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Metallic industrial piping

Part 2: Materials

National foreword

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31 October 2015	Corrected version issued by CEN, see EN foreword for details

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This European Standard was approved by CEN on 8 May 2012.

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Foreword

This document (EN 13480-2:2012) has been prepared by Technical Committee CEN/TC 267 “Industrial piping and pipelines”, the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2012, and conflicting national standards shall be withdrawn at the latest by December 2012.

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

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

This European Standard EN 13480 for metallic industrial piping consists of eight interdependent and not dissociable Parts which are:

— *Part 1: General;*

— *Part 2: Materials;*

— *Part 3: Design and calculation;*

— *Part 4: Fabrication and installation;*

— *Part 5: Inspection and testing;*

— *Part 6: Additional requirements for buried piping;*

— CEN/TR 13480-7*: Guidance on the use of conformity assessment procedures;*

— *Part 8: Additional requirements for aluminium and aluminium alloy piping.*

Although these Parts may be obtained separately, it should be recognised that the Parts are interdependent. As such the manufacture of metallic industrial piping requires the application of all the relevant Parts in order for the requirements of the Standard to be satisfactorily fulfilled.

This European Standard will be maintained by a Maintenance MHD working group whose scope of working is limited to corrections and interpretations related to EN 13480.

The contact to submit queries can be found at http://www.unm.fr (en13480@unm.fr). A form for submitting questions can be downloaded from the link to the MHD website. After subject experts have agreed an answer, the answer will be communicated to the questioner. Corrected pages will be given specific issue number and issued by CEN according to CEN Rules. Interpretation sheets will be posted on the website of the MHD.

This document supersedes EN 13480-2:2002+A1:2010+A2:2010. This new edition incorporates the Amendments/the corrigenda which have been approved previously by CEN members, the corrected pages up to Issue 17 without any further technical change. Annex Y provides details of significant technical changes between this European Standard and the previous edition.

Amendments to this new edition may be issued from time to time and then used immediately as alternatives to rules contained herein. It is intended to deliver a new Issue of EN 13480:2012 each year, consolidating these Amendments and including other identified corrections. Issue 4 (2015-07) includes the corrected pages listed in Annex Y.

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

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1 Scope

This Part of this European Standard specifies the requirements for materials (including metallic clad materials) for industrial piping and supports covered by EN 13480-1 manufactured from of metallic materials. It is currently limited to steels with sufficient ductility. This Part of this European Standard is not applicable to materials in the creep range.

NOTE Other materials will be added later by amendments.

It specifies the requirements for the selection, inspection, testing and marking of metallic materials for the fabrication of industrial piping.

2 Normative references

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

EN 764-3:2002, *Pressure equipment — Terminology Part 3: Definition of parties involved*

EN 1092-1:2007, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, PN designated — Part 1: Steel flanges*

EN 10028-1:2007+A1:2009+AC:2009*, Flat products made of steels for pressure purposes — Part 1: General requirements*

EN 10028-2:2009, *Flat products made of steels for pressure purposes — Part 2: Non-alloy and alloy steels with specified elevated temperature properties*

EN 10028-3:2009, *Flat products made of steels for pressure purposes — Part 3: Weldable fine grain steels, normalized*

EN 10028-4:2009, *Flat products made of steels for pressure purposes — Part 4: Nickel alloyed steels with specified low temperature properties*

EN 10028-5:2009, *Flat products made of steels for pressure purposes — Part 5: Weldable fine grain steels, thermomechanically rolled*

EN 10028-6:2009, *Flat products made of steels for pressure purposes — Part 6: Weldable fine grain steels, quenched and tempered*

EN 10028-7:2007, *Flat products made of steels for pressure purposes — Part 7: Stainless steels*

EN 10164:2004, *Steel products with improved deformation properties perpendicular to the surface of the product — Technical delivery conditions*

EN 10204:2004, *Metallic products — Types of inspection documents*

EN 10213:2007, *Steel castings for pressure purposes*

EN 10216-1:2002+A1:2004, *Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 1: Non-alloy steel tubes with specified room temperature properties*

EN 10216-2:2002+A2:2007, *Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 2: Non-alloy and alloy steel tubes with specified elevated temperature properties*

EN 10216-3:2002+A1:2004, *Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 3: Alloy fine grain steel tubes*

EN 10216-4:2002+A1:2004, *Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 4: Non-alloy and alloy steel tubes with specified low temperature properties*

EN 10216-5:2004, *Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 5: Stainless steel tubes*

EN 10217-1:2002+A1:2005, *Welded steel tubes for pressure purposes — Technical delivery conditions — Part 1: Non-alloy steel tubes with specified room temperature properties*

EN 10217-2:2002+A1:2005, *Welded steel tubes for pressure purposes — Technical delivery conditions — Part 2: Electric welded non-alloy and alloy steel tubes with specified elevated temperature properties*

EN 10217-3:2002+A1:2005, *Welded steel tubes for pressure purposes — Technical delivery conditions — Part 3: Alloy fine grain steel tubes*

EN 10217-4:2002+A1:2005, *Welded steel tubes for pressure purposes — Technical delivery conditions — Part 4: Electric welded non-alloy steel tubes with specified low temperature properties*

EN 10217-5:2002+A1:2005, *Welded steel tubes for pressure purposes — Technical delivery conditions — Part 5: Submerged arc welded non-alloy and alloy steel tubes with specified elevated temperature properties*

EN 10217-6:2002+A1:2005, *Welded steel tubes for pressure purposes — Technical delivery conditions — Part 6: Submerged arc welded non-alloy steel tubes with specified low temperature properties*

EN 10217-7:2005*, Welded steel tubes for pressure purposes — Technical delivery conditions – Part 7: Stainless steel tubes*

EN 10222-1:1998+A1:2002, *Steel forgings for pressure purposes — Part 1: General requirements for open die forgings*

EN 10222-2:2000, *Steel forgings for pressure purposes — Part 2: Ferritic and martensitic steels with specified elevated temperature properties*

EN 10222-3:1998, *Steel forgings for pressure purposes — Part 3: Nickel steels with specified low temperature properties*

EN 10222-4:1998+A1:2001, *Steel forgings for pressure purposes — Part 4: Weldable fine grain steels with high proof strength*

EN 10222-5:2000, *Steel forgings for pressure purposes — Part 5: Martensitic, austenitic and austenitic-ferritic stainless steels*

EN 10253-2:2007, *Butt-welding pipe fittings — Part 2: Non alloy and ferritic alloy steel with specific inspection requirements*

EN 10269:1999+A1:2006, *Steels and nickel alloys for fasteners with specified elevated and/or low temperature properties*

EN 10272:2007, *Stainless steel bars for pressure purposes*

EN 10273:2007, *Hot rolled weldable steel bars for pressure purposes with specified elevated temperature properties*

EN 12074:1999, *Welding consumables — Quality requirements for manufacture, supply and distribution of consumables for welding and allied processes*

EN 13445-4:2009, *Unfired pressure vessels — Part 4: Fabrication*

EN 13445-5:2009*, Unfired pressure vessels — Part 5: Inspection and testing*

EN 13479:2004, *Welding consumables — General product standard for filler metals and fluxes for fusion welding of metallic materials*

EN 13480-1:2012, *Metallic industrial piping — Part 1: General*

EN 13480-3:2012, *Metallic industrial piping — Part 3: Design and calculation*

EN 13480-4:2012, *Metallic industrial piping — Part 4: Fabrication and installation*

EN 13480-5:2012, *Metallic industrial piping — Part 5: Inspection and testing*

EN 20898-2:1993, *Mechanical properties of fasteners — Part 2: Nuts with specified proof load values — Coarse thread*

EN ISO 148-1:2010, *Metallic materials — Charpy pendulum impact test — Part 1: Test method (ISO 148-1:2009)*

EN ISO 898-1:2009, *Mechanical properties of fasteners made of carbon steel and alloy steel — Part 1: Bolts, screws and studs with specified property classes — Coarse thread and fine pitch thread (ISO 898-1:2009)*

EN ISO 2566-1:1999, *Steel — Conversion of elongation values — Part 1: Carbon and low alloy steels (ISO 2566-1:1984).*

EN ISO 2566-2:1999*, Steel — Conversion of elongation values — Part 2: Austenitic steels (ISO 2566-2:1984)*

EN ISO 3506-1:1997*, Mechanical properties of corrosion-resistant stainless steel fasteners — Part 1: Bolts, screws and studs (ISO 3506-1:1997)*

EN ISO 3506-2:1997*, Mechanical properties of corrosion-resistant stainless steel fasteners — Part 2: Nuts (ISO 3506-2:1997)*

CEN ISO/TR 15608:2000, *Welding — Guidelines for a metallic materials grouping system (ISO/TR 15608:2000)*

3 Terms and definitions, symbols and untis

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 13480-1:2012, EN 764-3:2002 and the following definitions apply.

3.1.1
minimum metal temperature T_M
lowest temperature determined for any of the following conditions:

— normal operations;

— start up and shut down procedures;

— possible process upsets, such as flashings of fluid, which have an atmospheric boiling point below 0 °C;

— during pressure or leak testing.

Note to entry See also 3.1.2 and 3.1.3.

3.1.2
temperature adjustment term T_S
temperature relevant to the calculation of the design reference temperature T_R and dependent on the calculated tensile membrane stress at the appropriate minimum metal temperature

Note 1 to entry Values for temperature adjustment term T_S are given in Table B.2-12.

Note 2 to entry For tensile membrane stress reference is made to EN 13480-3:2012, clause 12.

3.1.3
design reference temperature T_R
temperature used for determining the impact energy requirements and determined by adding the temperature adjustment T_S to the minimum metal temperature T_M

$$T_R = T_M + T_S$$

3.1.4
impact test temperature T_{KV}
temperature at which the required resistance to impact energy is achieved

Note to entry See B.2.

3.1.5
impact energy KV
energy absorbed by a sample of material when subjected to a Charpy-V-notch impact test in accordance with EN ISO 148-1:2010

3.1.6
reference thickness e_B
thickness of a component to be used to relate the design reference temperature T_R of the component with its required impact test temperature T_{KV}

Note 1 to entry See Tables B.2-2 to B.2-7 and Figures B.2-1 to B.2-11.

Note 2 to entry The reference thickness e_B, defined in Table B.4-1, is based on the nominal thickness (including corrosion allowance). For butt welded components e_B is the nominal wall thickness of the component at the edge of the weld preparation.

3.2 Symbols and units

For the purposes of this Part of this European Standard, the symbols and units of EN 13480-1:2012 apply together with those given in Table 3.2-1.

Table 3.2-1 — Symbols and units

Symbol	Characteristic	Unit
a_K	Form factor	–
b	width	mm
C	constant	–
e_B	reference thickness	mm
G	shear modulus	N/mm^2 (MPa)
HB	Brinell hardness	–
HV	Vickers hardness	–
h	maximum permissible reinforcement of weld	mm
KV	Impact rupture energy	J
L_o	length (gauge length)	mm
P	pressure	bar
P_{LM}	parameter according to Larson-Miller	–
R_e	yield strength	N/mm^2 (MPa)
$R_{m\,T\,t}$	creep rupture strength for T in h at temperature t	N/mm^2 (MPa)
S_0	original cross section area	mm^2
T_M	minimum metal temperature	°C
T_{KV}	material impact test temperature	°C
T_R	design reference temperature	°C
T_S	temperature adjustment term	°C
α	linear expansion coefficient	K^{-1}
ε	strain	%

NOTE 1 N/mm^2 = 1 MPa

4 Requirements for materials to be used for pressure containing parts in industrial piping

4.1 General

4.1.1 Materials to be used for pressure containing parts in industrial piping shall meet the general requirements of 4.1 and the special provisions of 4.2 if applicable. Materials for pressure containing parts shall be ordered complying with the technical delivery conditions in 4.3.

Marking of materials for pressure containing parts shall be performed in accordance with 4.4.

Materials shall be selected in accordance with Annex A.

Materials shall be selected to be compatible with anticipated fabrication steps and to be suitable for the internal fluid and external environment. Both normal operating conditions and transient conditions occurring during fabrication, transport, testing, commissioning and decommissioning shall be taken into account when specifying the materials.

NOTE 1 The requirements of 4.1 and 4.2 should also be fulfilled when technical delivery conditions are developed for European Standards for materials , European Approval of Materials or Particular Material Appraisals.

NOTE 2 When technical delivery conditions for pressure-containing parts are developed, the structure and requirements of EN 764-4:2002 should be met. Exceptions should be technically justified.

The materials shall be grouped in accordance with CEN ISO/TR 15608:2000 to relate manufacturing and inspection requirements to generic material types.

NOTE 3 Materials have been allocated into these groups in accordance with their chemical composition and properties in relation to manufacture and heat treatment after welding.

4.1.2 Materials for pressure containing parts compliant with the requirements of this European Standard shall be certified on the basis of EN 10204:2004.

NOTE The certification should be in accordance with EN 764-5:2002.

4.1.3 The products shall be free from surface and internal defects which might impair their usability.

4.1.4 The specified minimum elongation of the steel after fracture shall be:

— $\geq$ 14 % for the transverse direction; and

— $\geq$ 16 % for the longitudinal direction, or where this is the less critical direction, the transverse direction;

when measured on a gauge length, L_0, calculated as follows:

$$L_0 = 5{,}65\sqrt{S_0} \qquad (4.1\text{-}1)$$

where

S_0 is the original cross sectional area within the gauge length in order to fulfil formula 4.1-1.

However, lower elongation values than specified in 4.1 (e. g. for fasteners or castings) may also be applied, provided that appropriate measures shall be taken by the parties concerned to compensate for these lower values and that compliance with the specific requirements is verifiable.

NOTE Examples of appropriate measures:

— application of higher safety factors in design;

— performance of appropriate burst tests to demonstrate ductile material behaviour.

4.1.5 When measured on a gauge length other than that stated in 4.1.4, the minimum elongation after fracture shall be determined by converting the elongation given in 4.1.4 in accordance with:

— EN ISO 2566-1:1999 for carbon and low alloy steels;

— EN ISO 2566-2:1999 for austenitic steels.

4.1.6 Steels shall have a specified minimum impact energy measured on a Charpy V-notch impact test specimen (EN ISO 148-1:2010) as follows:

— ≥ 27 J for ferritic and 1,5 % to 5 % Ni alloyed steels;

— ≥ 40 J for steels of material groups 8, 9.3 and 10,

at a test temperature in accordance with Annex B, but not higher than 20 °C. The other requirements of Annex B shall also apply.

4.1.7 The chemical composition of steels intended for welding or forming shall not exceed the values given in Table 4.1-1. Exceptions shall be technically justified.

Table 4.1-1 — Maximum carbon, phosphorus and sulphur content for steel intended for welding or forming

Material group (according to Table A.1)	Maximum content of cast analysis		
	% C	% P	% S
Steels (1 to 6 and 9)	0,23 [a]	0,035	0,025
Ferritic stainless steels (7.1)	0,08	0,040	0,015
Martensitic stainless steels (7.2)	0,06	0,040	0,015
Austenitic stainless steels (8.1)	0,08	0,045	0,015 [b]
Austenitic stainless steels (8.2)	0,10	0,035	0,015
Austenitic-ferritic stainless steels (10)	0,030	0,035	0,015

[a] Maximum content of product analysis 0,25 %.
[b] For products to be machined a controlled sulphur content of 0,015 % to 0,030 % is permitted by agreement provided the resistance to corrosion is satisfied for the intended purpose.

4.2 Special provisions

4.2.1 Special properties

4.2.1.1 General

Where the behaviour of a material can be affected by manufacturing processes or operating conditions, to an extent that would adversely affect the safety or service life of the piping system, this shall be taken into consideration when specifying the material.

Adverse effects can arise from:

— manufacturing processes: e.g. degree of cold forming, heat treatment;

— operating conditions: e.g. hydrogen embrittlement, corrosion, scaling, ageing behaviour after cold forming.

4.2.1.2 Lamellar tearing

Where lamellar tearing due to the joint design and loading needs to be addressed (see EN 13480-3:2012, 7.2.3.3), steels shall be used which have improved deformation properties perpendicular to the surface shall be specified and verified in accordance with EN 10164:2004.

NOTE For guidance see EN 1011-2:2001.

4.2.2 Design temperature above 20 °C

4.2.2.1 A material shall only be used for pressure parts within the range of temperatures for which the material properties required by EN 13480-3:2012 are defined in the technical specification for the material. If the technical delivery condition does not contain the specific material values required for the design temperature T_R the values required in EN 13480-3:2012 for the design shall be determined by linear interpolation between the two adjacent values. Values shall not be rounded up.

For other than austenitic and austenitic-ferritic stainless steels, the specified value of R_{eH} ($R_{p0,2}$) at room temperature may be used for temperatures less than or equal to 50 °C. Interpolation for design temperatures between 50 °C and 100 °C shall be performed with the values of R_{eH} at room temperature and at 100 °C, and using 20 °C as the starting point for interpolation. Above 100 °C linear interpolation shall be performed between the tabulated values given in the appropriate material standards.

In the case of creep rupture strength values or strength values for plastic strain in a given time, linear interpolation shall be permissible only if the difference between the two temperatures serving as starting points for the interpolation is equal to or less than 10 °C.

4.2.2.2 Materials in the creep range shall not be used unless the creep rupture strength values or strength values for plastic strain needed for design are specified in the base material specification. The manufacturer of the piping system installation shall be assured by the material supplier that the material supplied is capable of complying with specified properties (within the normal scatter band) by a statement that the manufacturing processes have remained equivalent to those for the steel for which the test results were obtained.

4.2.3 Prevention of brittle fracture

The requirements given in Annex B shall apply.

4.2.4 Specific requirements for fasteners

Fasteners include bolts, studs and nuts.

Free cutting steel shall not be used. Fasteners made of carbon steel or low alloyed ferritic steel with > 3,5 % nickel shall not be used above 300 °C.

The specified minimum tensile strength of bar material of ferritic and martensitic steel for bolts shall not exceed 1 000 N/mm^2. The minimum elongation after fracture of bar material shall be at least 14%.

Impact requirements for ferritic steels shall be in accordance with B.2.2-4.

Bolt material with a design temperature below –160 °C shall be impact tested at –196 °C.

Hydrogen embrittlement, fatigue or relaxation properties shall be taken into account where appropriate.

NOTE Detailed requirements on the surface condition and internal soundness of the bar can be necessary for some applications.

4.2.5 Lined piping

The pressure containing steel of lined industrial piping need not be suitable for the internal fluid if the lining provides leak tight containment during operation.

4.3 Technical delivery conditions

4.3.1 European Standards

The European Standards for plates, strips, bars, tubes, forgings, fittings and castings for pressure purposes shall be used.

NOTE 1 Table D.1-1 provides an informative summary of European Materials Standards for steels and steel components for pressure purposes.

NOTE 2 Table D.2-1 provides an informative summary regarding materials for pressure purposes specified in harmonised standards grouped according to product forms.

Special provisions due to fabrication and operation shall be taken into account, if appropriate.

4.3.2 European Approval for Materials (EAM)

A material specified in an EAM for piping system shall only be used within its range of application.

4.3.3 Particular Material Appraisals (PMA)

Materials other than those specified in 4.3.1 and 4.3.2 may also be used provided that they have been accepted by a particular material appraisal (PMA).

4.3.4 Clad products

Technical delivery conditions for clad products for pressure parts shall be in accordance with the requirements of Annex C.

NOTE 1 European Standards specifying technical delivery conditions for clad products for pressure purposes are not currently available.

NOTE 2 Examples of documents covering technical delivery condition for clad steels are given within the publications [2] to [4]

4.3.5 Technical delivery conditions for welding consumables

Technical delivery conditions for welding consumables used for the welding of pressure parts and attachments to pressure parts shall be in accordance with EN 10274:1999 and EN 13479-1:2004.

NOTE Equivalent national/international specifications are accepted which fulfil the same criteria with respect to the requirements for the Quality System and the requirements for manufacture, supply distribution, test methods and evaluation of consumables.

4.4 Marking

The marking of the products or delivery units shall ensure traceability between the product or delivery unit and the inspection documents.

For European standardized materials, the marking shall fulfil the requirements of the relevant standard. For materials not contained in a European standard the marking shall at least contain:

— the material specification (reference, material designation);

— the manufacturer's name or mark;

— the stamp of the inspection representative, if applicable.

For material supplied with specific inspection the marking shall include an identification which permits the correlation between the product or delivery unit and the relevant inspection document.

5 Requirements for materials to be used for non-pressure parts

For non-pressure parts, e.g. supporting lugs, skirts, baffles and similar parts welded to industrial piping, and for welding consumables, materials shall be used which are supplied to material specifications covering at least the requirements for the chemical composition and the tensile properties. These materials shall not limit the operating conditions of the material to which they are attached.

Requirements on materials used for pipe supports are defined in EN 13480-3.

Annex A
(normative)

Grouping system for steels for pressure equipment

Steels shall be grouped as shown in Table A.1. The figures given in group 1 are referring to the ladle analysis of the materials. The figures given in group 4 to 10 are based on the element content used in the designation of the alloys.

Table A.1 — Grouping system for steels (extract from CEN ISO/TR 15608:2000)

Group	Sub-group	Type of steel
1		Steels with a specified minimum yield strength $R_e \leq 460$ N/mm^2 [a] and with analysis in %: C ≤ 0,25 Si ≤ 0,60 Mn ≤ 1,70 Mo ≤ 0,70 [b] S ≤ 0,045 P ≤ 0,045 Cu ≤ 0,40 [b] Ni ≤ 0,5b Cr ≤ 0,3 (0,4 for castings) [b] Nb ≤ 0,05 V ≤ 0,12 [b] Ti ≤ 0,05
	1.1	Steels with a specified minimum yield strength $R_e \leq 275$ N/mm^2
	1.2	Steels with a specified minimum yield strength 275 N/mm^2 $< R_e \leq 360$ N/mm^2
	1.3	Normalised fine grain steels with a specified minimum yield strength $R_e > 360$ N/mm^2
	1.4	Steels with improved atmospheric corrosion resistance whose analysis may exceed the requirements for the single elements as indicated under 1
2		Thermomechanically treated fine grain steels and cast steels with a specified minimum yield strength $R_e > 360$ N/mm^2
	2.1	Thermomechanically treated fine grain steels and cast steels with a specified minimum yield strength 360 N/mm^2 $< R_e \leq 460$ N/mm^2
	2.2	Thermomechanically treated fine grain steels and cast steels with a specified minimum yield strength $R_e > 460$ N/mm^2
3		Quenched and tempered steels and precipitation hardened steels except stainless steels with a specified minimum yield strength $R_e > 360$ N/mm^2
	3.1	Quenched and tempered steels with a specified minimum yield strength 360 N/mm^2 $< R_e \leq 690$ N/mm2
	3.2	Quenched and tempered steels with a specified minimum yield strength $R_e > 690$ N/mm^2
	3.3	Precipitation hardened steels except stainless steels

Table A.1 (*concluded*)

Group	Sub-group	Type of steel
4		Low vanadium alloyed Cr-Mo-(Ni) steels with Mo ≤ 0,7 % and V ≤ 0,1 %
	4.1	Steels with Cr ≤ 0,3 % and Ni ≤ 0,7 %
	4.2	Steels with Cr ≤ 0,7 % and Ni ≤ 1,5 %
5		Cr-Mo steels free of vanadium with C ≤ 0,35 % [c]
	5.1	Steels with 0,75 % ≤ Cr ≤ 1,5 % and Mo ≤ 0,7 %
	5.2	Steels with 1,5 % < Cr ≤ 3,5 % and 0,7 < Mo ≤ 1,2 %
	5.3	Steels with 3,5 % < Cr ≤ 7,0 % and 0,4 < Mo ≤ 0,7 %
	5.4	Steels with 7,0 % < Cr ≤ 10 % and 0,7 < Mo ≤ 1,2 %
6		High vanadium alloyed Cr-Mo-(Ni) steels
	6.1	Steels with 0,3 % ≤ Cr ≤ 0,75 %, Mo ≤ 0,7 % and V ≤ 0,35 %
	6.2	Steels with 0,75 % < Cr ≤ 3,5 %, 0,7 % < Mo ≤ 1,2 % and V ≤ 0,35 %
	6.3	Steels with 3,5 % < Cr ≤ 7,0 %, Mo ≤ 0,7 % and 0,45 % ≤ V ≤ 0,55 %
	6.4	Steels with 7,0 % < Cr ≤ 12,5 %, 0,7 % < Mo ≤ 1,2 % and V ≤ 0,35 %
7		Ferritic, martensitic or precipitation hardened stainless steels with C ≤ 0,35 % and 10,5 % ≤ Cr ≤ 30 %
	7.1	Ferritic stainless steels
	7.2	Martensitic stainless steels
	7.3	Precipitation hardened stainless steels
8		Austenitic steels
	8.1	Austenitic stainless steels with Cr ≤ 19 %
	8.2	Austenitic stainless steels with Cr > 19 %
	8.3	Manganese austenitic stainless steels with 4 % < Mn ≤ 12 %
9		Nickel alloyed steels with Ni ≤ 10 %
	9.1	Nickel alloyed steels with Ni ≤ 3 %
	9.2	Nickel alloyed steels with 3,0 % < Ni ≤ 8 %
	9.3	Nickel alloyed steels with 8,0 % < Ni ≤ 10 %
10		Austenitic ferritic stainless steels (duplex)
	10.1	Austenitic ferritic stainless steels with Cr ≤ 24 %
	10.2	Austenitic ferritic stainless steels with Cr > 24 %

[a] In accordance with the specification of the steel product standards, R_e may be replaced by $R_{p0,2}$ or $R_{t0.5}$.

[b] A higher value is accepted provided that Cr + Mo + Ni + Cu + V ≤ 0,75 %.

[c] "Free of vanadium" means not deliberately added to the material.

Annex B
(normative)

Requirements for prevention of brittle fracture at low temperatures

B.1 General

This annex distinguishes between pressure equipment that has design temperature for normal operation higher or lower than 50 °C.

For pressure equipment with normal operation temperatures higher than 50 °C B.5 applies. If B.5 is not applicable, the following rules for lower normal operation temperatures shall be used.

For pressure equipment with design temperature equal to or less than 50 °C this annex specifies three alternative methods for establishing criteria for the prevention of low temperature brittle fracture[1)] of steels in the form of plate, strip, tubes, fittings, forgings, castings, flanges, fasteners and weldments used in pressure parts. In this case, the temperature for the design T_R shall be determined[2)]. The criteria are based on impact energy requirements at specified temperatures for the base material, heat affected zone (including the fusion line) and weld metals.

The three methods are:

Method 1 Code of Practice:

Technical requirements

a) Technical requirements based on the choice of T_R = T_{27J} as specified in harmonised European Material Standards and on the assumption that it is possible to achieve these minimum properties after fabrication. Calculated from the principles of fracture mechanics used for method 2 for C and CMn steels with yield strength < 460 MPa and

b) based on operating experience for Ni-alloyed steels with Ni ≥ 3 % up to 9 %, for austenitic steels and for bolts and nuts.

1) Including temperatures at pressure tests

2) See EN 13480-2:2012, 3.1.3.

Method 2 Method developed from the principles of fracture mechanics and from operating experiences:

A more flexible approach than method 1 for derivation of technical requirements applicable to C, CMn and low alloy ferritic steels with a specified minimum yield strength $\leq$ 500 N/mm^2 and for austenitic-ferritic steels with a specified minimum yield strength $\leq$ 550 N/mm^2. This method can be applied for these steels to a wider range of thicknesses and temperatures than method 1 because T_R must not be equal to T_{27J} (see Figures B.2-1 to B.2-11). In addition for ferritic steels with max. 355 N/mm^2 in PWHT condition operation experience was considered for higher thicknesses.

Method 3 The application of a fracture mechanics analysis:

This general method is applicable to cases not covered by methods 1 or 2. This method may also be used to justify deviations from the requirements of method 1 or 2. Only general guidance is given on the use of this method which shall only be used in agreement with the parties concerned.

Each of the three methods may be used independently. It is only necessary to satisfy the requirement of any one method.

All applicable combinations of the temperatures T_M (minimum metal temperature) and T_S (temperature adjustment term) shall be considered and the lowest possible T_R-value (design reference temperature) shall be used for the determination of the required material impact test temperature.

NOTE For definitions of temperature terms see 3.1.1 to 3.1.4.

B.2 Material selection and impact energy requirements

B.2.1 General

The methods specified in B.2.2 (Method 1) or B.2.3 (Method 2) shall be used to determine the impact energy required to avoid brittle fracture. Alternatively, B.2.4 (Method 3) may be used to determine the required toughness. The method used shall be fully documented, in order to ensure that compliance can be verified.

Reference thickness for constructional details is defined in Table B.4-1.

B.2.2 Method 1 – Code of practice

B.2.2.1 General

Method 1 allows the selection of materials taken from harmonised European material standards with regard to prevention of brittle fracture. Table B.2-1 gives an overview to the following tables by steel type and product form.

The weld metal, the heat affected zone and other parts affected by manufacturing processes shall satisfy the same impact energy requirements as the guaranteed minimum properties for the base material at T_R given in the tables.

The tables B.2-2 to B.2-11 list design reference temperatures for maximum thickness at given strength levels represented by steels from harmonised European material standards with guaranteed minimum strength and impact properties. Where it is not possible to achieve these minimum properties after fabrication a tougher material shall be selected.

Table B.2-1 — Guide to material selection

Table	Material or product form [a]	Steel group	Clause
B.2–2	Plates and strips	Ferritic steels	B.2.1.2
B.2–3	Seamless and welded pipes		
B.2–4	Bars		
B.2–5	Forgings		
B.2–6	Ni alloyed steels (1,5 < Ni ≤ 5 %)	Ferritic steels	B.2.1.3
B.2–7	Ni-alloyed steel (9 % Ni)		
B.2–8	Bolts and nuts	Ferritic steels Austenitic steels	B.2.1.4
B.2–9			
B.2–10			
B.2–11	Austenitic steel grades	Austenitic steels	B.2.1.5

[a] For standardized fittings (Tees, Reducers, Elbows and Caps) T_R may be taken from Tables B.2-2 to B.2-6 as for the applied material or product form. The reference thickness e_B of the fitting shall be considered as equal to the reference thickness of the thicker of the mating pipes.

NOTE Requirements for austenitic-ferritic steels are only given in B.2.3 (Method 2).

Where test pieces of at least 5 mm wide cannot be obtained, the material need not be subject to impact testing. For pipes with nominal thickness lower than 6,3 mm no impact testing is required.

Values of the design reference temperature T_R shall be calculated from the metal temperature T_M using the values of the temperature adjustment T_S given in Table B.2-12.

B.2.2.2 Ferritic steels

Tables B.2-2 to B.2-5 list ferritic steels taken from harmonised European material standards with specified impact properties below – 10 °C.

The tabulated value of T_R is based on the impact test temperature T_{KV} for KV = 27 J.

Table B.2-2 — General requirements for prevention of brittle fracture with reference thickness for plates and strips

Plates and Strips								
No. as per Table D.2-1	European Standard EN	Grade	Material No.	Max. reference thickness e_B mm		Design reference temperature T_R °C	Material group to CEN ISO/TR 15608:2000	Remarks
				AW	PWHT			
1	10028-2:2009	P235GH	1.0345	35	90	– 20	1.1	
2		P265GH	1.0425	35	75			
3		P295GH	1.0481	35	65		1.2	
4		P355GH	1.0473	35	55			
29	10028-3:2009	P275NH	1.0487	35	75	– 20	1.1	
30		P275NL1	1.0488	35	75	– 40		
31		P275NL2	1.1104	35	90	– 50		
32		P355N	1.0562	35	55	– 20	1.2	
33		P355NH	1.0565	35	55	– 20		
34		P355NL1	1.0566	35	55	– 40		
35		P355NL2	1.1106	35	55	– 50		
39	10028-4:2009	11MnNi5-3	1.6212	35	50	– 60	9.1	
40		13MnNi6-3	1.6217	35	50	– 60		
41		15NiMn6	1.6228	35	50	– 80		
50	10028-5:2009	P355M	1.8821	30	-	– 20	1.2	[a]
51		P355ML1	1.8832	35	-	– 40		[a]
52		P355ML2	1.8833	35	-	– 50		[a]
53		P420M	1.8824	35	-	– 20	2.1	[a]
54		P420ML1	1.8835	35	-	– 40		[a]
55		P420ML2	1.8828	35	-	– 50		[a]
59	10028-6:2009	P355Q	1.8866	35	60	– 20	1.2	
60		P355QH	1.8867	35	60	– 20		
61		P355QL1	1.8868	35	60	– 40		
62		P355QL2	1.8869	35	60	– 60	3.1	

[a] TMCP steels shall not be Post Weld Heat Treated.

Table B.2-3 — General requirements for prevention of brittle fracture with reference thickness for seamless and welded tubes

Seamless and welded tubes								
No. as per Table D.2-1	European Standard EN	Grade	Material No.	Max. reference thickness e_B mm		Design reference temperature T_R °C	Material group to CEN ISO/TR 15608:2000	Remarks
				AW	PWHT			
231	10216-3:2002+A1:2004	P275NL1	1.0488	35	75	– 40	1.1	
232		P275NL2	1.1104	35	75	– 50		
233		P355N	1.0562	35	55	– 20	1.2	
234		P355NH	1.0565	35	55	– 20		
235		P355NL1	1.0566	35	55	– 40		
236		P355NL2	1.1106	35	55	– 50		
248	10216-4:2002+A1:2004	P215NL	1.0451	10	10	– 40	1.1	[a]
249		P255QL	1.0452	35	40	– 50		
250		P265NL	1.0453	25	25	– 40		
251		26CrMo4-2	1.7219	15	40	– 60	5.1	
252		11MnNi5-3	1.6212	35	40	– 60	9.1	
253		13MnNi6-3	1.6217	35	40	– 60	9.1	
306	10217-3:2002+A1:2005	P275NL1	1.0488	35	40	– 40	1.1	
307		P275NL2	1.1104	35	40	– 50		
308		P355N	1.0562	35	40	– 20	1.2	
309		P355NH	1.0565	35	40	– 20		
310		P355NL1	1.0566	35	40	– 40		
311		P355NL2	1.1106	35	40	– 50		
316	10217-4:2002+A1:2005	P215NL	1.0451	10	10	– 40	1.1	[a]
317		P265NL	1.0453	16	16	– 40	1.1	[a]
321	10217-6:2002+A1:2005	P215NL	1.0451	10	10	– 40	1.1	[a]
322		P265NL	1.0453	25	25	– 40	1.1	[a]

[a] Thickness limitation results from wall thickness limitation in the European material standard and in the European component standards respectively.

Table B.2-4 — General requirements for prevention of brittle fracture with reference thickness for bars

Bars								
No. as per Table D.2-1	European Standard EN	Grade	Material No.	Max. reference thickness e_B mm		Design reference temperature T_R °C	Material group to CEN ISO/TR 15608:2000	Remarks
				AW	PWHT			
147	10273:2007	P275NH	1.0487	35	75	– 20	1.1	
148		P355NH	1.0565	35	55		1.2	
150		P355QH	1.8867	35	55		1.2	

Table B.2-5 — General requirements for prevention of brittle fracture with reference thickness for bars

Forgings								
No. as per Table D.2-1	European Standard EN	Grade	Material No.	Max. reference thickness e_B mm		Design reference temperature T_R °C	Material group to CEN ISO/TR 15608:2000	Remarks
				AW	PWHT			
367	10222-3:1998	13MnNi6-3	1.6217	35	70	– 60	9.1	
369		15NiMn6	1.6228	35	50	– 80	9.1	
378	10222-4:1998+ A1:2001	P285QH	1.0478	35	85	– 20	1.2	
380		P355QH1	1.0571	35	60	– 20	1.2	
382		P420QH	1.8936	35	50	– 20	3.1	

B.2.2.3 Ni –alloyed steels (Ni > 1,5 %)

Table B.2-6 lists Ni alloyed steels up to and including 5 % Nickel taken from harmonised European material standards.

Table B.2-7 lists Ni alloyed steels with 9 % Nickel taken from harmonised European material standards.

The tabulated value of T_R is based on the impact test temperature T_{KV} for KV = 27 J.

Table B.2-6 — General requirements for prevention of brittle fracture with reference thickness for Ni-alloyed steels with 1,5 % < Ni ≤ 5 %

Ni-alloyed steel, 1,5 % < Ni [a] ≤ 5 %								
No. as per Table D.2-1	European Standard EN	Grade	Material No.	Max. reference thickness e_B mm AW	Max. reference thickness e_B mm PWHT	Design reference temperature T_R °C	Material group to CEN ISO/TR 15608:2000	Remarks
plates and strips								
42	10028-4:2009	12Ni14	1.5637	35	80	– 100	9.2	[b]
43		X12Ni5	1.5680	35	80	– 120		
seamless tubes								
254	10216-4: 2002+ A1:2004	12Ni14	1.5637	25		– 100	9.2	[b]
255		12Ni14		35	40	– 90		[b]
256		X12Ni5	1.5680	25		– 120		
257		X12Ni5		35	40	– 110		
Forgings								
370	10222-3: 1998	12Ni14	1.5637	35		– 100	9.2	[b]
371		12Ni14		35	50			[b]
372		12Ni14		35	70			[b]
373		X12Ni5	1.5680	35		– 120		
374		X12Ni5		35	50			

[a] Nickel content is nominal.

[b] If used at – 105 °C (e. g. ethylene application), then 27 J shall be guaranteed at this temperature.

NOTE Thickness limitation result from wall thickness limitation in European material standards.

Table B.2-7 — General requirements for prevention of brittle fracture with reference thickness for Ni-alloyed steels with 9 % Ni

9 % - Ni [a] alloys							
No. as per Table D.2-1	European Standard EN	Grade	Material No.	Max. reference thickness e_B mm AW / PWHT	Design reference temperature T_R °C	Material group to CEN ISO/TR 15608:2000	Remarks
plates and strips							
44	10028-4:2009	X8Ni9	1.5662	— [b]	– 196	9.3	
48		X7Ni9	1.5663				
seamless tubes							
258	10216-4:2002 +A1:2004	X10Ni9	1.5682	— [b]	– 196	9.3	
Forgings							
375	10222-3:1998	X8Ni9	1.5662	— [b]	– 196	9.3	

[a] Nickel content is nominal.

[b] Materials can be used to maximum thickness permitted in harmonised European material standards.

B.2.2.4 Bolts and nuts

For other bolts and nuts than given in Table B.2-8 a specified impact energy of minimum 40 J is required at T_{KV} = RT for $T_M \geq -10$ °C.

If T_M is lower than – 10 °C, a specified impact energy of minimum 40 J is required at $T_{KV} \leq T_M$.

Except bolting material made from austenitic stainless steels specified in Table B.2-9 and B.2-10, bolting material with a design temperature below – 160 °C shall be impact tested at – 196 °C.

Table B.2-8 — General requirements for prevention of brittle fracture with reference thickness for nuts and bolts for $T_M \geq -10$ °C

European Standard	Type of material [a]	Thickness limitation	Impact test KV for $T_M \geq -10$ °C	Test temperature / value
EN 10269:1999+A1:2006	All steels	According to EN 10269:1999+ A1:2006	According to EN 10269:1999+ A1:2006, Table 4	According to EN 10269:1999+ A1:2006, Table 4
EN ISO 898-1:2009	5.6	M ≤ 39	M ≥ 16	+ 20 °C / 40 J
	8.8	M ≤ 39	M ≥ 16	+ 20 °C / 52 J
EN 20898-2:1993	5	M ≤ 39	None	—
	8	M ≤ 39	None	—

[a] Starting material shall comply with EN 10269:1999+A1:2006.

Table B.2-9 — General requirements for prevention of brittle fracture with reference thickness for nuts and bolts, bolting material according to EN 10269:1999+A1:2006

Type of material	Thickness limitation	Impact test	T_M	Remark
1.4307, 1.4301, 1.4303, 1.4404, 1.4401, 1.4948, 1.4919, 1.4941, 1.4980 [a]	According to EN 10269:1999 +A1:2006, Table 7	According to EN 10269:1999 +A1:2006, Table 4	– 196 °C	Verification required for diameter or thickness > 20mm
1.4429, 1.4910,	According to EN 10269:1999 +A1:2006, Table 7	According to EN 10269:1999 +A1:2006, Table 4	– 273 °C	Verification required for diameter or thickness > 20mm
1.5523, 1.1133 1.6563	According to EN 10269:1999 +A1:2006, Table 7	According to EN 10269:1999 +A1:2006, Table 7	– 20 °C	—
1.7218	$d \leq 60$ mm	According to EN 10269:1999 +A1:2006, Table 7	– 60 °C	—
	60 < $d \leq 100$ mm		– 50 °C	
1.6582, 1.6580, 1.7225	According to EN 10269:1999 +A1:2006, Table 7	According to EN 10269:1999 +A1:2006, Table 7	– 40 °C	—
1.5680	$d \leq 45$ mm	According to EN 10269:1999 +A1:2006, Table 7	– 120 °C	—
	45 < $d \leq 75$ mm		– 110 °C	
1.5662	According to EN 10269:1999 +A1:2006, Table 7	According to EN 10269:1999 +A1:2006, Table 7 at – 196°C	– 196 °C	—

[a] When used at – 273 °C, verification testing at –196 °C according to Table 7 of EN 10269:1999+A1:2006 is required.

Table B.2-10 — General requirements for prevention of brittle fracture with reference thickness for nuts and bolts

Standard	Type of material [a]		Thickness limitation	T_M	Impact test
EN ISO 3506-1:1997	A2, A3	50	M ≤ 39	– 196 °C	None
		70	M ≤ 24		
EN ISO 3506-1:1997	A4, A5	50	M ≤ 39	– 60 °C [b]	None
		70	M ≤ 24		
EN ISO 3506-2:1997	A2, A3, A4, A5	50	M ≤ 39	– 196 °C	None
		70	M ≤ 24		

[a] Starting material shall comply with EN 10269:1999+A1:2006.

[b] – 196 °C for studs

B.2.2.5 Lowest minimum metal temperatures for austenitic stainless steels

Solution annealed austenitic stainless steels according to table B.2-11 can be applied down to temperature T_M without impact testing, except when impact testing is required by the material standard e.g. EN 10028-7:2007 requires impact testing at room temperature above 20 mm thick for use at cryogenic temperature (below – 75 °C according to EN 10028-7:2007).

Table B.2-11 — Austenitic stainless steels and their lowest minimum metal temperature T_M

Material	Material number	T_M (in °C)
X1NiCrMoCu 31-27-4	1.4563	– 273
X1CrNiMoN 25-22-2	1.4466	
X1CrNi 25-21	1.4335	
X2CrNiMoN 17-13-3	1.4429	
X2CrNiMoN 17-11-2	1.4406	
X2CrNiMoN 18-12-4	1.4434	
X2CrNiMo 18-15-4	1.4438	
X2CrNiN 18-10	1.4311	
X2CrNiMo 18-14-3	1.4435	
X2CrNi 19-11	1.4306	
X6CrNiTi 18-10	1.4541	– 196
X1CrNiMoCuN 25-25-5	1.4537	
X1NiCrMoCuN 25-20-7	1.4529	
X1CrNiMoCuN 20-18-7	1.4547	
X1NiCrMoCu 25-20-5	1.4539	
X2CrNiMoN 17-13-5	1.4439	
X6CrNiMoTi 17-12-2	1.4571	
X3CrNiMo 17-13-3	1.4436	
X6CrNiMoNb 17-12-2	1.4580	
X2CrNiMo 17-12-3	1.4432	
X5CrNiMo 17-12-2	1.4401	
X2CrNiMo 17-12-2	1.4404	
X6CrNiNb 18-10	1.4550	
X5CrNi 18-10	1.4301	
X2CrNi 18-9	1.4307	
GX5CrNi9-10	1.4308	
GX5CrNiMo19-11-2	1.4408	
GX2NiCrMo28-20-2	1.4458	
GX2CrNi19-11	1.4309	
GX2CrNiMo19-11-2	1.4409	

Where the design temperature is below - 105°C weld metal and heat affected zones for austenitic stainless steels shall meet additional requirements of EN 13480-4:2012.

B.2.2.6 Temperature adjustment

T_S is a temperature adjustment which can be used under the conditions given in Table B.2–12.

Table B.2-12 — Temperature adjustment T_s [a]

Condition	Ratio of pressure induced general membrane stress f and maximum allowable design stress f_d			Membrane stress [b]
	$f/f_d > 0,75$	$0,75 \geq f/f_d > 0,25$	$f/f_d \leq 0,25$	≤ 50 MPa
Non welded or post-weld heat treated	0 °C	$T_s = 70 - 80 \times f/f_d$ [°C]	+ 50 °C	+ 50 °C
As welded	0 °C	0 °C	0 °C	+ 40 °C

[a] Except for material group 9.1, 9.2 and 9.3, T_R shall not be lower than -110°C for ferritic and austenitic-ferritic steels

[b] The membrane stress shall take account of internal and external pressure and dead weight. For walls and pipes of heat exchangers the restraint of free end displacement of the heat exchanger pipes should also be taken into account.

B.2.3 Method 2

B.2.3.1 General

This Method 2 applies to C, CMn, fine grain steels, Ni-alloyed steels with not more than 1,5 % of Ni with a specified minimum yield strength ≤ 500 N/mm^2 and to austenitic-ferritic steels with a specified minimum yield strength ≤ 550 N/mm^2. This Method 2, based on fracture mechanics [17, 18] can be used to determine the requirements to avoid brittle fracture in these steels, and may be used at a design reference temperature T_R which is lower than the value derived by Method 1. In this procedure the design reference temperature T_R is not equal to the impact test temperature T_{KV}. The diagrams show the relationship between T_R and T_{KV} depending on reference thickness and strength level. Distinction is made for as-welded (AW) and post weld heat treated (PWHT) condition. This method does not apply to thermomechanically-rolled steels thicker than 35 mm.

Reference thickness e_B for constructional details is defined in Table B.4-1.

Parent material, welds and HAZ shall meet the impact energy KV at impact test temperature $T_{KV.}$ Table B.2-13 and B.2-14 show which figure shall be used to determine the impact test temperature T_{KV} or the design reference temperature T_R. The condition "non-welded" shall be treated as the condition PWHT.

If the impact energy KV requirement of 40 J instead of 27 J is used, then the impact test temperature T_{KV} can be increased by 10 °C or T_R can be reduced by 10 °C.

Linear interpolation between strength and thickness levels given in the Figures B.2-1 to B.2-11 is allowed. Alternatively the next higher strength class or wall thickness can be used. Lower test temperatures than T_{KV} are admissible for the same requirements.

The dotted lines in figure B.2-1 and figure B.2-3 apply to a wall thickness up to and including 110 mm when impact values KV of 40 J can be guaranteed at T_{KV}.

The temperature adjustment given in Table B.2-12 applies also to Method 2. Extrapolations for temperature ranges beyond the temperature ranges as given in the nomograms are not permissible.

Table B.2-13 — Impact energy requirements for C, CMn, fine grain steels, Ni-alloyed steels with less than 3,0 % Ni

Specified minimum yield strength of base material	Required impact energy KV (on 10 mm × 10 mm test pieces)	Figure defining required T_{KV}	
N/mm^2	J	Non welded or post weld heat treated	As welded
$R_e \leq 265$	27	B.2-1	B.2-2
$R_e \leq 355$	27	B.2-3	B.2-4
$R_e \leq 460$	40	B.2-5	B.2-6
$R_e \leq 500$	40	B.2-7	B.2-8
NOTE The dashed lines in B.2-1 and B.2-3 shall only be used for KV = 40 J.			

Table B.2-14 — Impact energy requirements for austenitic-ferritic stainless steels

Specified minimum yield strength of base material	Required impact energy KV (on 10 mm x 10 mm test pieces)	Figure defining required T_{KV}
N/mm²	J	for all applications
$R_e \leq 385$	40	B.2-9
$R_e \leq 465$	40	B.2-10
$R_e \leq 550$	40	B.2-11

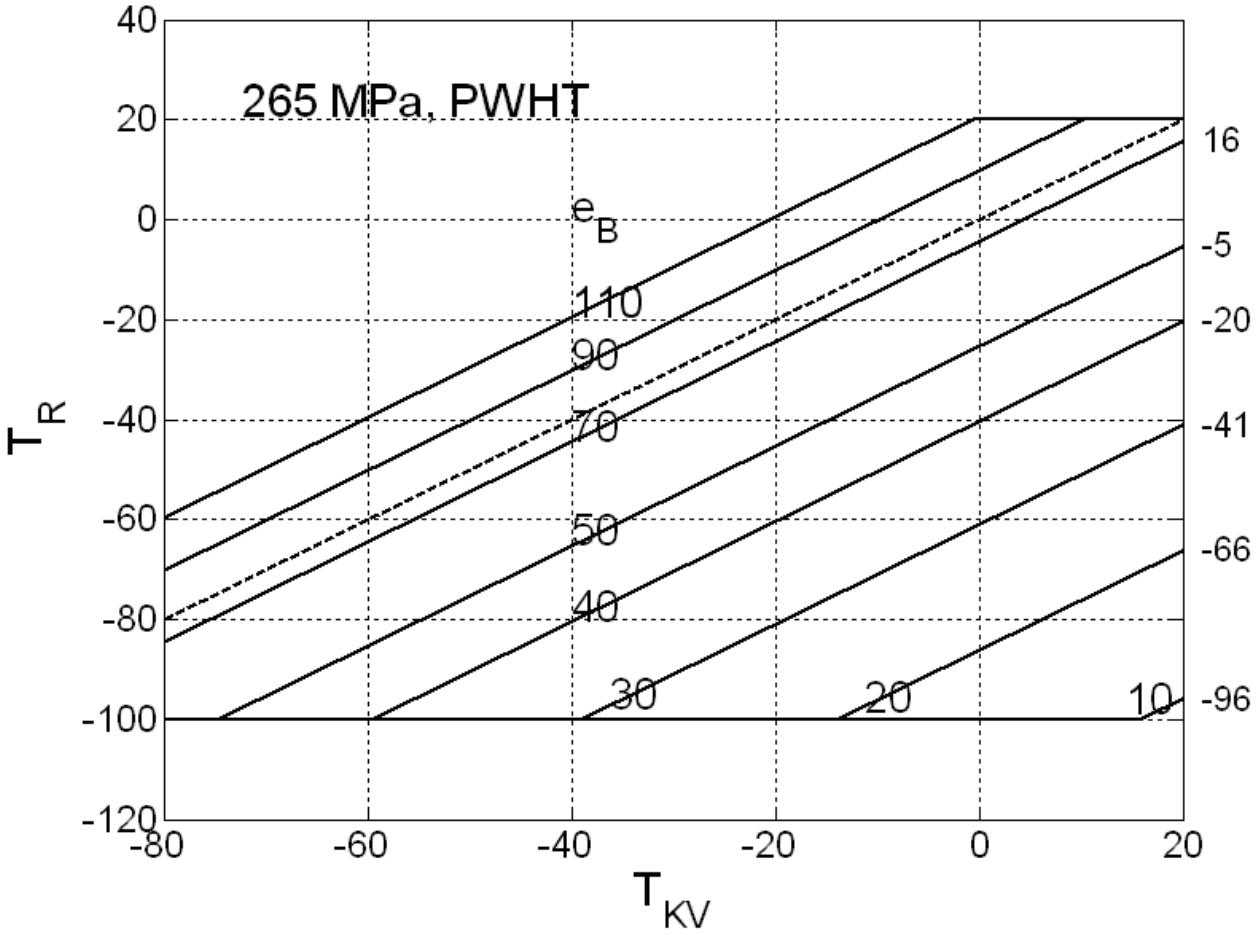
B.2.3.2 Procedure for base material less than 10 mm thick

T_R values and T_{KV} values shall be in accordance with Figures B.2-1 to B.2-11. The impact energy requirements are as specified in Tables B.2-13 and B.2-14.

For wall thicknesses $<$ 10 mm the curve for 10 mm shall be used.

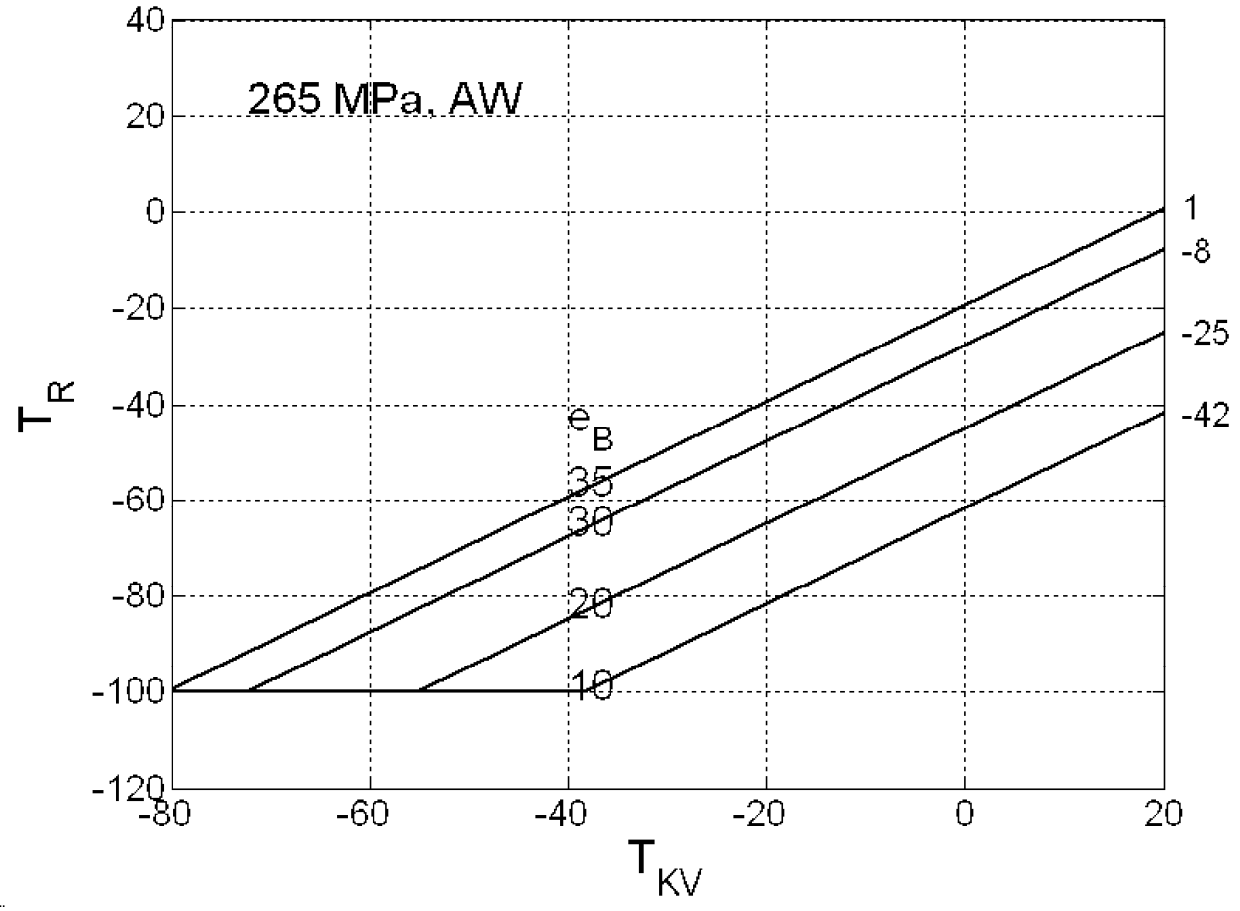
The required energies for the sub-sized specimens are given in Table B.3-1.

B.2.3.3 Nomograms for Method 2



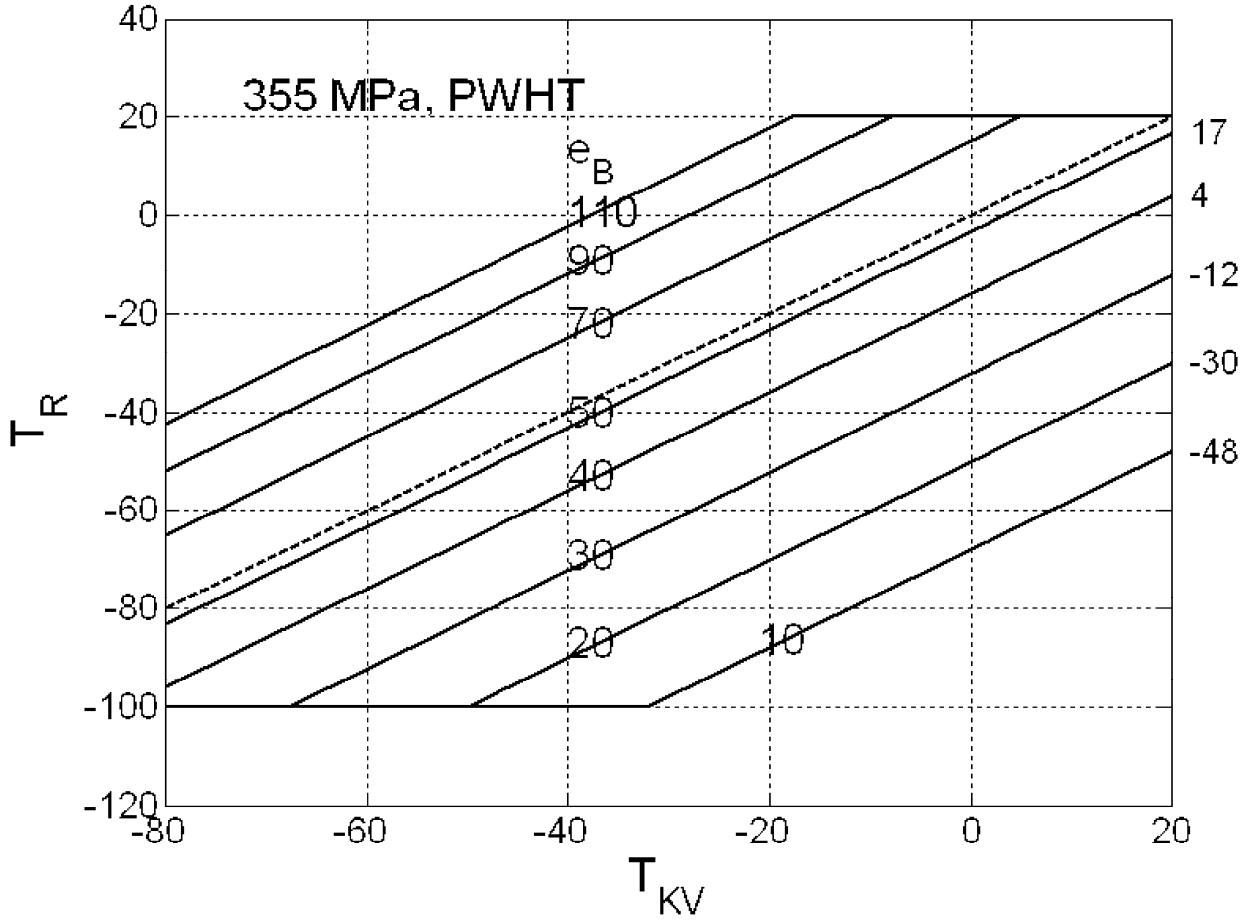
Key
T_R design reference temperature
T_{KV} material impact test temperature
e_B reference thickness

Figure B.2-1 — METHOD 2: Design reference temperature and impact test temperature, post weld heat treated (PWHT) condition, for $R_e \leq 265$ N/mm^2 and $KV \geq 27$ J. Dashed line only to be used for KV = 40 J and for thickness from 75 mm up to and including 110 mm



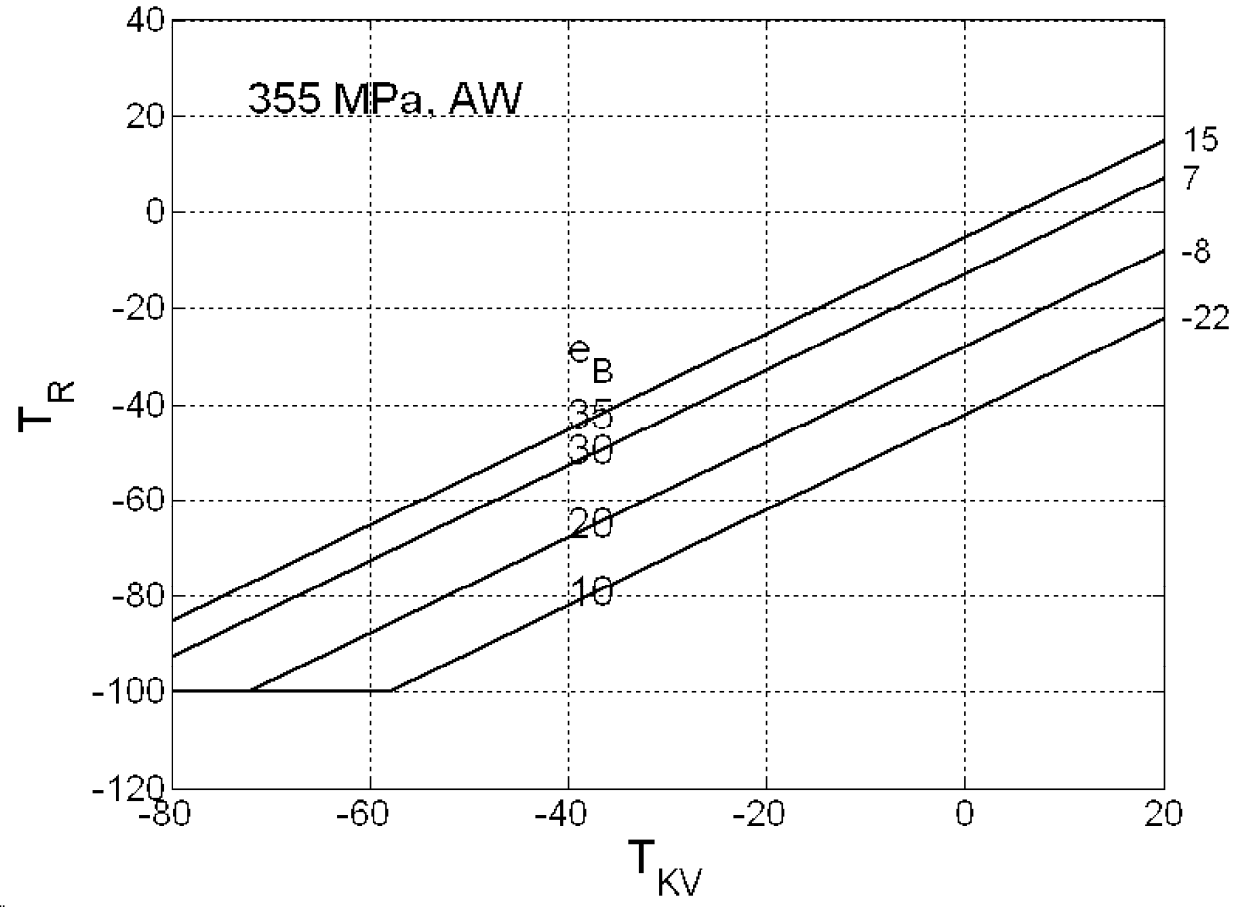
Key
T_R design reference temperature
T_{KV} material impact test temperature
e_B reference thickness

Figure B.2-2 — METHOD 2: Design reference temperature and impact test temperature as-welded (AW) condition, for $R_e \leq 265$ N/mm^2 and $KV \geq 27$ J



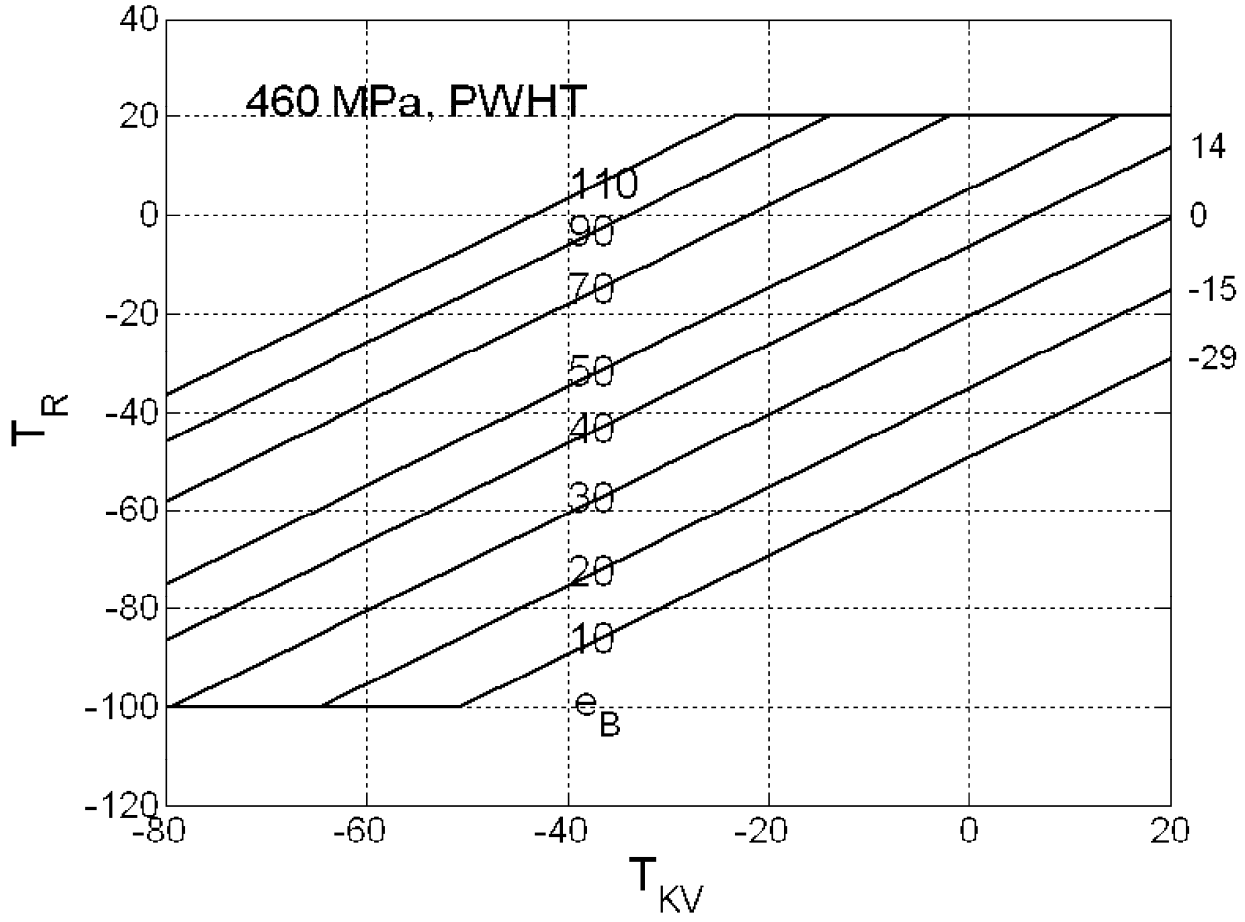
Key
T_R design reference temperature
T_{KV} material impact test temperature
e_B reference thickness

Figure B.2-3— METHOD 2: Design reference temperature and impact test temperature post weld heat treated (PWHT) condition, $R_e \leq 355$ N/mm^2 and $KV \geq 27$ J. Dashed line only to be used for $KV = 40$ J and for thickness from 55 mm up to and including 110 mm



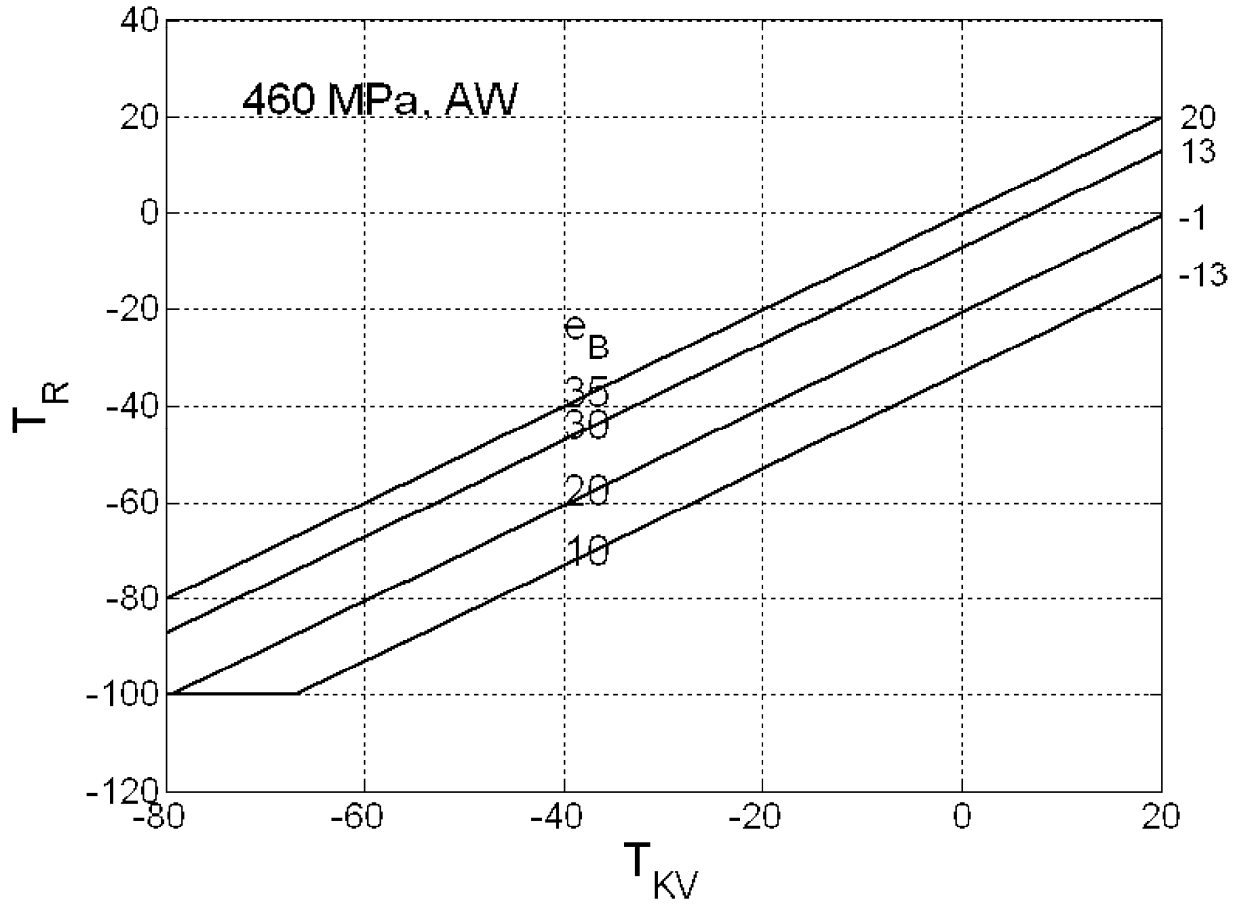
Key
T_R design reference temperature
T_{KV} material impact test temperature
e_B reference thickness

Figure B.2-4 — METHOD 2: Design reference temperature and impact test temperature as-welded (AW) condition, $R_e \leq 355$ N/mm^2 and $KV \geq 27$ J



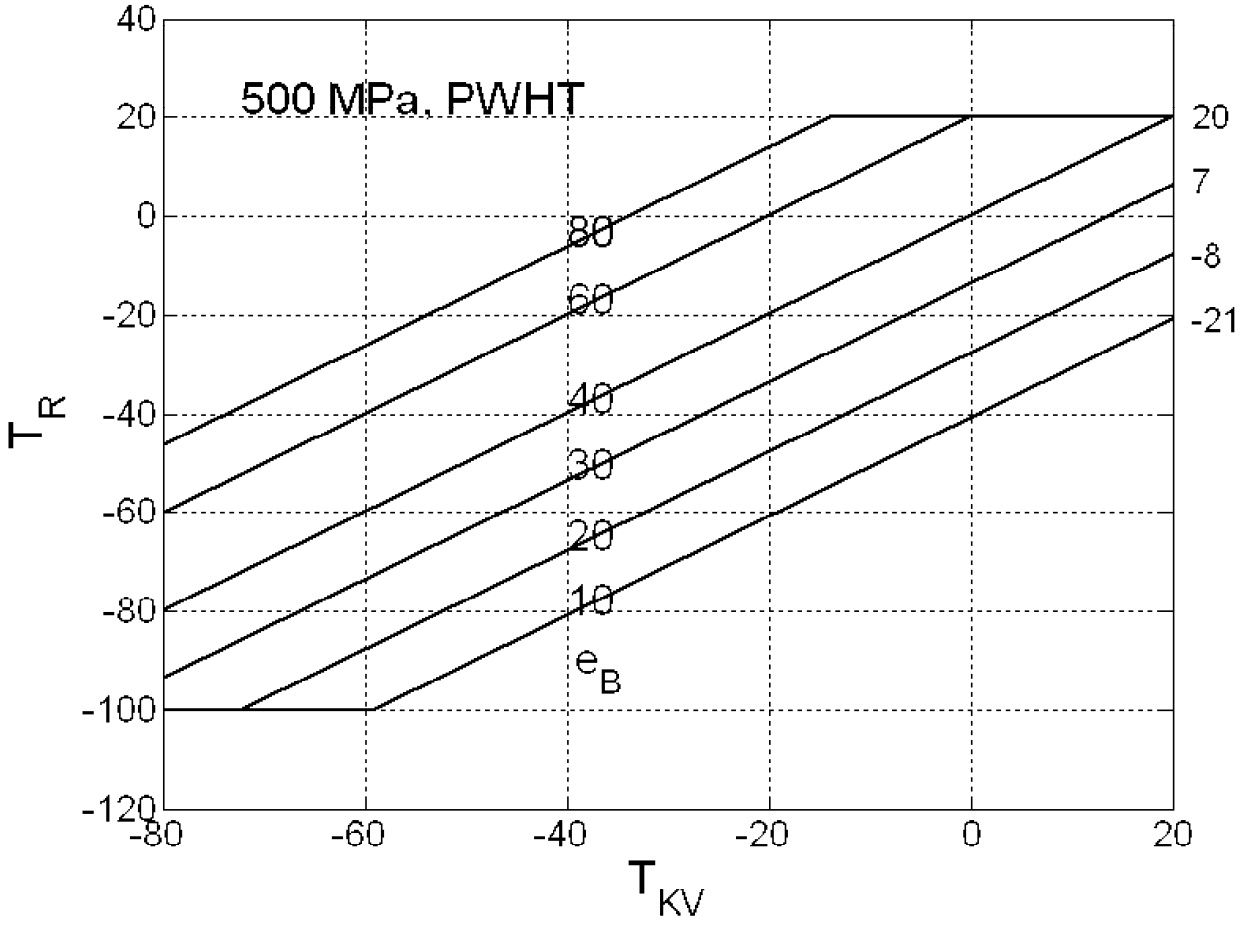
Key
T_R design reference temperature
T_{KV} material impact test temperature
e_B reference thickness

Figure B.2-5 — METHOD 2: Design reference temperature and impact test temperature post weld heat treated (PWHT) condition, R_e ≤ 460 N/mm^2 and KV ≥ 40 J



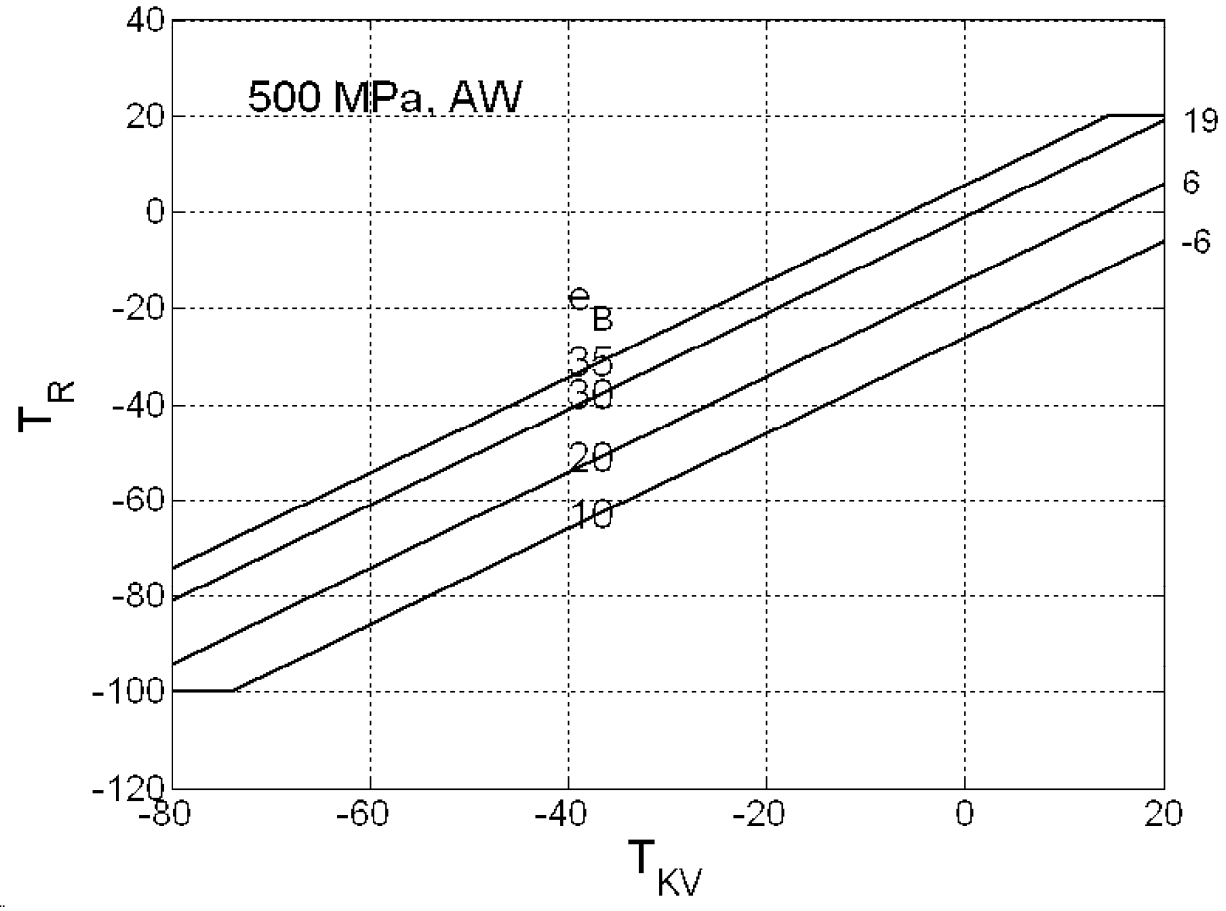
Key
T_R design reference temperature
T_{KV} material impact test temperature
e_B reference thickness

Figure B.2-6 — METHOD 2: Design reference temperature and impact test temperature as-welded (AW) condition, $R_e \leq 460$ N/mm^2 and $KV \geq 40$ J



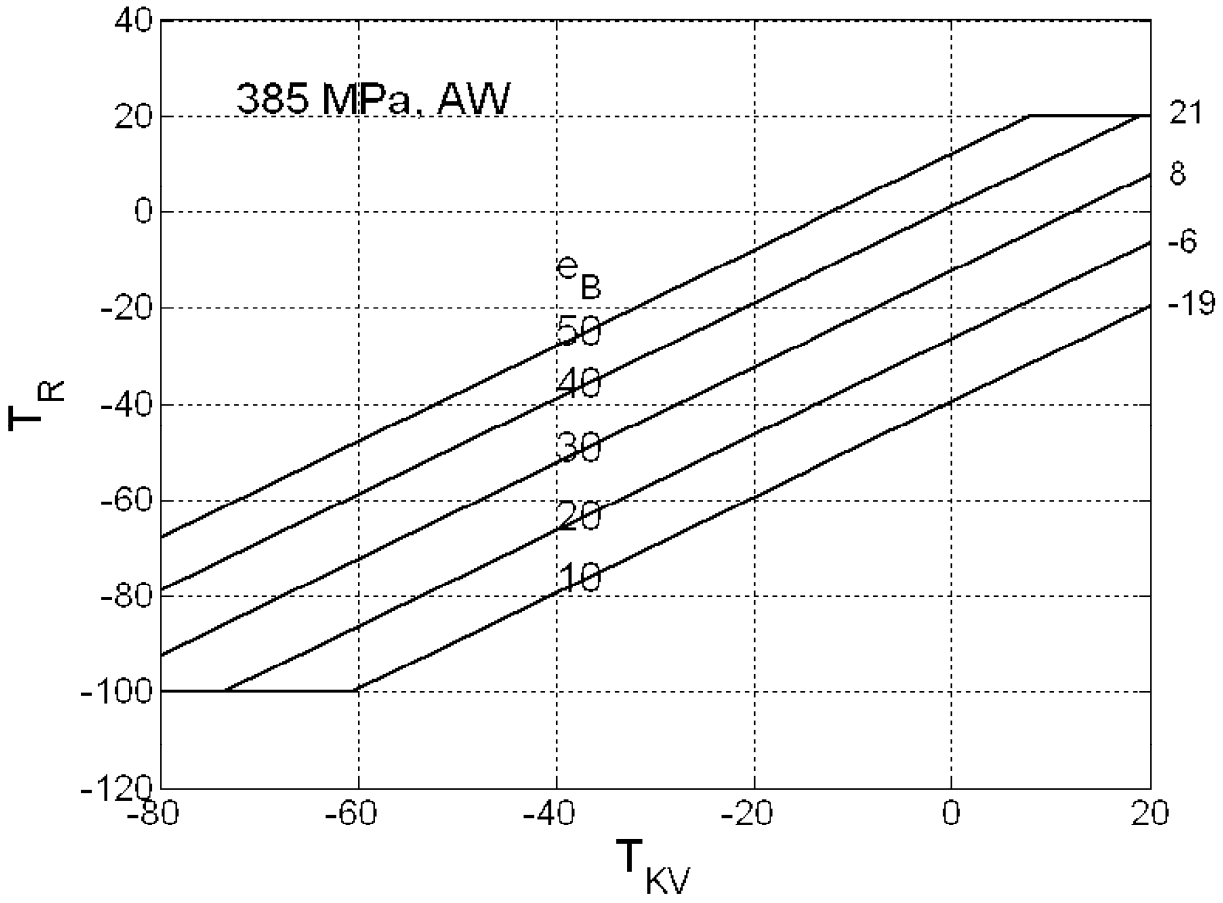
Key
T_R design reference temperature
T_{KV} material impact test temperature
e_B reference thickness

Figure B.2-7— METHOD 2: Design reference temperature and impact test temperature post weld heat treated (PWHT) condition, $R_e \leq 500$ N/mm^2 and $KV \geq 40$ J



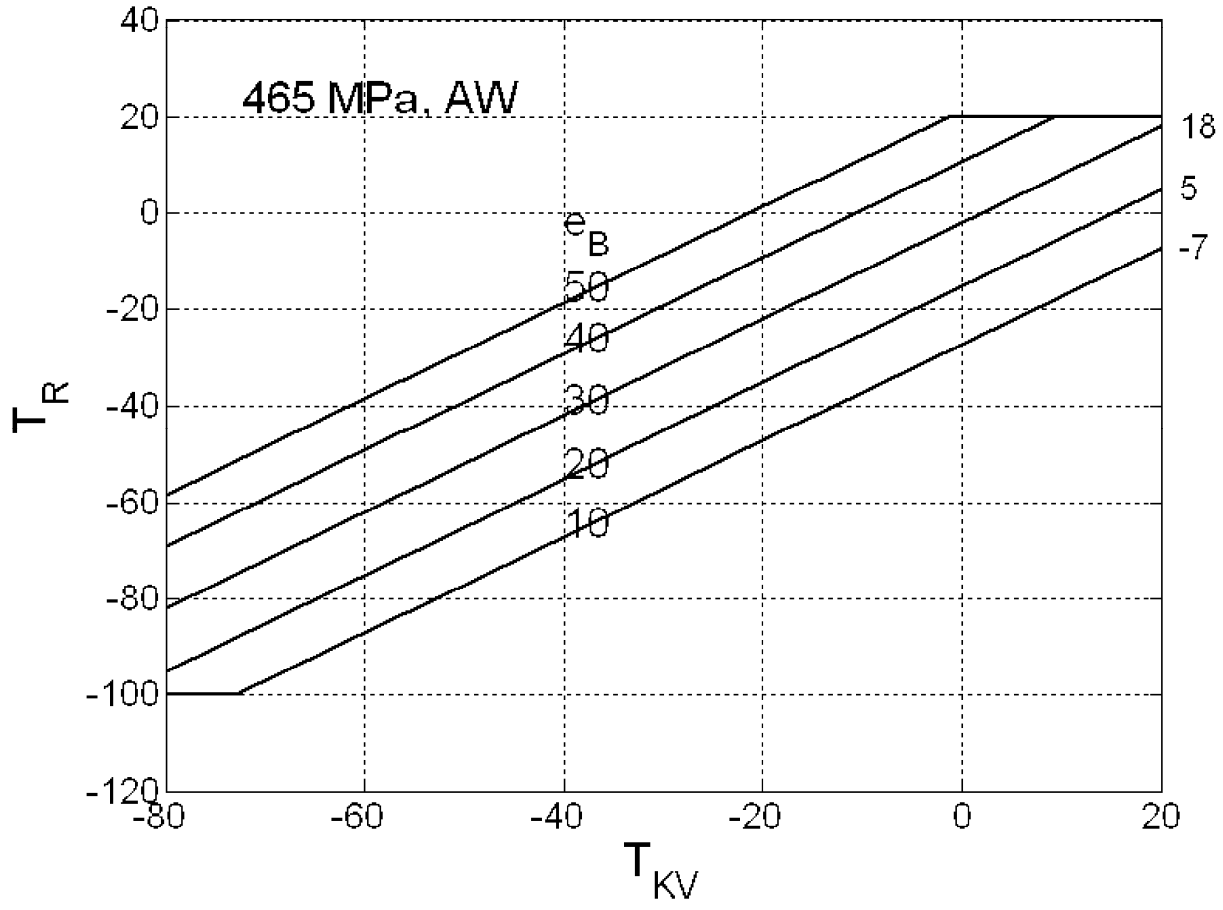
Key
T_R design reference temperature
T_{KV} material impact test temperature
e_B reference thickness

Figure B.2-8— METHOD 2: Design reference temperature and impact test temperature as-welded (AW) condition, $R_e \leq 500$ N/mm^2 and $KV \geq 40$ J



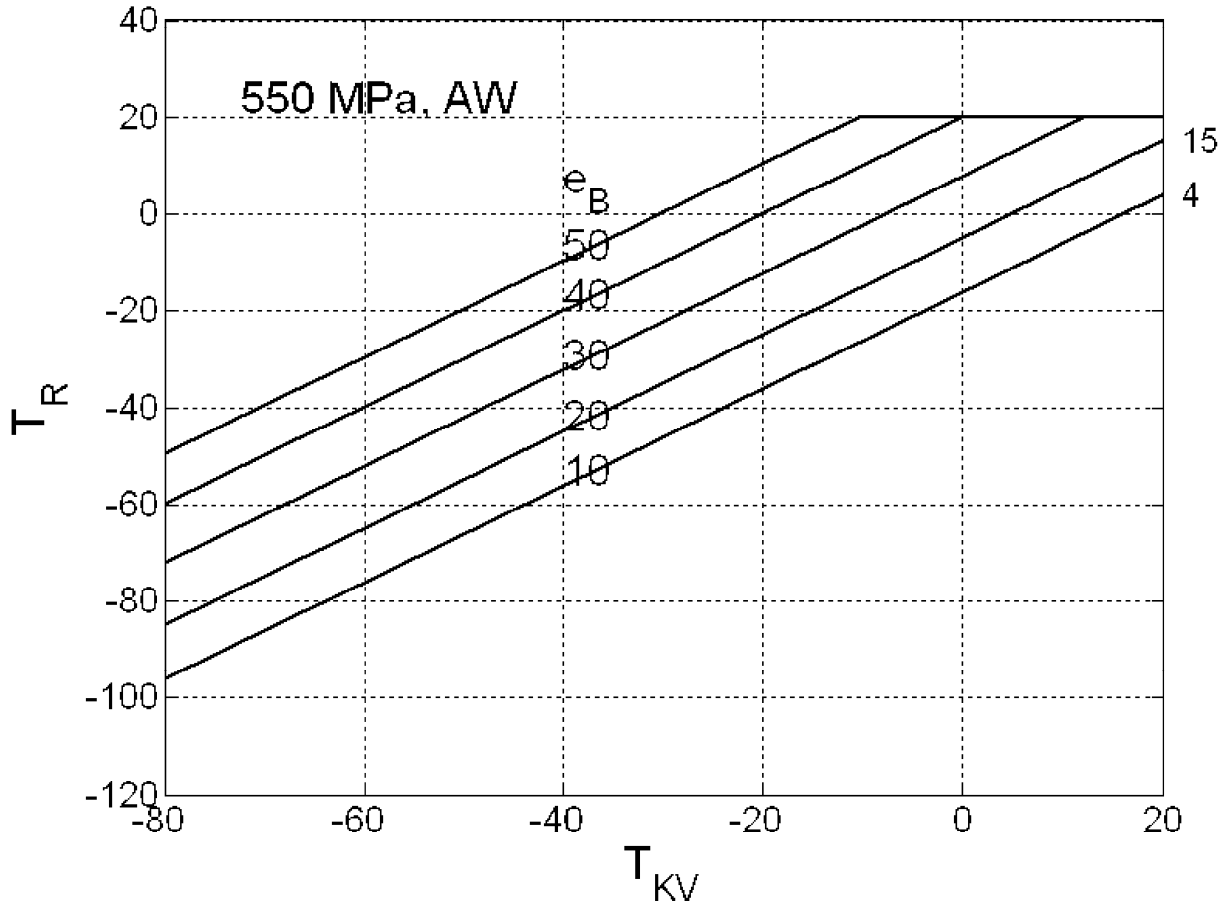
Key
T_R design reference temperature
T_{KV} material impact test temperature
e_B reference thickness

Figure B.2-9 — METHOD 2: Design reference temperature and impact test temperature for austenitic-ferritic steels, $e_B \leq 50$ mm, $R_e = 385$ N/mm^2 and $KV \geq 40$ J



Key
T_R design reference temperature
T_{KV} material impact test temperature
e_B reference thickness

Figure B.2-10— METHOD 2: Design reference temperature and impact test temperature for austenitic-ferritic steels, $e_B \leq 50$ mm, $R_e = 465$ N/mm^2 and $KV \geq 40$ J



Key
T_R design reference temperature
T_{KV} material impact test temperature
e_B reference thickness

Figure B.2-11 — METHOD 2: Design reference temperature and impact test temperature for austenitic-ferritic steels, $e_B \leq 50$ mm, $R_e = 550$ N/mm^2 and $KV \geq 40$ J

B.2.4 Method 3 — Fracture mechanics analysis

B.2.4.1 General

A fracture mechanics analysis may be used by the manufacturer as a basis for determining the suitability of particular vessels for their intended use for the following:

a) materials not currently covered by harmonised European Standards;

b) those cases where the requirements of methods 1 and 2 for low temperature applications cannot be satisfied;

c) when imperfections which are outside the acceptance criteria for the non-destructive testing specified in EN 13445-5:2009 are detected;

d) where it is proposed to use materials in thickness greater than permitted by the low temperature requirements.

NOTE Guidance on fracture mechanics analysis is given in publications [5] to [10] listed in the bibliography.

Such analyses shall be undertaken in accordance with the requirements of B.2.4.2 to B.2.4.5.

B.2.4.2 Fracture toughness properties shall be obtained in accordance with fracture toughness testing procedures using full thickness single edge notched bend specimens or equivalent compact tension tests with fatigue cracks located through thickness in the weld centre-line and in parent material. Further test sampling of heat affected zone regions shall also be specified, particularly when fatigue or some other in-service crack growth mechanism may be significant.

When HAZ tests are specified special considerations are necessary with regard to the placement of the notch and metallurgical sectioning subsequent to testing.

B.2.4.3 For material not covered by the low temperature requirements of methods 1 or 2, a similar level of tolerance to fracture can be obtained. This can be done by specifying fracture toughness requirements determined from the use of assessment procedures such as in [9] with a reference defect size as determined by the manufacturer (e.g. a through wall flaw of total length equal to 10 mm, or a quarter wall thickness surface flaw with length six times its depth). Also inputs of an equivalent stress (or strain) relating to the hydraulic test condition, for a defect in a region of stress concentration and subject to residual stresses equivalent to the room temperature yield strength of the base material for as welded components, or 30 % of yield for post weld heat treated components can be specified.

B.2.4.4 If non-destructive testing methods are employed which allow accurate sizing of defects, these values, together with information on the stress state of the critical regions in the vessel, shall be used with appropriate fracture assessment procedures to specify more accurate toughness requirements than those specified by Method 1 or 2.

B.2.4.5 For materials which are covered by the low temperature requirements for Method 1 or 2, but where the Charpy impact energy requirements cannot be met, a fitness for purpose assessment using representative fracture toughness data and inspection requirements may be employed to determine the integrity of the vessel for its intended use.

B.3 General test requirements

B.3.1 General

Where impact tests are required, Charpy-V-notch tests shall be performed in accordance with EN ISO 148-1:2010. The impact energy requirements shall be met in the base material, heat affected zone and weld metal.

The specimen position shall be in accordance with the specifications in the technical delivery conditions of the product form for materials for pressure equipment. For welded joints the specimen position for weld metal and HAZ shall be in accordance with EN 13480-4:2012.

From each sample three specimens shall be tested for each of the required positions and material impact test temperature T_{KV}. The mean value of the three specimens shall be at least equal to the impact energy requirement. Only one specimen may show a lower value, but this value shall not be less than 70 % of this requirement.

The required values for base material shall refer to the transverse direction. If geometry does not allow to extract specimen in the transverse direction the impact energy values shall be taken from tests in the longitudinal direction. The minimum impact energy requirements specified for transverse test pieces shall then be multiplied by the factor 1,5 for C, CMn, fine grained, low alloyed steels and high strength steels.

B.3.2 Sub-sized specimens

If sub-sized Charpy specimens shall be used, the measured value of the Charpy energy shall be proportionally converted to the reference specimen thickness of 10 mm. Table B.3-1 gives an example for 7,5 mm and 5 mm thick specimens. Where test pieces at least 5 mm wide cannot be obtained, the material shall not be subject to impact testing. For pipes with nominal thickness lower than 6,3 mm no impact testing is required.

Table B.3-1 — Impact requirements for sub-sized Charpy V-notched specimen if the base material is less than 10 mm thick

Reference value	Sub sized specimen	
Specimen geometry		
10 mm × 10 mm	10 mm × 7,5 mm	10 mm × 5 mm
Minimum impact energy J		
27	20	14
40	30	20

If full size Charpy specimen cannot be extracted from components and welds sub-sized specimens shall be tested. To represent the behaviour of a full thickness specimen a lower impact test temperature shall be applied. The temperature shifts shall be in accordance with Table B.3-2.

Impact tests should be performed on the maximum thickness, which can be extracted from the component under consideration.

Table B.3-2 — Equivalent impact energy requirements when sub sized specimens are extracted from thicker sections

Required impact energy	**Specimen geometry**	**Sub-sized specimen requirement**		
KV J	mm	KV J	Specimen geometry mm	Shift of impact test temperature °C
27	10 × 10	20 14	7,5 × 10 5,0 × 10	T_{KV} – 5 T_{KV} – 20
40	10 × 10	30 20	7,5 × 10 5,0 × 10	T_{KV} – 5 T_{KV} – 20
20	7,5 × 10	14	5,0 × 10	T_{KV} – 15
30	7,5 × 10	20	5,0 × 10	T_{KV} – 15
14	5,0 × 10	—	—	—
20	5,0 × 10	—	—	—

B.4 Welds

B.4.1 General

When materials are to be joined by welding, the choice of welding consumables and welding procedures shall ensure that in addition to the requirements of EN 13480-4:2012, the required impact energy properties are achieved in weld metal and heat affected zone regions, when tested in accordance with B.3.

The required impact energy shall be at least equal to the specified minimum impact energy for the base metal. The requirements of method 1 or 2 shall be met.

B.4.2 Welding procedure qualification

Welding procedure qualification shall be performed in accordance with EN 13480-4:2012.

B.4.3 Production test plates

For tubes and fittings with longitudinal or helical welds according to harmonised European Standards as normative references in this European standard, no further production testing is needed. For non standard components production testing shall be carried out in accordance with EN 13445-4:2009**.**

B.5 Materials for use at elevated temperatures

B.5.1 General

B.5 applies for pressure equipment with design temperature for normal operation higher than 50 °C and where:

— the material temperature at start up, shut down and at possible process upsets is not lower than –10 °C and

— start up and shut down procedure is under controlled conditions as given in B.5.4 and

— the conditions for pressure test as specified in B.5.5 are fulfilled.

If any of these requirements is not satisfied the methods for low temperature materials shall be applied.

NOTE The limitation regarding start-up and shut-down, process upsets and pressure test are not applicable to austenitic stainless steels.

B.5.2 Materials

Materials including weldments, in the finished pressure equipment shall have a specified minimum impact energy measured on a standard Charpy-V-notch impact test specimen (see EN ISO 148-1:2010) as follows:

— ≥ 27 J for ferritic and 1,5 % to 5 % Ni alloyed steels;

— ≥ 40 J for steels of material group 8, 9.3 and 10,

at a temperature not higher than 20 °C.

B.5.3 Welding procedure qualification and production test plates

Welding procedure qualification shall be performed in accordance with EN 13480-4:2012.

The weld production test plate shall be performed in accordance with EN 13480-4:2012.

B.5.4 Start up and shut down procedure

To avoid brittle fracture occurrence of pressure equipment made of ferritic or austenitic-ferritic steels during start-up and shut-down procedures, the pressure shall not exceed 50 % of the design pressure at temperatures lower than 20 °C.

This start-up and shut-down procedure need not to be considered, if the evaluation of the specified minimum impact values against Method 2 allows design pressures at lower temperatures.

B.5.5 Pressure test

Hydrostatic pressure test of piping made of ferritic or austenitic-ferritic steels shall not be carried out at material temperatures lower than 10 °C.

This temperature limitation needs not to be considered, if the evaluation of the specified minimum impact values against Method 2 allows design pressures at lower temperatures.

Table B.4-1 — Reference thickness e_B

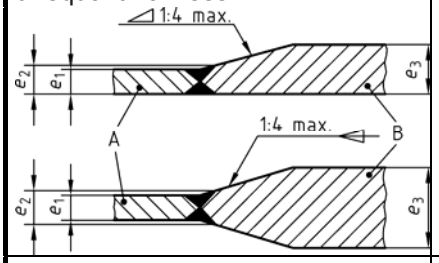
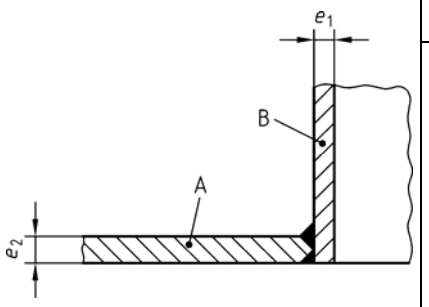
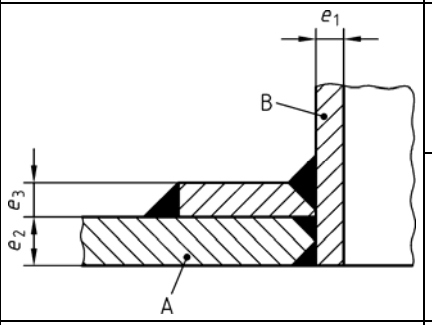
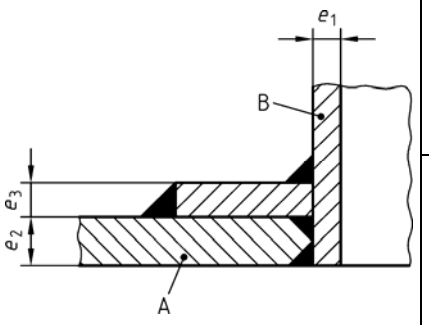
No.	Construction detail	as-welded (AW) or post weld heat treated (PWHT)	Reference thickness		
			Part A	Weld	Part B
1	Butt welded components of unequal thickness 	AW	e_1	e_2	e_2 [a] check e_3 [a] in Figures B.2-2, B.2-4, B.2-6, B.2-8
		PWHT	e_1	e_2	e_3
2	Branches and nozzles 	AW	e_2	e_2	e_1
		PWHT	e_2	e_2	e_1
3		AW	e_2	e_2 or e_3, if thicker	e_1
		PWHT	e_2	e_2 or e_3, if thicker	e_1
4		AW	e_2	e_2 or e_3, if thicker	e_1
		PWHT	e_2	e_2 or e_3 if thicker	e_1

Table B.4-1 (*continued*)

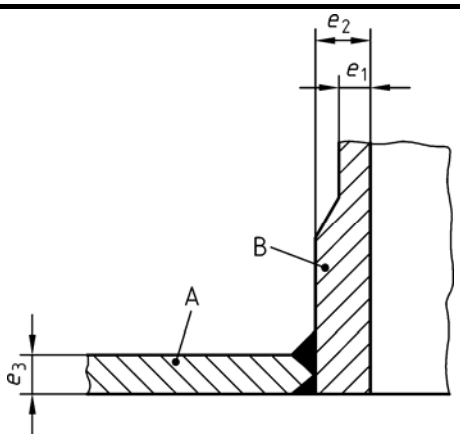
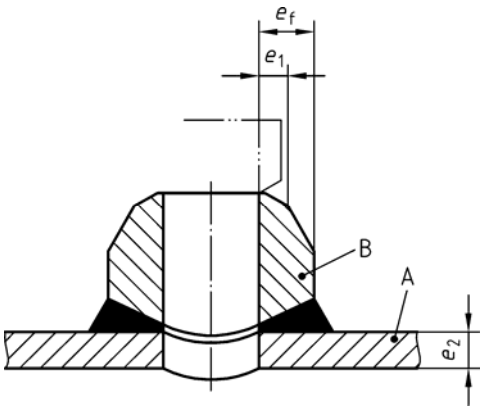
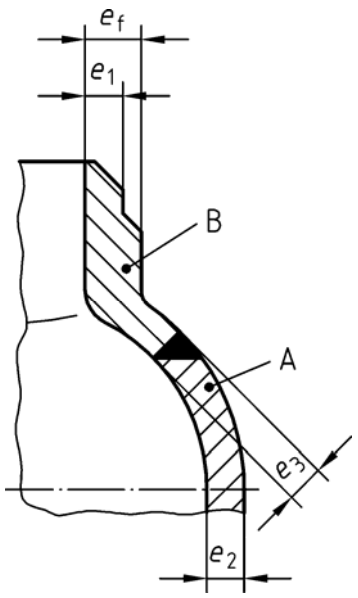
No.	Construction detail	as-welded (AW) or post weld heat treated (PWHT)	Reference thickness		
			Part A	Weld	Part B
5		AW	e_3	e_2 or e_3, if thicker	e_2
		PWHT	e_3	e_2 or e_3, if thicker	e_2
6		AW	e_2	e_2	e_1 or $e_f/4$ if thicker
		PWHT	e_2	e_2	e_1 [a] or $e_f/4$ [a], if thicker if necessary check e_1 in Figures B.2-1, B.2-3, B.2-5, B.2-7
7		AW	e_2	e_3	e_3 or $e_f/4$, if thicker ,
		PWHT	e_2	e_3	e_3 [a] or $e_f/4$ [a], if thicker if necessary check e_1 in Figures B.2-1, B.2-3, B.2-5, B.2-7

Table B.4-1 (*continued*)

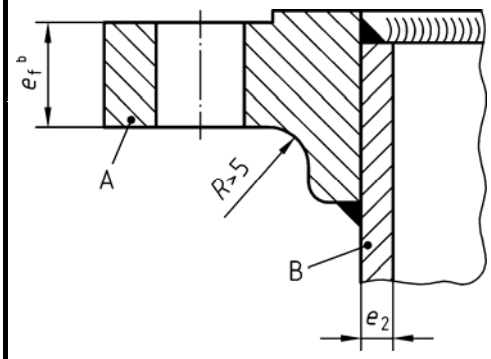
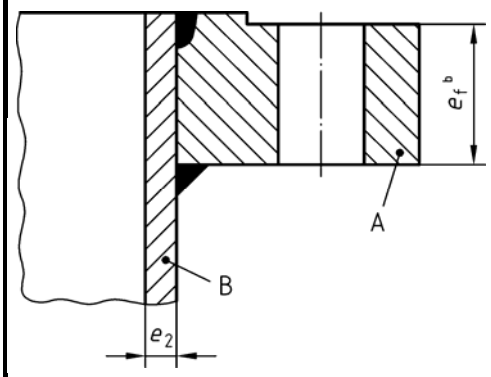
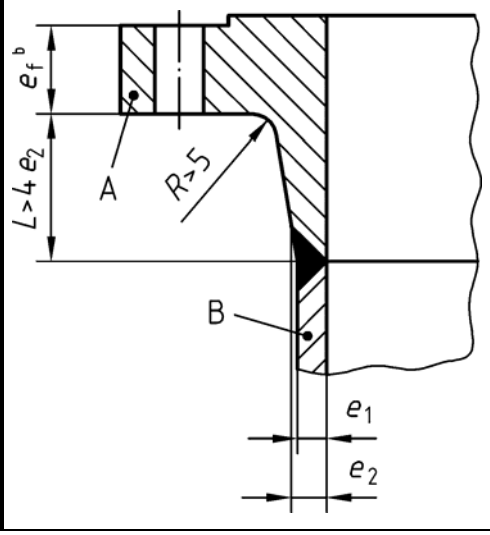
No.	Construction detail	as-welded (AW) or post weld heat treated (PWHT)	Reference thickness		
			Part A	Weld	Part B
8	Slip-on and plate flanges [c] 	AW	e_2 *or* e_f/4, if thicker	e_2 *or* e_f/4, if thicker	e_2
		PWHT	e_2 *or* e_f/4, if thicker	e_2 *or* e_f/4, if thicker	e_2
9		AW	e_2 *or* e_f/4, if thicker	e_2 *or* e_f/4, if thicker	e_2
		PWHT	e_2 *or* e_f/4, if thicker	e_2 *or* e_f/4, if thicker	e_2
10	Forged or cast welding neck flanges [c] 	AW	e_2 [a] check e_f/4 [a] in Figures B.2-1, B.2-3, B.2-5, B.2-7	e_2	e_1
		PWHT	e_2 or e_f/4, if thicker	e_2	e_1

Table B.4-1 (*continued*)

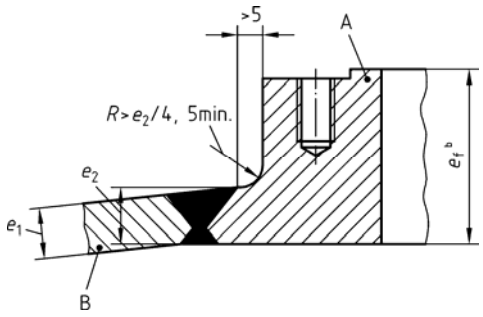
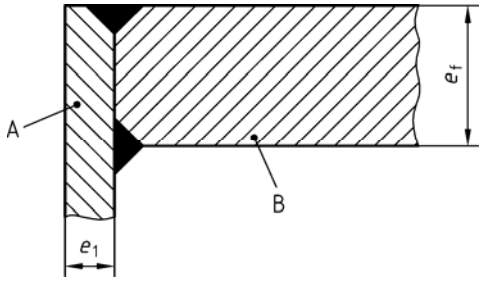
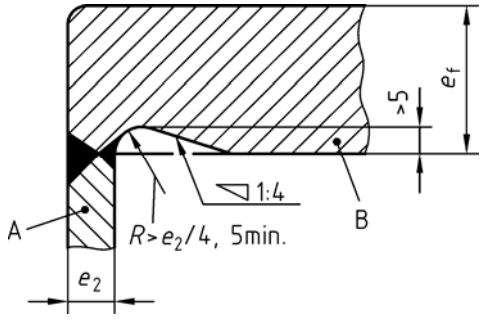
No.	Construction detail	as-welded (AW) or post weld heat treated (PWHT)	Reference thickness		
			Part A	Weld	Part B
11	Pad-type flanges 	AW	e_2 [a] check $e_f/4$ [a] in Figures B.2-2, B.2-4, B.2-6, B.2-8	e_2	e_1
		PWHT	e_2 or $e_f/4$, if thicker	e_2	e_1
12	Flat ends 	AW	e_1	e_1	$e_f/4$ or e_1, if thicker
		PWHT	e_1	e_1	$e_f/4$ or e_1, if thicker
13		AW	e_2	e_2	e_2 [a] or check $e_f/4$ [a], in Figures B.2-2, B.2-4, B.2-6, B.2-8
		PWHT	e_2	e_2	e_2 or $e_f/4$, if thicker

Table B.4-1 (*continued*)

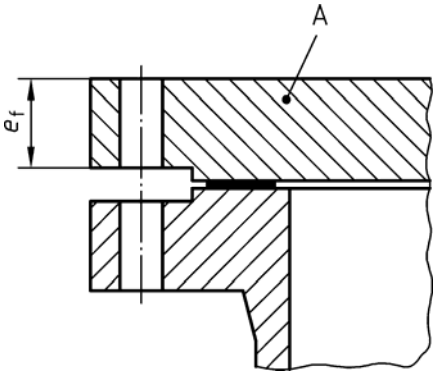
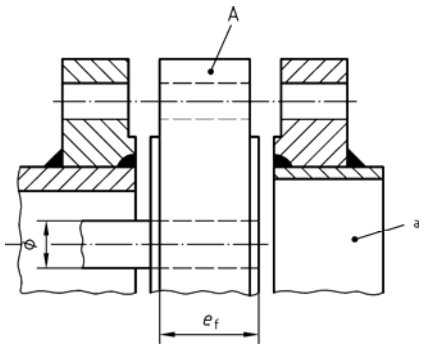
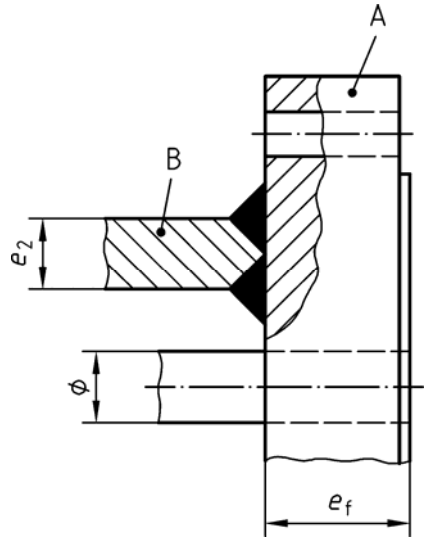
No.	Construction detail	as-welded (AW) or post weld heat treated (PWHT)	Reference thickness		
			Part A	Weld	Part B
14	Covers and blind flanges 	AW	$e_f/4$	—	—
		PWHT	$e_f/4$	—	—
15	Measuring Plate 	AW	(n. a.)	(n. a.)	(n. a.)
		PWHT	$e_f/4$	(n. a.)	(n. a.)
16		AW	$e_f/4$ or e_2, if thicker	e_2	e_2
		PWHT	$e_f/4$ or e_2, if thicker	e_2	e_2

Table B.4-1 (*continued*)

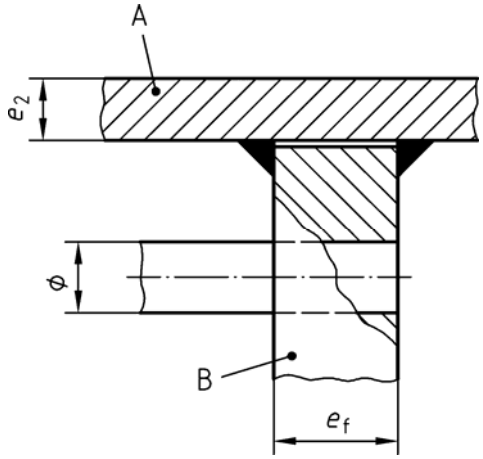
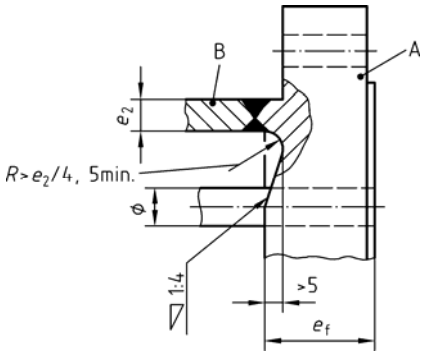
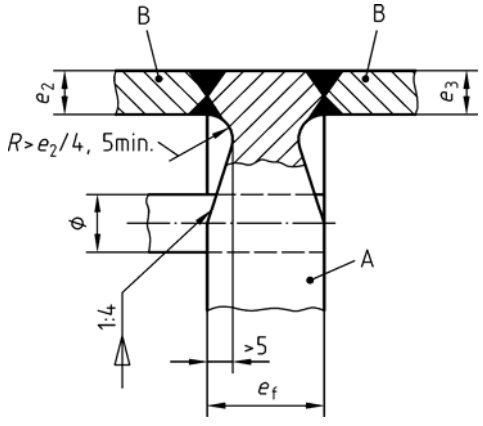
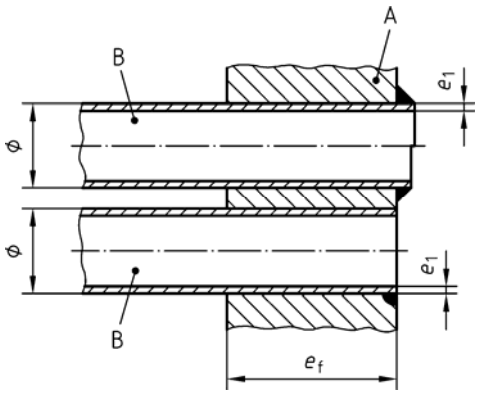
No.	Construction detail	as-welded (AW) or post weld heat treated (PWHT)	Reference thickness		
			Part A	Weld	Part B
17	Welded into shell/channel 	AW	e_2, check $e_f/4$ in Figures B.2-2, B.2-4, B.2-6, B.2-8	e_2	e_2 or $e_f/4$ if thicker
		PWHT	e_2 or $e_f/4$, if thicker	e_2	e_2 or $e_f/4$ if thicker
18	Forged tube plate with stubs 	AW	e_2 [a] check $e_f/4$ [a] in Figures B.2-2, B.2-4, B.2-6, B.2-8	e_2	e_2
		PWHT	$e_f/4$ or e_2, if thicker	e_2	e_2
19		AW	e_2 [a] or e_3 [a], if thicker check $e_f/4$ [a] in Figures B.2-2, B.2-4, B.2-6, B.2-8	e_2 (e_3)	e_2 (e_3)
		PWHT	$e_f/4$ or e_2 or e_3, if thicker	e_2 (e_3)	e_2 (e_3)

Table B.4-1 (*continued*)

No.	Construction detail	as-welded (AW) or post weld heat treated (PWHT)	Reference thickness		
			Part A	Weld	Part B
20	Tube-to-tube plate connection 	AW	(n. a.)	e_1	e_1
		PWHT	b	e_1	e_1

NOTE 1 (n. a.) means "not applicable".

NOTE 2 e_1, e_2 and e_3 refer to the nominal thickness of the various components shown in the figures.

1 e_f may be measured radically if that gives an advantage.

[a] The minimum test temperature of the two conditions: e_x (AW), e_y (PWHT) shall be taken.

[b] Reference thickness of part A is unaffected by this connection.

[c] For welding neck flanges and slip on flanges according to EN 1092-1:2007, R shall be as given in EN 1092-1:2007

Annex C
(normative)

Provisional technical delivery conditions for clad products for pressure purposes

C.1 Introduction

Until a European Standard for clad steel products for pressure purposes is available, the following requirements shall form the basis for the technical delivery conditions for such products.

C.2 Requirements for the base material

For the material of clad products the relevant conditions of EN 13480-2:2012 shall apply.

In addition, where appropriate, requirements for impact tests of the kind described in clause C.4, item b, shall be agreed at the time of enquiry and order.

C.3 Requirements for the cladding material

Clad steels shall comply with the following general regulations:

In the case of clad steels where the cladding has a lower degree of elasticity than that of the base metal, a tensile test on the cladding after the base has been removed shall show an elongation after fracture A_5 of at least 12 %.

The bond between the base and the cladding materials shall be of such a nature that there is no delamination either in the course of manufacture or in service. Unless otherwise stipulated in the order, the shear strength of cladding with a tensile strength of less than 280 N/mm^2 shall be more than half the minimum tensile strength of the cladding material and, for all other cladding materials, shall not be less than 140 N/mm^2, regardless of the direction of testing.

The bonded area shall cover at least 95 % of the entire surface and no single unbonded area shall cover more than 50 cm^2. In the case of clad steels which are highly stressed during manufacture (e.g. dished ends) or when in service (e.g. tube plates), additional requirements imposed by the purchaser (operator) can be necessary.

The cladding material shall have a surface texture which corresponds to the cladding process and be of uniform thickness with tolerances not exceeding those given in Table C.3-1.

The permissible tolerances for the base material shall be in accordance with the relevant dimensional standards for the various products.

The total area of defects on the cladding material shall not exceed 20 % of the clad surface.

Table C.3-1 — Limit deviation on thickness for cladding materials on clad steels

Nominal thickness mm	Limit deviation on thickness [a, b] mm
1,0	-0,10
1,5	-0.15
2,0	-0,20
2.5	-0,25
3,0	-0,35
3,5	-0,45
4,0	-0,50
4,5	-0.50
≥5,0	-0,50

a Deviations from the values in this table are subject to special agreement

b For intermediate thicknesses the limit deviation indicated for the next smallest thickness in the table applies.

C.4 Qualification of the cladding procedure

Before commencing production, suitable cladding conditions shall be verified by cladding procedure qualification tests, including welding procedures tests for weld overlay, if applicable. These conditions shall be carefully observed when cladding the products in the plant.

The cladding procedure qualification tests shall normally comprise

a) tensile tests;

b) Charpy-V-notch impact tests at the temperature specified for test pieces taken from the cladded base material so that

- one side of the test piece coincides with the bonded area between the base and deposited material;
- the longitudinal direction of the test piece is transverse to the direction of rolling; and
- the axis of the notch is perpendicular to the next surface of the base material (see Figure C.4-1, item d);

c) bend tests on test pieces which, as shown in Figure C.4-2 cover the bonded zone and are bent in a direction parallel to the bounding zone;

d) the examination of the hardness, micro and macrostructure and chemical composition in the transition zone;

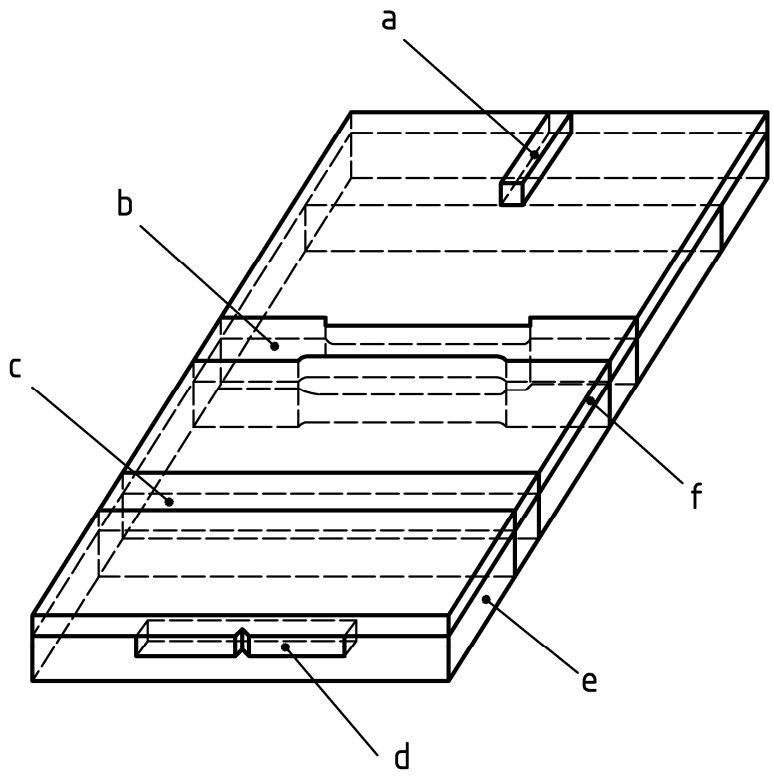
e) shear tests on shear specimens;

f) inspection of surface quality and conformity to dimensions;

g) ultrasonic testing of the bond between the base material and the cladding.

C.5 Production tests

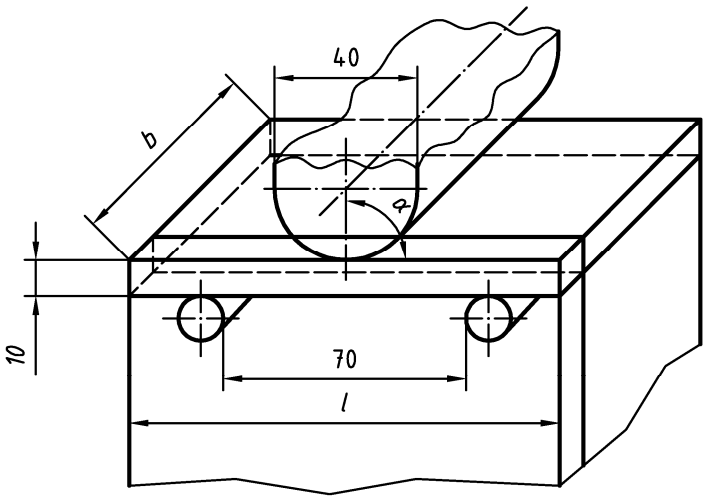
During production, at suitable intervals, samples of the base material shall be cladded under the same conditions as the products and be tested. The types of tests to be carried out and the requirements to be complied with shall be agreed on the basis of the results of the cladding procedure qualification tests and practical experience.



Key

a shear test specimen
b tensile test specimen
c side bend test specimen
d notched bar impact bend test specimen
e base material
f cladding material

Figure C.5-1 — Position of test pieces



Dimensions of specimen

Width:	*b*	is the thickness of finished product, but not greater than 80 mm (base and cladding material). If finished product is over 80 mm thick, the excess base material may be removed.
Length:	*l*	is not less than 130 mm
Angle:	α	= 90°

Figure C.5-2 — Arrangement for side bend tests of clad products

Annex D
(informative)

European steels for pressure purposes

D.1 European Standards for steels and steel components for pressure purposes

Table D.1-1 contains an informative summary on European Standards for steels and steel components for pressure purposes.

Table D.1-1 — European Standards for steels and steel components for pressure purposes

Product form	General requirements	Room temperature grades [a]	Elevated temperature grades	Fine grain steels			Low temperature grades	Stainless steels
				Normalised	Thermo-mechanically treated	Quenched and tempered		
Plate and strip	EN 10028-1	—	EN 10028-2	EN 10028-3	EN 10028-5	EN 10028-6	EN 10028-4	EN 10028-7
Rolled bar	—	—	EN 10273	—	—	—	—	EN 10272
Seamless tube	—	EN 10216-1	EN 10216-2	EN 10216-3	—	EN 10216-3	EN 10216-4	EN 10216-5
Electric welded tube	—	EN 10217-1	EN 10217-2	EN 10217-3	—	—	EN 10217-4	—
Submerged arc welded tube	—	EN 10217-1	EN 10217-5	EN 10217-3	—	—	EN 10217-6	—
Fusion welded tube	—	—	—	—	—	—	—	EN 10217-7
Fitting	—	EN 10253-2	EN 10253-2	EN 10253-2	EN 10253-2	EN 10253-2	EN 10253-2	EN 10253-4
Forging including forged bars	EN 10222-1	—	EN 10222-2	EN 10222-4	—	—	EN 10222-3	EN 10222-5
Casting	EN 10213	—	EN 10213	—	—	—	EN 10213	EN 10213
Steel for fastener	—	—	EN 10269	—	—	—	EN 10269	EN 10269

[a] Room temperature values are given in all standards of this table.

D.2 European standardised steels grouped according to product forms

Table D.2-1 — European standardised steels grouped according to product forms

1	2	3	4	5	6	7	8		9	10
No	Product form	European Standard	Material description	Grade	Material number	Heat treatment [g]	Thickness mm		Material group to CR ISO 15608	Notes
							min.	max.		
1	plate and strip	EN 10028-2	elevated temperature properties	P235GH	1.0345	N	0	250	1.1	
2	plate and strip	EN 10028-2	elevated temperature properties	P265GH	1.0425	N	0	250	1.1	
3	plate and strip	EN 10028-2	elevated temperature properties	P295GH	1.0481	N	0	250	1.2	
4	plate and strip	EN 10028-2	elevated temperature properties	P355GH	1.0473	N	0	250	1.2	
5	plate and strip	EN 10028-2	elevated temperature properties	16Mo3	1.5415	N, NT	0	250	1.2	e
6	plate and strip	EN 10028-2	elevated temperature properties	18MnMo4-5	1.5414	NT	0	150	1.2	
7	plate and strip	EN 10028-2	elevated temperature properties	18MnMo4-5	1.5414	QT	150	250	1.2	
8	plate and strip	EN 10028-2	elevated temperature properties	20MnMoNi4-5	1.6311	QT	0	250	3.1	
9	plate and strip	EN 10028-2	elevated temperature properties	15NiCuMoNb5-6-4	1.6368	NT	0	100	3.1	
10	plate and strip	EN 10028-2	elevated temperature properties	15NiCuMoNb5-6-4	1.6368	NT, QT	100	150	3.1	
11	plate and strip	EN 10028-2	elevated temperature properties	15NiCuMoNb5-6-4	1.6368	QT	150	200	3.1	
12	plate and strip	EN 10028-2	elevated temperature properties	13CrMo4-5	1.7335	NT	0	100	5.1	
13	plate and strip	EN 10028-2	elevated temperature properties	13CrMo4-5	1.7335	NT,QT	100	150	5.1	
14	plate and strip	EN 10028-2	elevated temperature properties	13CrMo4-5	1.7335	QT	150	250	5.1	
15	plate and strip	EN 10028-2	elevated temperature properties	13CrMoSi5-5	1.7336	NT, QT	0	100	5.1	
16	plate and strip	EN 10028-2	elevated temperature properties	13CrMoSi5-5	1.7336	QT	100	250	5.1	
17	plate and strip	EN 10028-2	elevated temperature properties	10CrMo9-10	1.7380	NT	0	60	5.2	
18	plate and strip	EN 10028-2	elevated temperature properties	10CrMo9-10	1.7380	NT,QT	60	100	5.2	

Table D.2-1 (*continued*)

1	2	3	4	5	6	7	8		9	10
No	Product form	European Standard	Material description	Grade	Material number	Heat treatment [g]	Thickness mm		Material group to CR ISO 15608	Notes
19	plate and strip	EN 10028-2	elevated temperature properties	10CrMo9-10	1.7380	QT	100	250	5.2	
20	plate and strip	EN 10028-2	elevated temperature properties	12CrMo9-10	1.7375	NT,QT	0	250	5.2	
21	plate and strip	EN 10028-2	elevated temperature properties	X12CrMo5	1.7362	NT	0	150	5.3	
22	plate and strip	EN 10028-2	elevated temperature properties	X12CrMo5	1.7362	QT	150	250	5.3	
23	plate and strip	EN 10028-2	elevated temperature properties	13CrMoV9-10	1.7703	NT	0	150	6.2	
24	plate and strip	EN 10028-2	elevated temperature properties	13CrMoV9-10	1.7703	QT	150	250	6.2	
25	plate and strip	EN 10028-2	elevated temperature properties	12CrMoV12-10	1.7767	NT	0	150	6.2	
26	plate and strip	EN 10028-2	elevated temperature properties	12CrMoV12-10	1.7767	QT	150	250	6.2	
27	plate and strip	EN 10028-2	elevated temperature properties	X10CrMoVNb9-1	1.4903	NT	0	150	6.4	
28	plate and strip	EN 10028-2	elevated temperature properties	X10CrMoVNb9-1	1.4903	QT	150	250	6.4	
29	plate and strip	EN 10028-3	fine grain steel normalised	P275NH	1.0487	N	0	250	1.1	
30	plate and strip	EN 10028-3	fine grain steel normalised	P275NL1	1.0488	N	0	250	1.1	
31	plate and strip	EN 10028-3	fine grain steel normalised	P275NL2	1.1104	N	0	250	1.1	
32	plate and strip	EN 10028-3	fine grain steel normalised	P355N	1.0562	N	0	250	1.2	
33	plate and strip	EN 10028-3	fine grain steel normalised	P355NH	1.0565	N	0	250	1.2	
34	plate and strip	EN 10028-3	fine grain steel normalised	P355NL1	1.0566	N	0	250	1.2	
35	plate and strip	EN 10028-3	fine grain steel normalised	P355NL2	1.1106	N	0	250	1.2	
36	plate and strip	EN 10028-3	fine grain steel normalised	P460NH	1.8935	N	0	100	1.3	
37	plate and strip	EN 10028-3	fine grain steel normalised	P460NL1	1.8915	N	0	100	1.3	
38	plate and strip	EN 10028-3	fine grain steel normalised	P460NL2	1.8918	N	0	100	1.3	

Table D.2-1 (*continued*)

1	2	3	4	5	6	7	8		9	10
No	Product form	European Standard	Material description	Grade	Material number	Heat treatment [g]	Thickness mm		Material group to CR ISO 15608	Notes
39	plate and strip	EN 10028-4	low temperature properties	11MnNi5-3	1.6212	N,NT	0	80	9.1	
40	plate and strip	EN 10028-4	low temperature properties	13MnNi6-3	1.6217	N,NT	0	80	9.1	
41	plate and strip	EN 10028-4	low temperature properties	15NiMn6	1.6228	N,NT,QT	0	80	9.1	
42	plate and strip	EN 10028-4	low temperature properties	12Ni14	1.5637	N,NT,QT	0	80	9.2	
43	plate and strip	EN 10028-4	low temperature properties	X12Ni5	1.5680	N,NT,QT	0	50	9.2	
44	plate and strip	EN 10028-4	low temperature properties	X8Ni9+NT640	1.5662	N+NT	0	50	9.3	
45	plate and strip	EN 10028-4	low temperature properties	X8Ni9+QT640	1.5662	QT	0	50	9.3	
46	plate and strip	EN 10028-4	low temperature properties	X8Ni9+QT680	1.5662	N+NT, QT	0	15	9.3	
47	plate and strip	EN 10028-4	low temperature properties	X8Ni9+QT680	1.5662	QT	15	50	9.3	
48	plate and strip	EN 10028-4	low temperature properties	X7Ni9	1.5663	N+NT, QT	0	15	9.3	
49	plate and strip	EN 10028-4	low temperature properties	X7Ni9	1.5663	QT	15	50	9.3	
50	plate and strip	EN 10028-5	fine grain steel, thermomechanically rolled	P355M	1.8821	M	0	63	1.2	[f]
51	plate and strip	EN 10028-5	fine grain steel, thermomechanically rolled	P355ML1	1.8832	M	0	63	1.2	[f]
52	plate and strip	EN 10028-5	fine grain steel, thermomechanically rolled	P355ML2	1.8833	M	0	63	1.2	[f]
53	plate and strip	EN 10028-5	fine grain steel, thermomechanically rolled	P420M	1.8824	M	0	63	2.1	[f]
54	plate and strip	EN 10028-5	fine grain steel, thermomechanically rolled	P420ML1	1.8835	M	0	63	2.1	[f]
55	plate and strip	EN 10028-5	fine grain steel, thermomechanically rolled	P420ML2	1.8828	M	0	63	2.1	[f]

Table D.2-1 (*continued*)

1	2	3	4	5	6	7	8		9	10
No	Product form	European Standard	Material description	Grade	Material number	Heat treatment [g]	Thickness mm		Material group to CR ISO 15608	Notes
56	plate and strip	EN 10028-5	fine grain steel, thermomechanically rolled	P460M	1.8826	M	0	63	2.1	[f]
57	plate and strip	EN 10028-5	fine grain steel, thermomechanically rolled	P460ML1	1.8837	M	0	63	2.1	[f]
58	plate and strip	EN 10028-5	fine grain steel, thermomechanically rolled	P460ML2	1.8831	M	0	63	2.1	[f]
59	plate and strip	EN 10028-6	fine grain steel, quenched/tempered	P355Q	1.8866	QT	0	150	1.2	
60	plate and strip	EN 10028-6	fine grain steel, quenched/tempered	P355QH	1.8867	QT	0	150	1.2	
61	plate and strip	EN 10028-6	fine grain steel, quenched/tempered	P355QL1	1.8868	QT	0	150	1.2	
62	plate and strip	EN 10028-6	fine grain steel, quenched/tempered	P355QL2	1.8869	QT	0	150	1.2	
63	plate and strip	EN 10028-6	fine grain steel, quenched/tempered	P460Q	1.8870	QT	0	150	3.1	
64	plate and strip	EN 10028-6	fine grain steel, quenched/tempered	P460QH	1.8871	QT	0	150	3.1	
65	plate and strip	EN 10028-6	fine grain steel, quenched/tempered	P460QL1	1.8872	QT	0	150	3.1	
66	plate and strip	EN 10028-6	fine grain steel, quenched/tempered	P460QL2	1.8864	QT	0	150	3.1	
67	plate and strip	EN 10028-6	fine grain steel, quenched/tempered	P500Q	1.8873	QT	0	150	3.1	
68	plate and strip	EN 10028-6	fine grain steel, quenched/tempered	P500QH	1.8874	QT	0	150	3.1	
69	plate and strip	EN 10028-6	fine grain steel, quenched/tempered	P500QL1	1.8875	QT	0	150	3.1	
70	plate and strip	EN 10028-6	fine grain steel, quenched/tempered	P500QL2	1.8865	QT	0	150	3.1	
71	plate and strip	EN 10028-6	fine grain steel, quenched/tempered	P690Q	1.8879	QT	0	150	3.1	
72	plate and strip	EN 10028-6	fine grain steel, quenched/tempered	P690QH	1.8880	QT	0	150	3.1	
73	plate and strip	EN 10028-6	fine grain steel, quenched/tempered	P690QL1	1.8881	QT	0	150	3.1	
74	plate and strip	EN 10028-6	fine grain steel, quenched/tempered	P690QL2	1.8888	QT	0	150	3.1	

Table D.2-1 (*continued*)

1	2	3	4	5	6	7	8		9	10
No	Product form	European Standard	Material description	Grade	Material number	Heat treatment [g]	Thickness mm		Material group to CR ISO 15608	Notes
75	plate and strip	EN 10028-7	stainless steel, austenitic	X2CrNiN18-7	1.4318	AT	0	75	8.1	
76	plate and strip	EN 10028-7	stainless steel, austenitic	X2CrNi18-9	1.4307	AT	0	75	8.1	
77	plate and strip	EN 10028-7	stainless steel, austenitic	X2CrNi19-11	1.4306	AT	0	75	8.1	
78	plate and strip	EN 10028-7	stainless steel, austenitic	X2CrNiN18-10	1.4311	AT	0	75	8.1	
79	plate and strip	EN 10028-7	stainless steel, austenitic	X5CrNi18-10	1.4301	AT	0	75	8.1	
80	plate and strip	EN 10028-7	stainless steel, austenitic	X5CrNiN19-9	1.4315	AT	0	75	8.1	
81	plate and strip	EN 10028-7	stainless steel, austenitic	X6CrNi18-10	1.4948	AT	0	75	8.1	
82	plate and strip	EN 10028-7	stainless steel, austenitic	X6CrNi23-13	1.4950	AT	0	75	8.2	
83	plate and strip	EN 10028-7	stainless steel, austenitic	X6CrNi25-20	1.4951	AT	0	75	8.2	
84	plate and strip	EN 10028-7	stainless steel, austenitic	X6CrNiTi18-10	1.4541	AT	0	75	8.1	
85	plate and strip	EN 10028-7	stainless steel, austenitic	X6CrNiTiB18-10	1.4941	AT	0	75	8.1	
86	plate and strip	EN 10028-7	stainless steel, austenitic	X2CrNiMo17-12-2	1.4404	AT	0	75	8.1	
87	plate and strip	EN 10028-7	stainless steel, austenitic	X2CrNiMoN17-12-2	1.4406	AT	0	75	8.1	
88	plate and strip	EN 10028-7	stainless steel, austenitic	X5CrNiMo17-12-2	1.4401	AT	0	75	8.1	
89	plate and strip	EN 10028-7	stainless steel, austenitic	X6CrNiMoTi17-12-2	1.4571	AT	0	75	8.1	
90	plate and strip	EN 10028-7	stainless steel, austenitic	X2CrNiMo17-12-3	1.4432	AT	0	75	8.1	
91	plate and strip	EN 10028-7	stainless steel, austenitic	X2CrNiMo18-14-3	1.4435	AT	0	75	8.1	
92	plate and strip	EN 10028-7	stainless steel, austenitic	X2CrNiMoN17-13-5	1.4439	AT	0	75	8.1	
93	plate and strip	EN 10028-7	stainless steel, austenitic	X1NiCrMoCu25-20-5	1.4539	AT	0	75	8.2	
94	plate and strip	EN 10028-7	stainless steel, austenitic	X5NiCrAlTi31-20	1.4958	AT	0	75	8.2	

Table D.2-1 (*continued*)

1	2	3	4	5	6	7	8		9	10
No	Product form	European Standard	Material description	Grade	Material number	Heat treatment [g]	Thickness mm		Material group to CR ISO 15608	Notes
95	plate and strip	EN 10028-7	stainless steel, austenitic	X5NiCrAlTi31-20+RA	1.4958+RA	AT+RA	0	75	8.2	
96	plate and strip	EN 10028-7	stainless steel, austenitic	X8NiCrAlTi32-21	1.4959	AT	0	75	8.2	
97	plate and strip	EN 10028-7	stainless steel, austenitic	X3CrNiMoBN17-13-3	1.4910	AT	0	75	8.2	
98	plate and strip	EN 10028-7	stainless steel, austenitic, special	X1CrNi25-21	1.4335	AT	0	75	8.2	
99	plate and strip	EN 10028-7	stainless steel, austenitic, special	X6CrNiNb18-10	1.4550	AT	0	75	8.1	
100	plate and strip	EN 10028-7	stainless steel, austenitic, special	X8CrNiNb16-13	1.4961	AT	0	75	8.1	
101	plate and strip	EN 10028-7	stainless steel, austenitic, special	X1CrNiMoN25-22-2	1.4466	AT	0	75	8.2	
102	plate and strip	EN 10028-7	stainless steel, austenitic, special	X6CrNiMoNb17-12-2	1.4580	AT	0	75	8.1	
103	plate and strip	EN 10028-7	stainless steel, austenitic, special	X2CrNiMoN17-13-3	1.4429	AT	0	75	8.1	
104	plate and strip	EN 10028-7	stainless steel, austenitic, special	X3CrNiMoN17-13-3	1.4436	AT	0	75	8.1	
105	plate and strip	EN 10028-7	stainless steel, austenitic, special	X2CrNiMoN18-12-4	1.4434	AT	0	75	8.1	
106	plate and strip	EN 10028-7	stainless steel, austenitic, special	X2CrNiMo18-15-4	1.4438	AT	0	75	8.1	
107	plate and strip	EN 10028-7	stainless steel, austenitic, special	X1NiCrMoCu31-27-4	1.4563	AT	0	75	8.2	
108	plate and strip	EN 10028-7	stainless steel, austenitic, special	X1CrNiMoCuN25-25-5	1.4537	AT	0	75	8.2	
109	plate and strip	EN 10028-7	stainless steel, austenitic, special	X1CrNiMoCuN20-18-7	1.4547	AT	0	75	8.2	
110	plate and strip	EN 10028-7	stainless steel, austenitic, special	X1NiCrMoCuN25-20-7	1.4529	AT	0	75	8.2	
111	plate and strip	EN 10028-7	stainless steel, austenitic-ferritic	X2CrNiN23-4	1.4362	AT	0	75	10.1	c
112	plate and strip	EN 10028-7	stainless steel, austenitic-ferritic	X2CrNiMoN22-5-3	1.4462	AT	0	75	10.1	c
113	plate and strip	EN 10028-7	stain, steel, austenitic-ferritic, special	X2CrNiMoCuN25-6-3	1.4507	AT	0	75	10.2	c
114	plate and strip	EN 10028-7	stain, steel, austenitic-ferritic, special	X2CrNiMoN25-7-4	1.4410	AT	0	75	10.2	c
115	plate and strip	EN 10028-7	stain, steel, austenitic-ferritic, special	X2CrNiMoCuWN25-7-4	1.4501	AT	0	75	10.2	c

Table D.2-1 (*continued*)

1	2	3	4	5	6	7	8		9	10
No	Product form	European Standard	Material description	Grade	Material number	Heat treatment [g]	Thickness mm		Material group to CR ISO 15608	Notes
116	bar	EN 10272	stainless steel, martensitic	X4CrNiMo16-5-1	1.4418	QT760	0	160	7.2	e
117	bar	EN 10272	stainless steel, austenitic	X2CrNi18-9	1.4307	AT	0	250	8.1	
118	bar	EN 10272	stainless steel, austenitic	X2CrNi19-11	1.4306	AT	0	250	8.1	
119	bar	EN 10272	stainless steel, austenitic	X2CrNiN18-10	1.4311	AT	0	250	8.1	
120	bar	EN 10272	stainless steel, austenitic	X5CrNi18-10	1.4301	AT	0	250	8.1	
121	bar	EN 10272	stainless steel, austenitic	X6CrNiTi18-10	1.4541	AT	0	250	8.1	
122	bar	EN 10272	stainless steel, austenitic	X2CrNiMo17-12-2	1.4404	AT	0	250	8.1	
123	bar	EN 10272	stainless steel, austenitic	X2CrNiMoN17-11-2	1.4406	AT	0	250	8.1	
124	bar	EN 10272	stainless steel, austenitic	X5CrNiMo17-12-2	1.4401	AT	0	250	8.1	
125	bar	EN 10272	stainless steel, austenitic	X6CrNiMoTi17-12-2	1.4571	AT	0	250	8.1	
126	bar	EN 10272	stainless steel, austenitic	X2CrNiMo17-12-3	1.4432	AT	0	250	8.1	
127	bar	EN 10272	stainless steel, austenitic	X2CrNiMo18-14-3	1.4435	AT	0	250	8.1	
128	bar	EN 10272	stainless steel, austenitic	X2CrNiMo17-13-5	1.4439	AT	0	250	8.1	
129	bar	EN 10272	stainless steel, austenitic	X1NiCrMoCu25-20-5	1.4539	AT	0	250	8.2	
130	bar	EN 10272	stainless steel, austenitic	X6CrNiNb18-10	1.4550	AT	0	250	8.1	
131	bar	EN 10272	stainless steel, austenitic	X6CrNiMoNb17-12-2	1.4580	AT	0	250	8.1	
132	bar	EN 10272	stainless steel, austenitic	X2CrNiMoN17-13-3	1.4429	AT	0	250	8.1	
133	bar	EN 10272	stainless steel, austenitic	X3CrNiMo17-13-3	1.4436	AT	0	250	8.1	
134	bar	EN 10272	stainless steel, austenitic	X1NiCrMoCu31-27-4	1.4563	AT	0	250	8.2	
135	bar	EN 10272	stainless steel, austenitic	X1CrNiMoCuN20-18-7	1.4547	AT	0	250	8.2	

Table D.2-1 (*continued*)

1	2	3	4	5	6	7	8		9	10
No	Product form	European Standard	Material description	Grade	Material number	Heat treatment [g]	Thickness mm		Material group to CR ISO 15608	Notes
136	bar	EN 10272	stainless steel, austenitic	X1NiCrMoCuN25-20-7	1.4529	AT	0	250	8.2	
137	bar	EN 10272	stainless steel, austenitic-ferritic	X2CrNiMoN22-5-3	1.4462	AT	0	160	10.1	c
138	bar	EN 10272	stainless steel, austenitic-ferritic	X2CrNiN23-4	1.4362	AT	0	160	10.1	c
139	bar	EN 10272	stainless steel, austenitic-ferritic	X2CrNiMoCuN25-6-3	1.4507	AT	0	160	10.2	c
140	bar	EN 10272	stainless steel, austenitic-ferritic	X2CrNiMoN25-7-4	1.4410	AT	0	160	10.2	c
141	bar	EN 10272	stainless steel, austenitic-ferritic	X2CrNiMoCuWN25-7-4	1.4501	AT	0	160	10.2	c
142	bar	EN 10273	elevated temperature properties	P235GH	1.0345	N	0	150	1.1	
143	bar	EN 10273	elevated temperature properties	P250GH	1.0460	N	0	150	1.1	
144	bar	EN 10273	elevated temperature properties	P265GH	1.0425	N	0	150	1.1	
145	bar	EN 10273	elevated temperature properties	P295GH	1.0481	N	0	150	1.2	
146	bar	EN 10273	elevated temperature properties	P355GH	1.0473	N	0	150	1.2	
147	bar	EN 10273	elevated temperature properties	P275NH	1.0487	N	0	150	1.1	
148	bar	EN 10273	elevated temperature properties	P355NH	1.0565	N	0	150	1.2	
149	bar	EN 10273	elevated temperature properties	P460NH	1.8935	N	0	150	1.3	
150	bar	EN 10273	elevated temperature properties	P355QH	1.8867	QT	0	150	1.2	
151	bar	EN 10273	elevated temperature properties	P460QH	1.8871	QT	0	150	3.1	
152	bar	EN 10273	elevated temperature properties	P500QH	1.8874	QT	0	150	3.1	

Table D.2-1 (*continued*)

1	2	3	4	5	6	7	8		9	10
No	Product form	European Standard	Material description	Grade	Material number	Heat treatment [g]	Thickness mm		Material group to CR ISO 15608	Notes
153	bar	EN 10273	elevated temperature properties	P690QH	1.8880	QT	0	150	3.1	
154	bar	EN 10273	elevated temperature properties	16Mo3	1.5415	N	0	150	1.2	e
155	Bar	EN 10273	elevated temperature properties	13CrMo4-5	1.7335	NT	0	16	5.1	
156	bar	EN 10273	elevated temperature properties	13CrMo4-5	1.7335	NT, QA, QL	16	150	5.1	
157	bar	EN 10273	elevated temperature properties	10CrMo9-10	1.7380	NT	0	60	5.2	
158	bar	EN 10273	elevated temperature properties	10CrMo9-10	1.7380	NT, QA, QL	60	150	5.2	
159	bar	EN 10273	elevated temperature properties	11CrMo9-10	1.7383	NT, QA, QL	0	60	5.2	
160	bar	EN 10273	elevated temperature properties	11CrMo9-10	1.7383	QL	60	100	5.2	
161	fastener	EN 10269	elevated temperature properties	C35E	1.1181	N	0	60	—	d
162	fastener	EN 10269	elevated temperature properties	C35E	1.1181	QT	0	150	—	d
163	fastener	EN 10269	elevated temperature properties	C45E	1.1191	N	0	60	—	d
164	fastener	EN 10269	elevated temperature properties	C45E	1.1191	QT	0	150	—	d
165	fastener	EN 10269	elevated temperature properties	35B2	1.5511	QT	0	150	—	d
166	fastener	EN 10269	elevated and low temperature properties	20Mn5	1.1133	N	0	150	—	d
167	fastener	EN 10269	elevated and low temperature properties	25CrMo4	1.7218	QT	0	150	—	d
168	fastener	EN 10269	elevated and low temperature properties	42CrMo4	1.7225	QT	0	60	—	d
169	fastener	EN 10269	elevated temperature properties	42CrMo5-6	1.7233	QT	0	150	—	d
170	fastener	EN 10269	elevated temperature properties	40CrMoV4-6	1.7711	QT	0	160	—	d
171	fastener	EN 10269	elevated temperature properties	21CrMoV5-7	1.7709	QT	0	160	—	d
172	fastener	EN 10269	elevated temperature properties	20CrMoVTiB4-10	1.7729	QT	0	160	—	d

Table D.2-1 (*continued*)

1	2	3	4	5	6	7	8		9	10
No	Product form	European Standard	Material description	Grade	Material number	Heat treatment [g]	Thickness mm		Material group to CR ISO 15608	Notes
173	fastener	EN 10269	elevated temperature properties	X15CrMo5-1	1.7390	NT, QT	0	160	—	d
174	fastener	EN 10269	elevated temperature properties	X22CrMoV12-1	1.4923	QT1, QT2	0	160	—	d
175	fastener	EN 10269	elevated temperature properties	X12CrNiMoV12-3	1.4938	QT	0	160	—	d
176	fastener	EN 10269	elevated temperature properties	X19CrMoNbVN11-1	1.4913	QT	0	160	—	d
177	fastener	EN 10269	elevated temperature properties	X2CrNi18-9	1.4307	AT	0	160	—	d
178	fastener	EN 10269	elevated and low temperature properties	X2CrNi18-9	1.4307	C700, C800	0	25	—	d
179	fastener	EN 10269	elevated and low temperature properties	X2CrNi18-9	1.4307	C700	25	35	—	d
180	fastener	EN 10269	elevated and low temperature properties	X5CrNi18-10	1.4301	AT	0	160	—	d
181	fastener	EN 10269	elevated and low temperature properties	X5CrNi18-10	1.4301	C700	0	35	—	d
182	fastener	EN 10269	elevated and low temperature properties	X4CrNi18-12	1.4303	AT	0	160	—	d
183	fastener	EN 10269	elevated and low temperature properties	X4CrNi18-12	1.4303	C700, C800	0	25	—	d
184	fastener	EN 10269	elevated and low temperature properties	X4CrNi18-12	1.4303	C700	25	35	—	d
185	fastener	EN 10269	elevated temperature properties	X2CrNiMo17-12-2	1.4404	AT	0	160	—	d
186	fastener	EN 10269	elevated and low temperature properties	X2CrNiMo17-12-2	1.4404	C700, C800	0	25	—	d
187	fastener	EN 10269	elevated and low temperature properties	X2CrNiMo17-12-2	1.4404	C 700	25	35	—	d
188	fastener	EN 10269	elevated temperature properties	X5CrNiMo17-12-2	1.4401	AT	0	160	—	d
189	fastener	EN 10269	elevated and low temperature properties	X5CrNiMo17-12-2	1.4401	C700, C800	0	25	—	d

Table D.2-1 (*continued*)

1	2	3	4	5	6	7	8		9	10
No	Product form	European Standard	Material description	Grade	Material number	Heat treatment [g]	Thickness mm		Material group to CR ISO 15608	Notes
190	fastener	EN 10269	elevated and low temperature properties	X5CrNiMo17-12-2	1.4401	C700	25	35	—	d
191	fastener	EN 10269	elevated and low temperature properties	X2CrNiMoN17-13-3	1.4429	AT	0	160	—	d
192	fastener	EN 10269	room temperature properties	X3CrNiCu18-9-4	1.4567	AT	0	160	—	d
193	fastener	EN 10269	room temperature properties	X3CrNiCu18-9-4	1.4567	C700	0	35	—	d
194	fastener	EN 10269	elevated and low temperature properties	X6CrNi18-10	1.4948	AT	0	160	—	d
195	fastener	EN 10269	elevated temperature properties	X10CrNiMoMnNbVB15-10-1	1.4982	AT + WW	0	100	—	d
196	fastener	EN 10269	elevated and low temperature properties	3CrNiMoBN17-13-3	1.4910	AT	0	160	—	d
197	fastener	EN 10269	elevated and low temperature properties	X6CrNiMoB17-12-2	1.4919	AT	0	160	—	d
198	fastener	EN 10269	elevated and low temperature properties	X6CrNiTiB18-10	1.4941	AT	0	160	—	d
199	fastener	EN 10269	elevated and low temperature properties	X6NiCrTiMoVB25-15-2	1.4980	AT + P	0	160	—	d
200	fastener	EN 10269	elevated temperature properties	X7CrNiMoBNb16-16	1.4986	WW + P	0	100	—	d
201	fastener	EN 10269	low temperature properties	19MnB4	1.5523	QT	0	16	—	d
202	fastener	EN 10269	low temperature properties	41NiCrMo7-3-2	1.6563	QT	0	160	—	d
203	fastener	EN 10269	low temperature properties	34CrNiMo6	1.6582	QT	0	100	—	d
204	fastener	EN 10269	low temperature properties	30CrNiMo8	1.6580	QT	0	100	—	d
205	fastener	EN 10269	low temperature properties	X12Ni5	1.5680	N, NT, QT	0	75	—	d
206	fastener	EN 10269	low temperature properties	X8Ni9	1.5662	N, NT, QT	0	75	—	d

Table D.2-1 (*continued*)

1	2	3	4	5	6	7	8		9	10
No	Product form	European Standard	Material description	Grade	Material number	Heat treatment [g]	Thickness mm		Material group to CR ISO 15608	Notes
207	seamless tube	EN 10216-1	room temperature properties	P195TR2	1.0108	N	0	60	1.1	
208	seamless tube	EN 10216-1	room temperature properties	P235TR2	1.0255	N	0	60	1.1	
209	seamless tube	EN 10216-1	room temperature properties	P265TR2	1.0259	N	0	60	1.1	
210	seamless tube	EN 10216-2	elevated temperature properties	P195GH	1.0348	N	0	16	1.1	
211	seamless tube	EN 10216-2	elevated temperature properties	P235GH	1.0345	N	0	60	1.1	
212	seamless tube	EN 10216-2	elevated temperature properties	P265GH	1.0425	N	0	60	1.1	
213	seamless tube	EN 10216-2	elevated temperature properties	20MnNb6	1.0471	N	0	60	1.2	
214	seamless tube	EN 10216-2	elevated temperature properties	16Mo3	1.5415	N	0	60	1.2	e
215	seamless tube	EN 10216-2	elevated temperature properties	8MoB5-4	1.5450	N	0	16	1.3	
216	seamless tube	EN 10216-2	elevated temperature properties	14MoV6-3	1.7715	NT, QT [b]	0	60	6.1	
217	seamless tube	EN 10216-2	elevated temperature properties	10CrMo5-5	1.7338	NT, QT [b]	0	60	5.1	
218	seamless tube	EN 10216-2	elevated temperature properties	13CrMo4-5	1.7335	NT, QT [b]	0	60	5.1	
219	seamless tube	EN 10216-2	elevated temperature properties	10CrMo9-10	1.7380	NT, QT [b]	0	60	5.2	
220	seamless tube	EN 10216-2	elevated temperature properties	11CrMo9-10	1.7383	QT	0	60	5.2	
221	seamless tube	EN 10216-2	elevated temperature properties	25CrMo4	1.7218	QT	0	60	5.1	a
222	seamless tube	EN 10216-2	elevated temperature properties	20CrMoV13-5-5	1.7779	QT	0	60	6.3	
223	seamless tube	EN 10216-2	elevated temperature properties	15NiCuMoNb5-6-4	1.6368	NT, QT [b]	0	80	3.1	
224	seamless tube	EN 10216-2	elevated temperature properties	X11CrMo5 + I [g]	1.7362 + I	I	0	100	5.3	

Table D.2-1 (*continued*)

1	2	3	4	5	6	7	8		9	10
No	Product form	European Standard	Material description	Grade	Material number	Heat treatment [g]	Thickness mm		Material group to CR ISO 15608	Notes
225	seamless tube	EN 10216-2	elevated temperature properties	X11CrMo5 + NT1 [g]	1.7362 + N1	NT	0	100	5.3	
226	seamless tube	EN 10216-2	elevated temperature properties	X11CrMo5 + NT2 [g]	1.7362 + N2	NT, QT [b]	0	100	5.3	
227	seamless tube	EN 10216-2	elevated temperature properties	X11CrMo9-1 + I [g]	1.7386 + I	I	0	60	5.4	
228	seamless tube	EN 10216-2	elevated temperature properties	X11CrMo9-1 + NT [g]	1.7386 + NT	NT, QT [b]	0	60	5.4	
229	seamless tube	EN 10216-2	elevated temperature properties	X10CrMoVNb9-1	1.4903	NT, QT [b]	0	100	6.4	
229-2	seamless tube	EN 10216-2	elevated temperature properties	X10CrWMoVNb9-2	1.4901	NT	0	100	6.4	
229-3	seamless tube	EN 10216-2	elevated temperature properties	X11CrMoWVNb9-1-1	1.4905	NT	0	100	6.4	
230	seamless tube	EN 10216-2	elevated temperature properties	X20CrMoV11-1	1.4922	NT, QT [b]	0	100	6.4	
231	seamless tube	EN 10216-3	fine grain steel	P275NL1	1.0488	N	0	100	1.1	
232	seamless tube	EN 10216-3	fine grain steel	P275NL2	1.1104	N	0	100	1.1	
233	seamless tube	EN 10216-3	fine grain steel	P355N	1.0562	N	0	100	1.2	
234	seamless tube	EN 10216-3	fine grain steel	P355NH	1.0565	N	0	100	1.2	
235	seamless tube	EN 10216-3	fine grain steel	P355NL1	1.0566	N	0	100	1.2	
236	seamless tube	EN 10216-3	fine grain steel	P355NL2	1.1106	N	0	100	1.2	
237	seamless tube	EN 10216-3	fine grain steel	P460N	1.8905	N [b]	0	100	1.3	
238	seamless tube	EN 10216-3	fine grain steel	P460NH	1.8935	N [b]	0	100	1.3	
239	seamless tube	EN 10216-3	fine grain steel	P460NL1	1.8915	N [b]	0	100	1.3	
240	seamless tube	EN 10216-3	fine grain steel	P460NL2	1.8918	N [b]	0	100	1.1	
241	seamless tube	EN 10216-3	fine grain steel	P620Q	1.8876	Q	0	65	3.1	
242	seamless tube	EN 10216-3	fine grain steel	P620QH	1.8877	Q	0	65	3.1	
243	seamless tube	EN 10216-3	fine grain steel	P620QL	1.8890	Q	0	65	3.1	
244	seamless tube	EN 10216-3	fine grain steel	P690Q	1.8879	Q	0	100	3.1	
245	seamless tube	EN 10216-3	fine grain steel	P690QH	1.8880	Q	0	100	3.1	

Table D.2-1 (*continued*)

1	2	3	4	5	6	7	8		9	10
No	Product form	European Standard	Material description	Grade	Material number	Heat treatment [g]	Thickness mm		Material group to CR ISO 15608	Notes
246	seamless tube	EN 10216-3	fine grain steel	P690QL1	1.8881	Q	0	100	3.1	
247	seamless tube	EN 10216-3	fine grain steel	P690QL2	1.8888	Q	0	100	3.1	
248	seamless tube	EN 10216-4	low temperature properties	P215NL	1.0451	N	0	10	1.1	
249	seamless tube	EN 10216-4	low temperature properties	P255QL	1.0452	QT	0	40	1.1	e
250	seamless tube	EN 10216-4	low temperature properties	P265NL	1.0453	N	0	25	1.1	
251	seamless tube	EN 10216-4	low temperature properties	26CrMo4-2	1.7219	QT	0	40	5.1	a
252	seamless tube	EN 10216-4	low temperature properties	11MnNi5-3	1.6212	N, NT [b]	0	40	9.1	
253	seamless tube	EN 10216-4	low temperature properties	13MnNi6-3	1.6217	N, NT [b]	0	40	9.1	
254	seamless tube	EN 10216-4	low temperature properties	12Ni14	1.5637	NT	0	40	9.2	
255	seamless tube	EN 10216-4	low temperature properties	12Ni14 + QT	1.5637	QT	0	40	9.2	
256	seamless tube	EN 10216-4	low temperature properties	X12Ni5	1.5680	N	0	40	9.2	
257	seamless tube	EN 10216-4	low temperature properties	X12Ni5 + QT	1.5680	QT	0	40	9.2	
258	seamless tube	EN 10216-4	low temperature properties	X10Ni9	1.5682	N, NT	0	40	9.3	
259	seamless tube	EN 10216-4	low temperature properties	X10Ni9 + QT	1.5682	QT [b]	0	40	9.3	
260	seamless tube	EN 10216-5	stainless steel, austenitic	X2CrNi18-9	1.4307	AT	0	60	8.1	
261	seamless tube	EN 10216-5	stainless steel, austenitic	X2CrNi19-11	1.4306	AT	0	60	8.1	
262	seamless tube	EN 10216-5	stainless steel, austenitic	X2CrNiN18-10	1.4311	AT	0	60	8.1	
263	seamless tube	EN 10216-5	stainless steel, austenitic	X5CrNi18-10	1.4301	AT	0	60	8.1	
264	seamless tube	EN 10216-5	stainless steel, austenitic	X6CrNiTI18-10	1.4541	AT	0	60	8.1	
265	seamless tube	EN 10216-5	stainless steel, austenitic	X6CrNiNb18-10	1.4550	AT	0	60	8.1	
266	seamless tube	EN 10216-5	stainless steel, austenitic	X2CrNiMo18-14-3	1.4435	AT	0	60	8.1	
267	seamless tube	EN 10216-5	stainless steel, austenitic	X2CrNiMo17-12-2	1.4404	AT	0	60	8.1	

Table D.2-1 (*continued*)

1	2	3	4	5	6	7	8		9	10
No	Product form	European Standard	Material description	Grade	Material number	Heat treatment [g]	Thickness mm		Material group to CR ISO 15608	Notes
268	seamless tube	EN 10216-5	stainless steel, austenitic	X5CrNiMo17-12-2	1.4401	AT	0	60	8.1	
269	seamless tube	EN 10216-5	stainless steel, austenitic	X1CrNiMoN25-22-2	1.4466	AT	0	60	8.2	
270	seamless tube	EN 10216-5	stainless steel, austenitic	X6CrNiMoTi17-12-2	1.4571	AT	0	60	8.1	
271	seamless tube	EN 10216-5	stainless steel, austenitic	X6CrNiMoNb17-12-2	1.4580	AT	0	60	8.1	
272	seamless tube	EN 10216-5	stainless steel, austenitic	X2CrNiMoN17-13-3	1.4429	AT	0	60	8.1	
273	seamless tube	EN 10216-5	stainless steel, austenitic	X3CrNiMo17-13-3	1.4436	AT	0	60	8.1	
274	seamless tube	EN 10216-5	stainless steel, austenitic	X1CrNi25-21	1.4335	AT	0	60	8.2	
275	seamless tube	EN 10216-5	stainless steel, austenitic	X2CrNiMoN17-13-5	1.4439	AT	0	60	8.1	
276	seamless tube	EN 10216-5	stainless steel, austenitic	X1NiCrMoCu31-27-4	1.4563	AT	0	60	8.2	
277	seamless tube	EN 10216-5	stainless steel, austenitic	X1NiCrMoCu25-20-5	1.4539	AT	0	60	8.2	
278	seamless tube	EN 10216-5	stainless steel, austenitic	X1CrNiMoCuN20-18-7	1.4547	AT	0	60	8.2	
279	seamless tube	EN 10216-5	stainless steel, austenitic	X1NiCrMoCuN25-20-7	1.4529	AT	0	60	8.2	
280	seamless tube	EN 10216-5	stainless steel, austenitic	X2NiCrAlTi32-20	1.4558	AT	0	60	8.2	
281	seamless tube	EN 10216-5	stainless steel, austenitic	X6CrNi18-10	1.4948	AT	0	50	8.1	
282	seamless tube	EN 10216-5	stainless steel, austenitic	X7CrNiTi18-10	1.4940	AT	0	50	8.1	
283	seamless tube	EN 10216-5	stainless steel, austenitic	X7CrNiNb18-10	1.4912	AT	0	50	8.1	
284	seamless tube	EN 10216-5	stainless steel, austenitic	X7CrNiTiB18-10	1.4941	AT	0	50	8.1	
285	seamless tube	EN 10216-5	stainless steel, austenitic	X6CrNiMo17-13-2	1.4918	AT	0	50	8.1	
286	seamless tube	EN 10216-5	stainless steel, austenitic	X5NiCrAlTi31-20	1.4958	AT	0	50	8.2	
287	seamless tube	EN 10216-5	stainless steel, austenitic	X8NiCrAlTi32-21	1.4959	AT	0	50	8.2	
288	seamless tube	EN 10216-5	stainless steel, austenitic	X3CrNiMoNB17-13-3	1.4910	AT	0	50	8.1	
289	seamless tube	EN 10216-5	stainless steel, austenitic	X8CrNiNb16-13	1.4961	AT	0	50	8.1	
290	seamless tube	EN 10216-5	stainless steel, austenitic	X8CrNiMoVNb16-13	1.4988	AT	0	50	8.1	
291	seamless tube	EN 10216-5	stainless steel, austenitic	X8CrNiMoNb16-16	1.4981	AT	0	50	8.1	

Table D.2-1 (*continued*)

1	2	3	4	5	6	7	8		9	10
No	Product form	European Standard	Material description	Grade	Material number	Heat treatment [g]	Thickness mm		Material group to CR ISO 15608	Notes
292	seamless tube	EN 10216-5	stainless steel, austenitic	X10CrNiMoMnNbVB15-10-1	1.4982	AT	0	50	8.1	
293	seamless tube	EN 10216-5	stainless steel, austenitic-ferritic	X2CrNiMoN22-5-3	1.4462	AT	0	30	10.1	c
294	seamless tube	EN 10216-5	stainless steel, austenitic-ferritic	X2CrNiMoSi18-5-3	1.4424	AT	0	30	10.1	c
295	seamless tube	EN 10216-5	stainless steel, austenitic-ferritic	X2CrNiN23-4	1.4362	AT	0	30	10.1	c
296	seamless tube	EN 10216-5	stainless steel, austenitic-ferritic	X2CrNiMoN25-7-4	1.4410	AT	0	30	10.2	c
297	seamless tube	EN 10216-5	stainless steel, austenitic-ferritic	X2CrNiMoCuN25-6-3	1.4507	AT	0	30	10.2	c
298	seamless tube	EN 10216-5	stainless steel, austenitic-ferritic	X2CrNiMoCuWN25-7-4	1.4501	AT	0	30	10.2	c
299	welded tube	EN 10217-1	room temperature properties	P195TR2	1.0108	N	0	40	1.1	
300	welded tube	EN 10217-1	room temperature properties	P235TR2	1.0255	N	0	40	1.1	
301	welded tube	EN 10217-1	room temperature properties	P265TR2	1.0259	N	0	40	1.1	
302	welded tube	EN 10217-2	elevated temperature properties	P195GH	1.0348	N	0	16	1.1	
303	welded tube	EN 10217-2	elevated temperature properties	P235GH	1.0345	N	0	16	1.1	
304	welded tube	EN 10217-2	elevated temperature properties	P265GH	1.0425	N	0	16	1.1	
305	welded tube	EN 10217-2	elevated temperature properties	16Mo3	1.5415	N	0	16	1.2	e
306	welded tube	EN 10217-3	fine grain steel	P275NL1	1.0488	N	0	40	1.1	
307	welded tube	EN 10217-3	fine grain steel	P275NL2	1.1104	N	0	40	1.1	
308	welded tube	EN 10217-3	fine grain steel	P355N	1.0562	N	0	40	1.2	
309	welded tube	EN 10217-3	fine grain steel	P355NH	1.0565	N	0	40	1.2	

Table D.2-1 (*continued*)

1	2	3	4	5	6	7	8		9	10
No	Product form	European Standard	Material description	Grade	Material number	Heat treatment [g]	Thickness mm		Material group to CR ISO 15608	Notes
310	welded tube	EN 10217-3	fine grain steel	P355NL1	1.0566	N	0	40	1.2	
311	welded tube	EN 10217-3	fine grain steel	P355NL2	1.1106	N	0	40	1.2	
312	welded tube	EN 10217-3	fine grain steel	P460N	1.8905	N	0	40	1.3	
313	welded tube	EN 10217-3	fine grain steel	P460NH	1.8935	N	0	40	1.3	
314	welded tube	EN 10217-3	fine grain steel	P460NL1	1.8915	N	0	40	1.3	
315	welded tube	EN 10217-3	fine grain steel	P460NL2	1.8918	N	0	40	1.3	
316	welded tube	EN 10217-4	low temperature properties	P215NL	1.0451	N	0	10	1.1	
317	welded tube	EN 10217-4	low temperature properties	P265NL	1.0453	N	0	16	1.1	
318	welded tube	EN 10217-5	elevated temperature properties	P235GH	1.0345	N	0	40	1.1	
319	welded tube	EN 10217-5	elevated temperature properties	P265GH	1.0425	N	0	40	1.1	
320	welded tube	EN 10217-5	elevated temperature properties	16Mo3	1.5415	N	0	40	1.2	[e]
321	welded tube	EN 10217-6	low temperature properties	P215NL	1.0451	N	0	10	1.1	
322	welded tube	EN 10217-6	low temperature properties	P265NL	1.0453	N	0	25	1.1	
323	welded tube	EN 10217-7	stainless steel, austenitic	X2CrNi18-9	1.4307	AT	0	60	8.1	
324	welded tube	EN 10217-7	stainless steel, austenitic	X2CrNi19-11	1.4306	AT	0	60	8.1	
325	welded tube	EN 10217-7	stainless steel, austenitic	X2CrNiN18-10	1.4311	AT	0	60	8.1	
326	welded tube	EN 10217-7	stainless steel, austenitic	X5CrNi18-10	1.4301	AT	0	60	8.1	
327	welded tube	EN 10217-7	stainless steel, austenitic	X6CrNiTi18-10	1.4541	AT	0	60	8.1	

Table D.2-1 (*continued*)

1	2	3	4	5	6	7	8		9	10
No	Product form	European Standard	Material description	Grade	Material number	Heat treatment [g]	Thickness mm		Material group to CR ISO 15608	Notes
328	welded tube	EN 10217-7	stainless steel, austenitic	X6CrNiNb18-10	1.4550	AT	0	60	8.1	
329	welded tube	EN 10217-7	stainless steel, austenitic	X2CrNiMo17-12-2	1.4404	AT	0	60	8.1	
330	welded tube	EN 10217-7	stainless steel, austenitic	X5CrNiMo17-12-2	1.4401	AT	0	60	8.1	
331	welded tube	EN 10217-7	stainless steel, austenitic	X6CrNiMoTi17-12-2	1.4571	AT	0	60	8.1	
332	welded tube	EN 10217-7	stainless steel, austenitic	X2CrNiMo17-12-3	1.4432	AT	0	60	8.1	
333	welded tube	EN 10217-7	stainless steel, austenitic	X2CrNiMoN17-13-3	1.4429	AT	0	60	8.1	
334	welded tube	EN 10217-7	stainless steel, austenitic	X3CrNiMo17-13-3	1.4436	AT	0	60	8.1	
335	welded tube	EN 10217-7	stainless steel, austenitic	X2CrNiMo18-14-3	1.4435	AT	0	60	8.1	
336	welded tube	EN 10217-7	stainless steel, austenitic	X2CrNiMoN17-13-5	1.4439	AT	0	60	8.1	
337	welded tube	EN 10217-7	stainless steel, austenitic	X2CrNiMo18-15-4	1.4438	AT	0	60	8.1	
338	welded tube	EN 10217-7	stainless steel, austenitic	X1NiCrMoCu31-27-7	1.4563	AT	0	60	8.2	
339	welded tube	EN 10217-7	stainless steel, austenitic	X1NiCrMoCu25-20-5	1.4539	AT	0	60	8.2	
340	welded tube	EN 10217-7	stainless steel, austenitic	X1CrNiMoCuN20-18-7	1.4547	AT	0	60	8.2	
341	welded tube	EN 10217-7	stainless steel, austenitic	X1NiCrMoCuN25-20-7	1.4529	AT	0	60	8.2	
342	welded tube	EN 10217-7	stainless steel, austenitic-ferritic	X2CrNiMoN22-5-3	1.4462	AT	0	30	10.1	c
343	welded tube	EN 10217-7	stainless steel, austenitic-ferritic	X2CrNiN23-4	1.4362	AT	0	30	10.1	c
344	welded tube	EN 10217-7	stainless steel, austenitic-ferritic	X2CrNiMoN25-7-4	1.4410	AT	0	30	10.2	c
345	welded tube	EN 10217-7	stainless steel, austenitic-ferritic	X2CrNiMoCuWN25-7-4	1.4501	AT	0	30	10.2	c

Table D.2-1 (*continued*)

1	2	3	4	5	6	7	8		9	10
No	Product form	European Standard	Material description	Grade	Material number	Heat treatment [g]	Thickness mm		Material group to CR ISO 15608	Notes
346	forging	EN 10222-2	elevated temperature properties	P245GH	1.0352	A	0	35	1.1	
347	forging	EN 10222-2	elevated temperature properties	P245GH	1.0352	N, NT, QT	35	160	1.1	
348	forging	EN 10222-2	elevated temperature properties	P280GH	1.0426	N	0	35	1.2	
349	forging	EN 10222-2	elevated temperature properties	P280GH	1.0426	NT, QT	35	160	1.2	
350	forging	EN 10222-2	elevated temperature properties	P305GH	1.0436	N	0	35	1.2	
351	forging	EN 10222-2	elevated temperature properties	P305GH	1.0436	NT	35	160	1.2	
352	forging	EN 10222-2	elevated temperature properties	P305GH	1.0436	QT	0	70	1.2	e
353	forging	EN 10222-2	elevated temperature properties	16Mo3	1.5415	N	0	35	1.2	e
354	forging	EN 10222-2	elevated temperature properties	16Mo3	1.5415	QT	35	500	1.2	e
355	forging	EN 10222-2	elevated temperature properties	13CrMo4-5	1.7335	NT	0	70	5.1	
356	forging	EN 10222-2	elevated temperature properties	13CrMo4-5	1.7335	NT, QT	70	500	5.1	
357	forging	EN 10222-2	elevated temperature properties	15MnMoV4-5	1.5402	NT, QT	0	250	1.2	
358	forging	EN 10222-2	elevated temperature properties	18MnMoNi5-5	1.6308	QT	0	200	4.1	
359	forging	EN 10222-2	elevated temperature properties	14MoV6-3	1.7715	NT, QT	0	500	6.1	
360	forging	EN 10222-2	elevated temperature properties	15MnCrMoNiV5-3	1.6920	NT, QT	0	100	4.1	
361	forging	EN 10222-2	elevated temperature properties	11CrMo9-10	1.7383	NT	0	200	5.2	
362	forging	EN 10222-2	elevated temperature properties	11CrMo9-10	1.7383	NT, QT	200	500	5.2	
363	forging	EN 10222-2	elevated temperature properties	X16CrMo5-1	1.7366	A	0	300	5.3	
364	forging	EN 10222-2	elevated temperature properties	X16CrMo5-1	1.7366	NT	0	300	5.3	

Table D.2-1 (*continued*)

1	2	3	4	5	6	7	8		9	10
No	Product form	European Standard	Material description	Grade	Material number	Heat treatment [g]	Thickness mm		Material group to CR ISO 15608	Notes
365	forging	EN 10222-2	elevated temperature properties	X10CrMoVNb9-1	1.4903	NT	0	130	6.4	
366	forging	EN 10222-2	elevated temperature properties	X20CrMoV11-1	1.4922	QT	0	330	6.4	
367	forging	EN 10222-3	low temperature properties	13MnNi6-3	1.6217	NT	0	70	9.1	
368	forging	EN 10222-3	low temperature properties	15NiMn6	1.6228	N	0	35	9.1	
369	forging	EN 10222-3	low temperature properties	15NiMn6	1.6228	NT, QT	35	50	9.1	
370	forging	EN 10222-3	low temperature properties	12Ni14	1.5637	N	0	35	9.2	
371	forging	EN 10222-3	low temperature properties	12Ni14	1.5637	NT	35	50	9.2	
372	forging	EN 10222-3	low temperature properties	12Ni14	1.5637	QT	50	70	9.2	
373	forging	EN 10222-3	low temperature properties	X12Ni5	1.5680	N	0	35	9.2	
374	forging	EN 10222-3	low temperature properties	X12Ni5	1.5680	NT, QT	35	50	9.2	
375	forging	EN 10222-3	low temperature properties	X8Ni9	1.5662	N, NT	0	50	9.3	
376	forging	EN 10222-3	low temperature properties	X8Ni9	1.5662	QT	50	70	9.3	
377	forging	EN 10222-4	fine grain steel, high proof strength	P285NH	1.0477	N	0	70	1.2	
378	forging	EN 10222-4	fine grain steel, high proof strength	P285QH	1.0478	QT	70	400	1.2	e
379	forging	EN 10222-4	fine grain steel, high proof strength	P355NH	1.0565	N	0	70	1.2	
380	forging	EN 10222-4	fine grain steel, high proof strength	P355QH1	1.0571	QT	70	400	1.2	e
381	forging	EN 10222-4	fine grain steel, high proof strength	P420NH	1.8932	N	0	70	1.3	
382	forging	EN 10222-4	fine grain steel, high proof strength	P420QH	1.8936	QT	70	400	3.1	
383	forging	EN 10222-5	stainless steel, martensitic	X3CrNi13-4	1.4313	QT+T	0	350	7.2	e
384	forging	EN 10222-5	stainless steel, martensitic	X3CrNi13-4	1.4313	QT	0	250	7.2	e

Table D.2-1 (*continued*)

1	2	3	4	5	6	7	8		9	10
No	Product form	European Standard	Material description	Grade	Material number	Heat treatment [g]	Thickness mm		Material group to CR ISO 15608	Notes
385	forging	EN 10222-5	stainless steel, austenitic	X2CrNi18-9	1.4307	AT	0	250	8.1	
386	forging	EN 10222-5	stainless steel, austenitic	X2CrNiN18-10	1.4311	AT	0	250	8.1	
387	forging	EN 10222-5	stainless steel, austenitic	X5CrNi18-10	1.4301	AT	0	250	8.1	
388	forging	EN 10222-5	stainless steel, austenitic	X6CrNiTi18-10	1.4541	AT	0	450	8.1	
389	forging	EN 10222-5	stainless steel, austenitic	X6CrNiNb18-10	1.4550	AT	0	450	8.1	
390	forging	EN 10222-5	stainless steel, austenitic	X6CrNi18-10	1.4948	AT	0	250	8.1	
391	forging	EN 10222-5	stainless steel, austenitic	X6CrNiTiB18-10	1.4941	AT	0	450	8.1	
392	forging	EN 10222-5	stainless steel, austenitic	X7CrNiNb18-10	1.4912	AT	0	450	8.1	
393	forging	EN 10222-5	stainless steel, austenitic	X2CrNiMo17-12-2	1.4404	AT	0	250	8.1	
394	forging	EN 10222-5	stainless steel, austenitic	X2CrNiMoN17-11-2	1.4406	AT	0	160	8.1	
395	forging	EN 10222-5	stainless steel, austenitic	X5CrNiMo17-12-2	1.4401	AT	0	250	8.1	
396	forging	EN 10222-5	stainless steel, austenitic	X6CrNiMoTi17-12-2	1.4571	AT	0	450	8.1	
397	forging	EN 10222-5	stainless steel, austenitic	X2CrNiMo17-12-3	1.4432	AT	0	250	8.1	
398	forging	EN 10222-5	stainless steel, austenitic	X2CrNiMoN17-13-3	1.4429	AT	0	160	8.1	
399	forging	EN 10222-5	stainless steel, austenitic	X3CrNiMo17-13-3	1.4436	AT	0	250	8.1	
400	forging	EN 10222-5	stainless steel, austenitic	X2CrNiMo18-14-3	1.4435	AT	0	75	8.1	
401	forging	EN 10222-5	stainless steel, austenitic	X3CrNiMoN17-13-3	1.4910	AT	0	75	8.1	
402	forging	EN 10222-5	stainless steel, austenitic	X2CrNiCu19-10	1.4650	AT	0	450	8.1	
403	forging	EN 10222-5	stainless steel, austenitic	X3CrNiMo18-12-3	1.4449	AT	0	450	8.1	
404	forging	EN 10222-5	stainless steel, austenitic-ferritic	X2CrNiMoN22-5-3	1.4462	AT	0	350	10.1	c

Table D.2-1 (*continued*)

1	2	3	4	5	6	7	8		9	10
No	Product form	European Standard	Material description	Grade	Material number	Heat treatment [g]	Thickness mm		Material group to CR ISO 15608	Notes
405	forging	EN 10222-5	stainless steel, austenitic-ferritic	X2CrNiMoN25-7-4	1.4410	AT	0	160	10.2	c
406	casting	EN 10213	elevated temperature properties	GP240GR	1.0621	N	0	100	1.1	
407	casting	EN 10213	elevated temperature properties	GP240GH	1.0619	N, QT	0	100	1.1	e
408	casting	EN 10213	elevated temperature properties	GP280GH	1.0625	N, QT	0	100	1.2	e
409	casting	EN 10213	elevated temperature properties	G20Mo5	1.5419	QT	0	100	3.1	
410	casting	EN 10213	elevated temperature properties	G17CrMo5-5	1.7357	QT	0	100	5.1	
411	casting	EN 10213	elevated temperature properties	G17CrMo9-10	1.7379	QT	0	150	5.2	
412	casting	EN 10213	elevated temperature properties	G12MoCrV5-2	1.7720	QT	0	100	6.1	
413	casting	EN 10213	elevated temperature properties	G17CrMoV5-10	1.7706	QT	0	150	6.2	
414	casting	EN 10213	elevated temperature properties	GX4CrNi13-4	1.4317	QT	0	300	8.1	
415	casting	EN 10213	elevated temperature properties	GX8CrNi12	1.4107	QT	0	300	8.1	
416	casting	EN 10213	elevated temperature properties	GX15CrMo5	1.7365	QT	0	150	5.3	
417	casting	EN 10213	elevated temperature properties	GX23CrMoV12-1	1.4931	QT	0	150	6.4	
418	casting	EN 10213	low temperature properties	G17Mn5	1.1131	QT	0	50	1.1	
419	casting	EN 10213	low temperature properties	G20Mn5	1.6220	N	0	30	1.2	
420	casting	EN 10213	low temperature properties	G20Mn5	1.6220	QT	0	100	1.2	e
421	casting	EN 10213	low temperature properties	G18Mo5	1.5422	QT	0	100	1.2	e
422	casting	EN 10213	low temperature properties	G9Ni10	1.5636	QT	0	35	9.1	
423	casting	EN 10213	low temperature properties	G17NiCrMo13-6	1.6781	QT	0	200	9.2	
424	casting	EN 10213	low temperature properties	G9Ni14	1.5638	QT	0	35	9.2	
425	casting	EN 10213	low temperature properties	GX3CrNi13-4	1.6982	QT	0	300	8.1	

Table D.2-1 (*continued*)

1	2	3	4	5	6	7	8		9	10
No	Product form	European Standard	Material description	Grade	Material number	Heat treatment [g]	Thickness mm		Material group to CR ISO 15608	Notes
426	casting	EN 10213	stainless steel, austenitic	GX2CrNi19-11	1.4309	AT	0	150	8.1	
427	casting	EN 10213	stainless steel, austenitic	GX5CrNi19-10	1.4308	AT	0	150	8.1	
428	casting	EN 10213	stainless steel, austenitic	GX5CrNiNb19-11	1.4552	AT	0	150	8.1	
429	casting	EN 10213	stainless steel, austenitic	GX2CrNiMo19-11-2	1.4409	AT	0	150	8.1	
430	casting	EN 10213	stainless steel, austenitic	GX5CrNiMo19-11-2	1.4408	AT	0	150	8.1	
431	casting	EN 10213	stainless steel, austenitic	GX5CrNiMoNb19-11-2	1.4581	AT	0	150	8.1	
432	casting	EN 10213	stainless steel, austenitic	GX2NiCrMo28-20-2	1.4458	AT	0	150	8.2	
433	casting	EN 10213	stainless steel, austenitic-ferritic	GX2CrNiMoN25-7-3	1.4417	-	0	150	10.2	c
434	casting	EN 10213	stainless steel, austenitic-ferritic	GX2CrNiMoN22-5-3	1.4470	AT	0	150	10.1	c
435	casting	EN 10213	stainless steel, austenitic-ferritic	GX2CrNiMoCuN25-6-3-3	1.4517	AT	0	150	10.2	c
436	casting	EN 10213	stainless steel, austenitic-ferritic	GX2CrNiMoN26-7-4	1.4469	AT	0	150	10.2	c

a Because of the carbon content special precautions are necessary when the material is welded.
b See EN 10216 series for details of heat treatment.
c See B.2-2, Figures B.2-9 to B.2-11 of EN 13480-2.
d Welding on fasteners made of these materials is not permitted.
e Additional requirements for forming and welding shall be considered on a case by case basis.
f Hot forming is not allowed for thermomechanically treated steels, see 9.3.2 of EN 13445-4:2009.
g Heat treatment conditions:

A	annealed
AT	solution annealed
C	cold worked
I	isothermally annealed
M	thermomechanically rolled
N	normalised
NT	normalised and tempered
P	precipitation hardened
QT	quenched and tempered
RA	recrystalised annealed
WW	warm worked

Annex Y
(informative)

History of EN 13480-2

Y.1 Differences between EN 13480-2:2002 and EN 13480-2:2012

The 2012 edition of EN 13480 contains the 2002 edition of the standard and all Amendment(s) and correction(s) issued in the meantime.

Significant technical changes include:

— Addition in Clause 2 of normative references related to seamless steel tubes for pressure purposes, to welded steel tubes for pressure purposes, to Steel forgings for pressure purposes and to mechanical properties of corrosion-resistant stainless steel fasteners.

— Revision of 4.3.1 related to the requirements for materials to be used for pressure-bearing parts with the introduction of references to European Standards for plates, strips, bars, tubes, forgings, fittings and castings for pressure purposes.

— Revision of Annex A related to the grouping system for steels for pressure equipment (new Table A.1).

— Revision of Annex B related to the requirements for prevention of brittle fracture at low temperatures (requirements for temperature adjustment revised in accordance with EN 13445-2:2009/A2:2012).

— Addition of the new Annex D related to European Standards for steels and steel components for pressure purposes and European standardised steels grouped according to product forms (new Tables D.1-1 and D.2.-1).

— Update of the Annexe ZA in relation with the Pressure Equipment Directive 97/23/EC.

NOTE The changes referred include the significant technical changes but is not an exhaustive list of all modifications.

Y.2 List of corrected pages of Issue 2 (2013-08)

Pages 3, 4, 9, 13, 14, 15, 19, 20, 25, 28, 43, 55 and 80.

Y.3 List of corrected pages of Issue 3 (2014-08)

Pages 4, 19, 41, 80 and 81.

Y.4 List of corrected pages of Issue 4 (2015-07)

Pages 4, 47 and 80.

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of EU Pressure Equipment Directive (97/23/EC)

This European Standard has been prepared under a mandate given to CEN by the European Commission to provide a means of conforming to Essential Requirements of the New Approach Directive 97/23/EC of the European Parliament and of the Council of 29 May 1997 on the approximation of the laws of the Member States concerning pressure equipment.

Once this standard is cited in the Official Journal of the European Union under that Directive and has been implemented as a national standard in at least one Member State, compliance with the clauses of this standard given in Table ZA.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential Requirements of that Directive and associated EFTA regulations.

Table ZA.1 — Correspondence between this European Standard and Directive 97/23/EC

Clause(s)/sub-clause(s) of this EN	Essential Requirements (ERs) of Directive 97/23/EC, Annex I	Qualifying remarks/Notes
4	2.2.3 (b), 5th indent	Provision and consideration of appropriate material properties
4.2.1.1	2.6	Consideration of corrosion
4.2.1.1	2.7	Consideration of wear
Annex B	4.1 (a)	Prevention of brittle fracture
4.1.7, 4.2.1.1	4.1 (d)	Material suitable for intended processing procedure
4.1.2	4.3	Technical documentation
4.1.4 4.1.6 and Annex B	7.5	Detailed requirements on elongation after fracture for steel Detailed requirements on impact rupture energy for steel
Annex A	4.2 a)	Essential characteristics of materials

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

Bibliography

[1] Directive 97/23/EC of the European Parliament and of the Council of 29 May 1997 on the approximation of the laws of the Member States concerning pressure equipment, OJEC No L 181, 9 July 1997

[2] AD-Merkblatt W 8. Plattierte Stähle (clad steels); July 1987

[3] CODAP, Section M 5: Rules applicable to ferrous and non ferrous cladded metal sheets

[4] SEL 075: Plattierte Erzeugnisse (plated products); February 1993

[5] Sanz G., Rev Metal CIT 1980, pp 621-642

[6] Sandström R., "Minimum usage temperatures for ferritic steels" Scandinavian Journal of Metallurgy 16 (1987), pp 242-252

[7] Garwood S. J. and Denham J. B., 'The fracture toughness requirements of BS 5500', ASME pressure vessel and piping conference (1988), paper 88-PBP-7

[8] Guidance on methods for assessing the acceptability of flaws in fusion welded structures, BS 7910:1999

[9] Assessment of the Integrity of Structures Containing Discontinuities, INSTA Technical Report, Materials Standards Institute, Stockholm 1991

[10] Case proposal to prEN 13445-2, clause 4.1.6 and Annex D.3.2 (prepared by SG Low Temperature), document CEN/TC 54/267/JWG B N 400

[11] EN 764-4:2002, *Pressure equipment — Part 4: Establishment of technical delivery conditions for metallic materials*

[12] EN 764-5:2002, *Pressure equipment — Part 5: Compliance and Inspection Documentation of Materials*

[13] EN 1011-2:2001, *Welding — Recommendations for welding of metallic materials — Part 2: Arc welding of ferritic steels*

[14] EN 10002-1:2001, Metallic materials — Tensile testing — Part 1: Method of test at ambient temperature

[15] EN 10079:1992, *Definition of steel products*

[16] EN ISO 14343:2007, *Welding consumables — Wire electrodes, strip electrodes, wires and rods for fusion welding of stainless and heat resisting steels — Classification (ISO 14343:2002 and ISO 14343:2002/Amd1:2006)*

[17] Langenberg P. (Edt.), ECOPRESS Economical and safe design of pressure vessels applying new modern steels, European research project, 5th framework RTD, project no. GRD1-1999-10640, 1/2000-5/2003, Final report 12/2003, info: www.i-w-t.de

[18] Sandström, R., Langenberg, P., Sieurin, H., New brittle fracture model for the European pressure vessel standard, International Journal of Pressure Vessels and Piping 81 (2004) 837–845'

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