272      | Stainless steel, austenitic          | X5CrNiMo17-12-2    | 1.4401               | AT                                | 0                    | 250  | 8.1                                          | a)          |
| 77                                                                            | Bar               | BS EN 10272      | Stainless steel, austenitic          | X6CrNiMoTi17-12-2  | 1.4571               | AT                                | 0                    | 250  | 8.1                                          | a)          |
| 78                                                                            | Bar               | BS EN 10272      | Stainless steel, austenitic          | X2CrNiMo17-12-3    | 1.4432               | AT                                | 0                    | 250  | 8.1                                          | a)          |
| 79                                                                            | Bar               | BS EN 10272      | Stainless steel, austenitic          | X2CrNiMo18-14-3    | 1.4435               | AT                                | 0                    | 250  | 8.1                                          | a)          |

**Table 2.1-2 List of materials covered by BS EN material standards** (*continued*)

| 1<br>No. | 2<br>Product form | 3<br>EN standard | 4<br>Material description       | 5<br>Grade         | 6<br>Material number | 7<br>Heat treatment <sup>1)</sup> | 8<br>Thickness<br>mm |      | 9<br>Material Group to PD CR ISO 15608 | 10<br>Notes |
|----------|-------------------|------------------|---------------------------------|--------------------|----------------------|-----------------------------------|----------------------|------|----------------------------------------|-------------|
|          |                   |                  |                                 |                    |                      |                                   | min.                 | max. |                                        |             |
| 80       | Bar               | BS EN 10272      | Stainless steel, austenitic     | X2CrNiMo17-13-5    | 1.4439               | AT                                | 0                    | 250  | 8.1                                    | a)          |
| 81       | Bar               | BS EN 10272      | Stainless steel, austenitic     | X1NiCrMoCu25-20-5  | 1.4539               | AT                                | 0                    | 250  | 8.2                                    | a)          |
| 82       | Bar               | BS EN 10272      | Stainless steel, austenitic     | X6CrNiNb18-10      | 1.4550               | AT                                | 0                    | 250  | 8.1                                    | a)          |
| 83       | Bar               | BS EN 10272      | Stainless steel, austenitic     | X6CrNiMoNb17-12-2  | 1.4580               | AT                                | 0                    | 250  | 8.1                                    | a)          |
| 84       | Bar               | BS EN 10272      | Stainless steel, austenitic     | X2CrNiMoN17-13-3   | 1.4429               | AT                                | 0                    | 250  | 8.1                                    | a)          |
| 85       | Bar               | BS EN 10272      | Stainless steel, austenitic     | X3CrNiMo17-13-3    | 1.4436               | AT                                | 0                    | 250  | 8.1                                    | a)          |
| 86       | Bar               | BS EN 10272      | Stainless steel, austenitic     | X1NiCrMoCu31-27-4  | 1.4563               | AT                                | 0                    | 250  | 8.2                                    | a)          |
| 87       | Bar               | BS EN 10272      | Stainless steel, austenitic     | X1CrNiMoCuN20-18-7 | 1.4547               | AT                                | 0                    | 250  | 8.2                                    | a)          |
| 88       | Bar               | BS EN 10272      | Stainless steel, austenitic     | X1NiCrMoCuN25-20-7 | 1.4529               | AT                                | 0                    | 250  | 8.2                                    | a)          |
| 89       | Bar               | BS EN 10273      | Elevated temperature properties | P235GH             | 1.0345               | N                                 | 0                    | 150  | 1.1                                    | a)          |
| 90       | Bar               | BS EN 10273      | Elevated temperature properties | P250GH             | 1.0460               | N                                 | 0                    | 150  | 1.1                                    | a)          |
| 91       | Bar               | BS EN 10273      | Elevated temperature properties | P265GH             | 1.0425               | N                                 | 0                    | 150  | 1.1                                    | a)          |
| 92       | Bar               | BS EN 10273      | Elevated temperature properties | P295GH             | 1.0481               | N                                 | 0                    | 150  | 1.2                                    | a)          |
| 93       | Bar               | BS EN 10273      | Elevated temperature properties | P355GH             | 1.0473               | N                                 | 0                    | 150  | 1.2                                    | a)          |
| 94       | Bar               | BS EN 10273      | Elevated temperature properties | P275NH             | 1.0487               | N                                 | 0                    | 150  | 1.1                                    | a)          |
| 95       | Bar               | BS EN 10273      | Elevated temperature properties | P355NH             | 1.0565               | N                                 | 0                    | 150  | 2.1                                    | a)          |
| 96       | Bar               | BS EN 10273      | Elevated temperature properties | P355QH             | 1.8867               | QT                                | 0                    | 150  | 1.2                                    | a)          |
| 97       | Bar               | BS EN 10273      | Elevated temperature properties | 16Mo3              | 1.5415               | N                                 | 0                    | 150  | 1.1                                    | a) f)       |
| 98       | Bar               | BS EN 10273      | Elevated temperature properties | 13CrMo4-5          | 1.7335               | NT QT                             | 60                   | 100  | 5.1                                    | a)          |
| 99       | Bar               | BS EN 10273      | Elevated temperature properties | 13CrMo4-5          | 1.7335               | QT                                | 100                  | 150  | 5.1                                    | a)          |
| 100      | Bar               | BS EN 10273      | Elevated temperature properties | 10CrMo9-10         | 1.7380               | NT                                | 0                    | 60   | 5.2                                    | a)          |
| 101      | Bar               | BS EN 10273      | Elevated temperature properties | 10CrMo9-10         | 1.7380               | NT QT                             | 60                   | 150  | 5.2                                    | a)          |
| 102      | Bar               | BS EN 10273      | Elevated temperature properties | 11CrMo9-10         | 1.7383               | NT QT                             | 0                    | 60   | 5.2                                    | a)          |
| 103      | Bar               | BS EN 10273      | Elevated temperature properties | 11CrMo9-10         | 1.7383               | QT                                | 60                   | 100  | 5.2                                    | a)          |
| 104      | Seamless tube     | prEN 10216-1     | Room temperature properties     | P195TR2            | 1.0255               | N                                 | 0                    | 60   | 1.1                                    | a)          |

| Table 2.1-2 List of materials covered by BS EN material standards (continued) |                   |                  |                                 |                 |                      |                                   |                      |      |                                        |             |
|-------------------------------------------------------------------------------|-------------------|------------------|---------------------------------|-----------------|----------------------|-----------------------------------|----------------------|------|----------------------------------------|-------------|
| 1<br>No.                                                                      | 2<br>Product form | 3<br>EN standard | 4<br>Material description       | 5<br>Grade      | 6<br>Material number | 7<br>Heat treatment <sup>1)</sup> | 8<br>Thickness<br>mm |      | 9<br>Material Group to PD CR ISO 15608 | 10<br>Notes |
|                                                                               |                   |                  |                                 |                 |                      |                                   | min.                 | max. |                                        |             |
| 105                                                                           | Seamless tube     | prEN 10216-1     | Room temperature properties     | P235TR2         | 1.0258               | N                                 | 0                    | 60   | 1.1                                    | a)          |
| 106                                                                           | Seamless tube     | prEN 10216-1     | Room temperature properties     | P265TR2         | 1.0259               | N                                 | 0                    | 60   | 1.1                                    | a)          |
| 107                                                                           | Seamless tube     | prEN 10216-2     | Elevated temperature properties | P195GH          | —                    | N                                 | 0                    | 16   | 1.1                                    | a)          |
| 108                                                                           | Seamless tube     | prEN 10216-2     | Elevated temperature properties | P235GH          | —                    | N                                 | 0                    | 60   | 1.1                                    | a)          |
| 109                                                                           | Seamless tube     | prEN 10216-2     | Elevated temperature properties | P265GH          | —                    | N                                 | 0                    | 60   | 1.1                                    | a)          |
| 110                                                                           | Seamless tube     | prEN 10216-2     | Elevated temperature properties | 20MnNb6         | 1.0471               | N                                 | 0                    | 60   | 1.4                                    | a)          |
| 111                                                                           | Seamless tube     | prEN 10216-2     | Elevated temperature properties | 16Mo3           | 1.5415               | N                                 | 0                    | 60   | 1.2                                    | a) f)       |
| 112                                                                           | Seamless tube     | prEN 10216-2     | Elevated temperature properties | 8MoB5-4         | 1.5450               | N                                 | 0                    | 16   | 1.4                                    | a)          |
| 113                                                                           | Seamless tube     | prEN 10216-2     | Elevated temperature properties | 14MoV6-3        | 1.7715               | NT QT c)                          | 0                    | 60   | 6.1                                    | a)          |
| 114                                                                           | Seamless tube     | prEN 10216-2     | Elevated temperature properties | 10CrMo5-5       | 1.7338               | NT QT c)                          | 0                    | 60   | 5.1                                    | a)          |
| 115                                                                           | Seamless tube     | prEN 10216-2     | Elevated temperature properties | 13CrMo4-5       | —                    | NT QT c)                          | 0                    | 60   | 5.1                                    | a)          |
| 116                                                                           | Seamless tube     | prEN 10216-2     | Elevated temperature properties | 10CrMo9-10      | —                    | NT QT c)                          | 0                    | 60   | 5.2                                    | a)          |
| 117                                                                           | Seamless tube     | prEN 10216-2     | Elevated temperature properties | 11CrMo9-10      | —                    | QT                                | 0                    | 60   | 5.2                                    | a)          |
| 118                                                                           | Seamless tube     | prEN 10216-2     | Elevated temperature properties | 25CrMo4         | —                    | QT                                | 0                    | 60   | 5.1                                    | a) b)       |
| 119                                                                           | Seamless tube     | prEN 10216-2     | Elevated temperature properties | 20CrMoV13-5-5   | 1.7779               | QT                                | 0                    | 60   | 6.3                                    | a)          |
| 120                                                                           | Seamless tube     | prEN 10216-2     | Elevated temperature properties | 15NiCuMoNb5-6-4 | 1.6368               | NT QT c)                          | 0                    | 80   | 2.1                                    | a)          |
| 121                                                                           | Seamless tube     | prEN 10216-2     | Elevated temperature properties | X11CrMo5 + I    | —                    | I                                 | 0                    | 100  | 5.3                                    | a)          |
| 122                                                                           | Seamless tube     | prEN 10216-2     | Elevated temperature properties | X11CrMo5 + NT1  | —                    | NT                                | 0                    | 100  | 5.3                                    | a)          |
| 123                                                                           | Seamless tube     | prEN 10216-2     | Elevated temperature properties | X11CrMo5 + NT2  | —                    | NT QT c)                          | 0                    | 100  | 5.3                                    | a)          |
| 124                                                                           | Seamless tube     | prEN 10216-2     | Elevated temperature properties | X11CrMo9-1 + I  | —                    | I                                 | 0                    | 60   | 5.4                                    | a)          |
| 125                                                                           | Seamless tube     | prEN 10216-2     | Elevated temperature properties | X11CrMo9-1 + NT | —                    | NT QT c)                          | 0                    | 60   | 5.4                                    | a)          |
| 126                                                                           | Seamless tube     | prEN 10216-2     | Elevated temperature properties | X10CrMoVNb9-1   | —                    | NT QT c)                          | 0                    | 100  | 6.4                                    | a)          |
| 127                                                                           | Seamless tube     | prEN 10216-2     | Elevated temperature properties | X20CrMoV11-1    | —                    | NT QT c)                          | 0                    | 100  | 6.4                                    | a)          |
| 128                                                                           | Seamless tube     | prEN 10216-3     | Fine grain steel                | P275NL1         | —                    | N                                 | 0                    | 100  | 1.1                                    | a)          |
| 129                                                                           | Seamless tube     | prEN 10216-3     | Fine grain steel                | P275NL2         | —                    | N                                 | 0                    | 100  | 1.1                                    | a)          |
| 130                                                                           | Seamless tube     | prEN 10216-3     | Fine grain steel                | P355N           | —                    | N                                 | 0                    | 100  | 1.2                                    | a)          |

**Table 2.1-2 List of materials covered by BS EN material standards** *(continued)*

| 1<br>No. | 2<br>Product form | 3<br>EN standard | 4<br>Material description   | 5<br>Grade      | 6<br>Material number | 7<br>Heat treatment <sup>1)</sup> | 8<br>Thickness<br>mm |      | 9<br>Material Group to<br>PD CR ISO<br>15608 | 10<br>Notes |
|----------|-------------------|------------------|-----------------------------|-----------------|----------------------|-----------------------------------|----------------------|------|----------------------------------------------|-------------|
|          |                   |                  |                             |                 |                      |                                   | min.                 | max. |                                              |             |
| 131      | Seamless tube     | prEN 10216-3     | Fine grain steel            | P355NH          | —                    | N                                 | 0                    | 100  | 1.2                                          | a)          |
| 132      | Seamless tube     | prEN 10216-3     | Fine grain steel            | P355NL1         | —                    | N                                 | 0                    | 100  | 1.2                                          | a)          |
| 133      | Seamless tube     | prEN 10216-3     | Fine grain steel            | P355NL2         | —                    | N                                 | 0                    | 100  | 1.2                                          | a)          |
| 134      | Seamless tube     | prEN 10216-3     | Fine grain steel            | P460NH          | —                    | N c)                              | 0                    | 100  | 1.3                                          | a)          |
| 135      | Seamless tube     | prEN 10216-3     | Fine grain steel            | P460NL2         | —                    | N c)                              | 0                    | 100  | 1.1                                          | a)          |
| 136      | Seamless tube     | prEN 10216-4     | Low temperature properties  | P215NL          | —                    | N                                 | 0                    | 10   | 1.1                                          | a)          |
| 137      | Seamless tube     | prEN 10216-4     | Low temperature properties  | P255QL          | —                    | QT                                | 0                    | 40   | 1.1                                          | a) f)       |
| 138      | Seamless tube     | prEN 10216-4     | Low temperature properties  | P265NL          | —                    | N                                 | 0                    | 25   | 1.1                                          | a)          |
| 139      | Seamless tube     | prEN 10216-4     | Low temperature properties  | 26CrMo4-2       | 1.7219               | QT                                | 0                    | 40   | 5.1                                          | a) b)       |
| 140      | Seamless tube     | prEN 10216-4     | Low temperature properties  | 11MnNi5-3       | 1.6212               | N NT c)                           | 0                    | 40   | 9.1                                          | a)          |
| 141      | Seamless tube     | prEN 10216-4     | Low temperature properties  | 13MnNi6-3       | 1.6217               | N NT c)                           | 0                    | 40   | 9.1                                          | a)          |
| 142      | Seamless tube     | prEN 10216-4     | Low temperature properties  | 12Ni14          | 1.5637               | NT                                | 0                    | 40   | 9.2                                          | a)          |
| 143      | Seamless tube     | prEN 10216-4     | Low temperature properties  | 12Ni14 + QT     | 1.5637               | QT                                | 0                    | 40   | 9.2                                          | a)          |
| 144      | Seamless tube     | prEN 10216-4     | Low temperature properties  | X12Ni5          | —                    | N                                 | 0                    | 40   | 9.2                                          | a)          |
| 145      | Seamless tube     | prEN 10216-4     | Low temperature properties  | X12Ni5 + QT     | —                    | QT                                | 0                    | 40   | 9.2                                          | a)          |
| 146      | Seamless tube     | prEN 10216-4     | Low temperature properties  | X10Ni9          | 1.5682               | N NT                              | 0                    | 40   | 9.3                                          | a)          |
| 147      | Seamless tube     | prEN 10216-4     | Low temperature properties  | X10Ni9 + QT     | 1.5682               | QT                                | 0                    | 40   | 9.3                                          | a)          |
| 148      | Seamless tube     | prEN 10216-5     | Stainless steel, austenitic | X2CrNi18-9      | 1.4307               | AT                                | 0                    | 60   | 8.1                                          | a)          |
| 149      | Seamless tube     | prEN 10216-5     | Stainless steel, austenitic | X2CrNi19-11     | 1.4306               | AT                                | 0                    | 60   | 8.1                                          | a)          |
| 150      | Seamless tube     | prEN 10216-5     | Stainless steel, austenitic | X2CrNiN18-10    | 1.4311               | AT                                | 0                    | 60   | 8.1                                          | a)          |
| 151      | Seamless tube     | prEN 10216-5     | Stainless steel, austenitic | X5CrNi18-10     | 1.4301               | AT                                | 0                    | 60   | 8.1                                          | a)          |
| 152      | Seamless tube     | prEN 10216-5     | Stainless steel, austenitic | X6CrNiTi18-10   | 1.4541               | AT                                | 0                    | 60   | 8.1                                          | a)          |
| 153      | Seamless tube     | prEN 10216-5     | Stainless steel, austenitic | X6CrNiNb18-10   | 1.4550               | AT                                | 0                    | 60   | 8.1                                          | a)          |
| 154      | Seamless tube     | prEN 10216-5     | Stainless steel, austenitic | X2CrNiMo18-14-3 | 1.4435               | AT                                | 0                    | 60   | 8.1                                          | a)          |
| 155      | Seamless tube     | prEN 10216-5     | Stainless steel, austenitic | X2CrNiMo17-12-2 | 1.4404               | AT                                | 0                    | 60   | 8.1                                          | a)          |
| 156      | Seamless tube     | prEN 10216-5     | Stainless steel, austenitic | X5CrNiMo17-12-2 | 1.4401               | AT                                | 0                    | 60   | 8.1                                          | a)          |

| Table 2.1-2 List of materials covered by BS EN material standards (continued) |                   |                  |                             |                        |                      |                                   |                      |      |                                              |             |
|-------------------------------------------------------------------------------|-------------------|------------------|-----------------------------|------------------------|----------------------|-----------------------------------|----------------------|------|----------------------------------------------|-------------|
| 1<br>No.                                                                      | 2<br>Product form | 3<br>EN standard | 4<br>Material description   | 5<br>Grade             | 6<br>Material number | 7<br>Heat treatment <sup>1)</sup> | 8<br>Thickness<br>mm |      | 9<br>Material Group to<br>PD CR ISO<br>15608 | 10<br>Notes |
|                                                                               |                   |                  |                             |                        |                      |                                   | min.                 | max. |                                              |             |
| 157                                                                           | Seamless tube     | prEN 10216-5     | Stainless steel, austenitic | X1CrNiMoN25-22-2       | 1.4466               | AT                                | 0                    | 60   | 8.2                                          | a)          |
| 158                                                                           | Seamless tube     | prEN 10216-5     | Stainless steel, austenitic | X6CrNiMoTi17-12-2      | 1.4571               | AT                                | 0                    | 60   | 8.1                                          | a)          |
| 159                                                                           | Seamless tube     | prEN 10216-5     | Stainless steel, austenitic | X6CrNiMoNb17-12-2      | 1.4580               | AT                                | 0                    | 60   | 8.1                                          | a)          |
| 160                                                                           | Seamless tube     | prEN 10216-5     | Stainless steel, austenitic | X2CrNiMoN17-13-3       | 1.4429               | AT                                | 0                    | 60   | 8.1                                          | a)          |
| 161                                                                           | Seamless tube     | prEN 10216-5     | Stainless steel, austenitic | X3CrNiMo17-13-3        | 1.4436               | AT                                | 0                    | 60   | 8.1                                          | a)          |
| 162                                                                           | Seamless tube     | prEN 10216-5     | Stainless steel, austenitic | X1CrNi25-21            | 1.4335               | AT                                | 0                    | 60   | 8.2                                          | a)          |
| 163                                                                           | Seamless tube     | prEN 10216-5     | Stainless steel, austenitic | X2CrNiMoN17-13-5       | 1.4439               | AT                                | 0                    | 60   | 8.1                                          | a)          |
| 164                                                                           | Seamless tube     | prEN 10216-5     | Stainless steel, austenitic | X1NiCrMoCu31-27-4      | 1.4563               | AT                                | 0                    | 60   | 8.2                                          | a)          |
| 165                                                                           | Seamless tube     | prEN 10216-5     | Stainless steel, austenitic | X1NiCrMoCu25-20-5      | 1.4539               | AT                                | 0                    | 60   | 8.2                                          | a)          |
| 166                                                                           | Seamless tube     | prEN 10216-5     | Stainless steel, austenitic | X1CrNiMoCuN20-18-7     | 1.4547               | AT                                | 0                    | 60   | 8.2                                          | a)          |
| 167                                                                           | Seamless tube     | prEN 10216-5     | Stainless steel, austenitic | X1NiCrMoCuN25-20-7     | 1.4529               | AT                                | 0                    | 60   | 8.2                                          | a)          |
| 168                                                                           | Seamless tube     | prEN 10216-5     | Stainless steel, austenitic | X2NiCrAlTi32-20        | 1.4558               | AT                                | 0                    | 60   | 8.2                                          | a)          |
| 169                                                                           | Seamless tube     | prEN 10216-5     | Stainless steel, austenitic | X6CrNi18-10            | 1.4948               | AT                                | 0                    | 60   | 8.1                                          | a)          |
| 170                                                                           | Seamless tube     | prEN 10216-5     | Stainless steel, austenitic | X7CrNiTi18-10          | —                    | AT                                | 0                    | 60   | 8.1                                          | a)          |
| 171                                                                           | Seamless tube     | prEN 10216-5     | Stainless steel, austenitic | X7CrNiNb18-10          | —                    | AT                                | 0                    | 60   | 8.1                                          | a)          |
| 172                                                                           | Seamless tube     | prEN 10216-5     | Stainless steel, austenitic | X7CrNiTiB18-10         | 1.4941               | AT                                | 0                    | 60   | 8.1                                          | a)          |
| 173                                                                           | Seamless tube     | prEN 10216-5     | Stainless steel, austenitic | X6CrNiMo17-13-2        | —                    | AT                                | 0                    | 60   | 8.1                                          | a)          |
| 174                                                                           | Seamless tube     | prEN 10216-5     | Stainless steel, austenitic | X5NiCrAlTi31-20        | 1.4958               | AT                                | 0                    | 60   | 8.2                                          | a)          |
| 175                                                                           | Seamless tube     | prEN 10216-5     | Stainless steel, austenitic | X8NiCrAlTi32-21        | 1.4959               | AT                                | 0                    | 60   | 8.2                                          | a)          |
| 176                                                                           | Seamless tube     | prEN 10216-5     | Stainless steel, austenitic | X3CrNiMoNb17-13-3      | 1.4910               | AT                                | 0                    | 60   | 8.1                                          | a)          |
| 177                                                                           | Seamless tube     | prEN 10216-5     | Stainless steel, austenitic | X8CrNiNb16-13          | 1.4961               | AT                                | 0                    | 60   | 8.1                                          | a)          |
| 178                                                                           | Seamless tube     | prEN 10216-5     | Stainless steel, austenitic | X8CrNiMoVNb16-13       | 1.4988               | AT                                | 0                    | 60   | 8.1                                          | a)          |
| 179                                                                           | Seamless tube     | prEN 10216-5     | Stainless steel, austenitic | X8CrNiMoNb16-16        | 1.4981               | AT                                | 0                    | 60   | 8.1                                          | a)          |
| 180                                                                           | Seamless tube     | prEN 10216-5     | Stainless steel, austenitic | X10CrNiMoMnNbVB15-10-1 | 1.4982               | AT                                | 0                    | 60   | 8.1                                          | a)          |
| 181                                                                           | Welded tube       | prEN 10217-1     | Room temperature properties | P195TR2                | 1.0108               | N                                 | 0                    | 40   | 1.1                                          | a)          |

**Table 2.1-2 List of materials covered by BS EN material standards** *(continued)*

| 1<br>No. | 2<br>Product form | 3<br>EN standard | 4<br>Material description             | 5<br>Grade    | 6<br>Material number | 7<br>Heat treatment <sup>1)</sup> | 8<br>Thickness<br>mm |      | 9<br>Material Group to PD CR ISO 15608 | 10<br>Notes |
|----------|-------------------|------------------|---------------------------------------|---------------|----------------------|-----------------------------------|----------------------|------|----------------------------------------|-------------|
|          |                   |                  |                                       |               |                      |                                   | min.                 | max. |                                        |             |
| 182      | Welded tube       | prEN 10217-1     | Room temperature properties           | P235TR2       | 1.0255               | N                                 | 0                    | 40   | 1.1                                    | a)          |
| 183      | Welded tube       | prEN 10217-1     | Room temperature properties           | P265TR2       | 1.0259               | N                                 | 0                    | 40   | 1.1                                    | a)          |
| 184      | Welded tube       | prEN 10217-2     | Elevated temperature properties       | P195GH        | —                    | N                                 | 0                    | 16   | 1.1                                    | a)          |
| 185      | Welded tube       | prEN 10217-2     | Elevated temperature properties       | P235GH        | —                    | N                                 | 0                    | 16   | 1.1                                    | a)          |
| 186      | Welded tube       | prEN 10217-2     | Elevated temperature properties       | P265GH        | —                    | N                                 | 0                    | 16   | 1.1                                    | a)          |
| 187      | Welded tube       | prEN 10217-2     | Elevated temperature properties       | 16Mo3         | 1.5415               | N                                 | 0                    | 16   | 1.2                                    | a) f)       |
| 188      | Welded tube       | prEN 10217-3     | Fine grain steel                      | P275NL1       | 1.0488               | N                                 | 0                    | 40   | 1.1                                    | a)          |
| 189      | Welded tube       | prEN 10217-3     | Fine grain steel                      | P275NL2       | 1.1104               | N                                 | 0                    | 40   | 1.1                                    | a)          |
| 190      | Welded tube       | prEN 10217-3     | Fine grain steel                      | P355N         | 1.0562               | N                                 | 0                    | 40   | 1.2                                    | a)          |
| 191      | Welded tube       | prEN 10217-3     | Fine grain steel                      | P355NH        | 1.0565               | N                                 | 0                    | 40   | 1.2                                    | a)          |
| 192      | Welded tube       | prEN 10217-3     | Fine grain steel                      | P355NL1       | 1.0566               | N                                 | 0                    | 40   | 1.2                                    | a)          |
| 193      | Welded tube       | prEN 10217-3     | Fine grain steel                      | P355NL2       | 1.1106               | N                                 | 0                    | 40   | 1.2                                    | a)          |
| 194      | Welded tube       | prEN 10217-4     | Low temperature properties            | P215NL        | 1.0451               | N                                 | 0                    | 16   | 1.1                                    | a)          |
| 195      | Welded tube       | prEN 10217-4     | Low temperature properties            | P265NL        | 1.0453               | N                                 | 0                    | 16   | 1.1                                    | a)          |
| 196      | Welded tube       | prEN 10217-5     | Sub. Arc, elevated temperature props. | P235GH        | 1.0345               | N                                 | 0                    | 40   | 1.1                                    | a)          |
| 197      | Welded tube       | prEN 10217-5     | Sub. Arc, elevated temperature props. | P265GH        | 1.0425               | N                                 | 0                    | 40   | 1.1                                    | a)          |
| 198      | Welded tube       | prEN 10217-5     | Sub. Arc, elevated temperature props. | 16Mo3         | 1.5415               | N                                 | 0                    | 40   | 1.1                                    | a) f)       |
| 199      | Welded tube       | prEN 10217-6     | Sub. Arc, low temperature props.      | P215NL        | 1.0451               | N                                 | 0                    | 25   | 1.1                                    | a)          |
| 200      | Welded tube       | prEN 10217-6     | Sub. Arc, low temperature props.      | P265NL        | 1.0453               | N                                 | 0                    | 25   | 1.1                                    | a)          |
| 201      | Welded tube       | prEN 10217-7     | Stainless steel, austenitic           | X2CrNi18-9    | 1.4307               | AT                                | 0                    | 60   | 8.1                                    | a)          |
| 202      | Welded tube       | prEN 10217-7     | Stainless steel, austenitic           | X2CrNi19-11   | 1.4306               | AT                                | 0                    | 60   | 8.1                                    | a)          |
| 203      | Welded tube       | prEN 10217-7     | Stainless steel, austenitic           | X2CrNi18-10   | 1.4311               | AT                                | 0                    | 60   | 8.1                                    | a)          |
| 204      | Welded tube       | prEN 10217-7     | Stainless steel, austenitic           | X5CrNi18-10   | 1.4301               | AT                                | 0                    | 60   | 8.1                                    | a)          |
| 205      | Welded tube       | prEN 10217-7     | Stainless steel, austenitic           | X6CrNiTi18-10 | 1.4541               | AT                                | 0                    | 60   | 8.1                                    | a)          |
| 206      | Welded tube       | prEN 10217-7     | Stainless steel, austenitic           | X6CrNiNb18-10 | 1.4550               | AT                                | 0                    | 60   | 8.1                                    | a)          |

| Table 2.1-2 List of materials covered by BS EN material standards (continued) |                   |                  |                                 |                    |                      |                                   |                      |      |                                        |             |
|-------------------------------------------------------------------------------|-------------------|------------------|---------------------------------|--------------------|----------------------|-----------------------------------|----------------------|------|----------------------------------------|-------------|
| 1<br>No.                                                                      | 2<br>Product form | 3<br>EN standard | 4<br>Material description       | 5<br>Grade         | 6<br>Material number | 7<br>Heat treatment <sup>1)</sup> | 8<br>Thickness<br>mm |      | 9<br>Material Group to PD CR ISO 15608 | 10<br>Notes |
|                                                                               |                   |                  |                                 |                    |                      |                                   | min.                 | max. |                                        |             |
| 207                                                                           | Welded tube       | prEN 10217-7     | Stainless steel, austenitic     | X2CrNiMo17-12-2    | 1.4404               | AT                                | 0                    | 60   | 8.1                                    | a)          |
| 208                                                                           | Welded tube       | prEN 10217-7     | Stainless steel, austenitic     | X5CrNiMo17-12-2    | 1.4401               | AT                                | 0                    | 60   | 8.1                                    | a)          |
| 209                                                                           | Welded tube       | prEN 10217-7     | Stainless steel, austenitic     | X6CrNiMoTi17-12-2  | 1.4571               | AT                                | 0                    | 60   | 8.1                                    | a)          |
| 210                                                                           | Welded tube       | prEN 10217-7     | Stainless steel, austenitic     | X2CrNiMo17-12-3    | 1.4432               | AT                                | 0                    | 60   | 8.1                                    | a)          |
| 211                                                                           | Welded tube       | prEN 10217-7     | Stainless steel, austenitic     | X2CrNiMoN17-13-3   | 1.4429               | AT                                | 0                    | 60   | 8.1                                    | a)          |
| 212                                                                           | Welded tube       | prEN 10217-7     | Stainless steel, austenitic     | X3CrNiMo17-13-3    | 1.4436               | AT                                | 0                    | 60   | 8.1                                    | a)          |
| 213                                                                           | Welded tube       | prEN 10217-7     | Stainless steel, austenitic     | X2CrNiMo18-14-3    | 1.4435               | AT                                | 0                    | 60   | 8.1                                    | a)          |
| 214                                                                           | Welded tube       | prEN 10217-7     | Stainless steel, austenitic     | X2CrNiMoN17-13-5   | 1.4439               | AT                                | 0                    | 30   | 8.1                                    | a)          |
| 215                                                                           | Welded tube       | prEN 10217-7     | Stainless steel, austenitic     | X2CrNiMo18-15-4    | 1.4438               | AT                                | 0                    | 60   | 8.1                                    | a)          |
| 216                                                                           | Welded tube       | prEN 10217-7     | Stainless steel, austenitic     | X1NiCrMoCu31-27-7  | 1.4563               | AT                                | 0                    | 60   | 8.2                                    | a)          |
| 217                                                                           | Welded tube       | prEN 10217-7     | Stainless steel, austenitic     | X1NiCrMoCu25-20-5  | 1.4539               | AT                                | 0                    | 60   | 8.2                                    | a)          |
| 218                                                                           | Welded tube       | prEN 10217-7     | Stainless steel, austenitic     | X1CrNiMoCuN20-18-7 | 1.4547               | AT                                | 0                    | 60   | 8.2                                    | a)          |
| 219                                                                           | Welded tube       | prEN 10217-7     | Stainless steel, austenitic     | X1NiCrMoCuN25-20-7 | 1.4529               | AT                                | 0                    | 60   | 8.2                                    | a)          |
| 220                                                                           | Forging           | BS EN 10222-2    | Elevated temperature properties | P245GH             | 1.0352               | A                                 | 0                    | 35   | 1.1                                    | a)          |
| 221                                                                           | Forging           | BS EN 10222-2    | Elevated temperature properties | P245GH             | 1.0352               | N NT QT                           | 35                   | 160  | 1.1                                    | a)          |
| 222                                                                           | Forging           | BS EN 10222-2    | Elevated temperature properties | P280GH             | 1.0426               | N                                 | 0                    | 35   | 1.2                                    | a)          |
| 223                                                                           | Forging           | BS EN 10222-2    | Elevated temperature properties | P280GH             | 1.0426               | NT QT                             | 35                   | 160  | 1.2                                    | a)          |
| 224                                                                           | Forging           | BS EN 10222-2    | Elevated temperature properties | P305GH             | 1.0436               | N                                 | 0                    | 35   | 1.2                                    | a)          |
| 225                                                                           | Forging           | BS EN 10222-2    | Elevated temperature properties | P305GH             | 1.0436               | NT                                | 35                   | 160  | 1.2                                    | a)          |
| 226                                                                           | Forging           | BS EN 10222-2    | Elevated temperature properties | P305GH             | 1.0436               | QT                                | 0                    | 70   | 1.2                                    | a) f)       |
| 227                                                                           | Forging           | BS EN 10222-2    | Elevated temperature properties | 16Mo3              | 1.5415               | N                                 | 0                    | 35   | 1.2                                    | a) f)       |
| 228                                                                           | Forging           | BS EN 10222-2    | Elevated temperature properties | 16Mo3              | 1.5415               | QT                                | 35                   | 500  | 1.2                                    | a) f)       |
| 229                                                                           | Forging           | BS EN 10222-2    | Elevated temperature properties | 13CrMo4-           | 1.7335               | NT                                | 0                    | 70   | 5.1                                    | a)          |
| 230                                                                           | Forging           | BS EN 10222-2    | Elevated temperature properties | 13CrMo4-5          | 1.7335               | NT QT                             | 70                   | 500  | 5.1                                    | a)          |
| 231                                                                           | Forging           | BS EN 10222-2    | Elevated temperature properties | 15MnMoV4-5         | 1.5402               | NT QT                             | 0                    | 250  | 1.4                                    | a)          |
| 232                                                                           | Forging           | BS EN 10222-2    | Elevated temperature properties | 18MnMoNi5-5        | 1.6308               | QT                                | 0                    | 200  | 1.4                                    | a)          |
| 233                                                                           | Forging           | BS EN 10222-2    | Elevated temperature properties | 14MoV6-3           | 1.7715               | NT QT                             | 0                    | 500  | 6.1                                    | a)          |
| 234                                                                           | Forging           | BS EN 10222-2    | Elevated temperature properties | 15MnCrMoNiV5-3     | 1.6920               | NT QT                             | 0                    | 100  | 4.1                                    | a)          |

**Table 2.1-2 List of materials covered by BS EN material standards** (*continued*)

| 1<br>No. | 2<br>Product form | 3<br>EN standard | 4<br>Material description             | 5<br>Grade    | 6<br>Material number | 7<br>Heat treatment <sup>1)</sup> | 8<br>Thickness<br>mm |      | 9<br>Material Group to PD CR ISO 15608 | 10<br>Notes |
|----------|-------------------|------------------|---------------------------------------|---------------|----------------------|-----------------------------------|----------------------|------|----------------------------------------|-------------|
|          |                   |                  |                                       |               |                      |                                   | min.                 | max. |                                        |             |
| 235      | Forging           | BS EN 10222-2    | Elevated temperature properties       | 11CrMo9-10    | 1.7383               | NT                                | 0                    | 200  | 5.2                                    | a)          |
| 236      | Forging           | BS EN 10222-2    | Elevated temperature properties       | 11CrMo9-10    | 1.7383               | NT QT                             | 200                  | 500  | 5.2                                    | a)          |
| 237      | Forging           | BS EN 10222-2    | Elevated temperature properties       | X16CrMo5-1    | 1.7366               | A                                 | 0                    | 300  | 5.3                                    | a)          |
| 238      | Forging           | BS EN 10222-2    | Elevated temperature properties       | X16CrMo5-1    | 1.7366               | NT                                | 0                    | 300  | 5.3                                    | a)          |
| 239      | Forging           | BS EN 10222-2    | Elevated temperature properties       | X10CrMoVNb9-1 | 1.4903               | NT                                | 0                    | 130  | 6.4                                    | a)          |
| 240      | Forging           | BS EN 10222-2    | Elevated temperature properties       | X20CrMoV11-1  | 1.4922               | QT                                | 0                    | 330  | 6.4                                    | a)          |
| 241      | Forging           | BS EN 10222-3    | Low temperature properties            | 13MnNi6-3     | 1.6217               | NT                                | 0                    | 70   | 9.1                                    | a)          |
| 242      | Forging           | BS EN 10222-3    | Low temperature properties            | 15NiMn6       | 1.6228               | N                                 | 0                    | 35   | 9.1                                    | a)          |
| 243      | Forging           | BS EN 10222-3    | Low temperature properties            | 15NiMn6       | 1.6228               | NT QT                             | 35                   | 50   | 9.1                                    | a)          |
| 244      | Forging           | BS EN 10222-3    | Low temperature properties            | 12Ni14        | 1.5637               | N                                 | 0                    | 35   | 9.2                                    | a)          |
| 245      | Forging           | BS EN 10222-3    | Low temperature properties            | 12Ni14        | 1.5637               | NT                                | 35                   | 50   | 9.2                                    | a)          |
| 246      | Forging           | BS EN 10222-3    | Low temperature properties            | 12Ni14        | 1.5637               | QT                                | 50                   | 70   | 9.2                                    | a)          |
| 247      | Forging           | BS EN 10222-3    | Low temperature properties            | X12Ni5        | 1.5680               | N                                 | 0                    | 35   | 9.2                                    | a)          |
| 248      | Forging           | BS EN 10222-3    | Low temperature properties            | X12Ni5        | 1.5680               | NT QT                             | 35                   | 50   | 9.2                                    | a)          |
| 249      | Forging           | BS EN 10222-3    | Low temperature properties            | X8Ni9         | 1.5662               | N NT                              | 0                    | 50   | 9.3                                    | a)          |
| 250      | Forging           | BS EN 10222-3    | Low temperature properties            | X8Ni9         | 1.5662               | QT                                | 50                   | 70   | 9.3                                    | a)          |
| 251      | Forging           | BS EN 10222-4    | Fine grain steel, high proof strength | P285NH        | 1.0477               | N                                 | 0                    | 70   | 1.2                                    | a)          |
| 252      | Forging           | BS EN 10222-4    | Fine grain steel, high proof strength | P285QH        | 1.0478               | QT                                | 70                   | 400  | 1.2                                    | a) f)       |
| 253      | Forging           | BS EN 10222-4    | Fine grain steel, high proof strength | P355NH        | 1.0565               | N                                 | 0                    | 70   | 1.2                                    | a)          |
| 254      | Forging           | BS EN 10222-4    | Fine grain steel, high proof strength | P355QH1       | 1.0571               | QT                                | 70                   | 400  | 1.2                                    | a) f)       |
| 255      | Forging           | BS EN 10222-4    | Fine grain steel, high proof strength | P420NH        | 1.8932               | N                                 | 0                    | 70   | 2.1                                    | a)          |
| 256      | Forging           | BS EN 10222-5    | Stainless steel, austenitic           | X2CrNi18-9    | 1.4307               | AT                                | 0                    | 250  | 8.1                                    | a)          |
| 257      | Forging           | BS EN 10222-5    | Stainless steel, austenitic           | X2CrNi18-10   | 1.4311               | AT                                | 0                    | 250  | 8.1                                    | a)          |
| 258      | Forging           | BS EN 10222-5    | Stainless steel, austenitic           | X5CrNi18-10   | 1.4301               | AT                                | 0                    | 250  | 8.1                                    | a)          |
| 259      | Forging           | BS EN 10222-5    | Stainless steel, austenitic           | X6CrNiTi18-10 | 1.4541               | AT                                | 0                    | 450  | 8.1                                    | a)          |
| 260      | Forging           | BS EN 10222-5    | Stainless steel, austenitic           | X6CrNiNb18-10 | 1.4550               | AT                                | 0                    | 450  | 8.1                                    | a)          |

| Table 2.1-2 List of materials covered by BS EN material standards (continued) |              |               |                                 |                   |                 |                              |              |      |                                   |       |
|-------------------------------------------------------------------------------|--------------|---------------|---------------------------------|-------------------|-----------------|------------------------------|--------------|------|-----------------------------------|-------|
| 1                                                                             | 2            | 3             | 4                               | 5                 | 6               | 7                            | 8            |      | 9                                 | 10    |
| No.                                                                           | Product form | EN standard   | Material description            | Grade             | Material number | Heat treatment <sup>1)</sup> | Thickness mm |      | Material Group to PD CR ISO 15608 | Notes |
|                                                                               |              |               |                                 |                   |                 |                              | min.         | max. |                                   |       |
| 261                                                                           | Forging      | BS EN 10222-5 | Stainless steel, austenitic     | X6CrNi18-10       | 1.4948          | AT                           | 0            | 250  | 8.1                               | a)    |
| 262                                                                           | Forging      | BS EN 10222-5 | Stainless steel, austenitic     | X6CrNiTiB18-10    | 1.4941          | AT                           | 0            | 450  | 8.1                               | a)    |
| 263                                                                           | Forging      | BS EN 10222-5 | Stainless steel, austenitic     | X7CrNiNb18-10     | 1.4912          | AT                           | 0            | 450  | 8.1                               | a)    |
| 264                                                                           | Forging      | BS EN 10222-5 | Stainless steel, austenitic     | X2CrNiMo17-12-2   | 1.4404          | AT                           | 0            | 250  | 8.1                               | a)    |
| 265                                                                           | Forging      | BS EN 10222-5 | Stainless steel, austenitic     | X2CrNiMoN17-11-2  | 1.4406          | AT                           | 0            | 160  | 8.1                               | a)    |
| 266                                                                           | Forging      | BS EN 10222-5 | Stainless steel, austenitic     | X5CrNiMo17-12-2   | 1.4401          | AT                           | 0            | 250  | 8.1                               | a)    |
| 267                                                                           | Forging      | BS EN 10222-5 | Stainless steel, austenitic     | X6CrNiMoTi17-12-2 | 1.4571          | AT                           | 0            | 450  | 8.1                               | a)    |
| 268                                                                           | Forging      | BS EN 10222-5 | Stainless steel, austenitic     | X2CrNiMo17-12-3   | 1.4432          | AT                           | 0            | 250  | 8.1                               | a)    |
| 269                                                                           | Forging      | BS EN 10222-5 | Stainless steel, austenitic     | X2CrNiMoN17-13-3  | 1.4429          | AT                           | 0            | 160  | 8.1                               | a)    |
| 270                                                                           | Forging      | BS EN 10222-5 | Stainless steel, austenitic     | X3CrNiMo17-13-3   | 1.4436          | AT                           | 0            | 250  | 8.1                               | a)    |
| 271                                                                           | Forging      | BS EN 10222-5 | Stainless steel, austenitic     | X2CrNiMo18-14-3   | 1.4435          | AT                           | 0            | 75   | 8.1                               | a)    |
| 272                                                                           | Forging      | BS EN 10222-5 | Stainless steel, austenitic     | X3CrNiMoN17-13-3  | 1.4910          | AT                           | 0            | 75   | 8.1                               | a)    |
| 273                                                                           | Forging      | BS EN 10222-5 | Stainless steel, austenitic     | X2CrNiCu19-10     | 1.4650          | AT                           | 0            | 450  | 8.1                               | a)    |
| 274                                                                           | Forging      | BS EN 10222-5 | Stainless steel, austenitic     | X3CrNiMo18-12-3   | 1.4449          | AT                           | 0            | 450  | 8.1                               | a)    |
| 275                                                                           | Casting      | BS EN 10213-2 | Elevated temperature properties | GP240GR           | 1.0621          | N                            | 0            | 100  | 1.1                               | a)    |
| 276                                                                           | Casting      | BS EN 10213-2 | Elevated temperature properties | GP240GH           | 1.0619          | N QT                         | 0            | 100  | 1.1                               | a) f) |
| 277                                                                           | Casting      | BS EN 10213-2 | Elevated temperature properties | GP280GH           | 1.0625          | N QT                         | 0            | 100  | 1.2                               | a) f) |
| 278                                                                           | Casting      | BS EN 10213-2 | Elevated temperature properties | G20Mo5            | 1.5419          | QT                           | 0            | 100  | 3.1                               | a)    |
| 279                                                                           | Casting      | BS EN 10213-2 | Elevated temperature properties | G17CrMo5-5        | 1.7357          | QT                           | 0            | 100  | 5.1                               | a)    |
| 280                                                                           | Casting      | BS EN 10213-2 | Elevated temperature properties | G17CrMo9-10       | 1.7379          | QT                           | 0            | 150  | 5.2                               | a)    |
| 281                                                                           | Casting      | BS EN 10213-2 | Elevated temperature properties | G12MoCrV5-2       | 1.7720          | QT                           | 0            | 100  | 6.1                               | a)    |
| 282                                                                           | Casting      | BS EN 10213-2 | Elevated temperature properties | G17CrMoV5-10      | 1.7706          | QT                           | 0            | 150  | 6.2                               | a)    |
| 283                                                                           | Casting      | BS EN 10213-2 | Elevated temperature properties | GX15CrMo5         | 1.7365          | QT                           | 0            | 150  | 5.3                               | a)    |
| 284                                                                           | Casting      | BS EN 10213-2 | Elevated temperature properties | GX23CrMoV12-1     | 1.4931          | QT                           | 0            | 150  | 6.4                               | a)    |
| 285                                                                           | Casting      | BS EN 10213-3 | Low temperature properties      | G17Mn5            | 1.1131          | QT                           | 0            | 50   | 1.1                               | a)    |
| 286                                                                           | Casting      | BS EN 10213-3 | Low temperature properties      | G20Mn5            | 1.6220          | N                            | 0            | 30   | 1.2                               | a)    |

**Table 2.1-2 List of materials covered by BS EN material standards** (*continued*)

| 1<br>No. | 2<br>Product form | 3<br>EN standard | 4<br>Material description   | 5<br>Grade         | 6<br>Material number | 7<br>Heat treatment <sup>1)</sup> | 8<br>Thickness<br>mm |      | 9<br>Material Group to<br>PD CR ISO<br>15608 | 10<br>Notes |
|----------|-------------------|------------------|-----------------------------|--------------------|----------------------|-----------------------------------|----------------------|------|----------------------------------------------|-------------|
|          |                   |                  |                             |                    |                      |                                   | min.                 | max. |                                              |             |
| 287      | Casting           | BS EN 10213-3    | Low temperature properties  | G20Mn5             | 1.6220               | QT                                | 0                    | 100  | 1.2                                          | a) f)       |
| 288      | Casting           | BS EN 10213-3    | Low temperature properties  | G18Mo5             | 1.5422               | QT                                | 0                    | 100  | 1.2                                          | a) f)       |
| 289      | Casting           | BS EN 10213-3    | Low temperature properties  | G9Ni10             | 1.5636               | QT                                | 0                    | 35   | 9.1                                          | a)          |
| 290      | Casting           | BS EN 10213-3    | Low temperature properties  | G17NiCrMo13-6      | 1.6781               | QT                                | 0                    | 200  | 9.2                                          | a)          |
| 291      | Casting           | BS EN 10213-3    | Low temperature properties  | G9Ni14             | 1.5638               | QT                                | 0                    | 35   | 9.2                                          | a)          |
| 292      | Casting           | BS EN 10213-4    | Stainless steel, austenitic | GX2CrNi19-11       | 1.4309               | AT                                | 0                    | 150  | 8.1                                          | a)          |
| 293      | Casting           | BS EN 10213-4    | Stainless steel, austenitic | GX5CrNi19-10       | 1.4308               | AT                                | 0                    | 150  | 8.1                                          | a)          |
| 294      | Casting           | BS EN 10213-4    | Stainless steel, austenitic | GX5CrNiNb19-11     | 1.4552               | AT                                | 0                    | 150  | 8.1                                          | a)          |
| 295      | Casting           | BS EN 10213-4    | Stainless steel, austenitic | GX2CrNiMo19-11-2   | 1.4409               | AT                                | 0                    | 150  | 8.1                                          | a)          |
| 296      | Casting           | BS EN 10213-4    | Stainless steel, austenitic | GX5CrNiMo19-11-2   | 1.4408               | AT                                | 0                    | 150  | 8.1                                          | a)          |
| 297      | Casting           | BS EN 10213-4    | Stainless steel, austenitic | GX5CrNiMoNb19-11-2 | 1.4581               | AT                                | 0                    | 150  | 8.1                                          | a)          |
| 298      | Casting           | BS EN 10213-4    | Stainless steel, austenitic | GX2NiCrMo28-20-2   | 1.4458               | AT                                | 0                    | 150  | 8.2                                          | a)          |

a) Materials are considered to meet the requirements of the PED and prEN 13445-2.

b) Because of the carbon content special precautions are necessary when the material is welded.

c) See prEN 10216 for details of heat treatment.

d) *Not used.*

e) *Not used.*

f) Additional requirements for forming and welding shall be considered on a case by case basis.

g) *Not used.*

1) Heat treatment conditions:

A annealed;

C cold worked;

AT solution annealed;

I isothermally annealed;

N normalized;

NT normalized and tempered;

QT quenched and tempered;

RA recrystallized annealed.

**2.1.2.2.2 Carbon, carbon manganese and alloy steels**

**2.1.2.2.2.1** The maximum allowable phosphorus and sulfur content shall not exceed 0.05 % each in the ladle analysis. For ferritic steels intended for welding, the upper limit of the carbon range (in the ladle analysis) shall not exceed 0.25 %. If the manufacturer proposes to weld materials with a carbon content exceeding 0.25 %, this proposal and the welding procedure shall be approved by the purchaser and inspection authority.

**2.1.2.2.2.2** The deoxidation practice shall be appropriate to the type of steel ordered, particularly where it influences the level of elevated or low temperature properties. It is permitted to use semi-killed steel in accordance with this specification for plates and seamless and welded tubes in carbon and carbon manganese steels with an upper limit of the specified tensile strength range of 640 N/mm<sup>2</sup> and with a thickness not exceeding 100 mm. Rimmed steel shall only be used for welded tubes in carbon and carbon manganese steel types with an upper limit of the specified tensile strength range of 490 N/mm<sup>2</sup> under service temperature conditions between 0 °C and 380 °C.

**2.1.2.2.2.3** Mechanical properties at room temperature shall be specified for acceptance tests in accordance with BS EN 10002-1<sup>3)</sup> covering  $R_m$ ,  $R_e$  (see 2.3) and minimum elongation at fracture.

The specified minimum percentage elongation at fracture referred to a gauge length of  $5.65 \sqrt{S_0}$ <sup>4)</sup> shall be appropriate to the type of steel with a lower limit of 16 % for plates, 15 % for castings and 14 % for tubes and forgings, unless the use of the steel is subject to special agreement (see 2.1.1.2).

The rate of testing and methods of acceptance testing shall generally be consistent with appropriate British Standards for similar product forms.

**2.1.2.2.2.4** For materials that will be used above 50 °C, yield point or proof stress properties shall be specified by the manufacturer for acceptance tests in accordance with BS EN 10002-5<sup>3)</sup>.

**2.1.2.2.2.5** Stress rupture properties shall be specified for materials that will be used in the creep range. These shall be determined in accordance with the procedure laid down in ISO 6303<sup>3)</sup>. The manufacturer of the vessel shall be assured that the product supplied is capable of conforming to the specified properties by a statement that the manufacturing processes have remained equivalent to those for the steel for which the test results were obtained.

**2.1.2.2.2.6** Charpy V-notch impact test properties at appropriate temperatures shall, where necessary, conform to 2.2.3 to 2.2.5.

**2.1.2.2.2.7** Materials shall be supplied in a heat treated condition appropriate to the nearest equivalent British Standard.

NOTE 1. Plates for hot forming may be supplied in any suitable condition as agreed between the manufacturer and the material supplier.

NOTE 2. Any proposal by the manufacturer to use the rolling process to achieve normalized properties of non-BS materials, should be agreed with the purchaser and Inspecting Authority. The properties of the normalized rolled plates should be demonstrated to be similar to the nearest equivalent BS normalized material.

**2.1.2.2.2.8** Carbon and carbon manganese steel plates for cold forming shall be supplied in the normalized condition except when their thickness is less than 25 mm, when it is permissible to supply plates as-rolled if guaranteed elevated temperature properties are not required.

Low alloy steel plates for cold forming shall normally be supplied in the normalized and tempered condition. Where the plate is metallurgically suitable and where post-weld heat treatment will suffice as the tempering treatment, plates supplied in the normalized condition shall be permitted.

**2.1.2.2.2.9** It is permissible to use electric resistance welded or induction welded tubes in the as-welded condition provided the specified upper limit of tensile strength does not exceed 540 N/mm<sup>2</sup> and they are not intended for service below a temperature of 0 °C.

**2.1.2.2.2.10** The heat treatment condition to which the specified properties relate shall be clearly stated in the material specifications. These properties can be affected by reheating during fabrication and, where necessary (see 3.4.2 or 4.4), the manufacturer shall discuss the application and proposed heating or reheating of the steel with the material supplier. However, the test plates shall be supplied and tested in a condition corresponding to the material specification specifically requested by the manufacturer. The heat treatment to be given to the test pieces and the acceptance properties shall be agreed between the manufacturer and the material supplier at the time of order.

**2.1.2.3 Materials for category 3 components**

It is permissible to use materials conforming to the British Standards listed in table 2.1-3 for the construction of category 3 components provided the qualifying requirements given in table 2.1-3 are satisfied.

**2.1.3 Materials for non-pressure parts**

Materials for supporting lugs, skirts, baffles and similar non-pressure parts welded to vessels shall be of established identity and shall be compatible with the material to which they are attached.

<sup>3)</sup> Acceptance of properties obtained by other recognized test methods (e.g. other national standards) shall be subject to agreement between the purchaser, manufacturer and inspection authority.

<sup>4)</sup>  $S_0$  is the original cross-sectional area of the gauge length of the tensile test specimen.

**Table 2.1-3 Additional materials that may be used for category 3 construction**

| Product form          | Material standards, BS references |                    | Conditions for use   |         |
|-----------------------|-----------------------------------|--------------------|----------------------|---------|
| Plate                 | BS EN 10025                       | 1.0038             | See notes 1, 4 and 5 |         |
|                       |                                   | 1.0041             |                      |         |
|                       |                                   | 1.0114             |                      |         |
|                       |                                   | 1.0143             |                      |         |
| Plate, sheet or strip | BS 1449 : Part 1                  | 37/23HR            | See notes 1, 2 and 4 |         |
|                       |                                   | 37/23CR            |                      |         |
|                       |                                   | 43/25HR            |                      |         |
|                       | BS 1449 : Part 2                  | 304 S15<br>310 S24 | See notes 3 and 4    |         |
| Plate, sheet or strip | BS EN 10088:                      |                    | See note 4           |         |
|                       |                                   | 1.4301             |                      | —       |
|                       |                                   | 1.4306             |                      | —       |
|                       |                                   | 1.4307             |                      | 304 S11 |
|                       |                                   | 1.4401             |                      | 316 S31 |
|                       |                                   | 1.4404             |                      | 316 S11 |
|                       |                                   | 1.4432             |                      | 316 S13 |
|                       |                                   | 1.4435             |                      | —       |
|                       |                                   | 1.4436             |                      | 316 S33 |
|                       |                                   | 1.4541             |                      | 321 S31 |
|                       |                                   | 1.4550             |                      | 347 S31 |
|                       |                                   | 1.4571             |                      | 320 S31 |

NOTE 1. The copper content shall not exceed 0.30 %.

NOTE 2. Rimming steel shall not be used.

NOTE 3. The steel supplier shall provide a certificate of compliance which shall also state:

a) the ladle analysis of the material supplied;

b) the results of mechanical tests on test pieces taken from samples representing the material supplied.

NOTE 4. Any negative tolerance on thickness permitted in the material standard shall be taken into account in specifying the ordering thickness (see **3.1.5**).

NOTE 5. The additional procedure for correction of defects in **7.4.4** of BS EN 10021 only applies with the agreement of the purchaser and Inspecting Authority. Specific inspection should be carried out and a certificate issued.

## 2.2 Materials for low temperature applications

**2.2.1** Special consideration shall be given to the selection of materials:

- a) for vessels designed to operate below 0 °C;
- b) where it is considered by the purchaser, Inspecting Authority or manufacturer that there would otherwise be undue risk of brittle fracture in pressure testing a vessel at the temperature of the available test fluid.

**2.2.2** Table 2.2-1 specifies bolting material suitable for use at low temperature and the minimum design temperature for each material.

**2.2.3** The impact requirements for ferritic steels, in band M0 to M4 inclusive, used for vessels designed to operate below 0 °C shall be in accordance with annex D.

Annex D shall be used when the final pressure test of a vessel is at a temperature higher than that of the available test fluid, as permitted by **5.8.2.4**.

**2.2.4** Requirements for the use of ferritic steels in the bands M5 (3½ % Ni) and M7 to M10 inclusive shall be specified in the purchase specification. If not specified there, the manufacturer shall propose them for agreement by the purchaser and Inspecting Authority.

**2.2.5** The impact requirements for ferritic steels in band M6 (9 % Ni) used for vessels designed to operate below 0 °C shall be in accordance with the British Standards listed in table K.1-1 for M6 steels.

**2.2.6** Austenitic stainless steels (including the high nitrogen and warm worked varieties) are not susceptible to low stress brittle fracture and no special requirements are necessary for their use at temperatures down to –196 °C.

**2.2.7** Aluminium and aluminium alloys are not susceptible to low stress brittle fracture and no special requirements are necessary for their use at temperatures down to –196 °C.

**Table 2.2-1 Bolting materials for low-temperature**

| Material/bolting specification                                                           | Material specification                                                                                     | Bolting grade                                            | Application    | Impact requirements <sup>1)</sup>                                        | Minimum design temperature °C |
|------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|----------------|--------------------------------------------------------------------------|-------------------------------|
| Carbon steel bolting in accordance with BS 1768, BS 1769, BS EN 20898-1 or BS EN 20898-2 | BS 3111 grade 0/3<br>BS 3111 grade 1/3<br>BS 3111 grade 10/2<br>BS 970 grade 070M20<br>BS 970 grade 080M40 | B or 4.8<br>P or 6.8<br>P or 6.8<br>B or 4.8<br>P or 6.8 | Nuts and bolts | Not required for BS 1769. At room temperature for BS 1768 and BS EN 2089 | −30                           |
| Low alloy steel bolting in accordance with BS 1768 or BS EN 20898-1 or BS EN 20898-2     | BS 1506 grade 630<br>BS 970 grade 135M44<br>BS 970 grade 708M40                                            | 6.8/8.8<br>S or 8.8<br>S or 8.8                          | Nuts and bolts | At room temperature                                                      | −50                           |
| Low alloy steel bolting in accordance with BS 4882                                       | BS 1506 grade 162                                                                                          | 2H/2HM                                                   | Nuts           | Not required <sup>2)</sup>                                               | −50                           |
|                                                                                          | BS 1506 grade 253                                                                                          | 4/4M                                                     |                |                                                                          |                               |
|                                                                                          | BS 1506 grade 253                                                                                          | L/4                                                      |                | At −100 °C                                                               | −100                          |
|                                                                                          | BS 1506 grade 630<br>BS 1506 grade 631<br>BS 1506 grade 670<br>BS 1506 grade 681<br>BS 1506 grade 671      | B7/B7M<br>B7A<br>B16<br>B16A<br>B16B                     | Nuts and bolts | At room temperature                                                      | −50                           |
|                                                                                          | BS 1506 grade 630                                                                                          | L7/L7M                                                   | Nuts and bolts | At −100 °C                                                               | −100                          |
|                                                                                          |                                                                                                            |                                                          |                |                                                                          |                               |
| 9 % nickel steel bolting in accordance with BS 4882                                      | BS 1506 grade 509-650<br>BS 1506 grade 509-690                                                             | L9<br>L9A                                                | Nuts and bolts | At −196 °C                                                               | −196                          |
| Austenitic stainless steel bolting in accordance with BS 4882                            | BS 1506 grade 304-S31, S51, S61, S71                                                                       | B8+                                                      | Nuts and bolts | Not required <sup>2)</sup>                                               | −196                          |
|                                                                                          | BS 1506 grade 316-S31, S33, S51, S53, S61, S63, S65, S67                                                   | B8M+                                                     |                |                                                                          |                               |
|                                                                                          | BS 1506 grade 321-S31, S51                                                                                 | B8T+                                                     |                |                                                                          |                               |
|                                                                                          | BS 1506 grade 304-S31, S61, S71                                                                            | L8+                                                      |                | At −196 °C                                                               | −250                          |
|                                                                                          | BS 1506 grade 316-S31, S33, S61, S63, S65, S67                                                             | L8M+                                                     |                |                                                                          |                               |
|                                                                                          | BS 1506 grade 321-S31<br>BS 1506 grade 347-S31                                                             | L8T<br>L8C                                               |                |                                                                          |                               |
| Precipitation hardening alloys in accordance with BS 4882                                | BS 1506 grade 286-S31<br>BS 3076 grade NA20                                                                | L17B+<br>L80A                                            | Nuts and bolts | At −196 °C                                                               | −196                          |

<sup>1)</sup> Impact energy values shall be as material/bolting specification at the temperature indicated.

<sup>2)</sup> “Not required” indicates that the material may be used, without impact testing, down to the minimum design temperature given in column 6.

## 2.3 Nominal design strength

### 2.3.1 General

**2.3.1.1** The nominal design strength  $f_N$  shall be determined:

- as the lesser of  $f_E$  and  $f_F$  which are derived by applying the factors of safety from **2.3.3** and **2.3.4** to the property values of the BS EN steels listed in table 2.1-2 or of the material as agreed between the manufacturer, Inspecting Authority and purchaser [see **2.1.2.1c**];
- in the case of existing BS steels, taking values from table K.1-2 to K.1-12.

It is permissible to use actual material properties instead of specified minimum values to derive time-independent nominal design strengths in order to consider a concessionary acceptance of a specific feature such as a localized manufacturing deviation. This procedure is acceptable provided that appropriate records are retained for the material(s) used in the part(s) under consideration, of:

- the tests made to determine the relevant values of  $R_m$  and  $R_e$ ;
- the tests or correlation used to derive the relevant  $R_{e(T)}$  value; if applicable;
- the tests made of actual weld properties joining the materials together.

This procedure shall not be used to derive basis design stresses for the original vessel design.

**2.3.1.2** Consideration of whether time dependent stresses are applicable shall be given when the design temperature exceeds the values given in table 2.3-1.

### 2.3.2 Notation

$R_m$  is the minimum tensile strength specified for the grade of material concerned at room temperature (tested in accordance with BS EN 10002-1).

$R_e$  is the minimum value of specified yield strength for the grade of steel concerned at room temperature (tested in accordance with BS EN 10002-1).

Where a standard specifies minimum values of  $R_{eL}$  or  $R_{p0.2}$  ( $R_{p1.0}$  for austenitic steels) these values are taken as corresponding to  $R_e$ .

$R_{e(T)}$  corresponds to the minimum value of  $R_{eL}$  or  $R_{p0.2}$  ( $R_{p1.0}$  for austenitic steels) specified for the grade of material concerned at a temperature  $T$  (tested in accordance with BS EN 10002-5).

$S_{Rt}$  is the mean value of the stress required to produce rupture in time  $t$  (at temperature  $T$ ) for the grade of steel in question (tested in accordance with BS 3500).

$f_E$  is the nominal design strength corresponding to the short-term tensile strength characteristics.

$f_F$  is the nominal design strength corresponding to the creep characteristics.

$f_N$  is the nominal design strength.

**Table 2.3-1 Temperature above which time dependent properties shall be considered**

| M band    | Material type                                 | Temperature<br>°C |
|-----------|-----------------------------------------------|-------------------|
| M0 and M1 | Carbon and carbon manganese steel             | 400               |
| M2        | Carbon molybdenum steel                       |                   |
| M5        | 3½Ni                                          |                   |
| M6        | 9Ni                                           |                   |
| M4        | Low alloy Mn, Cr, Mo, V                       | 470               |
| M7        | 1Cr ½Mo                                       |                   |
| M8        | ½Cr ½Mo ¼V                                    | 490               |
| M12       | 12Cr 1Mo V                                    |                   |
| M9        | 2¼Cr 1 Mo where $R_e \leq 350 \text{ N/mm}^2$ | 460               |
| M10       | 5Cr ½Mo                                       |                   |
| M11       | 9Cr 1Mo                                       |                   |
| M9        | 2¼Cr 1Mo where $R_e > 350 \text{ N/mm}^2$     | 350               |
| —         | Stainless steels                              |                   |
|           | Type 321 and Type 347                         | 540               |
|           | Type 304 and Type 316                         | 560               |

NOTE. Where the vessel is subject to fatigue, C.1.3 limits the applicability of annex C up to 350 °C for ferritic steels and 430 °C for austenitic stainless steels.