**SLOVENSKI STANDARD**
**SIST EN 16932-3:2018**

**01-junij-2018**

**Nadomešča:**
**SIST EN 1091:2000**
**SIST EN 1671:1998**

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**Sistemi za odvod odpadne vode in kanalizacijo zunaj stavb - Črpalni sistemi - 3. del: Vakuumski sistemi**

Drain and sewer systems outside buildings - Pumping systems - Part 3: Vacuum systems



Entwässerungssysteme außerhalb von Gebäuden - Pumpsysteme - Teil 3: Unterdruckentwässerungssysteme



Réseaux d'évacuation et d'assainissement à l'extérieur des bâtiments - Systèmes de pompage - Partie 3 : Systèmes sous vide

**Ta slovenski standard je istoveten z:** **EN 16932-3:2018**

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**ICS:**

| | | |
|---|---|---|
| 93.030 | Zunanji sistemi za odpadno vodo | External sewage systems |

**SIST EN 16932-3:2018** **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

# EN 16932-3

April 2018

ICS 93.030

Supersedes EN 1091:1996, EN 1671:1997

English Version

# Drain and sewer systems outside buildings - Pumping systems - Part 3: Vacuum systems

Réseaux d'évacuation et d'assainissement à l'extérieur des bâtiments - Systèmes de pompage - Partie 3: Systèmes sous vide

Entwässerungssysteme außerhalb von Gebäuden - Pumpsysteme - Teil 3: Unterdruckentwässerungssysteme

This European Standard was approved by CEN on 22 January 2018.

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. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists 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.



CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.



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

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Ref. No. EN 16932-3:2018 E

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# European foreword

This document (EN 16932-3:2018) has been prepared by Technical Committee CEN/TC 165 “Waste water engineering”, the secretariat of which is held by DIN.

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 October 2018, and conflicting national standards shall be withdrawn at the latest by October 2018.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN not be held responsible for identifying any or all such patent rights.

Together with EN 16932-1:2018 and EN 16932-2:2018, this document will supersede EN 1091:1996 and EN 1671:1997.

EN 16932:2018, *Drain and sewer systems outside buildings — Pumping systems*, contains the following parts:

— *Part 1: General requirements*;

— *Part 2: Positive pressure systems*;

— *Part 3: Vacuum systems*.



According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

# 1 Scope

This European Standard specifies requirements for design, construction and acceptance testing of wastewater pumping systems in drain and sewer systems outside the buildings they are intended to serve. It includes pumping systems in drain and sewer systems that operate essentially under gravity as well as systems using either positive pressure or partial vacuum.

This document is applicable to vacuum drain and sewer systems.

# 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 476, *General requirements for components used in drains and sewers*

EN 16323:2014, *Glossary of wastewater engineering terms*

EN 16932-1:2018, *Drain and sewer systems outside buildings — Pumping systems — Part 1: General requirements*

EN 16932-2:2018, *Drain and sewer systems outside buildings — Pumping systems — Part 2: Positive pressure systems*



EN 16933-2, *Drain and sewer systems outside buildings — Design — Part 2: Hydraulic design*



# 3 Terms and definitions



For the purposes of this document, the terms and definitions given in EN 16323, in EN 16932-1 and the following apply.

ISO and IEC maintain terminological 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

Note 1 to entry: Certain key definitions from EN 16323:2014 have been repeated below for clarity. The following additional terms used in this document are defined in EN 16323:

collection tank;

domestic wastewater;

extraneous flow;

gradient;

gravity system;

infiltration;

maintenance;

non-domestic wastewater;

pumping station;

relevant authority;

rising main;

runoff;

self-cleansing;

sewer;

sewer system.

Note 2 to entry: The following terms used in this standard are defined in EN 16932-1:

collection chamber;

level sensor;

controller;

forwarding pump;

interface valve;

pump unit;

slope section;

vacuum generator;

vacuum pipeline;

lift section;

profile;

pump;

vacuum drain;

vacuum sewer;

vacuum station,

vacuum vessel.

**3.1**
**air/water ratio (AWR)**
ratio of the air volume at standard temperature and pressure to the volume of wastewater

**3.2**
**batch volume**
wastewater volume in a collection tank that is removed during an evacuation cycle

**3.3**
**foul wastewater**
wastewater comprising domestic wastewater and/or industrial wastewater

[SOURCE: EN 16323:2014, 2.1.2.6]



**3.4**
**interface valve unit**
valve and controller in a collection chamber admitting wastewater and air into a vacuum sewer through a vacuum drain



**3.5**
**length specific population density**
total population connected to a vacuum sewer, including its branches, divided by the length of the vacuum sewer, not including side branches

**3.6**
**surface water**
water from precipitation, which has not seeped into the ground and is discharged to the drain or sewer system directly from the ground or from exterior building surfaces

[SOURCE: EN 16323:2014, 2.1.1.3]

**3.7**
**vacuum recovery time**
time taken, after the operation of an interface valve, for the sub-atmospheric pressure at the valve to be restored to a value sufficient to operate the valve again

**3.8**
**wastewater**
water composed of any combination of water discharged from domestic, industrial or commercial premises, surface run-off and accidentally any sewer infiltration water

[SOURCE: EN 16323:2014, 2.3.10.65]

# 4 Symbols and units

| | |
|---|---|
| $AWR$ | air/water ratio, dimensionless [-] |
| $D$ | internal diameter of the pipe (bore) in metres [m] |
| $D_i$ | internal diameter of the pipe (bore) in section i (each section extending from a high point to the next downstream high point), in metres [m] |
| $f_A$ | maximum start frequency of the vacuum pump per hour [1/h] |
| $f_W$ | maximum start frequency of the forwarding pump per hour [1/h] |
| $g$ | acceleration due to gravity, in metres per second squared [m/s$^2$] |
| $H_p$ | total head at the pump unit, in metres [m] |
| $h_R$ | maximum hydrostatic head difference at a lift section, in metres [m] |
| $\Sigma h_R$ | maximum hydrostatic head difference along the connected vacuum pipelines, in metres [m] |
| $J_{2,i}$ | gradient of the slope section in section I, dimensionless [-] |
| $L_1$ | length of the lift section, in metres [m] |
| $L_2$ | length of the slope section, in metres [m] |
| $L_{1,i}$ | length of the lift section at the end of section I, in metres [m] |
| $L_{VS}$ | length of the vacuum sewer, in metres [m] |
| $N_A$ | number of vacuum pumps |
| $N_{WW}$ | number of forwarding pumps |
| $P_A$ | power consumption of the vacuum pumps, in Watts [W] |
| $P_{WW}$ | power consumption of the forwarding pumps, in Watts [W] |
| $p_{aa}$ | ambient air pressure, in kilopascals [kPa]; |
| $p_{iv}$ | absolute pressure at the interface valve, in kilopascals [kPa] which is typically a value of 75 kPa |
| $p_{max}$ | maximum absolute pressure in the vacuum vessel, in kilopascals [kPa] |
| $p_{min}$ | minimum absolute pressure in the vacuum vessel, in kilopascals [kPa] |
| $Q_A$ | maximum air flow at standard temperature and pressure, in litres per second [l/s] |
| $Q_{A.p}$ | capacity of each vacuum pump at standard temperature and pressure, in litres per second [l/s] |
| $Q_{A,p,s}$ | suction capacity of the vacuum pump at the average working pressure of the system, in litres per second [l/s] |
| $Q_{WW}$ | design wastewater flow, in litres per second [l/s] |
| $Q_{WW,in}$ | incoming wastewater flow rate, in litres per second [l/s] |
| $Q_{WW,p}$ | capacity of each forwarding pump, in litres per second [l/s]. |

$Q_{WW,fl}$ flow of the flushed wastewater, in litres per second [l/s]

$R$ minimum bending radius of a vacuum pipeline, in metres [m]

$SF$ safety factor between 1,2 and 1,5.

$t_{fl}$ flushing time, in seconds [s];

$V_A$ minimum volume in the vacuum vessel provided for air, in litres [l]

$V_{AS}$ allowance for the storage volume in the vacuum sewer, which is no more than half of the volume of those last slope sections of the vacuum sewers, along which the maximum hydrostatic pressure difference is less than $p_{max} - p_{min}$.

$V_{min}$ minimum volume of the vacuum vessel, in litres [l]

$V_{vs}$ internal volume of the vacuum sewer, in litres [l];

$V_W$ minimum volume provided for wastewater in the vacuum vessel, in litres [l]

$WWR_{max}$ maximum wastewater ratio in the vacuum sewers, dimensionless [-]

$z$ lift height of a lift section, in metres [m]

$\eta_A$ efficiency of the vacuum pump units, dimensionless [-]

$\eta_{WW}$ efficiency of the wastewater forwarding pump units, dimensionless [-]

$\kappa_A$ adiabatic coefficient of air = 1,4, dimensionless [-]

$\rho$ density of wastewater, in kilogrammes per cubic metre [kg/m$^3$]



# 5 General

This European Standard shall be read in conjunction with EN 16932-1. Vacuum systems shall comply with the requirements of EN 16932-1 as well as the requirements of this European Standard.

# 6 Planning vacuum sewer systems

## 6.1 Basis of design

Foul wastewater flow rates into the vacuum system shall be established in accordance with EN 16933-2. The design peak, the minimum and the 24 h average foul wastewater flow rates shall be established. Infiltration and other extraneous water flows shall also be taken into account. The designer shall state the average air and water flows for which the system is designed, the peak flow (litres per second) used in the design and how the dynamic and static head losses have been calculated.

Where a vacuum system intercepts wastewater from a gravity or pressure system or accepts wastewater from commercial or industrial sites, the design performance criteria shall be specified, including the peak flow.

## 6.2 Location of collection chambers

The decision on whether each property has its own collection chamber or whether properties have common collection chambers should take account of:

a) the costs;

b) the ease of identifying the-origin of any debris causing a blockage;

c) the levels of the incoming drains; and

d) the available space.

Collection chambers should be located close to the properties served in order to keep the lengths of drain pipes to the chambers short. They can be located on private property (particularly where each property is served by an individual collection chamber) or on public ground (e.g. in streets or footways). However, they shall always be accessible for maintenance by the operator of the vacuum system unless an isolation valve is provided on the vacuum drain in an accessible location.

The type and costs of chambers shall be considered, e.g. whether they need to have watertight frames and covers, and whether they need to bear traffic load.

## 6.3 Route and profile of vacuum pipelines

The route and profile of vacuum drains and sewers should be planned taking account of the following:

a) the numbers and locations of the collection chambers (see 6.2);

b) avoiding up-hill movement of wastewater where possible;

c) minimizing the length of the vacuum pipelines;

d) avoiding obstacles (e.g. ditches, watercourses, major roads, railways) where possible;

e) maintaining a minimum 1:500 downslope gradient in the slope sections. However, this minimum gradient should be increased where normal construction tolerances (see Clause 11) cannot be achieved, for example when using trenchless construction methods;



f) short radius bends (R < 3 × DN) should be avoided;



g) limiting the height of each lift section to no more than 1,5 m - a series of smaller lifts is preferable to a single high lift;

h) limiting the distance between lift sections to no less than 6 metres on vacuum sewers and 1,5 m on vacuum drains;

i) maintaining self-cleansing conditions in the vacuum pipeline.

Where a wave profile is used the minimum length of a lift section should be (see Formula (1)):

$$L_1 > 2 \cdot \sqrt{z \cdot R} \quad (1)$$

where

$L_1$ is the length of the lift vsection in metres [m];

$R$ is the minimum bending radius of a vacuum pipeline in metres [m];

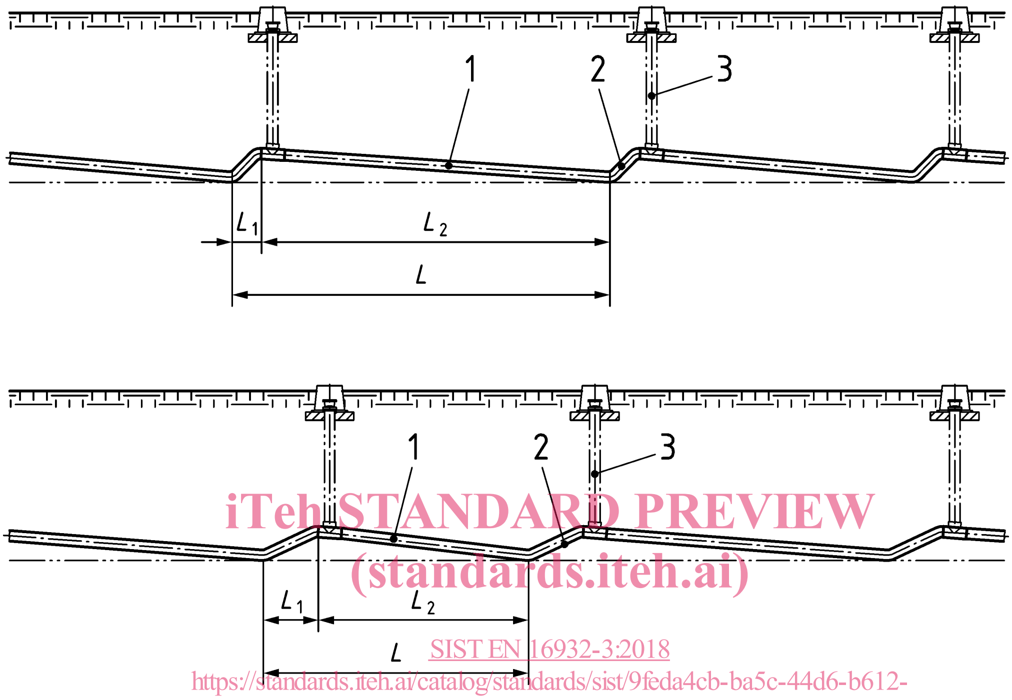
$z$ is the height of the lift section in metres [m].

Self cleaning conditions can be maintained by limiting the distances between lift sections to ensure the flow is deep enough to flush the solids through the slope sections. Where the distance between lift sections is longer than 150 m the designer should demonstrate how self-cleansing conditions will be maintained.

Where inspection pipes are provided (see 8.3 and Figure 3) the distance between them is typically not more than 100 m.

Either a saw-tooth profile or a wave profile can be used. The saw-tooth profile (see Figure 1, upper diagram) has straight downslope sections and steep lift sections and is typically formed using bend fittings. The wave profile (see Figure 1, lower diagram) is typically formed by bending flexible pipes. The saw-tooth profile is easier to install than the wave profile as in the wave profile the high and low points need to be secured in place. However, the head losses in the wave profile are significantly less than in the saw-tooth profile.

Examples of the profile of vacuum pipelines are shown in Figures 1 to 3.






**Key**

| | | | |
|---|---|---|---|
| 1 | slope section with minimum 1:500 gradient | $L_1$ | length of lift section |
| 2 | lift section | $L_2$ | length of slope section with minimum 1:500 gradient |
| 3 | inspection pipe (optional) | L | distance between low points ($L = L_1 + L_2$) |

**Figure 1 — Examples of vacuum sewer profiles (not to scale) – the upper diagram shows a saw-tooth profile and the lower diagram a wave profile**