SLOVENSKI STANDARD
kSIST-TP FprCEN/TR 13445-9:2011

01-januar-2011

Neogrevane tlačne posode - 9. del: Usklajenost serije EN 13445 z ISO 16528

Unfired pressure vessels - Part 9: Conformance of the EN 13445 series to ISO 16528

Unbefeuerte Druckbehälter - Gegenüberstellung der EN 13445 Normenreihe und ISO 16528

Récipients sous pression non soumis à la flamme - Partie 9 : Conformité de la série EN 13445 à l'ISO 16528

Ta slovenski standard je istoveten z: **FprCEN/TR 13445-9**

ICS:

23.020.30	Tlačne posode, plinske jeklenke	Pressure vessels, gas cylinders

kSIST-TP FprCEN/TR 13445-9:2011 **en,fr,de**

TECHNICAL REPORT

RAPPORT TECHNIQUE

TECHNISCHER BERICHT

FINAL DRAFT
FprCEN/TR 13445-9

December 2010

ICS 23.020.30

Will supersede CEN/TR 13445-9:2007

English Version

Unfired pressure vessels - Part 9: Conformance of the EN 13445 series to ISO 16528

Récipients sous pression non soumis à la flamme - Partie 9 : Conformité de la série EN 13445 à l'ISO 16528

Unbefeuerte Druckbehälter - Teil 9: Gegenüberstellung der EN 13445-Normenreihe und ISO 16528

This draft Technical Report is submitted to CEN members for Technical Committee Approval. It has been drawn up by the Technical Committee CEN/TC 54.

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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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Ref. No. FprCEN/TR 13445-9:2010: E

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Foreword

This document (FprCEN/TR 13445-9:2010) has been prepared by Technical Committee CEN/TC 54 “Unfired pressure vessels”, the secretariat of which is held by BSI.

This document is currently submitted to the Formal Vote.

This document will supersede CEN/TR 13445-9:2007.

1 Scope

This Technical Report details the conformance of the EN 13445 series for "Unfired pressure vessels" to ISO 16528-1, *Boilers and pressure vessels — Part 1: Performance requirements*.

This edition is limited to vessels of steel construction, but will be amended later to include spheroidal graphite cast iron and aluminium vessels.

2 Failure mode summary

Table 1 — Failure mode summary

STANDARD [a]: Unfired pressure vessels EN 13445-1:2009 to EN 13445-5:2009 and CR 13445-7	
FAILURE MODE SUMMARY [b]	
Failure modes according to ISO 16528-1:2007, 6.2	**Addressed (Y / N / P) [c]**
Brittle Fracture	Y
Ductile rupture	Y
Leakage at Joints	Y
Elastic or Plastic Instability	Y
Creep Rupture	Y
Additional failure modes according to ISO 16528-1:2007, 6.1	**Addressed (Y / N / P) [c]**
Crack formation or ductile tearing due to excessive local strains	Y
Creep – excessive deformations at mechanical joints or resulting in unacceptable transfer of load	Y
Creep instability	Y
Erosion, corrosion	P
Environmentally assisted cracking, e.g. stress corrosion cracking, hydrogen induced cracking, etc.	P
Progressive plastic deformation	Y
Alternating plasticity	Y
Fatigue under elastic strains (medium and high cycle fatigue) or under elastic-plastic strains (low cycle fatigue)	Y
Environmentally assisted fatigue	P

[a] Provide full title of the standard and revision or addenda level.

[b] Failure modes addressed by this form (see ISO 16528-1).

[c] Y – failure mode addressed by standard;
N – failure mode not addressed by standard;
P – failure mode recognized but details not addressed.

3 Detailed failure mode checklists

Table 2 — Detailed failure mode checklists

STANDARD: Unfired pressure vessels EN 13445:2009 (all parts)
FAILURE MODE [a] : Brittle fracture
EXPLICIT DESIGN [d]
References [b]: **EN 13445-2:2009, *Unfired pressure vessels — Part 2: Materials*,** **Annex B "Requirements for prevention of brittle fracture",** **Method 1 and Method 2**
Comments [c] : **Method 1** a) Technical requirements based on the choice of $T_R = T_{27J}$ as specified in harmonised European Material Standards and on the assumption that it is possible to achieve these minimum properties after fabrication. Calculated from the principles of fracture mechanics used for method 2 for C and CMn steels with yield strength < 460 MPa; and b) based on operating experience for Ni-alloyed steels with Ni $\geq$ 3 % up to 9 %, for austenitic steels and for bolts and nuts. **Method 2** Method developed from the principles of fracture mechanics and from operating experiences. A more flexible approach than method 1 for derivation of technical requirements applicable to C, CMn and low alloy ferritic steels with a specified minimum yield strength $\leq$ 500 MPa and for austenitic-ferritic steels with a specified minimum yield strength $\leq$ 550 MPa. This method can be applied for these steels to a wider range of thicknesses and temperatures than method 1 because T_R must not be equal to T_{27J} (see Figures B.2-1 to B.2-11). In addition, for ferritic steels with max 355 MPa in PWHT condition operation experience was considered for higher thicknesses.
IMPLICIT DESIGN
References: **EN 13445-2, *Unfired pressure vessels — Part 2: Materials*,** **Annex B "Requirements for prevention of brittle fracture",** **Method 3**
Comments: **Method 3 is the application of a fracture mechanics analysis.**
FABRICATION DETAILS [e]
References: **Design requirements for construction details are given in:** **EN 13445-3, *Unfired pressure vessels — Part 3: Design*** **and in Annex A "Design requirements for pressure bearing welds" of this Part.**

Manufacturing tolerances are given in: **EN 13445-4:2009, *Unfired pressure vessels — Part 4: Fabrication*,** **Clause 5 "Manufacturing tolerances"**
Comments: **Reference thickness is given in:** **EN 13445-2:2009, *Unfired pressure vessels — Part 2: Materials*,** **Annex B "Requirements for prevention of brittle fracture",** **Table B.4-1 "Reference thickness"**

MATERIAL REQUIREMENTS [f]
References: **EN 13445-2:2009, *Unfired pressure vessels — Part 2: Materials*,** **4.1.6: Specified minimum impact energy measured on a Charpy-V-notch specimen at a test temperature in accordance with Annex B.** **EN 13445-4:2009, *Unfired pressure vessels — Part 4: Fabrication,*** **Clause 8 "Manufacture and testing of welds – Production test"** **Testing of coupon plates with the same required impact energy as above.**
Comments: **Impact requirements are also specified for sub-sized Charpy-V-notch specimen if the base material is less than 10 mm thick.**
EXAMINATION REQUIREMENTS [g]
References: **EN 13445-5:2009, *Unfired pressure vessels — Part 5 : Inspection and testing,*** **Clause 6 "Inspection and testing during fabrication", 6.6 "Non-destructive testing of welded joints".**
Comments: **There are four testing (examination) groups: 1 (full NDE), 2 (full NDE and reduction with successful experience, fully mechanised and/or automatic welding process), 3 (spot testing), 4 (visual examination only and higher test pressure).** **Acceptance criteria are based on EN ISO 5817:2007, level C (level B in critical areas when vessels are subjected to cyclic loads, see Annex G of EN 13445-5:2009).**
TESTING REQUIREMENTS [h]
References: **EN 13445-3, *Unfired pressure vessels — Part 5 : Inspection and testing*,** **Clause 10 "Final assessment", 10.2.3 "Proof test".**

Comments: **Higher pressure test for vessels with visual NDE only.**
USE / FAILURE HISTORY [i]
References:
Comments:

a Failure mode addressed by this form (see Table 1).

b Provide specific clause or paragraph references (including the title, if any) indicating where relevant rules can be found. These references need not be exhaustive, but should be detailed enough to establish that the standard adequately addresses the selected failure mode.

c Provide explanatory comments indicating the background for the approach employed or other material that might be useful. For example, brief description of failure theor(ies) used should be provided. References to academic papers and empirical testing methods used to establish rules are encouraged.

d Reference(s) to rules or requirements that directly affect how the standard addresses the selected failure mode, e.g. formulas for sizing wall thickness of components for resisting ductile burst.

d This section may be used to provide references and comments when design tables, empirically based rules or other approaches are employed whose derivation is not obvious. It may also be used to provide general information on design margins (safety factors) on material properties, etc. Many successful standards do not provide explicit design rules for certain failure modes yet do employ combinations of material control, temperature limits or other means to provide adequate protection against failure. This section may be used to provide information on how his standard indirectly addresses certain failure modes when explicit rules are not provided.

e References for fabrication details relevant to the selected failure mode, e.g. control of cylinder ovality, weld profiling, control of tolerances, etc. For example, control of cylinder ovality is important for prevention of buckling of externally loaded vessels. This section should be used to describe such fabrication controls relevant for the designated failure mode.

f Relevant requirements for base and welding materials, e.g. control of YS/UTS ratios, provisions for addressing strain hardening, applications of heat treatment, etc. Assuring that fabrication processes have not adversely affected material properties beyond acceptable limits can be important for preventing certain types of failures. This section should be used to describe such controls.

g References for NDT or visual inspection relevant to the selected failure mode. (If NDT is correlated to design factors, this should be noted.)

h Provisions for final testing, i.e. hydrostatic or leak tests should be noted with specific information on normal test pressures and control of test lower and upper test pressures.

i An explanation shall be provided defining the limitations in the standard's scope or application relative to EN 13445-1:2009, 6.2 failure mode(s) not addressed. References to data quantifying failure rates and other relevant experience may be provided. Likely sources include regulatory authorities, trade associations and insurers.

STANDARD: Unfired pressure vessels EN 13445:2009 (all parts)
FAILURE MODE [a]: Ductile rupture
EXPLICIT DESIGN [d]
References [b]: **EN 13445-3:2009, *Unfired pressure vessels — Part 3: Design,*** **Clause 6 "Maximum allowed values of the nominal design stress for pressure parts"**
Comments [c]:
IMPLICIT DESIGN [d]
References: **EN 13445-3:2009, *Unfired pressure vessels — Part 3: Design,*** **Annex B "Design by Analysis – Direct Route", B.8.2: "Gross Plastic Deformation"** **Annex C "Design by Analysis – Method based on stress categories"**
Comments: **In Annex B, limit analysis is used. For ferritic steels, this analysis allows the use of a reduced safety factor versus the tensile strength at 20 °C.**
FABRICATION DETAILS [e]
References: **EN 13445-3:2009, *Unfired pressure vessels — Part 4: Fabrication,*** **Clause 5 "Manufacturing tolerances"**
Comments:
MATERIAL REQUIREMENTS [f]
References: **EN 13445-2:2009, *Unfired pressure vessels — Part 2: Materials*,** **Clause 4 "Requirements for materials to be used for pressure-bearing parts"**