BS EN 13445-5:2026

BSI Standards Publication

Unfired pressure vessels

Part 5: Inspection and testing



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Full document details: BS EN 13445-5:2026 Unfired pressure vessels Part 5: Inspection and testing

National foreword

This British Standard is the UK implementation of EN 13445-5:2026. It supersedes BS EN 13445-5:2021+A1:2024, which is withdrawn.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.

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

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Published by BSI Standards Limited 2026

ISBN 978 0 539 42117 0

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ICS 23.020; 23.020.30; 23.020.35

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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

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 13445-5

July 2026

ICS 23.020.30

Supersedes EN 13445-5:2021+A1:2024

English Version

Unfired pressure vessels - Part 5: Inspection and testing

Récipients sous pression non soumis à la flamme - Partie 5: Inspection et contrôle

Unbefeuerte Druckbehälter - Teil 5: Inspektion und Prüfung

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

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Ref. No. EN 13445-5:2026 E

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European foreword

This document (EN 13445-5:2026) 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of an identical text or by endorsement, at the latest by December 2026, and conflicting national standards shall be withdrawn at the latest by December 2026.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 13445-5:2021+A1:2024.

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.

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1 Scope

This Part of this document specifies the inspection and testing of individual and serially produced pressure vessels made of steels in accordance with EN 13445-2:2026.

Special provisions for cyclic operation are given in Annex G of this Part.

Special provisions for vessels or vessel parts working in the creep range are given in Annex F and Annex I of this Part.

NOTE The responsibilities of parties involved in the conformity assessment procedures are given in the European legislation on pressure equipment. Guidance on this can be found in CR 13445-7.

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.

CEN/TR 764-6:2012, *Pressure equipment — Part 6: Structure and content of operating instructions*

EN 1779:1999, EN 1779:1999/A1:2003, *Non-destructive testing — Leak testing — Criteria for method and technique selection*

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

EN ISO 5817:2014, *Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) – Quality levels for imperfections (ISO 5817:2014)*

EN ISO 6520-1:2007, *Welding and allied processes — Classification of geometric imperfections in metallic materials — Part 1: Fusion welding (ISO 6520-1:2007)*

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 9712:2022, *Non-destructive testing — Qualification and certification of NDT personnel (ISO 9712:2021)*

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 17635:2016, *Non-destructive testing of welds — General rules for metallic materials (ISO 17635:2016)*

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3 Terms and definitions

For the purposes of this document, the following terms and definitions 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/

3.1
design review
procedure by which a manufacturer ascertains and declares that the design meets the requirements of this standard

3.2
design approval
procedure by which a responsible authority ascertains that the design meets the requirements of this standard

3.3
testing group
grouping which determines the appropriate level of non-destructive testing (NDT) on a welded joint

Note 1 to entry: There are four testing groups.

3.4
inspection
survey activity which assesses the compliance of the pressure vessel to the technical specification

Note 1 to entry: It is a major activity, undertaken mainly by the manufacturer during design, manufacture and testing of equipment. It can be complemented by inspection by other parties. Inspection includes the assessment of testing activities.

3.5
testing
procedure used to verify vessel compliance with the technical requirements of this standard by one or more tests

3.6
technical specification
document stating requirements for a product or a procedure

3.7
repair
action or series of actions of rectifying a condition in either base material or weld to establish compliance with this standard

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3.8
serial production
manufacture of identical vessels or parts which subsequently are joined to form a complete vessel and which are manufactured to a single model acceptance, using the same manufacturing procedure involving a continuous fabrication process

Note 1 to entry: The definitions 3.8 to 3.13 relate to serially produced pressure vessels as described in Annex A.

3.9
continuous fabrication process
process where the welding of the main seams and branch welds is essentially continuous, that means there are no stoppages or fabrication break-downs requiring resetting of the welding machine and/or NDT equipment

Note 1 to entry: Adjustments to the welding machine within the welding procedure limitations do not qualify as resetting the welding machine.

Note 2 to entry: The definitions 3.8 to 3.13 relate to serially produced pressure vessels as described in Annex A.

3.10
model acceptance
procedure which ascertains that a representative sample of the production (a prototype vessel/part) meets the requirements of this standard in respect of design, manufacturing and testing

Note 1 to entry: Model acceptance is conducted by the manufacturer or the responsible authority depending on the conformity assessment module chosen.

Note 2 to entry: The definitions 3.8 to 3.13 relate to serially produced pressure vessels as described in Annex A.

3.11
prototype vessel/part
first or representative sample of a series of pressure vessels/parts covered by a single model acceptance

Note 1 to entry: The definitions 3.8 to 3.13 relate to serially produced pressure vessels as described in Annex A.

3.12
batch of vessels
part of a series where the welding of the main weld joints and branch welds has been essentially continuously produced by the same welding procedures

Note 1 to entry: The definitions 3.8 to 3.13 relate to serially produced pressure vessels as described in Annex A.

3.13
shift
period of time per day during which the welders and welding operators remain the same

Note 1 to entry: The definitions 3.8 to 3.13 relate to serially produced pressure vessels as described in Annex A.

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4 Performance of inspection and testing

4.1 General

Each individual vessel shall be inspected during construction and upon completion. Inspections shall be made to ensure that in all respects the design, materials, manufacturing, and testing comply with the requirements of this standard. Documented evidence shall be prepared to verify implementation of this requirement.

4.2 Inspection

Inspection shall be carried out by the manufacturer to verify that all requirements of this standard have been met. The level of non-destructive testing (NDT) shall be dependent on the testing group as described in 4.3.

All inspections shall be carried out by qualified personnel.

4.3 Non-destructive testing (NDT)

The type and amount of non-destructive testing of a pressure vessel shall be based upon the testing group or combination of testing groups when permitted in 6.6.1.2 (see Table 6.6.1-1: testing groups for steel pressure vessels and Table 6.6.2-1: extent of non-destructive testing).

5 Technical documents

5.1 General

The vessel manufacturer shall document those items listed in 5.2, which shall be reviewed in accordance with 5.3, prior to manufacture commencing.

The manufacturer shall state which vessels are covered by the same design.

5.2 Information to be contained in the technical documents

5.2.1 General

For the purposes of this standard the following types of documents shall be considered necessary as technical documents.

5.2.2 General description of the pressure vessel

a) Name of vessel manufacturer and subcontractors, if applicable;

b) Location/s of vessel manufacturer and sub-contractors, if applicable;

c) Document describing design data and special consideration which covers:

   1) maximum and minimum allowable pressures, design pressures and test pressures in bar for each compartment (vacuum with minus sign);

   2) capacity in litres for each compartment;

   3) maximum and minimum design temperatures;

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4) nature and location of marking of the pressure vessel, nameplate or stamp;

5) the fluid group;

6) if the vessel is designed for cyclic operation the allowed numbers of cycles, the range of action (as defined in EN 13445-3:2026, 5.3.1) during the cycle and the locations where the cumulative fatigue damage index D (as defined in EN 13445-3:2026, Clauses 17 and 18) is greater than 0,8. The maximum permissible peaking shall also be given.

7) if the vessel is working in the creep range, the following additional information:

   — the design life (e.g. 100 000 h) and expected life for each load case;

   — the parts of the vessel which are subjected to creep;

   — the value of the weld creep strength reduction factor which has been used for each weld joint subjected to creep;

   — whether lifetime monitoring, as defined in Clause 19 of EN 13445-3:2026, is being applied or not.

5.2.3 Design and construction drawings

The manufacturer analysis of hazards identifying those which apply to the pressure vessel on account of action (as defined in EN 13445-3:2026, 5.3.1) shall be documented and be of sufficient detail.

Details of the design including the design methods adopted, performance criteria and construction drawings shall be provided. Guidance about the detailed dimensional information that shall be provided is given in Annex B. Process diagrams, sub-assemblies or other data relevant to design shall also be maintained.

5.2.4 Descriptions and explanations necessary for an understanding of the drawings and diagrams and the operation of the pressure vessel

a) Operating instructions;

b) special checks to be carried out e.g. tests envisaged on closures, bellows, clamping bolts, etc.;

c) operational position if this is significant with regard to the safety evaluation.

5.2.5 Results of design calculations and examinations carried out

5.2.5.1 Design calculations shall be provided by the vessel manufacturer to the extent necessary to demonstrate compliance to this standard.

Supporting detailed drawings shall be prepared with all dimension notations marked. At least on the pressure vessel general arrangement drawing, the testing group(s) shall be clearly identified.

5.2.5.2 If calculations are made with the aid of a computer software in order to comply with this standard, then at least the following data shall be presented:

a) explanation of notations;

b) input values;

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c) reference number of the standard including edition and reference number of the formula;

d) results of intermediate formulae;

e) calculated minimum thickness without additions or the calculated stress and its comparison to the allowable stress;

f) wastage (corrosion) allowance;

g) thickness tolerance (negative thickness tolerance);

h) the chosen thickness.

5.2.5.3 In the event that stress analysis is carried out with the finite element method or other equivalent design methods they shall be documented as follows:

a) input data;

b) graphs which show;

1) the element subdivision (mesh size);

2) the stresses, e.g. as line or arrow figures or equal stress curves; stress curves of surfaces;

3) the displacements;

c) boundary conditions;

d) the stresses in the most critical areas;

e) where appropriate, the dividing and classifying of the stresses into different stress categories;

f) the comparison of stress intensities and the allowable stress values.

5.2.5.4 In specific cases the following information shall be given:

a) type of post weld heat treatment and, where necessary, type and extent of associated material tests;

b) construction sequence schedule if the testing is to be carried out in several steps;

c) fluid(s) being contained and its (their) specific gravity, if this is required for the design of the vessel;

d) pressure testing medium, if the initial or the periodic pressure tests are to be carried out with a medium other than water, the test minimum metal temperature for proof tests (both hydrostatic and pneumatic);

e) position of the vessel in the pressure tests (e.g. horizontal or vertical), if this is significant with regard to the safety evaluation;

f) maximum and minimum liquid levels, if these are required with regard to the safety evaluation;

g) static supplementary forces, e.g. bearing forces, wind and snow loads. An extra calculation shall be presented if the supplementary forces essentially affect the design of the pressure vessel;

h) cyclic and dynamic loading, including seismic loading, where applicable;

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i) additional requirements based on other regulations;

j) purchaser's requirements based on the vessel operating conditions in addition to the requirements of this standard;

k) possible corrosion attack, especially in crevices, which shall be taken into account;

l) joint coefficient.

5.2.6 Test reports

These shall consist, as a minimum, of the following:

a) welding procedure qualification records, certificates of qualification of welding personnel;

b) material certificates;

c) the content of the manufacturing records, including measurement of peaking for vessels subject to cyclic loads;

5.2.7 Technical/manufacturing schedule

This shall consist of the following information:

a) the welding processes to be used for the pressure containing parts and welding of any temporary or other attachments to pressure containing parts. The following data are required for the testing:

   1) weld location, shape and preparation and where necessary build up of the layers and treatment of welds;

   2) welding process (in the case of multiple processes, identification of the process against the weld joint);

   3) welding consumables (classification according to the relevant European Standards or trade names);

   4) type and extent of production test, number of test plates, non-destructive tests;

If some of the data listed before are not available for the design review, then these shall be completed before finishing the manufacture.

b) special checks to be carried out e.g. the tests envisaged on closures, bellows, clamping, bolts;

c) any pertinent details relative to vessel design and data required in specific cases:

   1) additional wall thickness if this is required by the purchaser;

   2) operational position if this is significant with regard to the safety evaluation;

   3) location and size of inspection and access openings and also closing mechanisms and special locking elements in accordance with Annex C;

   4) special equipment to enter the pressure vessel (e.g. spiral stairs, climbing irons);

   5) linings, e.g. of refractory and inserts, if significant with regard to the safety evaluation;

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6) marking of the welds that will be made on the construction site;

7) proposals on safety;

8) proposals on process requirements such as drainage, etc.

5.3 Design review

5.3.1 General

A design review and documented acceptance shall be conducted in all cases. It shall include the year of edition and the number of issue of the standard used, with reference to possible used Amendments.

In particular the review shall include design calculations in accordance with the requirements of this standard, taking into consideration the supporting information of the manufacturer analysis of hazards, and the technical/manufacturing schedule in respect of its intended services. Following the design, the pressure vessel shall be manufactured in accordance with the approved manufacturing drawings.

5.3.2 Design review

The design review shall consist of, but not be limited to, the following areas:

a) the suitability of material for intended use;

b) welding processes and consumables;

c) the access to perform the required levels of inspections and tests based on proposed vessel construction geometry;

d) the suitability of openings and closures in meeting the requirements of Annex C of this standard;

e) the provision and adequacy of safety accessories against the requirements of this standard for individual pressure vessels or devices which are contained within the pressure system or assembly. Alternatively, the parties responsible for satisfying the provision of safety accessories shall be identified;

f) the adequacy of proposed pressure retaining boundary (thickness, vessel geometry, weld joint geometry etc.) for design conditions against those required by the design requirements of this standard;

g) the adequacy of the stress analysis method in accordance with 5.2.5.3;

h) manufacturing and test procedures.

6 Inspection and testing during fabrication

6.1 General

The inspection and testing activities during fabrication, described in this clause, shall be the responsibility of the manufacturer and shall be fully implemented for all pressure vessels.

NOTE For guidance on use of conformity assessment procedures, see CEN/TR 13445-7.

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6.2 Manufacturing procedures and construction drawings

The manufacturer shall ensure that all construction drawings and manufacturing procedures reviewed and approved at the design stage in Clause 5, shall be available at the appropriate work area and shall be fully implemented in manufacturing. Inspection records shall document the use of the correct and appropriate procedures, and/or drawings including revision status at the time the inspection is performed.

6.3 Material traceability

6.3.1 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 vessel can be traced to its origin. This includes the use of welding consumable. The identification system used shall satisfy the requirements of EN 13445-4:2026.

Procedures to ensure material traceability, including transfer of markings, shall be performed throughout fabrication and records maintained to document the method used from those permitted in EN 13445-4:2026 (i.e. direct markings visible on the completed vessel, a direct coded marking on the vessel or tabulation/as built sketches). Final records shall include all material certification required by this standard.

6.3.2 Special Conditions - Material marking

Where service conditions prohibit die-stamping for material identification (see EN 13445-4:2026) and when so specified by the purchase order, the manufacturer of the base materials shall mark the required data on the materials in a manner which will allow positive identification during inspection upon delivery. The markings shall be recorded so that each item of material will be positively identified in its position in the completed vessel (e.g. material/position list) and shall form part of the final records.

6.4 Preparation for manufacturing processes

6.4.1 General

Preparation for manufacturing processes such as edge preparation, vessel supports for formed parts prior to welding and forming shall be controlled and inspected to ensure that such activities are not detrimental to the completed vessel.

6.4.2 Joint preparation testing

The extent to which edges are dressed prior to testing shall be in accordance with EN 13445-4:2026. All joint preparations shall be subject to visual inspection prior to any welding. Defects such as laminations, cracks and slag inclusion shall be removed prior to welding. In case of an increased probability of occurrence of imperfections or when imperfections have been detected, a visual inspection shall be supplemented by additional non-destructive testing.

The result of joint preparation testing shall be recorded in the NDT inspection schedule.

6.4.3 Inspection of vessel supports

All tack welds associated with bars, jacks, clamps, or other appropriate means used to hold the edges of vessel parts and/or provide support in welding shall be inspected.

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— Welds of permanent attachments to pressure parts shall be examined to the extent described in Table 6.6.2-1 (line 21).

— Welds of temporary attachments shall be examined after removal for surface cracks to the extent described in Table 6.6.2-1 (line 22).

— Any repairs necessary following removal of temporary attachments shall be tested as described in 6.5.3.

6.4.4 Inspection associated with forming

Prior to any forming the material to be formed shall be subject to visual inspection and thickness measurement in accordance with the requirements of EN 13445-4:2026. The result of the inspection shall be documented.

6.4.5 Testing of areas subject to significant through thickness tensile stress

In case of an increased probability of internal damage in areas subject to significant through thickness tensile stress caused by welding, these areas shall be examined for internal imperfections prior to welding. The result of the inspection shall be documented.

6.5 Welding

6.5.1 General

Permanent backing strip and joggle joints shall be subject to the same type of non-destructive testing and acceptance criteria as a single-sided butt weld.

Welds in all testing groups shall be subject to in-process inspections, especially welds of testing groups 3 or 4 not required to be subject to NDT under Table 6.6.1.2-1 shall be specifically subject to visual inspection at the "fit-up" and "chip back of second side of sound metal" stages.

All finished welding shall be subject to visual inspection. In addition, depending on the testing group, the finished welds shall be subject to NDT in accordance with Tables 6.6.1-1 and 6.6.2-1 for that type of weld.

6.5.2 Verification of welder and welding operator qualification and procedures qualification

The vessel manufacturer shall verify that welding has been done only by welders and operators who have been approved under the requirements as specified in EN 13445-4:2026, 8.4. Welding procedures shall be qualified in accordance with EN 13445-4:2026, 8.3.

Traceability of the welder and welding operator shall be monitored by inspection throughout construction of the pressure vessel and shall be verified at the final assessment, see 10.2.2.

6.5.3 Inspection of repairs

All welded repairs shall be subject to the same non-destructive testing requirements as those which detected the imperfection. This includes the same acceptance criteria. Such repairs shall be carried out using approved weld procedures and approved welders and welding operators. The extent of testing of repairs shall comply with Table 6.6.2-1 and cover 100 % of the area repaired.

Non welded repairs by surface dressing are permissible providing that the area of repair is subject to NDT according to Table 6.6.2-1 and free from unacceptable imperfections, see 6.6.5 for retesting requirements. For material groups 1.1 and 8.1 only visual testing (VT) is required.

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Weld metal deposited to restore base material shall be subject to non-destructive testing for the full surface area involved, using Magnetic Particle Testing (MT) or Penetrant Testing (PT).

6.6 Non-destructive testing of welded joints

6.6.1 Extent of non-destructive testing

6.6.1.1 General

The required extent of non-destructive testing depends both on the testing group and the type of the welded joints. Guidance to determine the required extent of testing is given in the following clauses.

For serially produced pressure vessels an alternative route is given in Annex A. This annex is not applicable to vessels or vessel parts designed according to Design by Analysis – Direct Route of Annex B of EN 13445-3:2026 or designed according to 6.3 of EN 13445-3:2026. This annex is not applicable for vessels or vessel parts working in the creep range.

6.6.1.2 Use of testing groups

6.6.1.2.1 General

The extent of non-destructive testing of welded joints for final acceptance purposes shall depend upon the testing group or subgroup of the welded joint under consideration.

In Table 6.6.1-1, testing groups 1, 2, 3 and 4 apply below the creep range. Testing groups 1, 2 and 3 are subdivided into sub-groups 1a, 1b, 2a, 2b, 3a, 3b, in order to reflect crack sensitivity of the material. In Table F.2-1 of Annex F, testing sub-groups 1c and 3c apply to creep.

NOTE 1 The testing groups or sub-groups take into consideration the manufacturing difficulties associated with different groups of steel, maximum thickness, welding process, service temperature range and joint coefficient. It is intended that any of the testing groups will provide adequate integrity for typical applications within the limitations contained within Tables 6.6.1-1 and F.2-1.

NOTE 2 The weld joint coefficient is not used in design by the experimental method without calculation.

NOTE 3 For vessels (or vessel parts) designed according to Design by Analysis – Direct Route of Annex B of EN 13445-3:2026 or designed according to 6.3 of EN 13445-3:2026, only testing group 1 is permissible.

NOTE 4 Further restrictions are given in Annex A of EN 13445-3:2026.

For vessels (or vessel parts) working in the creep range only testing groups 1c and 3c are permissible. The extent of NDT is given in Table F.2-1 of Annex F. Testing groups 1, 2 and 3 are permissible for any welded joint not subjected to creep.

6.6.1.2.2 Testing groups 1, 2 and 3

It is intended that a single testing group is applied to the entire vessel.

When the vessel is made of several sections (courses), a combination of testing groups 1, 2, and 3 is permissible providing that the requirements of Table 6.6.1-1 are met.

If a combination of testing groups is necessary for a vessel made of several parts designed according to different methods (e.g. one part according to DBF and another part according to DBA alternative route or creep range), the following shall apply:

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a) in each section (course) of the vessel, the testing group of the shell governing welded joints, where present, shall determine the minimum testing group for all the welds, including the nozzle welds, in that section;

b) the testing group of the weld between two welded sections of different testing groups shall be the more stringent of the two testing groups;

c) the minimum testing group (i.e. the one with the lower level of NDT) of the welds between a welded component and a seamless one (not welded), or between two seamless components, shall be determined by the available thickness (i.e. actual thickness less tolerances less corrosion allowance) at the weld. Where the available thickness is greater than 1,17 (this is equivalent to 1/0,85) times the minimum thickness, the testing group of the weld shall be 3 as a minimum requirement. Otherwise it shall be testing group 1 or 2 according to Table 6.6.1-1.

6.6.1.2.3 Testing group 4

Testing group 4 shall be used as a single group for the entire vessel and shall not be used with any other testing group.

6.6.1.2.4 Demonstration of satisfactory experience for testing group 2

Satisfactory experience shall be a minimum amount of welds or vessels of successfully produced and tested within the scope/parameters of the Welding Procedure Qualification (WPQR), as given below:

— in case of groups 1.1, 1.2 and 8.1 materials, the successful production is 25 consecutive pressure vessels or 50 consecutive metres of governing welded joints;

— in case of materials of other groups, it is 50 consecutive pressure vessels or 100 consecutive metres of governing welded joints;

— experience in material group 3.1 covers experience in material groups 1.1, 1.2 and 1.3;

— experience in material group 1.3 covers experience in material groups 1.1, 1.2;

— experience is accepted as long as there is a valid Welding Procedure Qualification (WPQR) for a more critical or at least a comparable material.

Any imperfection requiring repair by welding during the process of demonstrating experience shall require that the manufacturer start again the complete demonstration process.

Subsequently, (after demonstration of experience) isolated imperfections shall be handled in accordance with 6.5.3 and shall not affect the demonstration of experience.

However, multiple, systematic or process imperfections shall be investigated, corrected and the full demonstration of experience repeated. Such imperfections tend to be repetitive and similar in nature. They can be the result of inadequate welding parameters (e.g. resulting from equipment malfunction, a too large range of parameters, incorrect use of parameters within the range of qualification) or operator error. In the case of inadequate parameters, consideration of requalification of the Welding Procedure Specification (WPS) should be performed.

Documentary evidence of the process of demonstration of experience shall be maintained by the manufacturer.

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Table 6.6.1-1 — Testing groups for steel pressure vessels

Requirements	Testing group [a]						
	1		2		3		4 [b,j]
	1a	1b	2a	2b	3a	3b	
Permitted materials [g]	1 to 10	1.1, 1.2, 8.1	8.2, 9.1, 9.2, 9.3, 10	1.1, 1.2, 8.1	8.2, 9.1, 9.2, 10	1.1, 1.2, 8.1	1.1, 8.1
Extent of NDT for governing welded joints [e,h]	100 %	100 %	100 % - 10% [d]	100 % - 10 % [d]	25 %	10 %	0 % [k]
NDT of other welds	Defined for each type of weld in Table 6.6.2-1						
Joint coefficient	1	1	1	1	0,85	0,85	0,7
Maximum thickness for which specific materials are permitted	Unlimited [f]	Unlimited [f]	30 mm for groups 9.1, 9.2 16 mm for groups 9.3, 8.2[i],10	50 mm for groups 1.1, 8.1 35 mm for group 1.2	30 mm for groups 9.2, 9.1 16 mm for groups 8.2, 10	50 mm for groups 1.1, 8.1 30 mm for group 1.2	16 mm for groups 1.1, 8.1
Welding process	Unlimited [f]	Unlimited [f]	Fully mechanized welding only [c]		Unlimited [f]	Unlimited [f]	Unlimited [f]
Service temperature range	Unlimited [f]	Unlimited [f]	Unlimited [f]	Unlimited [f]	Unlimited [f]		Limited to (-10 to +300) °C for group 1.1, (-105 to +300) °C for group 8.1

[a] All testing groups shall require 100 % visual inspection
[b] Testing group 4 shall be applicable only for:
- Group 2 fluids; and
- $P_S \leq 20$ bar; and
- $P_S V \leq 20\,000$ bar·L above 100 °C; or $P_S V \leq 50\,000$ bar·L if temperature is equal or less than 100 °C; and
- maximum number of full pressure cycles less than 500.

If this testing group 4 is chosen, then a higher pressure test (see Clause 10) shall be used
[c] Fully mechanized and/or automatic welding process (See EN ISO 14732:2013).
[d] First figure: initially, second figure: after satisfactory experience. For definition of “satisfactory experience", see 6.6.1.2.4
[e] Testing details are given in Table 6.6.2-1
[f] Unlimited means no additional restriction due to testing. The limitations mentioned in the table are limitations imposed by testing. Other limitations given in the various clauses of the standard (such as design, or material limitations, etc.) shall also be taken into account.
[g] See EN 13445-2:2026 for permitted materials.
[h] The percentage relates to the percentage of welds of each individual vessel
[i] 30 mm for group 8.2 material is allowed if delta ferrite containing welding consumables are used for depositing filling passes up to but not including the capping run.
[j] Limited to single compartment vessels and single material group.
[k] Except for assembly of a conical shell to a cylindrical shell without knuckle (large end of the cone) for which MT or PT shall be 100 %.

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6.6.2 Determination of extent of non-destructive testing

6.6.2.1 General

As a general rule, the extent of non-destructive testing, given as a percentage value, shall be in accordance with Table 6.6.2-1 which only covers the processes listed in EN 13445-4:2026. This percentage value reflects the extent of non-destructive testing of the total length of the welded joint and takes into consideration the testing group and type of weld.

For vessels designed by experimental methods, the required extent of non-destructive testing of welded joints shall be determined according to the rules given in Table 6.6.2-1.

In case where it is not obvious whether the welded joint is a governing one or not, due to the complex shape of the vessel and/or the particular location of that joint, a conservative assumption shall be made, i.e. the welded joint shall be considered as a governing welded joint and tested accordingly.

NOTE For definition of governing welded joint, see EN 13445-3:2026, definition 3.13. For examples of governing welded joints, see EN 13445-3:2026, 5.6.

If no weld is present in the vessel or vessel part, testing group 1 shall be assumed.

6.6.2.2 Welded joints covered by Table 6.6.2-1

Table 6.6.2-1 applies to all joints, except those described in 6.6.2.3.

6.6.2.3 Other welded joints

6.6.2.3.1 General

Special problems arising from elements such as those described below are not covered in Table 6.6.2-1 and shall be considered for all butt-welded joints especially for longitudinal/governing joints:

— single run governing welds;

— joints between dissimilar materials or dissimilar consumables.

6.6.2.3.2 Single run governing welds made by manual welding procedure

For volumetric NDT of single runs, one of the two options below shall be used:

a) NDT extent shall be as prescribed in Table 6.6.2-1 conditional upon a hydrotest at a higher test pressure performed as specified in 10.2.3.3.1, Table 10.2.3.3.1-1 with control of peaking and excess weld.

b) NDT extent prescribed in Table 6.6.2-1 shall be multiplied by 2 without exceeding 100 % but not less than 25 % for longitudinal and 10 % for circumferential. When there is a change which could influence the performance of the welding process (e.g. before changing the copper bar or the gas, after changing the wire or the powder and production test specimens, before changing the copper bar or gas and after changing wire) additional NDT shall be performed at the start of those seams.

6.6.2.3.3 Non destructive testing of joints between dissimilar materials or dissimilar consumables

NDT on these joints must be performed to a specific written procedure with additional attention to interpretation of the results.

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6.6.2.3.4 Non destructive testing of welding joints in supporting structures

— Butt joints (full penetration or partial penetration) subjected to tensile stress shall have 10 % NDT.

— Fillet welds in tension or shear shall have 10 % NDT (PT or MT) if the throat thickness is more than 12 mm.

6.6.2.4 Testing group 2

For testing group 2, the reduction in percentage of NDT given in Table 6.6.2-1 is given by the two figures (e.g. 100 % - 10 %). The first value refers to the initial extent of NDT required until sufficient satisfactory experience (See 6.6.1.2.4) is established when the second lower value applies.

6.6.2.5 When less than 100 % NDT is required by the selected testing group in Table 6.6.1-1

In case of less than 100 % required testing, the extent and location of non-destructive testing shall be determined by the following criteria. The joints selected shall be representative of all welding on the pressure vessel.

a) For shells, formed heads, communicating chambers and jackets:

1) If e > 16 mm:

non-destructive testing shall be performed at all intersections of longitudinal and circumferential butt joints. In addition, if governing welds longer than 500 mm are present, at least one randomly chosen governing weld shall be tested with an extent of testing as required in Table 6.6.2-1.

As a minimum, the extent of testing as determined in Table 6.6.2-1 shall be fulfilled. Where the testing requirements exceed the percentage in Table 6.6.2-1 then this higher value will apply.

If e ≤ 16 mm:

it is acceptable for pressure vessels of testing group 3b or 3a (if material group is 8.2) to examine randomly the intersections and governing welds.

As a minimum, the extent of testing as determined in Table 6.6.2-1 shall be fulfilled.

2) If necessary to attain the percentage required in Table 6.6.2-1, additional randomly selected locations on the butt welded joint shall be subject to non-destructive testing.

3) Openings within main welds (longitudinal or circumferential) or within a distance of 12 mm from the main welds shall be examined for a length of 200 mm or reinforcing length l_{so} defined in EN 13445-3:2026 Clause 9, whatever is the smallest, on each side of the opening. These shall be included as an addition to the percentage in Table 6.6.2-1, if applicable.

b) Nozzles and branches made by butt joints (types 1, 3a, 3b and 4 in Figure 6.6.2-3).

To determine the extent of non-destructive testing, the total number of nozzles and branches which have full penetration butt welds shall be grouped for each type of weld as follows:

1) for 100 % non-destructive testing: the size of the group is 1 (i.e. every individual nozzle and branch);

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2) for 25 % non-destructive testing: the size group size is 4 (i.e. at least one complete nozzle or branch for each group of 4);

3) for 10 % non-destructive testing: the size of the group is 10 (i.e. at least one complete nozzle or branch for each group of 10).

Thereafter, the complete circumferential and longitudinal butt joints of at least one nozzle or branch in each group or partial group shall be tested. When the inclusion of the number of complete circumferential and longitudinal butt welds or nozzles exceeds the percentage in Table 6.6.2-1, then the higher value will apply.

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Table 6.6.2-1 — Extent of non-destructive testing

TYPE OF WELD [a, p]			TESTING [b]	EXTENT FOR TESTING GROUP [o]					
				1a	1b	2a [i]	2b [i]	3a	3b
				EXTENT FOR PARENT MATERIALS [l,m,n]					
				1 to 10	1.1, 1.2, 8.1	8.2, 9.1, 9.2, 9.3, 10	1.1, 1.2 8.1	8.2, 9.1, 9.2, 10	1.1, 1.2, 8.1
Full penetration butt weld	1	Longitudinal joints	RT or UT MT or PT	100 % 10 %	100 % 10 % [d]	(100–10) % 10 %	(100–10) % 0	10 % 0	2 % 0
	2a	Circumferential joints on a shell, including circumferential joints between a shell and a non-hemispherical head [c]	RT or UT MT or PT	25 % 10 %	10 % 10 % [d]	(25 –10) % 10 %	(10 - 5) % 0	5 % 0	2 % 0
	2b	Circumferential joints on a shell, including circumferential joints between a shell and a non-hemispherical head, with backing strip [c, k]	RT or UT MT or PT	NP NP	NA 100 %	NP NP	NA 100 %	NP NP	NA 100 %
	2c	Circumferential joggle joint, including circumferential joints between a shell and a non-hemispherical head [c, k]	RT or UT MT or PT	NP NP	NA 100 %	NP NP	NA 100 %	NP NP	NA 100 %
	2d	Circumferential joints in bellows crest or root area	RT or UT MT or PT	100 % 100 %	25 % 100 %	(25 –10) % 100 %	(25 - 10) % 100 %	10 % 100 %	10 % 100 %
	3a	Circumferential joints on a nozzle d_i > 150 mm or e > 16 mm	RT or UT MT or PT	25 % 10 %	10 % 10 % [d]	(25 –10) % 10 %	(10 - 5) % 10 % [d]	0 % 10 %	0 % 10 % [d]
	3b	Circumferential joints on a nozzle d_i > 150 mm or e > 16 mm with backing strip [k]	RT or UT MT or PT	NP NP	NA 100 %	NP NP	NA 10 %	NA 100 %	NA 100 %
	4	Circumferential joints on a nozzle $d_i \leq 150$ mm and $e \leq 16$ mm	RT or UT MT or PT	0 % 25 %	0 % 10 %	0 % (25 –10) %	0 % (10 – 5) %	0 % 0 %	0 % 0 %
	5	All welds in spheres, heads and hemispherical heads to shells	RT or UT MT or PT	100 % 10 %	100 % 10 % [d]	(100–10) % 10 %	(100–10) % 0	10 % 0	2 % 0
	6	Assembly of a conical shell with a cylindrical shell without a knuckle (large end of the cone) [q, r]	RT or UT MT or PT	100 % 100 %	25 % 100 %	(100–10) % 100 %	(25–10) % 100 %	10 % 10 %	2 % 10 % [d]
	7	Assembly of a conical shell with a cylindrical shell without a knuckle (small end of the cone)	RT or UT MT or PT	100 % 10 %	25 % 10 % [d]	(100–10) % 10 %	(25–10) % 10 % [d]	10 % 10 %	2 % 10 % [d]

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