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**Non-sewered sanitation systems —  
Prefabricated integrated treatment  
units — General safety and  
performance requirements for design  
and testing**

*Systèmes d'assainissement autonomes — Unités de traitement  
intégrées préfabriquées — Exigences générales de performance et de  
sécurité pour la conception et les essais*

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Project Committee ISO/PC 305, *Sustainable non-sewered sanitation systems*.

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Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).

## Introduction

It is estimated that 2,3 billion people do not have access to basic sanitation systems. The devastating consequences of the lack of sanitation facilities include an estimated 1,8 billion people globally using a source of drinking water that is faecally contaminated and 361 000 children under 5 years of age dying per year, primarily from dysentery-like diarrhoeal diseases.

In March 2013, the United Nations (UN) issued a global call to action to eliminate the practice of open defecation by 2025. The UN and regional sanitation leaders have concluded that areas where open defecation is common have the highest levels of child death and disease, as a result of ingesting human faecal matter that has entered the food or water supply. A lack of safe, private sanitation is also associated with the highest overall levels of malnutrition, poverty, and disparity between rich and poor, and makes women and girls more vulnerable to violence.

On 1st January 2016, the 17 UN Sustainable Development Goals (SDG) were launched, including SDG 6: ensure access to water and sanitation for all. The SDGs are a set of goals to end poverty, protect the planet, and ensure prosperity for all as part of the new UN sustainable development agenda.

Targets 6.2 and 6.3 of SDG 6 state:

- by 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations;
- by 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally.

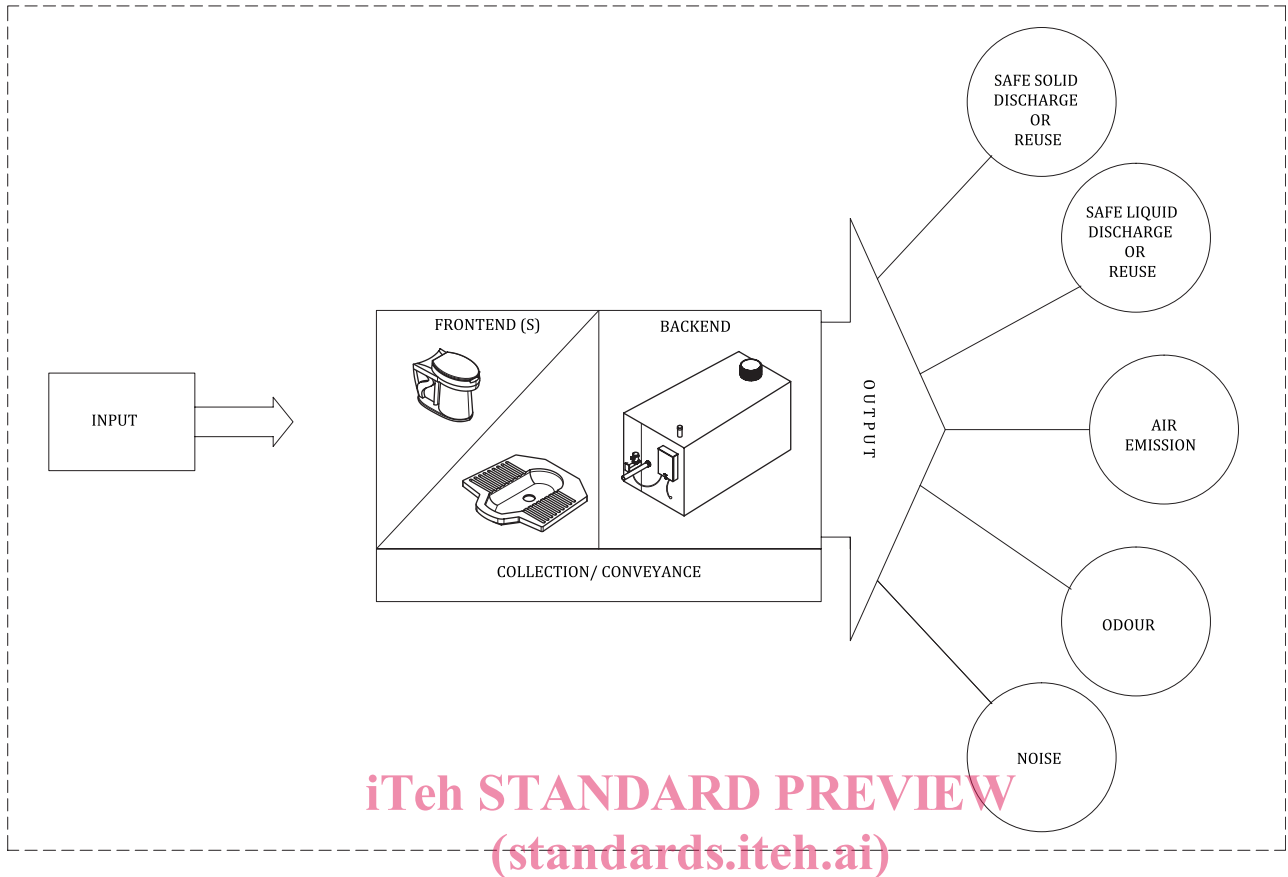
In this context, the purpose of this document is to support the development of stand-alone sanitation systems designed to address basic sanitation needs and promote economic, social, and environmental sustainability through strategies that include minimizing resource consumption (e.g. water, energy) and converting human excreta to safe output.

This document is intended to promote the implementation of sanitation systems where increased sustainability is desired, or where traditional sanitary sewer systems are unavailable or impractical and thus, to ensure human health and safety as well as protecting of the environment.

However, this document does not attempt to exhaustively address sustainability concerns with respect to non-sewered sanitation systems (NSSS). There are many aspects to sustainability that are not covered in this document.

The concept of a NSSS is indicated in [Figure 1](#), showing the integration of the frontend(s) and backend(s) along with the input and output. Inputs entering the NSSS primarily comprise of human faeces and urine, menstrual blood, bile, flushing water, anal cleansing water, toilet paper, other bodily fluids/solids. Outputs substances exiting the NSSS include the products of the backend treatment process such as solid output and effluent, as well as noise, air, and odour emissions.

By design, such sanitation systems operate without connection to any sewer or drainage network. The NSSS can be either manufactured as one package or manufactured as a set of prefabricated elements designed to be assembled without further fabrication or modification that influences the system function. The prefabricated components of NSSS are intended to require minimal work to be integrated and quickly provide fully functioning sanitation systems.



**Figure 1 — Concept of a non-sewered sanitation system**

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In NSSS, the frontend includes user interfaces such as a urinal, squatting pan, or sitting pan, which may apply evacuation mechanisms ranging from conventional flush, pour flush, and dry toilets to novel evacuation mechanisms such as those employing mechanical forces requiring little to no water. Conventional and novel evacuation mechanisms may be combined with urine diversion applications (e.g. urine diversion flush toilet, urine diversion dry toilet). Backend treatment technologies and processes of NSSS range from biological or chemical to physical unit processes (e.g. anaerobic and aerobic digestion, combustion, electrochemical disinfection, membranes). Some systems use only one of these technologies or processes while others apply various unit processes in combination through several treatment units.



# Non-sewered sanitation systems — Prefabricated integrated treatment units — General safety and performance requirements for design and testing

## 1 Scope

This document specifies general safety and performance requirements for design and testing as well as sustainability considerations for non-sewered sanitation systems (NSSS). A NSSS, for the purposes of this document, is a prefabricated integrated treatment unit, comprising frontend (toilet facility) and backend (treatment facility) components that

- a) collects, conveys, and fully treats the specific input within the system, to allow for safe reuse or disposal of the generated solid, liquid, and gaseous output, and
- b) is not connected to a networked sewer or networked drainage systems.

This document is applicable to sanitation systems that are either manufactured as one package, or manufactured as a set of prefabricated elements designed to be assembled in one location without further fabrication or modification that influences the system function. The plane or surface (e.g. flooring, concrete pad) upon which a fully assembled NSSS is situated is beyond the scope of this document. This document is not applicable to sanitation systems constructed *in situ*.

This document also covers NSSS backend components that are designed to be integrated with one or more specified frontends.

Although this document is primarily applicable to the development of sanitation systems that are not connected to water and electricity networks, it can also be applied to systems that can utilize water mains and/or electricity.

This document defines the basic treatable input as primarily human excreta and gives options for extending the range of input substances. Requirements for the quality of the outputs from the sanitation system are given for solid and liquid discharges as well as odour, air, and noise emissions.

It contains criteria for the safety, functionality, usability, reliability, and maintainability of the system, as well as its compatibility with environmental protection goals.

This document does not encompass the following aspects:

- guidelines for selection, installation, operation and maintenance, and management of sanitation systems;
- transportation of treated output outside of the sanitation system (e.g. manual transport, transportation by truck or trunk pipes) for further processing, reuse, or disposal;
- treatment processes taking place at another location separate from that of the frontend and backend components;
- reuse and disposal of sanitation system output.

## 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.

## ISO 30500:2018(E)

ISO 20816-1, *Mechanical vibration — Measurement and evaluation of machine vibration — Part 1: General guidelines*

ISO/IEC 17065:2012, *Conformity assessment — Requirements for bodies certifying products, processes and services*

IEC 60942:2017, *Electroacoustics — Sound calibrators*

IEC 61260-1:2014, *Electroacoustics — Octave-band and fractional-octave-band filters — Part 1: Specifications*

IEC 61672-1:2013, *Electroacoustics — Sound level meters — Part 1: Specifications*

EN 997:2012, *WC pans and WC suites with integral trap*

EN 13725:2003, *Air quality — Determination of odour concentration by dynamic olfactometry*

EPA Method 1A, *Sample and Velocity Traverses for Stationary Sources with Small Stacks or Ducts*

NSF/ANSI 41:2011, *Non-liquid saturated treatment systems*

WHO Guidelines for Drinking Water Quality, 4th edition

### 3 Terms, definitions and abbreviated terms

#### 3.1 Terms and definitions

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For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

#### 3.1.1 System structure

##### 3.1.1.1

##### non-sewered sanitation system

##### NSSS

system that is not connected to a networked sewer, and collects, conveys, and fully treats the specific *input* (3.1.2.1) to allow for safe reuse or disposal of the generated solid *output* (3.1.2.2) and/or *effluent* (3.1.2.7)

Note 1 to entry: For the purposes of this document, a NSSS that fully treats the specific input is a NSSS that meets the performance testing requirements specified in [Clause 7](#).

##### 3.1.1.2

##### evacuation mechanism

mechanism that delivers energy/movement to convey the *input* (3.1.2.1) from the *frontend* (3.1.1.3) to the *backend* (3.1.1.4) of the *non-sewered sanitation system* (3.1.1.1), such as conventional flushing mechanisms, pour flush, dry, and novel mechanisms

##### 3.1.1.3

##### frontend

any user interface such as urinal, squatting or seat pan of a *non-sewered sanitation system* (3.1.1.1) employed for human defecation and urination, including the *evacuation mechanism* (3.1.1.2) and all system components that are clearly visible to the user

#### 3.1.1.4 backend

combined set of system components encompassing the physical assets used to treat the *input* (3.1.2.1) entering the system via the *frontend* (3.1.1.3) in order to allow for the safe reuse or disposal of the generated *output* (3.1.2.2)

#### 3.1.1.5 superstructure

additional structure added to or integrated with the *non-sewered sanitation system* (3.1.1.1) in order to provide shelter or privacy to users

### 3.1.2 System inputs and outputs

#### 3.1.2.1 input

substances entering the *non-sewered sanitation system* (3.1.1.1) primarily comprising human *faeces* (3.1.2.4) and *urine* (3.1.2.3), menstrual blood, bile, flushing water, anal cleansing water, toilet paper, other bodily fluids/solids and, in some systems, additional input as defined by the manufacturer

EXAMPLE Examples of additional input may include water from hand washing, menstrual hygiene products, organic household waste.

#### 3.1.2.2 output

substances exiting the *non-sewered sanitation system* (3.1.1.1), which include the products of the backend treatment process [solid output and *effluent* (3.1.2.7)] as well as noise, air, and odour emissions

Note 1 to entry: The output can be reusable product, a direct output to the environment, or a residual waste.

#### 3.1.2.3 urine

liquid product of the human excretory system produced by the kidneys and expelled through the urethra via urination (i.e. micturition)

#### 3.1.2.4 faeces

excreta products of the human digestive system, including microorganisms

#### 3.1.2.5 excreta

waste products of human metabolism, in solid or liquid form, generally *urine* (3.1.2.3) and/or *faeces* (3.1.2.4)

[SOURCE: ISO 24521:2016, 3.3]

#### 3.1.2.6 diarrhoea

loose, watery *faeces* (3.1.2.4), often resulting from viral, parasitic protozoan, bacterial, or helminth infection

#### 3.1.2.7 effluent

treated liquid discharged from the *backend* (3.1.1.4)

#### 3.1.2.8 chemical and biological additives

substances added to the *non-sewered sanitation system* (3.1.1.1) either to support the treatment process or to clean the system, including, but not limited to, chemical substances and/or biological agents

EXAMPLE Deodorants, bactericides, bacteriostats, microbiocides, chemical reactants, surfactants, or enzymatic agents.

3.1.2.9

**energy supply**

energy from electrical grid, photovoltaic, or other sources (e.g. mechanical storages, pressurized air reservoirs or windmills) that powers the *non-sewered sanitation system* (3.1.1.1)

3.1.2.10

**electrical energy**

energy derived from an electric current, which can be supplied by a variety of means such as connection to upstream electric power grid, batteries, or photovoltaic systems

3.1.3 System safety and integrity

3.1.3.1

**hazard**

source or situation with a potential for harm in terms of human injury or ill health (both short and long term), damage to property, environment, soil and vegetation, or a combination of these

[SOURCE: ISO 30000:2009, 3.4, modified — “soil and vegetation” has been added.]

3.1.3.2

**risk**

combination of the probability of occurrence of harm and the severity of that harm

[SOURCE: ISO 12100:2010, 3.12]

3.1.3.3

**risk analysis**

systematic use of available information to identify hazards (3.1.3.1) and to estimate the risk (3.1.3.2)

[SOURCE: ISO/IEC Guide 51:2014, 3.10]

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3.1.3.4

**risk evaluation**

judgment, on the basis of *risk analysis* (3.1.3.3), of whether the risk reduction objectives have been achieved

[SOURCE: ISO 12100:2010, 3.16]

3.1.3.5

**risk assessment**

overall process comprising a *risk analysis* (3.1.3.3) and a *risk evaluation* (3.1.3.4)

[SOURCE: ISO 12100:2010, 3.17]

3.1.3.6

**guard**

physical barrier, designed as part of a *non-sewered sanitation system* (3.1.1.1) to provide protection

[SOURCE: ISO 12100:2010, 3.27, modified — The word “machine” has been replaced by “non-sewered sanitation system”.]

3.1.3.7

**safe state**

operating mode of a *non-sewered sanitation system* (3.1.1.1) with an acceptable level of *risk* (3.1.3.2) for users and professional service personnel

Note 1 to entry: The safe state mode protects the user or service personnel by preventing potentially hazardous conditions (e.g. in the event of a malfunction or following intentional stoppage).

[SOURCE: ISO 25119-1:2010, 3.43, modified — The word “system” has been replaced by “non-sewered sanitation system”, “for users and professional service personnel” and the note have been added.]

**3.1.3.8****exposed material**

material used within the *non-sewered sanitation system* (3.1.1.1) that comes into contact with human *urine* (3.1.2.3) or *faeces* (3.1.2.4), or intermediate products and residual waste in the course of operation of the system

**3.1.3.9****water tightness**

ability of the closed *non-sewered sanitation system* (3.1.1.1) to resist water penetration and prevent leakage

[SOURCE: ISO 15821:2007, 3.6, modified — The term “test specimen” has been replaced by “non-sewered sanitation system”, “and prevent leakage” has been added.]

**3.1.3.10****technical tightness**

inherent characteristics of a *non-sewered sanitation system* (3.1.1.1) that prevents hazardous fluids, gases, or suspended particulate matter from passing from the external environment through to the processing/treatment internal environment, or from the processing/treatment internal environment to the external environment, or both

Note 1 to entry: The sanitation system or components thereof are considered technically tight if the leakage rate does not exceed 0,001 Pa·l/s.

Note 2 to entry: Subsystems, components, or boundaries that require technical tightness are to be identified in the safety assessment (see 5.1).

**3.1.3.11****strength safety factor**

ratio between the load or pressure limit at the material yield strength and the limit load (or pressure)

Note 1 to entry: The strength safety factor prevents structures from experiencing fractures, deformation, and fatigue.

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**3.1.3.12****proven**

demonstrated through testing and validation, systematic analysis of operational experience, or other suitable qualification methods to be safe, effective, and reliable for the intended use

**3.1.4 System use and impact****3.1.4.1****intended use**

use of a *non-sewered sanitation system* (3.1.1.1) in accordance with the information for use provided in the instructions and the design limits of the manufacturer

**3.1.4.2****reasonably foreseeable misuse**

use of a *non-sewered sanitation system* (3.1.1.1) in a way not intended by the supplier, but which may result from readily predictable human behaviour

Note 1 to entry: Behaviours of interest include incorrect operation of the system such as overuse, inappropriate activation of mechanical and electrical controls, improper maintenance and depositing inappropriate materials into the frontend.

[SOURCE: ISO/IEC Guide 51:2014, modified — The term “product or system” has been replaced by “non-sewered sanitation system”, Notes have been deleted and a new Note 1 to entry has been added.]

**3.1.4.3  
sustainability**

state of the global system, including environmental, social, and economic aspects, in which the needs of the present are met without compromising the ability of future generations to meet their own needs

[SOURCE: ISO Guide 82:2014, 3.1]

**3.2 Abbreviated terms**

BL	Batch liquid
BS	Batch solid
CAPEX	Capital expenditure
CFU	Colony-forming units
COD	Chemical oxygen demand
EMC	Electromagnetic compatibility
EPA	US Environmental Protection Agency
GHG	Greenhouse gas
HACCP	Hazard analysis and critical control point
HAZOP	Hazard and operability study
IP	Ingress protection
LRV	Log reduction values
MOP	Maximum operating pressure
NIOSH	National Institute of Occupational Safety and Health
NPV	Net present value
OPEX	Operating expense
OSHA	Occupational Safety and Health Administration
PFU	Plaque-forming units
PL	Periodic liquid
PS	Periodic solid
PSLC	Product safety life cycle
SSF	Strength safety factors
TSS	Total suspended solids
UN	United Nations

UNICEF	United Nations Children's Emergency Fund
VOC	Volatile organic compound
WHO	World Health Organization

## 4 General requirements

### 4.1 User requirements

The NSSS shall be designed in such a way as to ensure that the users can use the system safely and in the manner intended by the manufacturer. The design and implementation of the system shall ensure that users with little or no literacy or those who do not have technical expertise are able to safely and effectively use the system frontend and perform routine user maintenance as intended by the manufacturer.

NOTE Additional requirements for specific users, such as persons with disabilities and small children, are provided, for example, in Reference [26], Reference [33] and Reference [40].

### 4.2 Metric system

Design and construction of NSSS shall be specified in International System of Units of measurement.

### 4.3 Design capacity **ITeH STANDARD PREVIEW** (standards.iteh.ai)

#### 4.3.1 Treatable input

NSSS shall be capable of treating, at a minimum, human faeces and urine, menstrual blood, bile, flushing water, anal cleansing water, toilet paper, and other bodily fluids/solids. Manufacturers may identify additional categories of input as acceptable for treatment, such as water from hand washing, menstrual hygiene products, and/or organic household waste.

#### 4.3.2 Treatment capacity

The design capacity with regard to human faeces and urine shall be indicated as expected uses per day (faecal uses/day and urine uses/day). The average amount of faeces (kg/use) and urine (l/use) per use shall be determined as the basis for capacity calculations and shall be clearly indicated. Additionally, the expected daily capacity for further input (such as water, menstrual hygiene products and organic waste) shall be indicated by the manufacturer (in units such as kg/day or l/day).

EXAMPLE Reference [25] measured the average faecal production rate as 250 g/person/day to 350 g/person/day for low income countries, 250 g/person/day for urban low-income settings and 350 g/person/day for rural low-income settings, and found general urine production rates for adults to be 1,0 l/person/day to 1,3 l/person/day.

#### 4.3.3 Menstrual hygiene products

If the system is intended to accept menstrual hygiene products separately from other system inputs, then the provisions and instructions for the safe operation and maintenance of the disposal mechanism or device shall be provided. Cultural norms, existing practices and aspirations regarding the disposal of menstrual hygiene products shall be considered (see D.4 and E.4).

#### 4.3.4 Overload protection

A reasonable safety factor shall be incorporated into the design and indicated by the manufacturer in order to prevent overload. In order to indicate when the system is nearing maximum capacity (design capacity plus safety factor) the system shall be equipped with a visual and/or audible mechanism