SLOVENSKI STANDARD
oSIST prEN 286-4:2019

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Enostavne neogrevane (nekurjene) tlačne posode, namenjene za zrak ali dušik - 4. del: Tlačne posode iz aluminijevih zlitin za zračne zavore in pomožno pnevmatsko opremo na tirnih vozilih

Simple unfired pressure vessels designed to contain air or nitrogen - Part 4: Aluminium alloy pressure vessels designed for air braking equipment and auxiliary pneumatic equipment for railway rolling stock

Einfache unbefeuerte Druckbehälter für Luft oder Stickstoff - Teil 4: Druckbehälter aus Aluminiumlegierungen für Druckluftbremsanlagen und pneumatische Hilfseinrichtungen in Schienenfahrzeugen

Récipients à pression simples, non soumis à la flamme, destinés à contenir de l'air ou de l'azote - Partie 4 : Récipients à pression en alliages d'aluminium destinés aux équipements pneumatiques de freinage et aux équipements pneumatiques auxiliaires du matériel roulant ferroviaire

Ta slovenski standard je istoveten z: **prEN 286-4**

ICS:

23.020.32	Tlačne posode	Pressure vessels
45.040	Materiali in deli za železniško tehniko	Materials and components for railway engineering
77.150.10	Aluminijski izdelki	Aluminium products

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EUROPEAN STANDARD

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Simple unfired pressure vessels designed to contain air or nitrogen - Part 4: Aluminium alloy pressure vessels designed for air braking equipment and auxiliary pneumatic equipment for railway rolling stock

Récipients à pression simples, non soumis à la flamme, destinés à contenir de l'air ou de l'azote - Partie 4 : Récipients à pression en alliages d'aluminium destinés aux équipements pneumatiques de freinage et aux équipements pneumatiques auxiliaires du matériel roulant ferroviaire

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

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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

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European foreword

This document (prEN 286-4:2019) 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.

1 Scope

1.1 This document is applicable to simple unfired aluminium alloy pressure vessels, referred to as "vessel" in this document, designed for air braking equipment and auxiliary pneumatic equipment for railway rolling stock (see 1.6).

1.2 The vessels to this document are:

a) made from a single shell;

b) made from aluminium alloy;

c) fabricated by welding;

d) used at a maximum working pressure of 10 bar;

e) the product of the maximum working pressure (in bar) and the volume (in litre): 50 bar litres < PV ≤ 10 000 bar litres;

f) made of a cylindrical part of circular cross-section called the shell with two outwardly dished torispherical ends, that is two dished ends with the same axis of rotation. This document therefore does not apply to vessels with one or two flat ends or those made up of several compartments;

g) calculated with a design pressure P (See 5.1.4.2);

h) designed for a working temperature of between −50 °C and +100 °C [+65 °C for certain grades of aluminium alloy (see 4.1.2)];

i) fastened to the vehicles by straps.

1.3 In normal service, a momentary overpressure of 1 bar of the maximum working pressure is permitted (10 % of PS).

1.4 This document applies to the vessel proper, from the inlet connection to the outlet connection and to all other connections and fittings belonging to the vessel.

1.5 This document gives the requirements to be met for the calculation, design, fabrication, inspection during fabrication and certification of the vessel, and fittings for assembly to the vehicle.

These requirements cannot be written in sufficient detail to ensure good workmanship or proper construction. Each manufacturer is therefore responsible for taking every necessary step to make sure that the quality of workmanship and construction is such as to ensure compliance with good engineering practice.

This document gives:

a) in Annex B, recommendations for assembly to the vehicles;

b) in Annex C, recommendations for the service surveillance of vessels.

1.6 The requirements of this document apply to vessels designed to be fitted to rail vehicles used on the main national networks, urban networks, underground railways, trams, private networks (regional railways, company railways, etc.).

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 ISO 2081, *Metallic and other inorganic coatings — Electroplated coatings of zinc with supplementary treatments on iron or steel (ISO 2081)*

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

EN ISO 9606-2, *Qualification test of welders — Fusion welding — Part 2: Aluminium and aluminium alloys (ISO 9606-2)*

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

EN ISO 15607, *Specification and qualification of welding procedures for metallic materials — General rules (ISO 15607)*

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

EN ISO 15614-2, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 2: Arc welding of aluminium and its alloys (ISO 15614-2)*

ISO 4520, *Chromate conversion coatings on electroplated zinc and cadmium coatings*

ISO 6362-2, *Wrought aluminium and aluminium alloys — Extruded rods/bars, tubes and profiles — Part 2: Mechanical properties*

3 Symbols

For the purposes of this document, the following symbols apply.

A	**Elongation at rupture**	**%**
A_{fb}	Cross sectional area effective as compensation, of the boss	mm^2
A_{fp}	Cross sectional area effective as compensation, of the reinforcing plate	mm^2
A_{fs}	Cross sectional area effective as compensation, of the shell	mm^2
A_p	Area of the pressurized zone	mm^2
c	Absolute value of the minus rolling tolerance for sheets as quoted in the standard	mm
D_o	Outside diameter of the shell of the vessel	mm
d_{ib}	Internal diameter of the boss	mm
d_{ob}	Outside diameter of the boss	mm
e	Nominal wall thickness	mm
e_c	Calculated thickness	mm

e_{ch}	Calculated thickness of the end	mm
e_{cs}	Calculated thickness of the shell	mm
e_h	Nominal thickness of the end	mm
e_{rb}	Wall thickness of the boss contributing to reinforcement	mm
e_{rp}	Wall thickness of the reinforcing plate contributing to reinforcement	mm
e_{rs}	Wall thickness of the shell contributing to reinforcement	mm
f	Nominal design stress at the design temperature	N/mm^2
f_b	Permitted stress of the boss	N/mm^2
g	Throat thickness of a weld	mm
h	External height of the dished part of an end (see Figure 3)	mm
h_1	Height of the cylindrical part of the end (see Figure 3)	mm
h_2	Internal height of a dished part of the end (see Figure 3)	mm
K_c	Design coefficient which is a function of the welding process	—
L	Total length of the vessel	mm
L_1	Distance between the axis of a drainage opening and the end of the vessel	mm
l_{rb}	Length of the boss contributing to reinforcement	mm
lrbi	Length of inward projecting boss contributing to reinforcement	mm
l_{rp}	Length of the reinforcing plate contributing to reinforcement, measured along the mid surface	mm
l_{rs}	Length of the shell contributing to reinforcement, measured along the mid surface	mm
P	Design pressure[1)] which is a function of the maximum working pressure, the welding process and inspection used	bar
PS	Maximum working pressure[1)]	bar
R	Internal radius of the spherical part of the end	mm
R_i	Local internal radius at the location of the opening in question	mm
R_m	Minimum tensile strength specified by the manufacturer or by the standard defining the material	N/mm^2
Rp0,2	Minimum proof stress	N/mm^2
r	Internal radius of the torispherical part of the end	mm
Tmin	Minimum working temperature	°C
Tmax	Maximum working temperature	°C
V	Volume of the vessel	litre

1) All pressures are gauge pressures.

4 Materials

4.1 Pressurized parts

4.1.1 General

The aluminium alloys used in the fabrication of the pressurized parts of the vessels shall fulfil the following conditions:

a) $R_m \leq 350$ N/mm^2;

b) elongation after rupture, *A*, shall be:

— if the test piece is taken parallel to the direction of rolling ≥ 16 %;

— if the test piece is taken perpendicular to the direction of rolling ≥ 14 %.

4.1.2 Shell and ends

The shell and ends shall be made of aluminium alloy sheet or strip of one of the grades given in Table 1.

All materials not listed in Table 1 may be used, provided they meet the requirements of 4.1, are approved by a notified body, and are manufactured in accordance with a National or International Standard.

Table 1 — Aluminium alloy materials

ISO designation [a]	**International registration record** [a]	**Temper designation** [b]	**Maximum temperature** °C	**Temperature** °C			**Design temperature** [c] °C			
				20	50	100	20	50	65	1 100
				Minimum proof stress R_{eT} N/mm^2			Minimum design stress *f* N/mm^2			
A1Mg2Mn0,8	5049	0	100	80	80	70	48	48	46 [e]	42
AlMg3	5754	0	100	80	80	70	48	48	46 [e]	42
A1Mg3Mn	5454	0	100	90	90	90	54	54	54 [e]	54 [d]
A1Mg4	5086	0	65	100	100	90 [d]	60	60	58 [e]	54 [d]
AlMg4,5Mn0,7	5083	0	65	125	125	120 [d]	75	75	74 [e]	72 [d]

[a] ISO designation and International registration record see ISO 209.

[b] Temper designation, see ISO 2107.

[c] For intermediate design temperatures linear interpolation may be used.

[d] For interpolation purposes only as temperature limit of 65 °C.

[e] Interpolated value.

4.1.3 Inspection bosses, pipes connection branches and drainage bosses

The bosses shall be made of 5083, 5086, 5454 or 5754 aluminium alloy bars or tubes in condition M in accordance with ISO 6362-2.

All materials may be used, provided they meet the requirements of 4.1, are approved by a notified body, and are manufactured in accordance with a National or International Standard.

4.2 Non-pressurized parts

The accessories to be welded to the vessel, but which do not contribute to its strength, shall be made of aluminium alloy compatible with the aluminium alloy from which the pressurized parts of the vessel are made. The product analysis of the aluminium alloy shall meet the following requirements:

— $R_m \leq 350\ N/mm^2$;

— Cu ≤ 0,5 %;

— Zn ≤ 0,25 %.

4.3 Welding materials

The filler material and gas fluxes shall be suitable for the parent metals. The recommended grades of filler material to be used are 5183 and 5356. These grades are suitable for welding the grades listed in 4.1 and 4.2.

Aluminium-silicon grades shall not be used.

The suitability of the welding products used is verified by means of the welding procedure test (see Clause 9).

5 Design

5.1 Shell and ends

5.1.1 General

The vessels are of simple geometrical form, composed of a cylindrical body of circular cross-section and two outwardly dished torispherical ends.

The design of the vessels shall take into account the installation and maintenance conditions. The installation and maintenance conditions shall be given by the manufacturer or the user.

NOTE Examples of installation and maintenance requirements are given in informative Annexes B and C.

5.1.2 Design of the shell

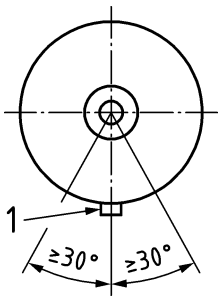
Shells are generally made from a single sheet. If the shell is made of several welded parts, the number of circular welds shall be kept to a minimum.

Longitudinal weld seams of parts of the shell shall:

— not be located on the lower part of the vessel defined by an angle of 30° on either side of the vertical axis (see Figure 1);

— be sufficiently far apart such as to form an angle greater than 40° (see example in Figure 2).

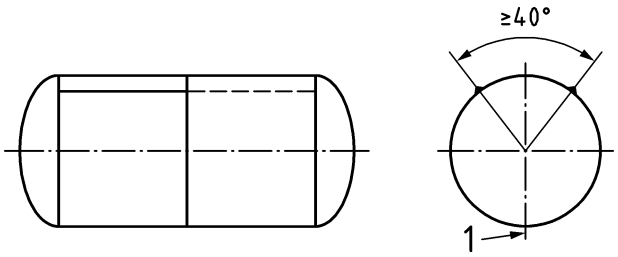
All welds, even of a temporary nature, located outside the designed seams are prohibited.



Key

1 drainage opening

Figure 1— Position of the longitudinal welds on the lower part of the shell



Key

1 drainage point or reference mark on the lower part

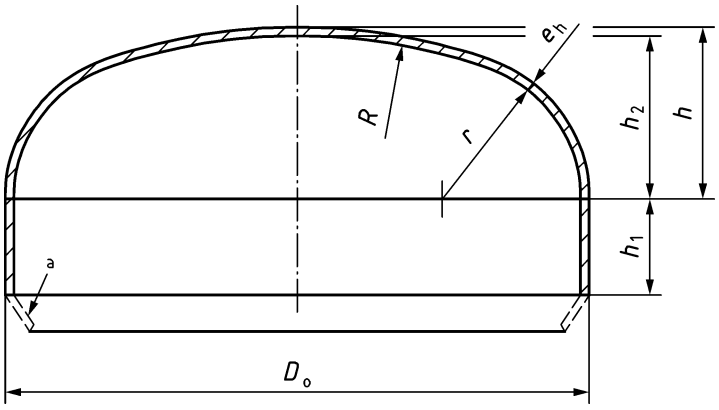
Figure 2 — Position of the longitudinal welds in the upper part of the shell

5.1.3 Design of the ends

5.1.3.1 Shape and dimensions of the ends

The torispherical ends shall be made from a single sheet. Dishing and flanging shall be carried out by a mechanical forming procedure, for example by pressing or spinning. Hand forming is not permitted.

The torispherical ends shall meet the conditions given in Figure 3.



Key

R (nominal) ≥ 0,8 D_o

r (nominal) ≥ 0,1 D_o

$h_{1min} \geq 3 \times e_h$

[a] see Figure 8

Figure 3 — Torispherical end

5.1.3.2 Heat treatment of the ends after forming

The parameters of the heat treatment to which ends are subjected after forming cannot be specified in this standard as they vary according to the following criteria:

— the grade of aluminium alloy;

— the type of oven (other than direct radiation, convection, etc.);

— the forming process (hot or cold drawing).

The heat treatment shall not affect the values of $R_{p0,2}$ and R_m used in calculating the thickness. In addition, after heat treatment the material shall satisfy the following conditions:

— tensile strength $R_m \leq 350$ N/mm^2;

— elongation after rupture $A > 16$ %.

The suitability of the heat treatment parameters shall be checked by the approved inspection body when the manufacturing record is submitted.

5.1.4 Calculation of shell and end thicknesses

5.1.4.1 General

The nominal thickness "e" of the shells and ends shall be such that:

$$e \geq e_r + c$$

The value of "e_r" shall in no case be less than 3 mm.

The manufacturer shall apply a correction to allow for thinning resulting from the manufacturing process.

5.1.4.2 Calculation of the shell thickness "e_{cs}"

$$e_{cs} = \frac{PD_o}{20f + P} \cdot K_c$$

The minimum design stress "f" is taken from Table 1.

NOTE It has been established from the standards quoted in this part that 0,3 R_m is always greater than 0,6 $R_{p0,2}$.

For materials not listed in Table 1, the following applies:

For the calculated design stress "f", one of the two values 0,6 R_{eT} or 0,3 R_m from the relevant material standard is used, whichever is less.

The values of P and K_c to be taken into account are:

a) Case no. 1: $P \geq 1{,}15\,PS$ and $K_c = 1$ for automatic welding and when tests are carried out in accordance with 11.1.3.1;

b) Case no. 2: $P \geq 1{,}3\,PS$ and $K_c = 1$ for automatic welding and when tests are carried out in accordance with 11.1.3.2;

c) Case no. 3: $P \geq 1{,}25\,PS$ and $K_c = 1{,}15$ for welding using a non-automatic process and when tests are carried out according to 11.1.2.

5.1.4.3 Calculation of the thickness of the ends "e_{ch}"

The end thickness shall be calculated in the following manner:

a) select the values of f from Table 1, and with $P = PS$, calculate $P/(10\,f)$;

b) calculate h_e/D_o with h_e the smaller of the three values:

$$h, \quad \frac{D_o^2}{4\left(R + e_{ch}\right)}$$

and

$$\sqrt{\frac{D_o\left(r + e_{ch}\right)}{2}}$$

where

$e_{ch} = e_{cs}$;

$$h = e_h + h_2 = e_h + R - \sqrt{\left(R - r\right)^2 - \left(D_o\,/\,2 - e_h - r\right)^2}$$

(take $e_h = e_{cs} + 0{,}3$).