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Unfired pressure vessels - Part 4: Fabrication

Unbefeuerte Druckbehälter - Teil 4: Herstellung

Récipients sous pression non soumis à la flamme - Partie 4 : Fabrication

Ta slovenski standard je istoveten z: EN 13445-4:2026

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Réceptacles sous pression non soumis à la flamme -
Partie 4 : Fabrication

Unbefeuerte Druckbehälter - Teil 4: Herstellung

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European foreword

This document (EN 13445-4:2026) 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of an identical text or by endorsement, at the latest by December 2026, and conflicting national standards shall be withdrawn at the latest by December 2026.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 13445-4:2021+A1:2023.

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, 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 the United Kingdom.

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1 Scope

This document specifies requirements for the manufacture of unfired pressure vessels and their parts, made of steels, including 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.

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 13134:2000, *Brazing — Procedure approval*

EN 13445-1:2026, *Unfired pressure vessels — Part 1: General*

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

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

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

EN 14276-1:2020, *Pressure equipment for refrigerating systems and heat pumps — Part 1: Vessels — General requirements*

EN ISO 3834-2:2021, *Quality requirements for fusion welding of metallic materials — Part 2: Comprehensive quality requirements (ISO 3834-2:2021)*

EN ISO 3834-3:2021, *Quality requirements for fusion welding of metallic materials — Part 3: Standard quality requirements (ISO 3834-3:2021)*

EN ISO 4136:2012, *Destructive tests on welds in metallic materials — Transverse tensile test (ISO 4136:2012)*

EN ISO 5173:2010, *Destructive tests on welds in metallic materials — Bend tests (ISO 5173:2009)*

EN ISO 5178:2019, *Destructive tests on welds in metallic materials — Longitudinal tensile test on weld metal in fusion welded joints (ISO 5178:2019)*

EN ISO 9015-1:2011, *Destructive tests on welds in metallic materials — Hardness testing — Part 1: Hardness test on arc welded joints (ISO 9015-1:2001)*

EN ISO 9016:2022, *Destructive tests on welds in metallic materials — Impact tests — Test specimen location, notch orientation and examination (ISO 9016:2022)*

EN ISO 9606-1:2017, *Qualification testing of welders — Fusion welding — Part 1: Steels (ISO 9606 - 1:2012 including Cor 1:2012 and Cor 2:2013)*

EN ISO 13585:2012, *Brazing — Qualification test of brazers and brazing operators (ISO 13585:2012)*

EN ISO 14732:2013, *Welding personnel — Qualification testing of welding operators and weld setters for mechanized and automatic welding of metallic materials (ISO 14732:2013)*

EN ISO 15609-1:2019, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 1: Arc welding (ISO 15609-1:2019)*

EN ISO 15611:2003, *Specification and qualification of welding procedures for metallic materials — Qualification based on previous welding experience (ISO 15611:2003)*

EN ISO 15612:2018, *Specification and qualification of welding procedures for metallic materials — Qualification by adoption of a standard welding procedure (ISO 15612:2018)*

EN ISO 15613:2004, *Specification and qualification of welding procedures for metallic materials — Qualification based on pre-production welding test (ISO 15613:2004)*

EN ISO 15614-1:2017, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys (ISO 15614-1:2017, Corrected version 2017-10-01)*

EN ISO 17639:2022, *Destructive tests on welds in metallic materials — Macroscopic and microscopic examination of welds (ISO 17639:2022)*

3 Terms and definitions

No terms and definitions are listed in this document.

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>

4 Requirements for manufacturing and subcontracting

4.1 Manufacturing

The general responsibilities of the pressure vessel manufacturer are stated in EN 13445-1:2026. Additionally to those requirements, the manufacturer shall ensure that:

- a) the organization for the control of manufacturing operations which includes special processes such as welding, forming and heat treatment shall be clearly defined by the manufacturer;
- b) the manufacturing procedures such as welding, forming and heat treatment are adequate for the purpose and the pressure vessel meets the requirements of this standard. Where specific requirements are associated with materials these shall be taken into account, e.g. EAMs;
- c) the manufacturing equipment is adequate for fabrication;
- d) the staff is adequate for the assigned tasks;

NOTE As far as welding co-ordination is concerned, the qualifications, tasks and responsibilities can be defined by the manufacturer in accordance with EN ISO 14731:2019 [1] in the job assignment.

- e) the quality requirements for welding defined in EN ISO 3834-3:2021 are met as a minimum.

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4.2 Subcontracting

The manufacturer may subcontract work, but shall ensure that the subcontractor carries out the work in accordance with the requirements of this document. The manufacturer is responsible for the adequate definition of the subcontracted task and the need for any associated records.

On all occasions that the subcontractor work includes:

- a) welding;
- b) forming including associated heat treatment;
- c) post weld heat treatment;
- d) non-destructive testing of welds (see EN 13445-5:2026);
- e) the manufacturer shall obtain a subcontractor form (see Annex B).

Where welding operations are subcontracted, the manufacturer shall also either obtain copies of the welding procedure and welding operator qualification records or take other action to ensure that they comply with this standard.

In discharging his responsibility to ensure that the subcontractor carries out the work in accordance with this standard the manufacturer shall ensure that surveillance of the subcontracted work is performed.

Where a manufacturer is producing equipment that requires the intervention of a responsible authority, the manufacturer should inform the responsible authority of his intention to subcontract so that the responsible authority has the opportunity to take part in the subcontractor surveillance.

NOTE See also EN 764-3:2002, 2.11 [2] and CR 13445-7:2002.

When the manufacturer is producing equipment based on quality assurance, the controls a manufacturer applies over subcontractors should be described in his approved quality system.

5 Materials

5.1 General

Materials for pressure vessels and the grouping of materials for pressure vessels shall be in accordance with EN 13445-2:2026.

The grouping applies regardless of product form, i.e. plate, forging, piping.

5.2 Material traceability

5.2.1 General

The vessel manufacturer shall have and maintain an identification system for materials used in fabrication, so that all material subject to stress due to pressure and those welded thereto in the completed work can be traced to its origin. This includes the use of welding consumables.

5.2.2 Identification system

5.2.2.1 The vessel manufacturer's identification system shall assure that all materials to be used in the vessel have been subjected to and satisfactorily passed the following:

- a) examination of material before fabrication for the purpose of detecting, as far as possible, imperfections which would affect the safety of the work;
- b) check of material to determine that it has the required thickness;
- c) check of the material to assure that the materials are permitted by this document, fully traceable to the correct material certification and as specified in the design documentation;
- d) check of the welding consumables to assure the correct markings and that correct conditions are maintained to prevent deterioration.

5.2.2.2 Material traceability to the original identification markings shall be by one or more of the following methods:

- a) accurate transfer of the original identification markings to a location where the markings will be visible on the completed vessel;
- b) identification by a coded marking traceable to the original required marking;
- c) recording the identification markings using material lists or as built sketches which assure identification of each piece of material during fabrication and subsequent identification in the completed vessel;
- d) the EN- or EN-ISO-designation or brand name of the welding consumables shall be recorded.

5.2.3 Visibility

Materials which cannot be stamped or which will not be visible after the vessel is completed or for small multiple parts or non pressure parts the manufacturer may operate a documented system which ensures material traceability for all materials in the completed vessel.

5.2.4 Review of material certification and material identification

All material certification shall be reviewed upon receipt. The review shall cover the completeness and adequacy of the reports against the following:

- a) mechanical and chemical properties required to be reported by the material specification;
- b) assuring that the reported results meet the requirements of the specification;
- c) all markings required by the material specification are satisfied and that there is traceability between the actual markings and those recorded on the material certification.

All materials certification shall be made readily available throughout manufacture.

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5.2.5 Transfer of markings

In case the original identification markings are unavoidably cut out or the material is divided into two or more pieces the markings shall be accurately transferred by the manufacturer's nominated personnel prior to cutting.

The actual material marking shall be by methods which are not harmful to the material in subsequent use/operation.

The transfer of markings shall take place before partitioning of the product and after verification of the marks present with the corresponding certification.

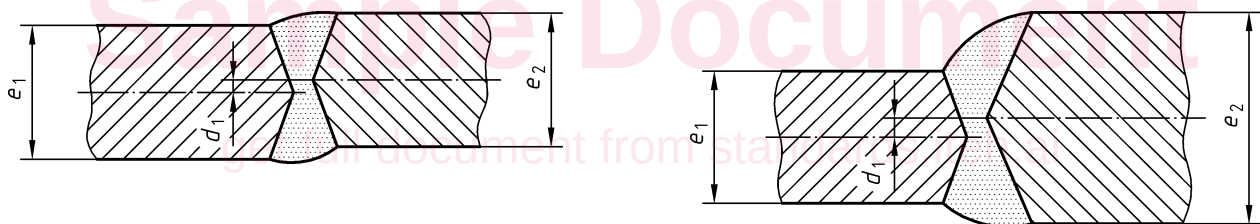
6 Manufacturing tolerances

6.1 Surface geometry of welds

The surface geometry of welded butt and fillet joints shall meet the requirements of EN 13445-5:2026, 5.3 and 6.6, unless the drawing specifies more stringent requirements.

6.2 Middle line alignment

The misalignment tolerances of middle lines shall be as specified in Tables 6.2-1, 6.2-2, 6.2-3 and Figure 6.2-1.



a) Middle line alignment d_1 at equal thickness $e_1 = e_2$ b) Middle line alignment d_1 at different thickness $e_1 \leq e_2$

Figure 6.2-1 — Middle line alignment d_1

For longitudinal welds in cylinders, cones and rectangular/prismatic structures the middle lines of adjacent components (whether of equal or different thickness) shall be aligned within the tolerances specified in Table 6.2-1.

Table 6.2-1 — Offset of middle lines for longitudinal welds in cylinders, cones and rectangular/prismatic structures

Dimensions in millimetres

Thinner part thickness e_1	Maximum misalignment d_1
$e_1 \leq 2$	0,5
$2 < e_1 \leq 4$	$e_1/4$
$4 < e_1 \leq 10$	1
$10 < e_1 \leq 30$	$e_1/10$
$30 < e_1 \leq 60$	$e_1/30 + 2$
$60 < e_1$	4

For longitudinal welds in dished ends and welds in spherical components the middle lines of adjacent parts (whether of equal or different thickness) shall be aligned within the tolerances specified in Table 6.2-2.

Table 6.2-2 — Offset of middle lines for longitudinal welds in dished ends and in spherical components of adjacent parts

Dimensions in millimetres

Thinner part thickness e_1	Maximum misalignment d_1
$e_1 \leq 2$	0,5
$2 < e_1 \leq 4$	$e_1/4$
$4 < e_1 \leq 10$	1
$10 < e_1 \leq 30$	$e_1/10$
$30 < e_1 \leq 120$	$e_1/30 + 2$
$120 < e_1$	6

For circumferential welds the middle lines of adjacent parts (whether of equal or different thickness) shall be aligned within the tolerances specified in Table 6.2-3.

Table 6.2-3 — Offset of middle lines of circumferential welds of adjacent parts

Dimensions in millimetres

Thinner part thickness e_1	Maximum misalignment d_1
$e_1 \leq 30$	$e_1/10 + 1$
$30 < e_1 \leq 150$	$e_1/30 + 3$
$150 < e_1$	8

EN 13445-4:2026 (E)**6.3 Surface alignment****6.3.1 Surface misalignment between parts**

Where there is misalignment at the surface between parts of the same nominal thickness the transition across the weld shall be smooth and gradual with a slope of 1 in 4 over the width of the weld. If this taper cannot be accommodated within the weld width it is permissible to either:

- a) grind the higher plate surface, where this will not reduce the joint thickness at any point below the nominal specified plate thickness minus the plate thickness tolerance;
- b) build up the lower plate surface with added weld metal.

6.3.2 Joining of parts of different thickness

Where different thickness are being joined a taper shall be produced in accordance with EN 13445-3:2026 by either:

- a) taper the thicker plate in accordance with the design drawing and then applying the requirements above for the same nominal thickness parts; or
- b) obtain the required slope across the width of the welds, or by a combination of weld build up on the lower surface with added weld metal and thereafter obtain the required slope across the weld width.

6.4 Tolerances for vessels subjected to internal pressure**6.4.1 External diameter**

For cylindrical and spherical pressure vessels the mean external diameter derived from the circumference shall not deviate by more than 1,5 % from the specified external diameter.

For rectangular vessels and/or prismatic structures each external dimension shall not deviate by more than 1,5 % from the specified external dimension.

6.4.2 Out of roundness

Out of roundness (O) shall be calculated in accordance with the following Formula (6.4-1):

$$O [\%] = \frac{2 \cdot (D_{\max} - D_{\min})}{D_{\max} + D_{\min}} \cdot 100 \quad (6.4-1)$$

It shall not exceed the following values:

- a) 1,5 % for the ratio of $e/D < 0,01$;
- b) 1,0 % for the ratio of $e/D \geq 0,01$.

NOTE The determination of the out of roundness need not consider the elastic deformation due to the deadweight of the pressure vessel.

Irregularities in vessel profile (e.g. dents, buckling, flats on nozzle positions) shall be also within the tolerances in a) and b). A greater out of roundness may be acceptable provided they have been proven admissible by calculation or strain gauge measurements.

6.4.3 Deviation from the longitudinal axis

The deviation from the longitudinal axis over the length of the cylindrical portion of the pressure vessel shall not exceed 0,5 % of the length of the shell.

6.4.4 Irregularities in profile

a) Local irregularities in vessel profile

Irregularities in profile (e.g. dents, buckling, flats on nozzle positions) shall be smooth and the depth shall be checked by a 20° gauge and shall not exceed the following values:

- 1) 2 % of the gauge length; or
- 2) 2,5 % of the gauge length provided that the length of the irregularities does not exceed one quarter of the length (with a maximum of 1 m) of the shell part between two circumferential joints.

Greater irregularities require proof by calculation or strain gauge measurement that the stresses are permissible.

b) Peaking on longitudinal butt welds

When irregularity in the profile occurs at the welded joint and is associated with "flats" adjacent to the weld, the irregularity in profile or (peaking) shall not exceed the values given in Tables 6.4-1 and 6.4-2.

Measurement for peaking shall be made by means of a 20° profile gauge (or template), see Figure 6.4-1, or other types of gauge such as a bridge gauges or needle gauges.

For outwards peaking two readings shall be taken, P_1 and P_2 on each side of the joint, at any particular location, the maximum peaking is determined using Formula (6.4-2)

$$P = 0,25 \cdot (P_1 + P_2) \quad (6.4-2)$$

The inwards peaking P shall be measured.

The inside radius of the gauge shall be equal to the nominal outside radius of the vessel.