SLOVENSKI STANDARD
SIST EN 13445-3:2009/oprA5:2012

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Neogrevane tlačne posode - 3. del: Konstruiranje - Dopolnilo A5

Unfired pressure vessels - Part 3: Design

Unbefeuerte Druckbehälter - Teil 3: Konstruktion

Récipients sous pression non soumis à la flamme - Partie 3: Conception

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ICS:

23.020.30	Tlačne posode, plinske jeklenke	Pressure vessels, gas cylinders

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ICS

English Version

Unfired pressure vessels - Part 3: Design

Récipients sous pression non soumis à la flamme - Partie 3: Conception

Unbefeuerte Druckbehälter - Teil 3: Konstruktion

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

This draft amendment A5, if approved, will modify the European Standard EN 13445-3:2009. If this draft becomes an amendment, 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.

This draft amendment was established by CEN 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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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
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

Page

Foreword

This document (EN 13445-3:2009/prA5:2012) 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 CEN Enquiry.

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(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

1 Modification to 16.12

Delete the existing text of 16.12. and substitute the following:

16.12 Vertical vessels with skirts

16.12.1 Purpose

This clause gives rules for the design of support skirts for vertical vessels. It deals with the skirt itself and local stresses in the region where skirt and pressure vessel join and with the design of the base ring.

16.12.2 Specific symbols and abbreviations (see Figure 16.12-1 to Figure 16.12-4)

The following symbols and abbreviation are in addition to those in clauses 4 and 16.3:²

a is the lever-arm due to offset of centre-line of shell wall;

e_B is the thickness of vessel wall;

e_Z is the thickness of skirt;

f_Z is the allowable design stress of skirt;

f_T is the allowable design stress of the ring (Shape A);

r is the inside knuckle radius of torispherical end;

R is the inside crown radius of torispherical end;

D_B is the mean shell diameter;

D_Z is the mean skirt diameter;

F_{Zn} is the equivalent force in the considered point ($n = p$ or $n = q$) in the skirt;

F_G is the weight of vessel without content;

ΔF_G is the vessel weight below section 2-2;

F_F is the weight of content;

M is the global bending moment, at the height under consideration;

ΔM is the moment increase due to change of centre of gravity in cut-out section;

P_H is the hydrostatic pressure;

W is the section modulus of ring according to Figure 16.12-1;

α is a stress intensification factor (see equations 16.12-33 to 16.12-36);

γ_a is the knuckle angle of a domed end (see Figure 16.12-2);

γ is part of the knuckle angle (see Figure 16.12-2);

σ is the stress;

Subscripts:

a refers to the external shell surface, i.e. side facing away from central axis of shell;

b refers to bending (superscript);

m refers to membrane stress (superscript);

i refers to the inside shell surface;

o refers to the outside shell surface;

p is the point in the section under consideration where the global moment causes the greatest tensile force in the skirt (e.g. side facing the wind = windward side);

q is the point in the section under consideration where the global moment causes the greatest compressive force in the skirt (e.g. side facing away from the wind = leeward side);

1 is the section 1-1 (see Figures 16.12-1 to 16.12-4);

2 is the section 2-2;

3 is the section 3-3;

4 is the section 4-4.

5 is the section 5-5.

16.12.3 Connection skirt/shell

16.12.3.1 Conditions of applicability

a) The load on the skirt shall be determined according to generally accepted practice;
NOTE For tall vertical vessels the loads on the skirt shall be determined according to clause 22.

b) Attention shall be paid to the need to provide inspection openings.

16.12.3.2 Forms of construction

The forms of construction covered in this section are:

a) Structure shape A: skirt connection via support in cylinder area - Figure16.12-1;

Cylindrical or conical skirt with angle of inclination $\leq 7^{o}$ to the axis;

b) Structure shape B: Frame connection in knuckle area - Figure 16.12-2;

Cylindrical or conical stand frame with angle of inclination $\leq 7^{\circ}$ to the axis and welded directly onto the domed end in the area $0^{\circ} \leq \gamma \leq 20^{\circ}$;

Wall thickness ratio: $0,5 \leq e_B/e_Z \leq 2,25$;

Torispherical end of Kloepper or Korbbogen type (as defined in 7.2) or elliptical end having an aspect ratio $K \leq 2$ (where K as defined in equation (7.5-18)) and a thickness not less than that of a Korbbogen-type end of same diameter;

c) Structure shape C: skirt slipped over vessel shell - Figure 16.12-3;

Cylindrical skirt slipped over vessel shell and welded on directly

It is assumed that, on either side of the joining seam for a distance of 3 e_B, there is no disturbance due to openings, end connections, vessel circumferential welds, etc.;

Note has to be taken of the risk of crevice corrosion.

NOTE Outside the above limitations, subclauses 16.12.3.4.1 and 16.12.3.4.2 do not apply. Nevertheless, subclause 16.12.3.4.3 may be used subject to calculate existing stresses by elastic shell theories.

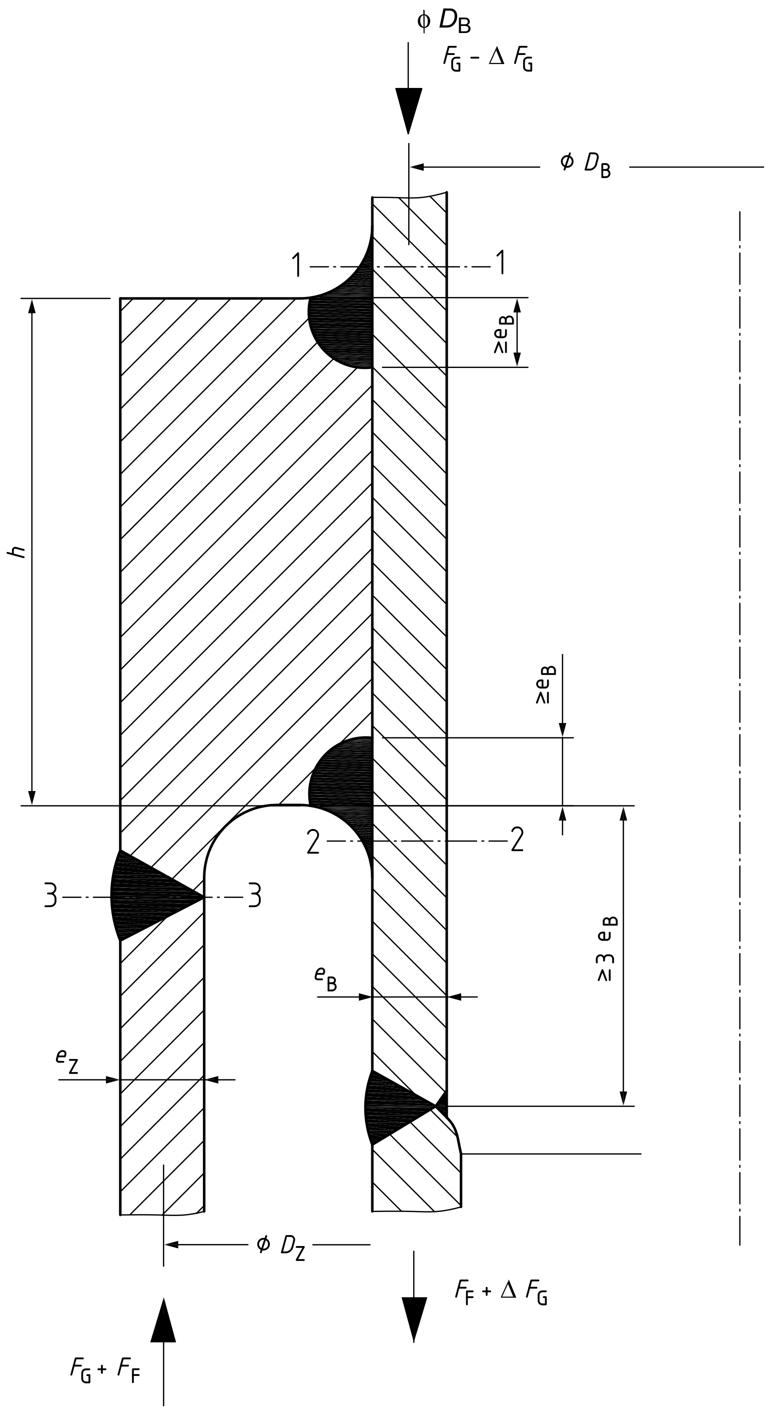


Figure 16.12-1 — Shape A: Skirt connection with supporting ring (Membrane forces due to self weight and fluid weight)

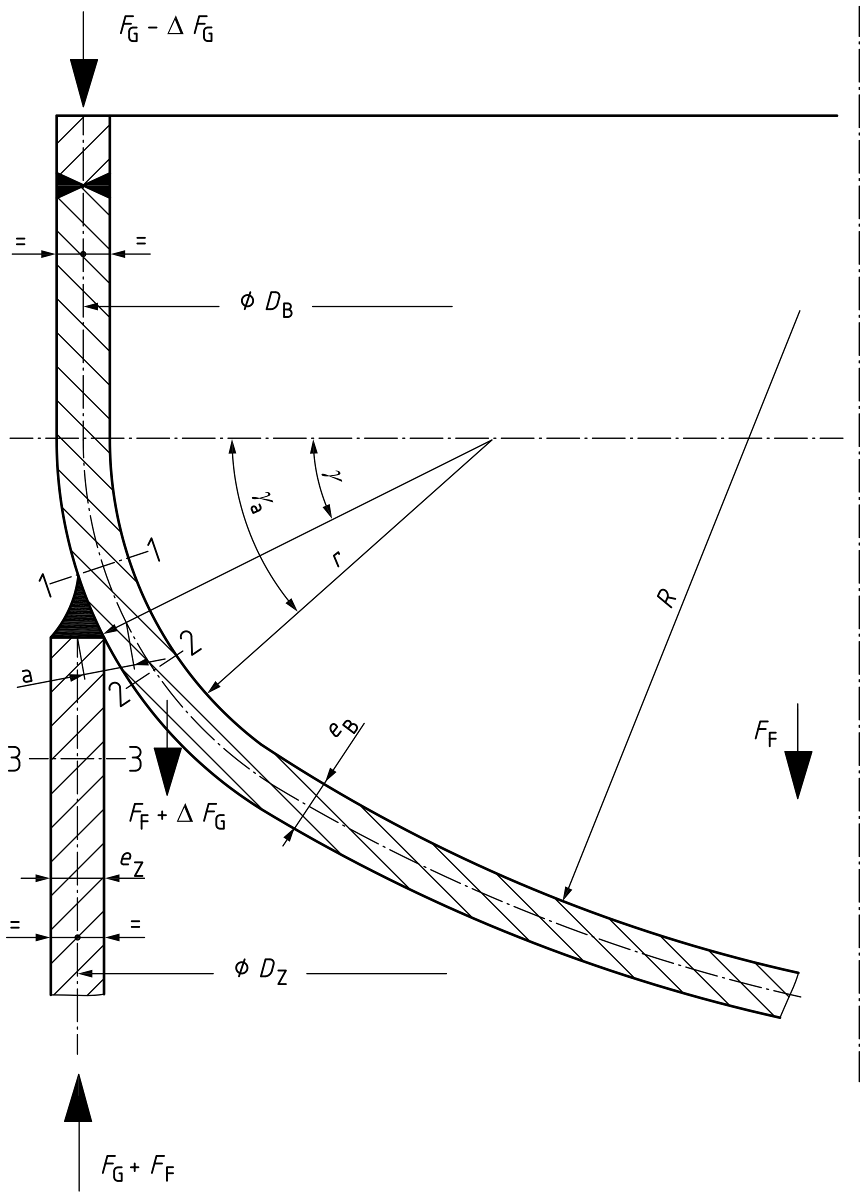


Figure 16.12-2 — Shape B: Skirt connection in knuckle area (Membrane forces due to self weight and fluid weight)

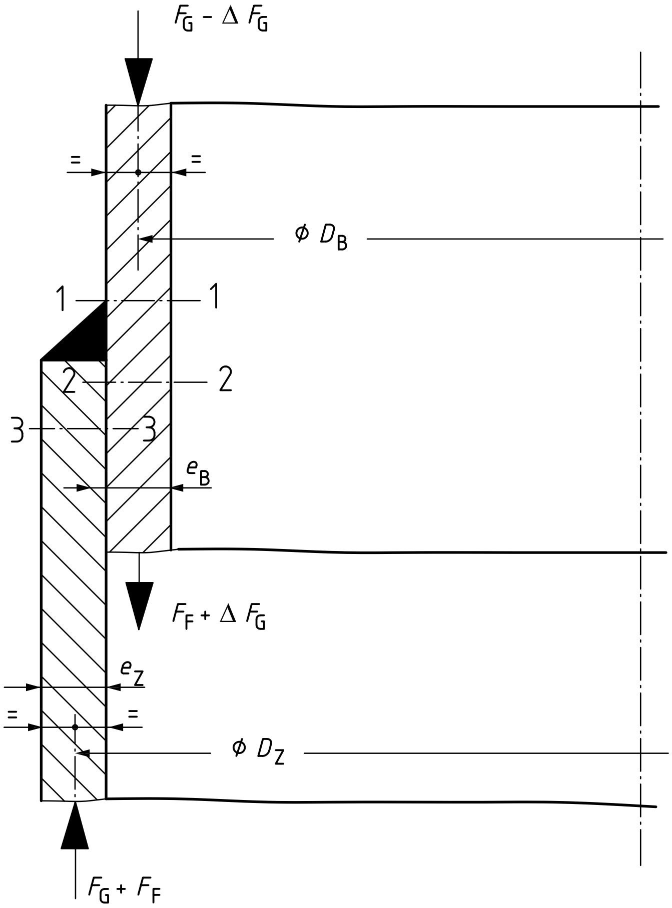
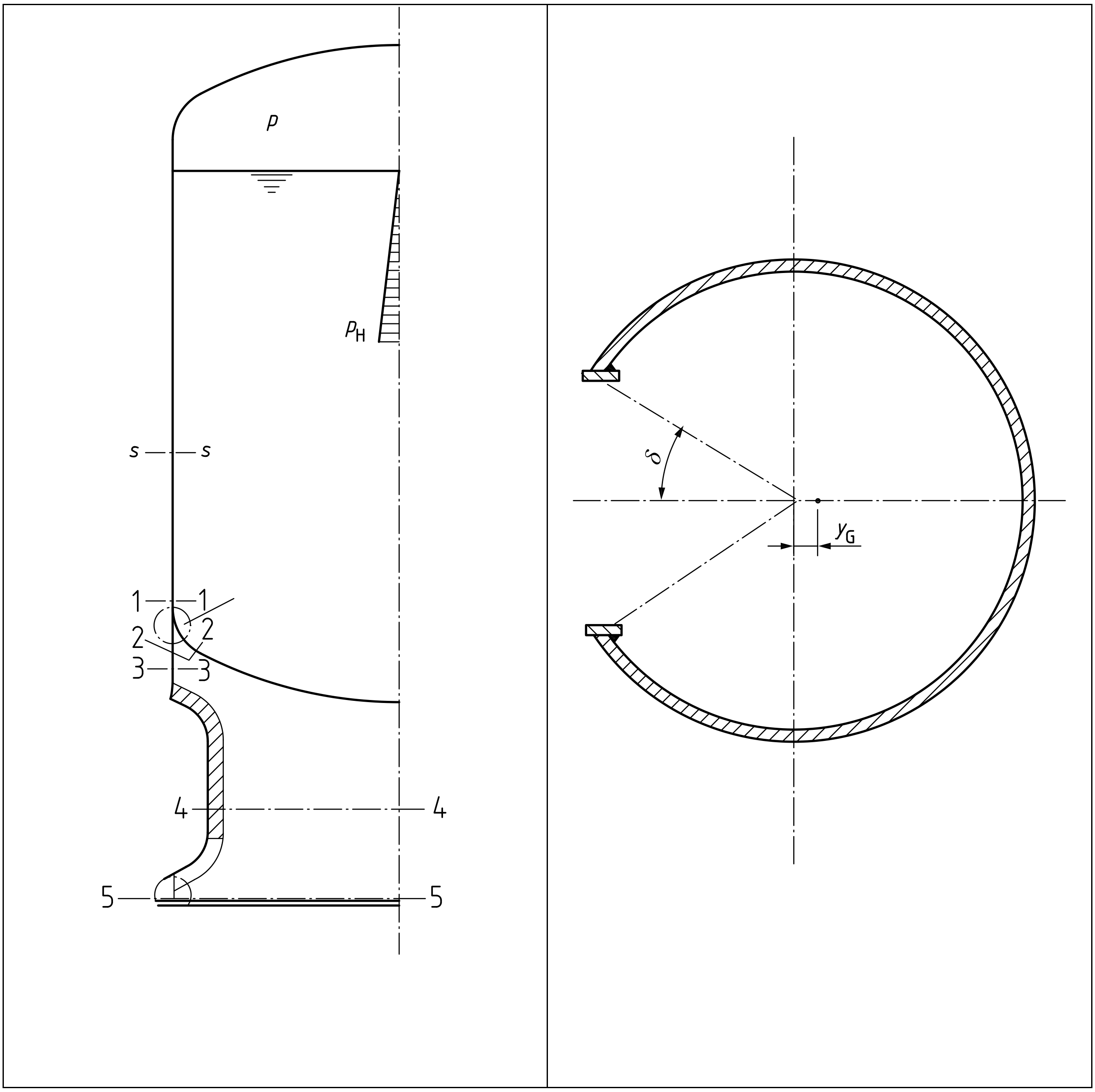


Figure 16.12-3 — Shape C: Skipped-over skirt area (Membrane forces due to self weight and fluid weight)



(a) = Section 1-1 to 5-5 (b) = Section 4-4

Figure 16.12-4 — Schematic diagram of stand frame - sections

16.12.3.3 Forces and moments

The values F_n and M_n at the respective sections n=1 to n=4 are determined as a function of the combination of all the loads to be taken into consideration in this load case (see Figure 16.12-4). Further checking may be necessary if the wall thickness in the skirt is stepped.

16.12.3.4 Checking at connection areas (sections 1-1, 2-2 and 3-3)

In the connection area, sections 1 to 3 defined in Figure 16.12-1 to 16.12-3 have to be checked. Checking is required for the membrane and the total stresses, while only the respective longitudinal components are being taken into account.

The section force F_Z in the skirt in the region of the joint depends on the position (n), i.e. whether the moment strengthen (q) or weakens (p) the load component:

$$F_{Zp} = -F_1 - F_G - F_F + 4\frac{M_1}{D_Z} \qquad (16.12\text{-}1)$$

$$F_{Zq} = -F_1 - F_G - F_F - 4\frac{M_1}{D_Z} \qquad (16.12\text{-}2)$$

where

F_1 is the global additional axial force in section 1-1;

M_1 is the resulting moment due to external loads in section 1-1 above the joint; between the pressure-loaded shell and skirt.

1.1.1.1.1 Membrane stresses

The checking procedure for membrane stresses is the same for structural shapes A, B and C. The membrane stresses at point 1-1 are:

$$\sigma_{1p}^{m} = \frac{F_{Zp} + \Delta F_G + F_F}{\pi D_B e_B} + \frac{P D_B}{4 e_B} \qquad (16.12\text{-}3)$$

$$\sigma_{1q}^{m} = \frac{F_{Zq} + \Delta F_G + F_F}{\pi D_B e_B} + \frac{P D_B}{4 e_B} \qquad (16.12\text{-}4)$$

check that:

$$\left|\sigma_{1p}^{m}\right| \le f \qquad (16.12\text{-}5)$$

$$\left|\sigma_{1q}^{m}\right| \le f \qquad (16.12\text{-}6)$$

The minimum required wall thickness in section 1-1 are obtained from next equations:

$$e_{1p}^{m} = \frac{1}{f}\left(\frac{F_{Zp} + \Delta F_G + F_F}{\pi D_B} + \frac{P D_B}{4}\right) \qquad (16.12\text{-}7)$$

$$e_{1q}^{m} = \frac{1}{f}\left(\frac{F_{Zq} + \Delta F_G + F_F}{\pi D_B} + \frac{P D_B}{4}\right) \qquad (16.12\text{-}8)$$

The calculation of this wall thickness is necessary for structural shape A.

If σ_{1p}^{m} or σ_{1q}^{m} is a compressive stress, a stability check shall be carried out according to 16.14. This check is not required if the longitudinal stress component is less than 1,6 times the value of the resulting meridian membrane compressive stress for a vacuum or partial vacuum load case, provided the latter was checked according to clause 8. This applies also to other sections in the cylindrical area of the shell.

Regardless of the check point, the membrane stress in section 2-2 is:

$$\sigma_{2}^{m} = \sigma_{2q}^{m} = \sigma_{2p}^{m} = \frac{F_F + \Delta F_G}{\pi D_B e_B} + \frac{P D_B}{4 e_B} \qquad (16.12\text{-}9)$$