

SLOVENSKI STANDARD oSIST prEN 286-4:2019

01-november-2019

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

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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 Materials and components

tehniko for railway engineering

77.150.10 Aluminijski izdelki Aluminium products

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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

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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.

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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

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Cont	ents	Page
Europ	ean foreword	5
1	Scope	6
2	Normative references	7
3	Symbols	7
4	Materials	
4.1	Pressurized parts	
4.1.1	General	
4.1.2 4.1.3	Shell and endsInspection bosses, pipes connection branches and drainage bosses	
4.2	Non-pressurized parts	
4.3	Welding materials	10
5	Design	10
5.1	Shell and ends	
5.1.1 5.1.2	General Design of the shell	10 10
5.1.3	Design of the shell	11
5.1.4	Calculation of shell and end thicknesses	12
5.1.5 5.2	OpeningsOpenings	
5.2.1	General OSIST nrFN 286-4-2019	17
5.2.2	Holes for bosses https://standards.iteh.ai/catalog/standards/sist/fad6ce8c-8fbd-4c96-98f9-	17
5.2.3 5.2.4	Calculation of the opening reinforcement osist-pren-286-4-2019	
	Welding of bosses	
6	Inspection and drainage bosses	
7 7.1	Marking	
7.1 7.2	General Marking stamped in the metal of the vessel	
7.3	Marking stamped on a plate	
7.4	Identity and service marks	
8	Corrosion protection	
8.1	GeneralProtection of internal walls	
8.2 8.3	Protection of internal walls	
9	Welding procedure test	
10	Qualification of welders, welding operators and welding inspectors	
11	Testing of the vessels	28
11.1	Testing of welds by the manufacturer	
	GeneralWelds made by non-automatic welding	
	Fields made by an automatic process	
11.1.4	Destructive testing of welds on coupon plates	32
	X-rays	
11.1.6	Acceptance criteria for welds	32

, ,	
•	
Delivery	36
Operating instructions	36
A (normative) Pressure cycling operation	37
B (informative) Assembly to the vehicles	38
General	38
Fixing	38
Fixing straps	42
General	42
Fixing by two straps	42
Fixing by a single strap	42
Insulating tapes	42
Mounting	43
General	43
Fixing by two straps. S.T.A.N.D.A.R.D. P.R.F.V.IF.V.	43
Fixing by a single strap of the	43
Pipe connections	44
Protection of the drainage mechanism 286-42019	44
C (informative) Service surveillance of vessels 4.2019.	45
General	45
Vessels used at: <i>PS</i> ≤ 6 bar	45
Vessels used at: 6 bar < PS ≤ 10 bar	45
External inspection	46
Cleaning	46
Examination of marking	46
Inspection of the walls	46
Deformation and irregularities	46
.1 General	46
.2 Dished ends	46
.3 Shell wall	47
Other cases leading to rejection of the vessel	47
Detailed inspection and hydrostatic test	48
	Finish of longitudinal and circular joints. Dimensional inspection Pressure test. Delivery Operating instructions A (normative) Pressure cycling operation. B (informative) Assembly to the vehicles General Fixing straps General Fixing by two straps Fixing by a single strap Insulating tapes Mounting General Fixing by two straps Fixing by a single strap Fixing by a single strap Fixing by a single strap (standardistictival) Pipe connections. Protection of the drainage mechanism Protection of the drainage mechanism General Vessels used at: PS ≤ 6 bar Vessels used at: 6 bar < PS ≤ 10 bar External inspection Cleaning Examination of marking Inspection of the walls Deformation and irregularities 1 General 2 Dished ends 3 Shell wall Corrosion Other cases leading to rejection of the vessel Inspection of the fixings Internal examination Detailed inspection and hydrostatic test

oSIST prEN 286-4:2019

prEN 286-4:2019 (E)

C.6.2 Detailed inspection	48
C 6 2.1 Canaral	
C.O.Z.1 General	48
C.6.2.2 Preparation	
C.6.2.3 Internal and external inspection	48
C.6.3 Hydrostatic test	48
C.6.4 Return to service	48
C.7 Analysis of the results of the annual sampling on 1 % of the population of a specific type of vessel	49
C.8 Withdrawal of vehicles or devices to which the vessel is fitted	49
C.9 Special cases of vessels fitted to a series of vehicles being phased out, vehicles intended for a museum, or vehicles kept in service for historical reasons	49
C.10 Rejection	49
C.11 Filing of results of examination, inspections and tests	49
C.12 Responsibilities	49
Annex ZA (informative) Relationship between this European Standard and the essential requirements of Directive 2014/29/EU aimed to be covered	50
Bibliography(standards.iteh.ai)	51

oSIST prEN 286-4:2019 https://standards.iteh.ai/catalog/standards/sist/fad6ce8c-8fbd-4c96-98f9-24b8f6b90ff4/osist-pren-286-4-2019

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.

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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 $< PV \le 10\,000$ 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 5.14.2); ARD PREVIEW
- 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)];

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- i) fastened to the vehicles by straps ds. iteh.ai/catalog/standards/sist/fad6ce8c-8fbd-4c96-98f9-24b8f6b90ff4/osist-pren-286-4-2019
- **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	$^{\rm mm^2}$
A_{fp}	Cross sectional area effective as compensation, of the reinforcing plate	$^{\rm mm^2}$
A_{fs}	Cross sectional area effective as compensation, of the shell	mm^2
$A_{\mathbf{p}}$	Area of the pressurized zone	$^{\rm mm^2}$
c	Absolute value of the minus rolling tolerance for sheets as quoted in the standard	mm
$D_{\mathbf{O}}$	Outside diameter of the shell of the vessel	mm
d_{ib}	Internal diameter of the boss	mm
$d_{\mathbf{ob}}$	Outside diameter of the boss	mm
e	Nominal wall thickness	mm
e_{C}	Calculated thickness	mm

Calculated thickness of the end	mm
Calculated thickness of the shell	mm
Nominal thickness of the end	mm
Wall thickness of the boss contributing to reinforcement	mm
Wall thickness of the reinforcing plate contributing to reinforcement	mm
Wall thickness of the shell contributing to reinforcement	mm
Nominal design stress at the design temperature	N/mm ²
Permitted stress of the boss	N/mm ²
Throat thickness of a weld	mm
External height of the dished part of an end (see Figure 3)	mm
Height of the cylindrical part of the end (see Figure 3)	mm
Internal height of a dished part of the end (see Figure 3)	mm
Design coefficient which is a function of the welding process	_
Total length of the vessel	mm
Distance between the axis of a drainage opening and the end of the vessel	mm
Length of the boss contributing to reinforcement	mm
Length of inward projecting boss contributing to reinforcement	mm
Length of the reinforcing plate contributing to reinforcement, measured along the mid surface	emm
Length of the shell contributing to reinforcement, measured along the mid surface	mm
Design pressure ¹⁾ which is a function of the maximum working pressure, th welding process and inspection used	ebar
Maximum working pressure ¹⁾	bar
Internal radius of the spherical part of the end	mm
Local internal radius at the location of the opening in question	mm
Minimum tensile strength specified by the manufacturer or by the standar defining the material	d _{N/mm} 2
Minimum proof stress	N/mm ²
Internal radius of the torispherical part of the end	mm
Minimum working temperature	°C
Maximum working temperature	°C
Volume of the vessel	litre
	Calculated thickness of the end Nominal thickness of the boss contributing to reinforcement Wall thickness of the boss contributing to reinforcement Wall thickness of the shell contributing to reinforcement Wall thickness of the shell contributing to reinforcement Nominal design stress at the design temperature Permitted stress of the boss Throat thickness of a weld External height of the dished part of an end (see Figure 3) Height of the cylindrical part of the end (see Figure 3) Internal height of a dished part of the end (see Figure 3) Design coefficient which is a function of the welding process Total length of the vessel Distance between the axis of a drainage opening and the end of the vessel Length of the boss contributing to reinforcement Length of inward projecting boss contributing to reinforcement Internal height of the reinforcing plate contributing to reinforcement, measured along the mid surface Length of the shell contributing to reinforcement, measured along the mid surface Length of the shell contributing to reinforcement, measured along the mid surface Length of the shell contributing to reinforcement, measured along the mid surface Length of the shell contributing to reinforcement, measured along the mid surface Length of the shell contributing to reinforcement, measured along the mid surface Length of the shell contributing to reinforcement, measured along the mid surface Length of the shell contributing to reinforcement, measured along the mid surface Length of the shell contributing to reinforcement, measured along the mid surface Length of the shell contributing to reinforcement, measured along the mid surface Length of the shell contributing to reinforcement, measured along the mid surface Length of the shell contributing to reinforcement, measured along the mid surface Length of the shell contributing to reinforcement measured along the mid surface Length of the shell contributing to reinforcement measured along the mid surface Length of the shell contribut

 $^{^{1)}}$ 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) $R_{\rm m} \le 350 \, \rm N/mm^2$;
- b) elongation after rupture, *A*, shall be:
 - if the test piece is taken parallel to the direction of rolling \geq 16 %;
 - if the test piece is taken perpendicular to the direction of rolling $\geq 14 \%$.

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.

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Table 1—Aluminium alloy materials

		(standa	ards.iteh.a	Temperature °C		Design temperature ^C				
ISO	International	rds.i Temper log/	stan Maximum 6ce	8c- 20 bd	-450-	98100	20	50	65	1 100
designation ^a	registration record ^a	designation b	vo temperature 20 °C	Minimum proof stress R _{eT}			Minimum design stress f			
				N/mm ²		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:

- $R_{\rm m} \le 350 \,\rm N/mm^2$;
- $Cu \le 0.5 \%$;
- $Zn \le 0.25 \%$.

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.

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Aluminium-silicon grades shall not be used. (Standards.iteh.ai)

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

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5 Design

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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.

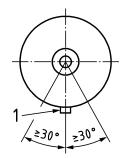
5.1.2 Design of the shell

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).

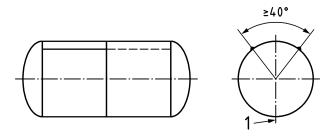
All welds, even of a temporary nature, located outside the designed seams are prohibited.



Key

1 drainage opening

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



Key

drainage point or reference mark on the lower part

(standards.iteh.ai)

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

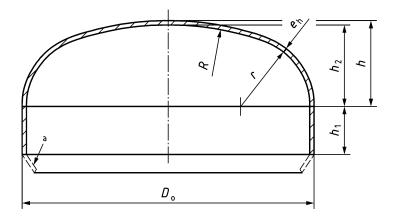
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5.1.3 Design of the ends standards.iteh.ai/catalog/standards/sist/fad6ce8c-8fbd-4c96-98f9-24b8f6b90ff4/osist-pren-286-4-2019

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

 $R \text{ (nominal)} \ge 0.8 D_0$ $r \text{ (nominal)} \ge 0.1 D_0$ $h_{1\text{min}} \ge 3 \times e_h$ a see Figure 8

Figure 3 — Torispherical end iTeh STANDARD PREVIEW

5.1.3.2 Heat treatment of the ends after forming (Standards.iteh.ai)

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: 2019

- https://standards.iteh.ai/catalog/standards/sist/fad6ce8c-8fbd-4c96-98f9the grade of aluminium alloy; 24b8f6b90ff4/osist-pren-286-4-2019
- 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 $R_{\rm m} \le 350 \,\mathrm{N/mm^2}$;
- 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:

$$e \ge e_r + c$$

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 " $e_{\rm CS}$ "

$$e_{\rm cs} = \frac{PD_{\rm o}}{20\,f + P} \cdot K_{\rm c}$$

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 $R_{
m m}$ 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 $R_{\rm eT}$ or 0,3 $R_{\rm m}$ from the relevant material standard is used, whichever is less.

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

- Case no. 1: $P \ge 1,15 \, PS$ and $K_C = 1$ for automatic welding and when tests are carried out in accordance with 11.1.3.1;
- b) Case no. 2: $P \ge 1.3$ PS and $K_C = 1$ for automatic welding and when tests are carried out in accordance with 11.1.3.2; iTeh STANDARD PREVIEW
- c) Case no. 3: $P \ge 1,25$ PS and $R_C = 1,15$ for welding using a non-automatic process and when tests are carried out according to 11.1.2.

 $\textbf{5.1.4.3 Calculation of the thickness of the ends designation} \\ \textbf{24b8f6b90ff4/osist-pren-286-4-2019}$

The end thickness shall be calculated in the following manner:

- select the values of f from Table 1, and with P = PS, calculate P/(10 f);
- calculate h_e/D_0 with h_e the smaller of the three values:

$$h, \frac{D_0^2}{4(R+e_{\rm ch})}$$

and

$$\sqrt{\frac{D_{\rm o}\left(r+e_{\rm ch}\right)}{2}}$$

where

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

$$h = e_{\rm h} + h_2 = e_{\rm h} + R - \sqrt{\left(R - r\right)^2 - \left(D_{\rm o} / 2 - e_{\rm h} - r\right)^2}$$

$$(take e_h = e_{CS} + 0.3).$$