



**SLOVENSKI STANDARD**  
**SIST EN 13445-1:2014/A2:2018**  
**01-maj-2018**

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**Neogrevane (nekurjene) tlačne posode - 1. del: Splošno - Dopolnilo A2**

Unfired pressure vessels - Part 1: General

Unbefeuerte Druckbehälter - Teil 1: Allgemeines

Réipients sous pression non soumis à la flamme - Partie 1 : généralités

**Ta slovenski standard je istoveten z: EN 13445-1:2014/A2:2018**

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**ICS:**

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EUROPEAN STANDARD

EN 13445-1:2014/A2

NORME EUROPÉENNE

EUROPÄISCHE NORM

March 2018

ICS 23.020.30

English Version

## Unfired pressure vessels - Part 1: General

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

Unbefeuerte Druckbehälter - Teil 1: Allgemeines

This amendment A2 modifies the European Standard EN 13445-1:2014; it was approved by CEN on 25 November 2017.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for inclusion of this amendment into the relevant 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 amendment 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.

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

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## European foreword

This document (EN 13445-1:2014/A2:2018) 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of an identical text or by endorsement, at the latest by September 2018, and conflicting national standards shall be withdrawn at the latest by September 2018.

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 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 2014/68/EU.

For relationship with EU Directive 2014/68/EU, see informative Annex ZA, which is an integral part of this document.

According to the CEN-CENELEC Internal Regulations, the national standards organisations 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, Turkey and the United Kingdom. (standards.iteh.ai)

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**EN 13445-1:2014/A2:2018 (E)****1 Modification to Clauses 1 to 3 (Scope, Normative references and Terms and definitions)**

Replace Clauses 1 to 3 with the following text [the former NOTE after the 2<sup>nd</sup> paragraph was inserted into Clause 6]:

“

**1 Scope**

This European Standard 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 European Standard 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 European Standard 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 European standard 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 13445-2:2014, *Unfired pressure vessels — Part 2: Materials*

EN 13445-3:2014, *Unfired pressure vessels — Part 3: Design*

EN 13445-4:2014, *Unfired pressure vessels — Part 4: Fabrication*

EN 13445-5:2014, *Unfired pressure vessels — Part 5: Inspection and testing*

EN 13445-6:2014, *Unfired pressure vessels — Part 6: Requirements for the design and fabrication of pressure vessels and pressure parts constructed from spheroidal graphite cast iron*

EN 13445-8:2014, *Unfired pressure vessels — Part 8: Additional requirements for pressure vessels of aluminium and aluminium 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.

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.

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#### 3.3

##### **hazard**

potential source of harm

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#### 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.

#### 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 can subcontract one or more of the above mentioned tasks under its responsibility.

**EN 13445-1:2014/A2:2018 (E)****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.

**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)

”

**2 Addition of new Clause 6**

Add the following new Clause 6:

“

**6 Risk assessment and handling****6.1 Hazards**

Pressure vessels according to this European Standard shall be designed, constructed, installed and equipped under consideration of all significant hazards and risks that may 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 13445-3:2014, 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.

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## 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.

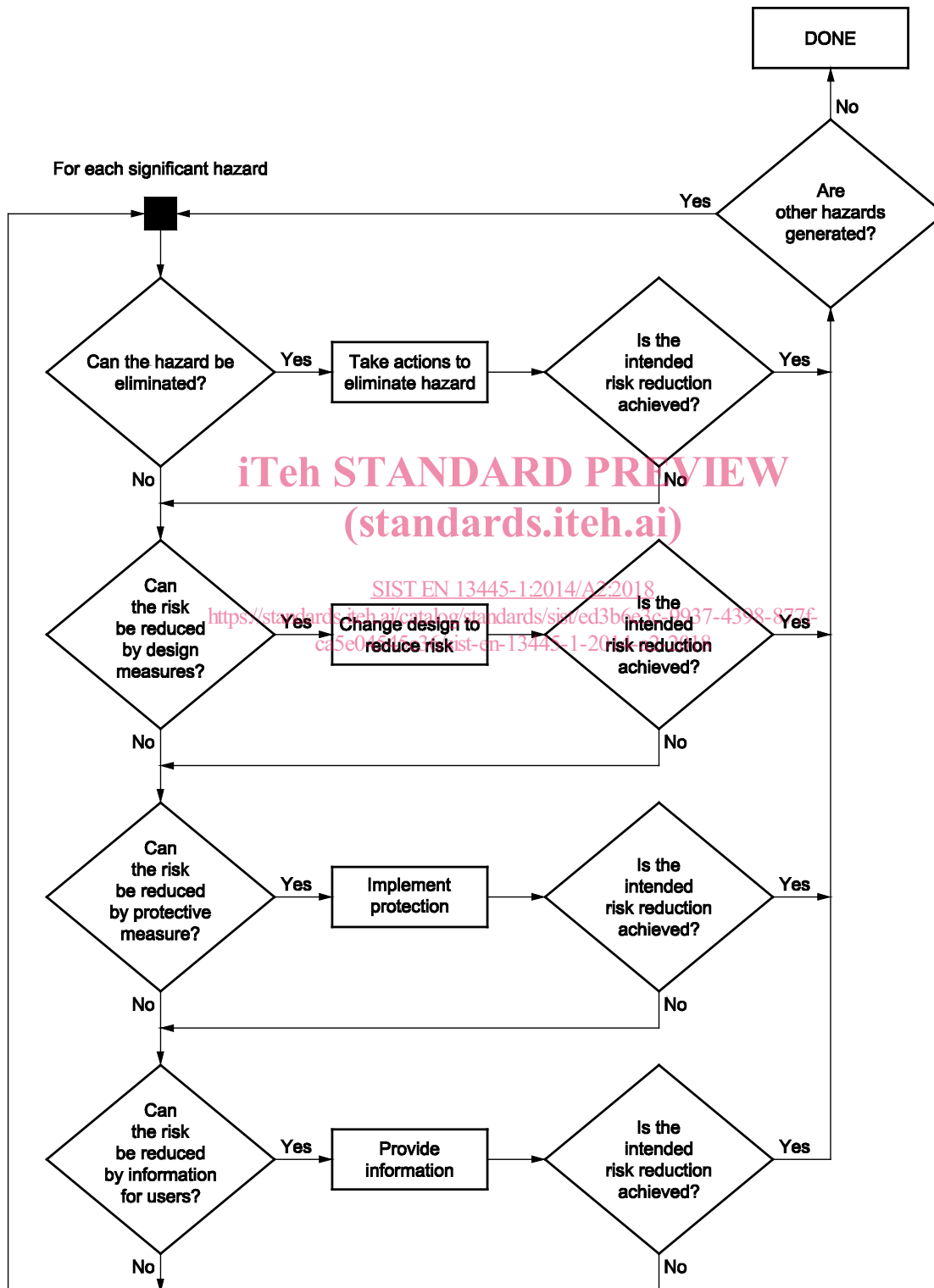


Figure 6.2-1 — Hazard consideration

”

### 3 Modification to Annex A

*Replace the current Annex A with the following:*

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**EN 13445-1:2014/A2:2018 (E)**

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**Annex A**  
(informative)**Using the standard****A.1 Purpose**

The EN 13445 series is a standard which in many places uses other design, fabrication, inspection, and testing philosophies than other pressure vessel standards. 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. Only in the case that the standard gives no information to specific parts of pressure vessels other standards may be used exceptionally. In such a case, special attention should be paid to ensure that application of such other standard(s) is made consistent with the safety philosophy and the general safety requirements of EN 13445 (i.e. same nominal design stresses, same safety margins, etc.).

NOTE 2 Part 7 and Part 9 are not mandatory parts 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 13445-3:2014, 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 Directive CR 13445-7:2002, 4.2 and CR 13445-7:2002, Annex A shows how the category of a vessel is to be established.

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 may also influence how particular material appraisals (see A.4.2) are to be performed.

- The assessment module (as defined in the Directive) to be used. CR 13445-7:2002, 4.3 and CR 13445-7:2002, Annex B describe the different assessment modules and which assessment modules can be used for the different categories.

The choice of module may 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 as enumerated in CR 13445-7:2002, Annex C. (It should be noted that the use of user inspectorates may not be permitted in all member states).

- The testing group of the vessel according to EN 13445-5:2014, 6.6.1.2. The available testing groups depend upon the material group, thickness, and welding method. Category 4 is further limited with regards to pressure, temperature, content, number of cycles, design stress, and dimensions.

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.

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).

## A.4 Materials

### A.4.1 General

Specific requirements for steels are given in Part 2.

Specific rules for spheroidal graphite cast iron, aluminium, and nickel/nickel alloys are given in EN 13445-6:2014 (see A.8 in this annex), EN 13445-8:2014 (see A.9 in this annex), and EN 13445-10:2015 (see A.10 in this annex), respectively. In some instances, references may be made from these parts to EN 13445-2:2014.

### 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 13445-2:2014, 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 13445-2:2014, Table E.2-1.

- Materials with a European Approval for Materials (EAM), see EN 13445-2:2014, 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 there.

- Materials with a Particular Material Appraisal (PMA), see EN 13445-2:2014, 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". The document is published on [https://ec.europa.eu/commission/index\\_en](https://ec.europa.eu/commission/index_en) (Search for Particular Materials Appraisal).

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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 13445-2:2014, Annex B.

Three different routes are allowed:

- Code of practice (EN 13445-2:2014, B.2.2).
- More flexible approach based on fracture mechanics and operating experience (EN 13445-2:2014, B.2.3).
- Application of fracture mechanics analysis (EN 13445-2:2014, B.2.4).

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

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

**A.4.4 Material grouping**

Materials are grouped in EN 13445-2:2014, 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. (standards.iteh.ai)

**A.5 Design**

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**A.5.1 General**

Most of the requirements for design are to be found in Part 3.

NOTE Specific design rules for vessels manufactured from spheroidal graphite cast iron, aluminium, and nickel/nickel alloys are given in EN 13445-6:2014 (see A.8 in this annex), EN 13445-8:2014 (see A.9 in this annex), and EN 13445-10:2015 (see A.10 in this annex), respectively.

**A.5.2 Design for static loads**

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

- Design by formulas (DBF).

These rules are contained in EN 13445-3:2014, Clauses 7 to 16, 20 to 22 and Annexes F, G, GA and J.

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

For more complicated geometries, a trial-and-error approach shall be used in most cases. The designer will have to assume the analysis thickness(es), and use the formulas to compute the stresses and/or the load ratios as applicable. These stresses and/or load ratios are then compared with allowable values. EN 13445-3:2014, Figure 5-1 shows the relations between different thickness definitions.

In the design formulas 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 13445-3:2014, Table 5.6-1 and EN 13445-5:2014, Table 6.6.1-1.

NOTE Governing welds are listed in EN 13445-3:2014, 5.6.

For two types of components, flange connections and heat exchanger tubesheets, multiple sets of rules are given (in EN 13445-3:2014, Clause 11, Annex G, and Annex GA, and in EN 13445-3:2014, Clause 13 and Annex J, respectively). The alternative rules of EN 13445-3:2014, Annexes G, GA 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 GA is a further development of Annex G. It may be used particularly for flange connections in vessels containing gases or vapours, for which it is necessary to fix a maximum allowable leak rate.

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 13445-3:2014, Annex B.

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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 13445-3:2014, 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 13445-3:2014, 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 13445-3:2014, 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 13445-3:2014, Clauses 16 and 22.

DBA is used to assess structural shapes and load configurations not covered by DBF. It may also be used as an alternative to DBF. Between the two possible DBA routes, that in EN 13445-3:2014, Annex B is expected to be less conservative or more realistic than that in EN 13445-3:2014, Annex C, as being based on more advanced methods.