BS EN 13445-1:2026

BSI Standards Publication

Unfired pressure vessels

Part 1: General



Documents
Document Sharing Hub

National foreword

This British Standard is the UK implementation of EN 13445-1:2026. It supersedes BS EN 13445-1:2021, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PVE/1, Pressure Vessels.

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

Contractual and legal considerations

This publication has been prepared in good faith, however no representation, warranty, assurance or undertaking (express or implied) is or will be made, and no responsibility or liability is or will be accepted by BSI in relation to the adequacy, accuracy, completeness or reasonableness of this publication. All and any such responsibility and liability is expressly disclaimed to the full extent permitted by the law.

This publication is provided as is, and is to be used at the recipient's own risk.

The recipient is advised to consider seeking professional guidance with respect to its use of this publication.

This publication is not intended to constitute a contract. Users are responsible for its correct application.

This publication has been prepared under a mandate given to the European Standards Organizations by the European Commission and the European Free Trade Association. It is intended to support requirements of the EU legislation detailed in the European Foreword. A European Annex, usually Annex ZA or ZZ, describes how this publication relates to that EU legislation.

For the Great Britain market (England, Scotland and Wales), if UK Government has designated this publication for conformity with UKCA marking (or similar) legislation, it may contain an additional National Annex. Where such a National Annex exists, it shows the correlation between this publication and the relevant UK legislation. If there is no National Annex of this kind, the relevant Annex ZA or ZZ in the body of the European text will indicate the relationship to UK regulation applicable in Great Britain. References to EU legislation may need to be read in accordance with the UK designation and the applicable UK law. Further information on designated standards can be found at www.bsigroup.com/standardsandregulation.

For the Northern Ireland market, UK law will continue to implement relevant EU law subject to periodic confirmation. Therefore Annex ZA/ZZ in the European text, and references to EU legislation, are still valid for this market.

UK Government is responsible for legislation. For information on legislation and policies relating to that legislation, consult the relevant pages of www.gov.uk.

© The British Standards Institution 2026
Published by BSI Standards Limited 2026

ISBN 978 0 539 42072 2

AVA Documents
Document Sharing Hub

Full document details: BS EN 13445-1:2026 Unfired pressure vessels - Part 1: General

ICS 23.020.30; 23.020.35

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 July 2026.

Amendments/corrigenda issued since publication

Date	Text affected

Documents
Document Sharing Hub

Full document details: BS EN 13445-1:2026 Unfired pressure vessels - Part 1: General

Documents
Document Sharing Hub

Full document details: BS EN 13445-1:2026 Unfired pressure vessels - Part 1: General

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 13445-1

July 2026

ICS 23.020.30

Supersedes EN 13445-1:2021

English Version

Unfired pressure vessels - Part 1: General

Récipients sous pression non soumis à la flamme - Partie 1: Généralités

Unbefeuerte Druckbehälter - Teil 1: Allgemeines

This European Standard was approved by CEN on 24 June 2026.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and United Kingdom.



EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

© 2026 CEN All rights of exploitation in any form and by any means reserved worldwide for CEN national Members.

Ref. No. EN 13445-1:2026 E

Documents
Document Sharing Hub

Full document details: BS EN 13445-1:2026 Unfired pressure vessels - Part 1: General

Contents

Page

European foreword ... **3**
Introduction ... **4**
1 Scope ... **6**
2 Normative references ... **6**
3 Terms and definitions ... **7**
4 Interdependency of the parts of the series ... **9**
5 Quantities, symbols and units ... **9**
6 Risk assessment and handling ... **12**
Annex A (informative) Using the standard ... **14**
Annex B (informative) Index ... **30**
Annex X (informative) List of Essential Safety Requirements ... **51**
Annex Y (informative) History of EN 13445-1 ... **60**
Annex ZA (informative) Relationship between this European Standard and the essential requirements of Directive 2014/68/EU aimed to be covered ... **61**
Bibliography ... **62**

Documents
Document Sharing Hub
Full document details: BS EN 13445-1:2026 Unfired pressure vessels - Part 1: General

European foreword

This document (EN 13445-1:2026) has been prepared by Technical Committee CEN/TC 54 “Unfired pressure vessels”, the secretariat of which is held by BSI.

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 2026, and conflicting national standards shall be withdrawn at the latest by December 2026.

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

This document supersedes EN 13445-1:2021.

Annex Y provides details of significant technical changes between this European Standard and the previous edition.

This document has been prepared under a standardization request addressed to CEN by the European Commission. The Standing Committee of the EFTA States subsequently approves these requests for its Member States.

For the relationship with EU Legislation, see informative Annex ZA, which is an integral part of this document.

A list of all parts in the EN 13445 series can be found on the CEN website.

Although these Parts may be obtained separately, it should be recognized that the Parts are interdependent. As such, the manufacture of unfired pressure vessels requires the application of all the relevant Parts in order for the requirements of the Standard to be satisfactorily fulfilled.

Corrections to the standard interpretations where several options seem possible are conducted through the Migration Help Desk (MHD). Information related to the Help Desk can be found at https://unm.fr/en/maintenance-agencies/maintenance-agency-en-13445/. 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.

Any feedback and questions on this document should be directed to the users’ national standards body. A complete listing of these bodies can be found on the CEN website.

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, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

AVA Documents
Document Sharing Hub

Full document details: BS EN 13445-1:2026 Unfired pressure vessels - Part 1: General

Introduction

EN 13445 specifies the requirements for design, construction, inspection and testing of unfired pressure vessels. It defines terms, definitions and symbols applicable to unfired pressure vessels.

NOTE In EN 13445 the term pressure vessel includes the welded attachments up to and including the nozzle flanges, screwed or welded connections, or the edge to be welded at the first circumferential weld at connecting piping or other elements. The term unfired excludes vessels that are subject to direct generated heat or flame impingement from a fired process. This does not exclude vessels subject to electrical heating or heated process streams.

In Parts 2 to 5 only pressure vessels manufactured from steels and steel castings as detailed in Part 2 of this standard are covered. Parts 6, 8, 10, and 11 specifically deal with vessels of spheroidal graphite cast iron, aluminium, nickel, and titanium, respectively, where special considerations apply.

Part 1

EN 13445-1 contains general information on the scope of the standard as well as terms, definitions, quantities, symbols and units which are applied throughout the standard.

Part 2

EN 13445-2 deals with the general philosophy on materials, material grouping and low temperature behaviour. It is limited to steel with sufficient ductility and, for components operating in the creep range, sufficient creep ductility.

Part 2 also provides the general requirements for establishing technical delivery conditions and the requirements for marking of material.

Part 3

EN 13445-3 gives the rules to be used for design and calculation under internal and/or external pressure (as applicable), local loads and actions other than pressure. The rules provided are both design by formula (DBF), design by analysis (DBA) and design by experiment (DBE).

The part also sets the requirements for when fatigue analysis is performed and the rules to be followed when this is the case.

NOTE Collaborative work is in hand to harmonize flange design across European Standards.

Part 4

EN 13445-4 specifies requirements for the manufacture of unfired pressure vessels and their connections to non-pressure parts. It specifies requirements for material traceability, manufacturing tolerances, welding requirements, requirements for permanent joints other than welding, production tests, forming requirements, heat treatment, repairs and finishing operations.

Documents
Document Sharing Hub
Full document details: BS EN 13445-1:2026 Unfired pressure vessels - Part 1: General

Part 5

EN 13445-5 covers all those inspection and testing activities associated with the verification of the pressure vessel for compliance with the standard, including design review by the manufacturer and supporting technical documentation, NDT and other inspection activities including document control, material traceability, joint preparation and welding.

The level of testing is driven by the selection of the vessel testing group. Basically, the testing group determines the level of NDT and the joint coefficient used in the design.

In terms of NDT, the overall philosophy has been the general adoption of EN ISO 5817:2014 quality level 'C' for predominantly non-cyclic loaded vessels and level 'B' for vessels subject to cyclic loadings.

Part 6

EN 13445-6 contains special rules for material, design, fabrication, inspection, and testing of pressure vessels made from spheroidal graphite cast iron. In general the rules in the relevant parts of parts 2–5 apply with additions and exceptions outlined in this part.

Part 7

CEN Technical Report CR 13445-7:2002 has been withdrawn.

Part 8

EN 13445-8 contains special rules for material, design, fabrication, inspection, and testing of pressure vessels made from aluminium and aluminium alloys. In general the rules in the relevant parts of parts 2–5 apply with additions and exceptions outlined in this part.

Part 9

CEN/TR 13445-9 details the conformance of the whole EN 13445 series to ISO 16528-1 "Boilers and pressure vessels — Part 1: Performance requirements". This is a CEN Technical Report. The first edition and second editions are limited to vessels of steel construction, but will be amended later to include spheroidal graphite cast iron, aluminium, nickel and titanium.

Part 10

EN 13445-10 contains special rules for material, design, fabrication, inspection, and testing of pressure vessels made from nickel and nickel alloys. In general, the rules in the relevant parts of parts 2–5 apply with additions and exceptions outlined in this part.

Part 11

EN 13445-11 contains special rules for material, design, fabrication, inspection, and testing of pressure vessels made from titanium and titanium alloys. In general, the rules in the relevant parts of parts 2–5 apply with additions and exceptions outlined in this part.

AVA Documents
Document Sharing Hub

Full document details: BS EN 13445-1:2026 Unfired pressure vessels - Part 1: General

1 Scope

This document defines the terms, definitions, quantities, symbols and units that are used throughout the EN 13445 series and gives general information on the design and manufacturing of vessels under this standard.

It also contains instructions on how to use the standard (Annex A) as well as an index which covers the whole standard (Annex B). This information is aimed to aid users of the EN 13445 series.

This document applies to unfired pressure vessels with a maximum allowable pressure greater than 0,5 bar gauge but may be used for vessels operating at lower pressures, including vacuum.

This document is not applicable to pressure vessels of the following types:

— vessels of riveted construction;

— vessels of lamellar cast iron or any other materials not included in Parts 2, 6, or 8 of the standard;

— multilayered, autofrettaged or pre-stressed vessels.

This document can be applied to the following pressure vessels, provided that account is taken of additional and/or alternative requirements resulting from the hazard analysis and from rules or instructions specific for:

— transportable vessels;

— items specifically designed for nuclear use;

— pressure vessels with a risk of overheating.

NOTE EN 14222 covers electrically fired boilers made from stainless steel and can be used as an example of additional requirements for such vessels.

Other European Standards apply to industrial piping (EN 13480 series) and to water tube and shell boilers (EN 12952 series and EN 12953 series).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 764-1:2015+A1:2016, *Pressure equipment — Part 1: Vocabulary*

EN 764-2:2012, *Pressure equipment — Part 2: Quantities, symbols and units*

EN 13445-2:2026, *Unfired pressure vessels — Part 2: Materials*

EN 13445-3:2026, *Unfired pressure vessels — Part 3: Design*

Documents
Document Sharing Hub
Full document details: BS EN 13445-1:2026 Unfired pressure vessels - Part 1: General

EN 13445-4:2026, *Unfired pressure vessels — Part 4: Fabrication*

EN 13445-5:2026, *Unfired pressure vessels — Part 5: Inspection and testing*

EN 13445-6:2026, *Unfired pressure vessels — Part 6: Requirements for the design and fabrication of pressure vessels and pressure parts constructed from spheroidal graphite cast iron*

EN 13445-8:2026, *Unfired pressure vessels — Part 8: Additional requirements for pressure vessels of aluminium and aluminium alloys*

EN 13445-10:2026, *Unfired pressure vessels — Part 10 Additional requirements for pressure vessels of nickel and nickel alloys*

EN 13445-11:2026, *Unfired pressure vessels — Part 11 Additional requirements for pressure vessels of titanium and titanium alloys*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 764-1:2015+A1:2016, EN 764-2:2012 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

NOTE To aid the user, some of the most important terms and definitions from EN 764-1 have been repeated here.

3.1
assembly
several pieces of pressure equipment assembled by a manufacturer to constitute an integrated and functional whole

3.2
fluid
gas, liquid and vapour in their pure phase as well as mixtures thereof

Note 1 to entry: A fluid may contain a suspension of solids.

3.3
hazard
potential source of harm

3.4
hazard category
category of the pressure vessel taking into account the potential hazards

3.5
joint coefficient
reduction coefficient, which is applied to the nominal design stress

Note 1 to entry: E.g. used for a welded joint and related to the testing group.

Documents
Document Sharing Hub
Full document details: BS EN 13445-1:2026 Unfired pressure vessels - Part 1: General

3.6
main pressure bearing parts
parts which constitute the envelope under pressure, essential for the integrity of the equipment

3.7
manufacturer
individual or organization responsible for the design, fabrication, testing, installation where relevant, and compliance with the requirements of the relevant product standard, whether executed by him or a subcontractor

Note 1 to entry: The manufacturer may subcontract one or more of the above mentioned tasks under its responsibility.

3.8
material manufacturer
individual or organization that produces material in the basic product form used in the manufacture of pressure components

3.9
maximum allowable pressure
PS
maximum pressure for which the pressure vessel is designed as specified by the manufacturer

3.10
maximum allowable temperature
TS_{max}
maximum temperature for which the pressure vessel is designed as specified by the manufacturer

3.11
minimum allowable temperature
TS_{min}
minimum temperature for which the pressure vessel is designed as specified by the manufacturer

3.12
pipelines
piping or system of piping designed for the conveyance of any fluid or substance to or from an installation (onshore or offshore) starting from and including the first isolation device located within the installation and including all the annexed equipment designed specifically for pipelines

3.13
piping
tubing, fittings, expansion joints, hoses or other pressure-bearing components, intended for the transport of fluid, connected together and integrated into a pressure system

3.14
pressure vessel
housing and its direct attachments up to the coupling point connecting it to other equipment, designed and built to contain fluids under pressure

Note 1 to entry: A vessel may be composed of more than one chamber.

Documents
Document Sharing Hub
Full document details: BS EN 13445-1:2026 Unfired pressure vessels - Part 1: General

3.15
required thickness
thickness excluding corrosion or any other allowances specified in the EN 13445 series

Note 1 to entry: The minimum thickness that the component can have in service to fulfil the standard.

3.16
risk
combination of the probability of occurrence of harm and the severity of that harm

3.17
significant hazard
hazard which has been identified as associated with the pressure vessel and which requires specific action by the designer to eliminate or to reduce the risk according to the risk assessment

3.18
testing factor
reduction factor taking into account the amount of NDT testing in castings, applied on the nominal design stress to take account of possible manufacturing deficiencies

3.19
testing group
grouping which determines the appropriate level of non-destructive testing (NDT) on a welded joint

Note 1 to entry: The testing group of a vessel is not linked to the hazard category.

3.20
weldment
weld metal, heat affected zone and adjacent base material(s)

4 Interdependency of the parts of the series

Parts 2 to 6 and parts 8, 10 and 11 of EN 13445, together with Part 1, form a consistent set of specifications which shall be followed for compliance to the standard.

NOTE Part 9 of this series is published as a CEN Technical Report. It is not a European Standard.

5 Quantities, symbols and units

Quantities, symbols and units to be used for pressure equipment shall be in accordance with Tables 5-1 and 5-2 and EN 764-2:2012.

NOTE 1 Other symbols used in specific parts of this document are tabulated in the relevant part.

NOTE 2 The choice of the appropriate multiple (decimal multiple or sub-multiple) of a unit is governed by convenience, the multiple chosen for a particular application being one which leads to numerical values within a practical range. Therefore, when indicating quantities, it is recommended that decimal multiple or sub-multiple quantities are chosen such that the resulting values are easy to handle, e.g. between 0,1 and 1 000. The non-SI units, bar for pressure and L for volume are used on the nameplate.

Documents
Document Sharing Hub
Full document details: BS EN 13445-1:2026 Unfired pressure vessels - Part 1: General

Table 5-1 — Quantities for space and time

Quantity	Symbol	Unit
Time	t	s, min, h
Frequency	f	Hz
Dimension	any Latin letter [a]	mm
Length	l	mm
Thickness	e	mm
Corrosion allowance	c	mm
Diameter	d, D	mm
Radius	r, R	mm
Area	A, S	mm^2
Volume, capacity	V	mm^3 [b c]
Weight	W	N, kN
Density	ρ	kg/mm^3 [d]
Second moment of area	I	mm^4
Section modulus	Z	mm^3
Acceleration	γ	m/s^2
Plane angle	any Greek letter [a]	rad, °

[a] Symbols may use any lower-case letter, except for those defined elsewhere in this table.
[b] volume may also be given in m^3 or L.
[c] litre "L" is a non-SI unit which may be used with SI units and their multiples.
[d] Density may also be given in kg/m^3.

Documents
Document Sharing Hub
Full document details: BS EN 13445-1:2026 Unfired pressure vessels - Part 1: General

Table 5-2 — Mechanical quantities

Quantity [a]	Symbol [b]	Unit
Force	F	N
Moment	M	N·mm
Pressure	p, P	bar [c], MPa
Temperature	T	°C
Linear expansion coefficient	α	µm/m°C
Normal stress	σ	MPa
Shear stress	τ	MPa
Nominal design stress	f	MPa
Tensile strength	R_m	MPa
Yield strength	R_e	MPa
1 % proof strength	$R_{p1.0}$	MPa
Proof strength at temperature T	$R_{p/T}$	MPa
Upper yield strength	R_{eH}	MPa
0,2 % proof strength	$R_{p0,2}$	MPa
0,2 % proof strength at temperature T	$R_{p0,2/T}$	MPa
Ultimate tensile strength at temperature T	$R_{m/T}$	MPa
Modulus of elasticity	E	MPa
Shear modulus	G	MPa
Poisson's ratio	υ	-
Strain	ε	%
Elongation after rupture/fracture	A	%
Impact energy	KV	J
Hardness	HB, HV	-
Joint coefficient	z	-
Safety factor	S	-

[a] Quantities without a temperature index normally refer to room temperature.

[b] Some of these symbols, such as R, f, are not part of ISO 31.

[c] "bar" is a non-SI unit which may be used with SI units and their multiples. The unit bar shall be used on nameplates, certificates, drawings, pressure gauges and instrumentation and is always used as a gauge pressure. This is in line with the requirements of the Pressure Equipment Directive 2014/68/EU.

NOTE The use of symbols for temperature may be different from the PED.

Documents
Document Sharing Hub
Full document details: BS EN 13445-1:2026 Unfired pressure vessels - Part 1: General

6 Risk assessment and handling

6.1 Hazards

Pressure vessels according to this document shall be designed, constructed, installed and equipped under consideration of all significant hazards and risks that can arise when the vessel is erected, tested and operated in accordance with the manufacturer's instructions or else are reasonably foreseeable.

Such hazards shall be analysed by the manufacturer prior to designing the vessel. Apart from normal hazards connected to the operation of the vessel (see EN 13445-3:2026, 5.3), the following hazards shall be considered (as applicable):

— corrosion and chemical attack;

— wear;

— external fire;

— reasonably foreseeable misuse of the vessel.

6.2 Hazard removal and risk reduction

6.2.1 General

As far as practically feasible, the vessel shall be designed as to remove or reduce the respective risk. If removal of a certain hazard is not feasible, the vessel shall be designed and equipped to protect against the respective risk or (as a final measure) information be given on the hazard and what measures are to be taken to reduce the risks from the hazard. Such information shall be given through warning signs and in the operating instructions.

NOTE The procedure to follow is outlined in Figure 6.2–1.

6.2.2 Design considerations

If it is envisaged that safety accessories will have to be fitted to the vessel, the vessel shall be equipped with the necessary connections for such accessories.

NOTE The selection, application and installation of safety related accessories intended to protect pressure vessels during operation are covered in EN 764-7:2002.

Documents
Document Sharing Hub
Full document details: BS EN 13445-1:2026 Unfired pressure vessels - Part 1: General

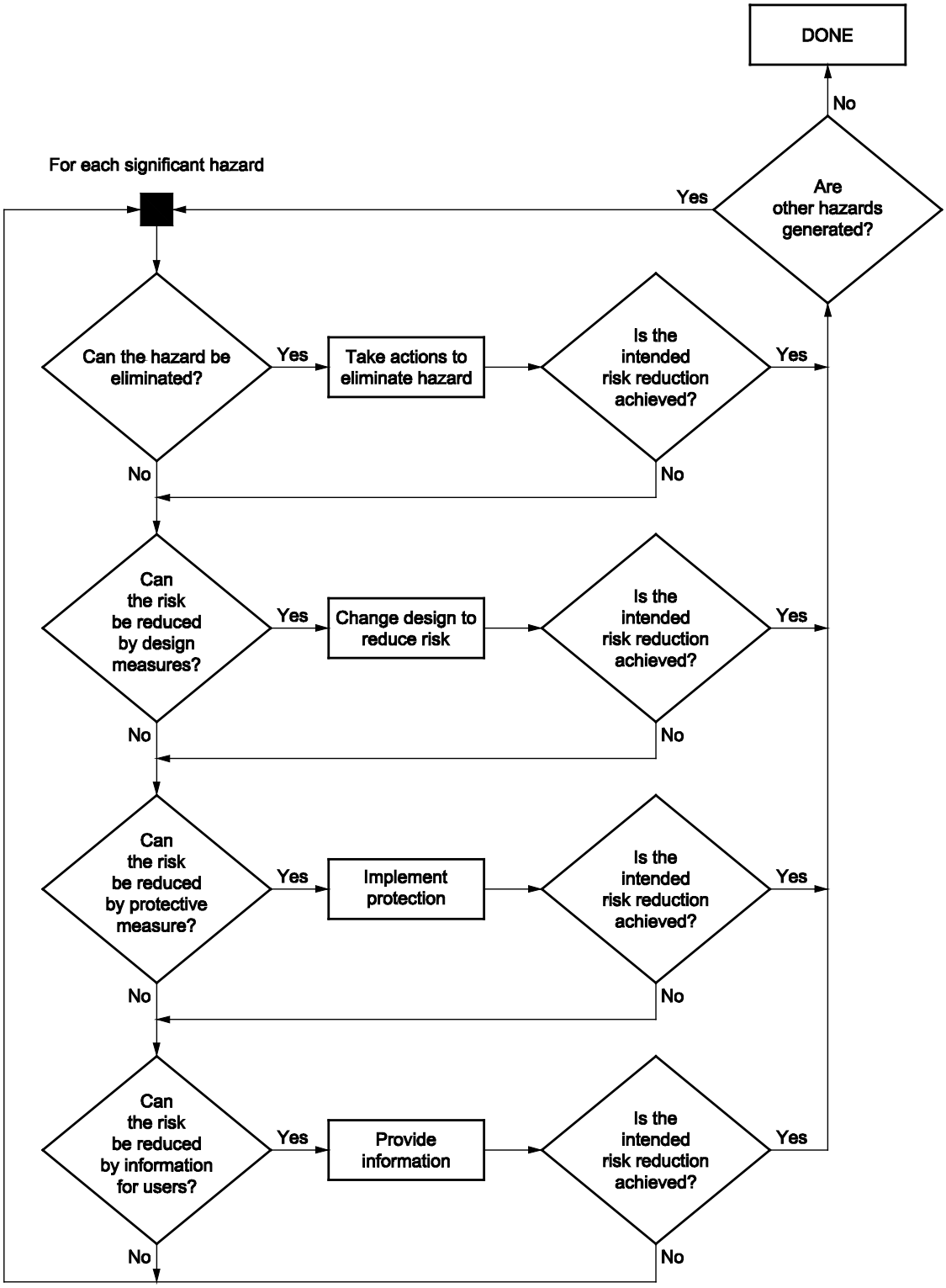


Figure 6.2-1 — Hazard consideration

Documents
Document Sharing Hub

Full document details: BS EN 13445-1:2026 Unfired pressure vessels - Part 1: General

Annex A
(informative)

Using the standard

A.1 Purpose

This annex is designed to facilitate the introduction to the use of the standard.

This annex only gives a general overview of the requirements of the standard. Reference shall always be made to the standard text itself, and not all requirements are necessarily mentioned in this annex.

A.2 General

The standard is harmonized under the Pressure Equipment Directive (2014/68/EU). This means that if an unfired pressure vessel meets the requirements of the standard, this pressure vessel can be presumed to conform to those essential safety requirements in Annex I of the Directive which are listed in the Annexes ZA of the individual parts of the standard.

NOTE 1 A compilation of all Annexes ZA can be found as Annex X of this Part 1.

In this connection, it should be understood that the standard is indivisible. The design and manufacture of unfired pressure vessels requires the application of all relevant Parts of the standard for the requirements of the standard to be fulfilled.

NOTE 2 Part 9 is not a mandatory part of the standard in this sense.

This standard applies to unfired pressure vessels with the limitations and exclusions stated in Clause 1 of this Part 1.

A.3 Prerequisites

Prior to designing and manufacturing a pressure vessel under the standard, the manufacturer shall establish a number of prerequisites:

— The conditions under which the vessel will be operating.

— Load cases to be considered are enumerated in EN 13445-3:2026, 5.3.1 to 5.3.2 and also in clause 6 of this Part 1.

— The category of the vessel (I to IV) as defined in the Directive.

NOTE 1 The category determines the type of inspection document required for the materials of the main pressure-bearing parts, as stated in Annex I, section 4.3 of the Directive (Inspection Documents are defined in EN 10204:2004). The category can also influence performance of welding, NDT qualification and particular material appraisals (see A.4.2).

Documents
Document Sharing Hub
Full document details: BS EN 13445-1:2026 Unfired pressure vessels - Part 1: General

— The assessment module (as defined in the directive) to be used.

The choice of module can affect the participation of a notified body and/or a recognized third party organization or user inspectorate in the inspection and testing of the vessel (It should be noted that the use of user inspectorates is not necessarily permitted in all member states).

— The testing group of the vessel according to EN 13445-5:2026, 6.6.1.2. The available testing groups depend upon the material group, thickness, and welding method. Testing Group 4 is further limited with regards to pressure, temperature, content, number of cycles, and dimensions.

Although the same testing group normally applies to the whole vessel, it is (with the exception of Group 4) permissible to have different testing groups apply to different parts (e.g., welds).

NOTE 2 The testing group affects not only the testing requirements but also design and manufacturing aspects, e.g. joint coefficient, permitted weld details and required weld production tests.

A.4 Materials

A.4.1 General

Specific requirements for steels are given in Part 2.

Specific rules for spheroidal graphite cast iron, aluminium, nickel/nickel alloys, and titanium/titanium alloys are given in EN 13445-6:2026 (see A.8 in this annex), EN 13445-8:2026 (see A.9 in this annex), EN 13445-10:2026 (see A.10 in this annex), and EN 13445-11:2026 (see A.11 in this annex) respectively. In some instances, references are made from these parts to EN 13445-2:2026.

A.4.2 Permitted materials

Only materials which are qualified for pressure equipment may be used. Qualification of materials can be made in three different ways

— Materials from European harmonized standards, see EN 13445-2:2026, 4.3.1.

Certain materials supplied in accordance with European material Standards are accepted as qualified for use in pressure-bearing parts. These materials are enumerated in EN 13445-2:2026, Table E.2-1.

— Materials with a European Approval for Materials (EAM), see EN 13445-2:2026, 4.3.2.

Materials with an EAM, which states that they can be used for products under the PED, are qualified for use in relevant products according to this standard.

EAMs are published in the Official Journal, and the European Commission maintains a list of EAMs on its web site.

— Materials with a Particular Material Appraisal (PMA), see EN 13445-2:2026, 4.3.3.

Materials, which have been subject to a PMA are qualified. This appraisal is carried out by the manufacturer (and in certain cases checked by a Notified Body).

NOTE The European Commission and Member States have in November 2006 agreed on ”Guiding Principles for the contents of Particular Materials Appraisals". This document is published on:
https://ec.europa.eu/docsroom/documents/10642?locale=en

Documents
Document Sharing Hub
Full document details: BS EN 13445-1:2026 Unfired pressure vessels - Part 1: General

Whichever method of qualification is used, the qualification does not necessarily cover the suitability of the material with regards to the environment and content of the vessel, i.e. corrosion, erosion, etc. The manufacturer will always have to evaluate the material's resistance to such action.

Whichever way the material has been qualified, all other rules in Part 2 will have to be fulfilled.

A.4.3 Prevention of brittle fracture

Rules for prevention against brittle fracture are given in EN 13445-2:2026, Annex B.

Three different routes are allowed:

— Code of practice (EN 13445-2:2026, B.2.2).

— More flexible approach based on fracture mechanics and operating experience (EN 13445-2:2026, B.2.3).

— Application of fracture mechanics analysis (EN 13445-2:2026, B.2.4).

The first two methods are limited to certain materials and thicknesses.

The third method requires detailed work in fracture mechanics, and the standard only contains guidance on it. It may only be used after agreement between the concerned parties.

A.4.4 Material grouping

Materials are grouped in EN 13445-2:2026, Table A-1 with respect to major chemical elements, specified minimum tensile test data. This grouping is used throughout the standard to decide design, manufacturing, and inspection aspects.

A.5 Design

A.5.1 General

Most of the requirements for design are to be found in EN 13445-3.

NOTE Specific design rules for vessels manufactured from spheroidal graphite cast iron, aluminium, nickel/nickel alloys, and titanium/titanium alloys are given in EN 13445-6:2026 (see A.8 in this annex), EN 13445-8:2026 (see A.9 in this annex), EN 13445-10:2026 (see A.10 in this annex), and EN 13445-11:2026 (see A.11 in this annex), respectively.

A.5.2 Design for static loads

There are four different methods for design, which may be used either separately or in combination with each other

— Design by formula (DBF)

These rules are contained in EN 13445-3:2026, Clauses 7 to 16, 20 to 22 and Annexes F, G and J.

For simple geometries such as cylinders and spheres, formulae can be given where pressure and geometrical dimensions give the required minimum thicknesses directly.

AVA Documents
Document Sharing Hub
Full document details: BS EN 13445-1:2026 Unfired pressure vessels - Part 1: General

For more complicated geometries, a trial-and-error approach shall be used in most cases. The designer will have to assume the analysis thickness(e_a), and use the formulae to compute the stresses and/or the load ratios as applicable. These stresses and/or load ratios are then compared with allowable values. EN 13445-3:2026, Figure 5-1 shows the relations between different thickness definitions.

In the design formulae of components having a governing weld, the weakening effect of that weld is accounted for by means of a joint coefficient *z*. The maximum allowed value of this coefficient depends upon the testing group of the weld as specified in EN 13445-3:2026, Table 5.6-1 and EN 13445-5:2026, Table 6.6.1-1.

NOTE Governing welds are defined in EN 13445-3:2026, 5.6.

For two types of components, flange connections and heat exchanger tubesheets, multiple sets of rules are given (in EN 13445-3:2026, Clause 11, Annex G, and in EN 13445-3:2026, Clause 13 and Annex J, respectively). The alternative rules of EN 13445-3:2026, Annexes G and J are based on more advanced methods than their corresponding main clause, and are expected to lead to more appropriate and less conservative designs. Either set can be used at the designer's option within the limitations given for each set.

- Annex G is recommended for the design of flange connections where the flanges are subject to strong leak-tightness requirements, significant thermal cycling, and/or significant additional loads (forces or moments). It implies that the bolt stress is controlled by the use of a defined tightening procedure.

- Annex J is recommended for the design of heat exchanger tubesheets subject to relatively low cyclic loading.

— Design by analysis using direct assessment of failure modes (DBA - Direct Route)

These rules are contained in EN 13445-3:2026, Annex B.

For each failure mode a specific assessment method is provided (e.g. limit analysis for assessment of gross plastic deformation, shakedown analysis for progressive deformation).

— Design by analysis using stress categorization (DBA – Method based on stress categories)

These rules are contained in EN 13445-3:2026, Annex C.

Stresses shall be computed (in most cases using finite element methods) and divided into different categories. The stresses in each category are then compared to allowable values for the respective category.

— Design by experiment (DBE)

These rules are contained in EN 13445-3:2026, Annex T.

Design by experiment always includes a burst test and may be supplemented by control of deformation and a fatigue test. It can either be used separately (with limitations given in EN 13445-3:2026, T.4.1) or as a verification of DBF or DBA calculations.

DBF is the most common and simple way to design vessels. All DBF rules cover pressure. Some kinds of non-pressure loads can be taken into account through use of EN 13445-3:2026, Clauses 16 and 22.

AVA Documents
Document Sharing Hub

Full document details: BS EN 13445-1:2026 Unfired pressure vessels - Part 1: General