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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 ~~générales~~ pour la conception et les essais

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Foreword

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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 document 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).

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

This second edition cancels and replaces the first edition (ISO 30500:2018), which has been technically revised.

The main changes are as follows:

— Clause 2 normative references have been updated;

— Clause 3 terms and definitions have been updated;

— technical information throughout the document has been aligned with the state of art;

— the bibliography has been updated.

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.

Introduction

It is estimated that 1,5 billion people do not have access to basic sanitation systems. The devastating consequences of the lack of sanitation facilities include an estimated 2,0 billion people globally using a source of drinking water that is faecally contaminated, and in March of 2024, the World Health Organization (WHO) reported that around 444,000 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. However, by 2018, the plan to end open defecation had been extended to 2030 and beyond. Although open defecation is often associated with low-income regions, it is also an increasing problem in urban areas of higher-income regions, where the provision of public toilets has been reduced for economic reasons.[158 ~~[158].~~] 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 1 January 2016, the 17 UN Sustainable Development Goals (SDG) were launched, including SDG 6: ~~ensure~~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 May 2024, the UN released the report *United Nations System-Wide Strategy for Water and Sanitation*, which highlighted that progress on SDG 6 was ~~"~~"off-track~~',~~." To accelerate progress, the report identifies five Global Accelerators, including innovation.[156~~Innovation [156].~~] In this context, the purpose of this document is to support the development of stand-alone sanitation systems designed to address sanitation needs while promoting economic, social, and environmental sustainability through strategies that include minimizing resource consumption (e.g. water, energy) and converting human excreta to safe output.

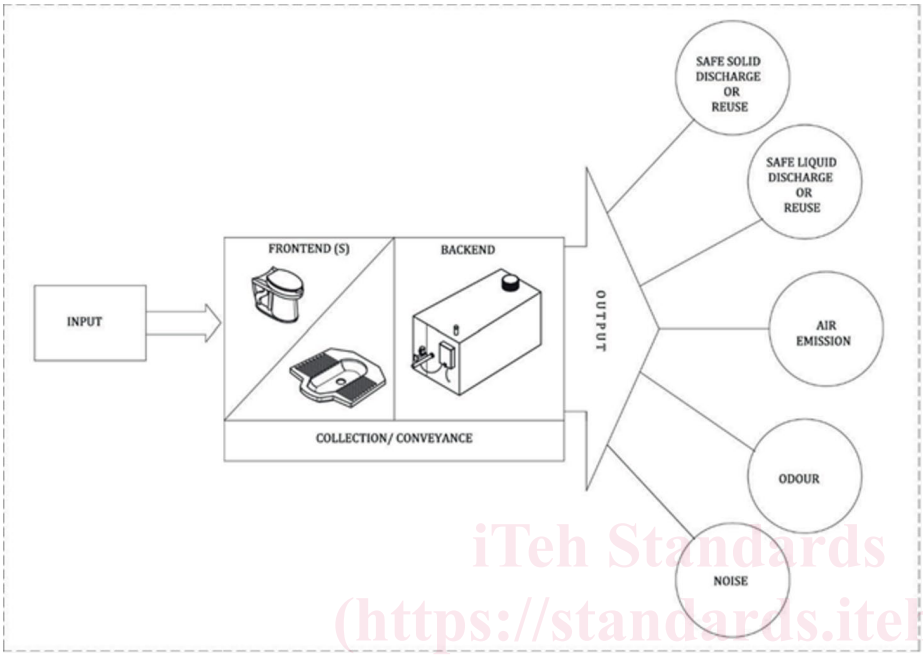
This document is intended to promote the development and implementation of prefabricated integrated treatment units as non-sewered sanitation systems (NSSS), notably where other sanitation systems are not cost effective, unavailable or impractical. This aims to ensure human health and safety as well as protecting the environment.

However, this document does not attempt to exhaustively address sustainability concerns with respect to NSSS.

The concept of the NSSS is indicated in Figure 1~~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, and 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, NSSS operate without being connected to a networked sewer or networked drainage systems. The NSSS can be either manufactured as one package or manufactured as a set of prefabricated components

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.



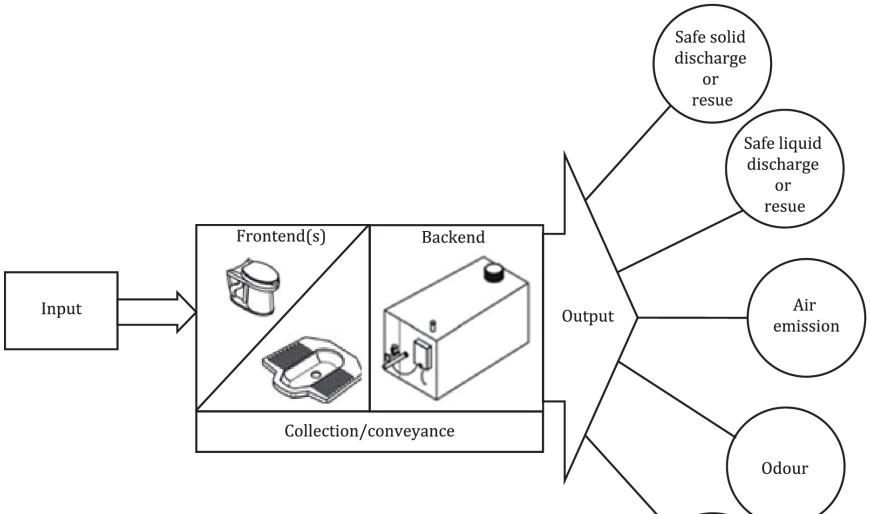


Figure 1 — Concept of a NSSS

In NSSS, the frontend includes user interfaces such as a urinal, squatting pan, or sitting pan, which ~~may~~can 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~~can 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 ~~may~~can use only one of these technologies or processes while others ~~may~~can 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 limited sustainability considerations such as recovery of nutrients, water consumption and reuse, energy consumption and recovery, and a life cycle assessment for non-sewered sanitation systems (NSSS).

This document is applicable to NSSS that are either manufactured as one package, or manufactured as a set of prefabricated components designed to be assembled in one location without further fabrication or modification that influences the NSSS function.

An NSSS, for the purposes of this document, is a prefabricated integrated treatment unit, comprising frontend (toilet facility) and backend (treatment facility) components that:

a) ~~a)~~ collects, conveys and fully treats the specific input within the NSSS, to allow for safe reuse or disposal of the generated solid and liquid outputs, and the safe emission of air, noise and odour outputs;

b) ~~b)~~ is designed to operate without being connected to a networked sewer or networked drainage systems.

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

This document is primarily intended for NSSS that are designed to operate without being connected to water and electricity networks. However, it may also be applied to systems that utilize supplies of either water or electricity, or both.

This document defines the basic treatable input as primarily human excreta and gives options for extending the range of input substances. Requirements for the protection of human health and the environment are provided by the specified quality of the outputs, and recirculated water, if any.

This document provides 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 cover the following aspects:

— ~~—~~guidelines for selection, installation, operation and maintenance, and management of NSSS;

— ~~—~~requirements for the amount or type of energy or resources to recover;

— ~~—~~transportation of treated output outside of the NSSS (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;

— ~~—~~external reuse and disposal of NSSS output;

— —the plane or surface (e.g. flooring, concrete pad) upon which a fully assembled NSSS is situated;

— —NSSS constructed in situ without prefabricated parts.

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

IEC 60942, *Electroacoustics — Sound calibrators*

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

EN 997:2018, *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 Potable Water Reuse (Potable reuse: Guidance for producing safe drinking-water,2017)*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

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

— —ISO Online browsing platform: available at https://www.iso.org/obp

— —IEC Electropedia: available at https://www.electropedia.org/

3.1.1 System components

3.1.1.1 ~~3.1.1.1~~
non-sewered sanitation system
NSSS
prefabricated integrated treatment unit that is designed to operate without being connected to a networked sewer or networked drainage systems, and collects, conveys, and fully treats the specific *input* (3.1.2.1~~(3.1.2.1)~~) to allow for safe reuse or disposal of either the generated solid *output* (3.1.2.2~~(3.1.2.2)~~) or *effluent* (3.1.2.7~~(3.1.2.7)~~), or both

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~~Clause 7~~.

3.1.1.2 ~~3.1.1.2~~
evacuation mechanism
mechanism that delivers energy/movement to convey the *input* (3.1.2.1~~(3.1.2.1)~~) from the *frontend* (3.1.1.3~~(3.1.1.3)~~) to the *backend* (3.1.1.4~~(3.1.1.4)~~) of the *non-sewered sanitation system* (3.1.1.1~~(3.1.1.1)~~)

Note 1 to entry: Evacuation mechanisms include conventional flushing mechanisms, pour flush, dry and novel mechanisms.

3.1.1.3 ~~3.1.1.3~~
frontend
any user interface of a *non-sewered sanitation system* [3.1.1.1(~~3.1.1.1~~)] employed for human defecation and urination, including the *evacuation mechanism* [3.1.1.2(~~3.1.1.2~~)]

Note 1 to entry: Examples of a front end include urinal, squatting or seat pan.

3.1.1.4 ~~3.1.1.4~~
backend
combined set of system components encompassing the physical parts used to treat the *input* [3.1.2.1(~~3.1.2.1~~)] entering the system via the *frontend* [3.1.1.3(~~3.1.1.3~~)] in order to allow for the safe reuse or disposal of the generated *output* [3.1.2.2(~~3.1.2.2~~)]

3.1.1.5 ~~3.1.1.5~~
superstructure
additional structure added to or integrated with the *non-sewered sanitation system* [3.1.1.1(~~3.1.1.1~~)]

Note 1 to entry: A superstructure provides shelter and privacy to the user.

Note 2 to entry: A superstructure can house the *backend* [3.1.1.4(~~3.1.1.4~~).].

3.1.2 System inputs and outputs

3.1.2.1 ~~3.1.2.1~~
input
substances entering the *non-sewered sanitation system* [3.1.1.1(~~3.1.1.1~~)]

Note 1 to entry: Inputs primarily comprise human *faeces* [3.1.2.4(~~3.1.2.4~~)] and *urine* [3.1.2.3(~~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.

Note 2 to entry: During controlled laboratory testing, the input may include an *alternative feedstock* [3.1.2.13(~~3.1.2.13~~)].

Note 3 to entry: Examples of additional input may include water from hand washing, menstrual hygiene products, organic household waste.

3.1.2.2 ~~3.1.2.2~~
output
substances exiting the *non-sewered sanitation system* [3.1.1.1(~~3.1.1.1~~),], which include the products of the backend treatment process

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

3.1.2.3 ~~3.1.2.3~~
urine
liquid product of the human excretory system produced by the kidneys and expelled through the urethra via urination

Note 1 to entry: Urination is also known as micturition.

3.1.2.4 ~~3.1.2.4~~
faeces
excreta products of the human digestive system

3.1.2.5 ~~**3.1.2.5**~~
excreta
waste products of human metabolism, in solid or liquid form, generally urine or faeces, or both

[SOURCE: ISO 24513:2019, 3.2.2.2.4]

3.1.2.6 ~~**3.1.2.6**~~
diarrhoea
condition in which *faeces* {3.1.2.4(~~3.1.2.4~~)} are discharged from the bowels frequently and in a liquid form

Note 1 to entry: Diarrhoea often results from viral, parasitic protozoan, bacterial, or helminth infection.

3.1.2.7 ~~**3.1.2.7**~~
effluent
treated liquid discharged from the *backend* {3.1.1.4(~~3.1.1.4~~)} into the environment

3.1.2.8 ~~**3.1.2.8**~~
recirculated water
treated liquid for internal reuse within the *non-sewered sanitation system* {3.1.1.1(~~3.1.1.1~~)}

Note 1 to entry: Recirculated water is often reused at the frontend for flushing.

3.1.2.9 ~~**3.1.2.9**~~
chemical and biological additives
substances added to the *non-sewered sanitation system* {3.1.1.1(~~3.1.1.1~~)} either to support the treatment process or to clean the system

Note 1 to entry: Chemical and biological additives include, but are not limited to, chemical substances or biological agents, or both.

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

3.1.2.10 ~~**3.1.2.10**~~
energy supply
energy from an electrical grid, photovoltaic, or other sources that powers the operation of the *non-sewered sanitation system* {3.1.1.1(~~3.1.1.1~~)}

EXAMPLE mechanical storages, pressurized air reservoirs or windmills

3.1.2.11 ~~**3.1.2.11**~~
electrical energy
energy derived from an electric current

Note 1 to entry: Electrical energy can be supplied by a variety of means including connection to upstream electric power grid, batteries, or photovoltaic systems.

3.1.2.12 ~~**3.1.2.12**~~
personal hygiene products
consumable products that are intended to maintain body cleanliness

Note 1 to entry: Personal hygiene products include, but are not limited to, diapers, wipes, and incontinence products.

3.1.2.13 ~~**3.1.2.13**~~
alternative feedstock
input {3.1.2.1(~~3.1.2.1~~)} used to simulate real human *faeces* {3.1.2.4(~~3.1.2.4~~)} and *urine* {3.1.2.3(~~3.1.2.3~~)} used during controlled laboratory testing of the *non-sewered sanitation system* {3.1.1.1(~~3.1.1.1~~)~~3.1.2.14~~}

3.1.2.14
toilet paper
base paper taken from the tissue machine before conversion (typically between 30~~±~~ ± 10 g/m2) tissue paper intended for sanitary use after using the toilet

Note 1 to entry: Products labelled as "moist toilet paper" are often made from non-woven material and therefore not in the scope of this document.

3.1.3 System safety and integrity

3.1.3.1 ~~**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 ~~**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 ~~**3.1.3.3**~~
risk analysis
systematic use of available information to identify *hazards* (3.1.3.1(~~3.1.3.1~~)) and to estimate the *risk* (3.1.3.2(~~3.1.3.2~~))

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

3.1.3.4 ~~**3.1.3.4**~~
risk evaluation
judgment, on the basis of *risk analysis* (3.1.3.3(~~3.1.3.3~~)), of whether the risk reduction objectives have been achieved

[SOURCE: ISO 12100:2010, 3.16]

3.1.3.5 ~~**3.1.3.5**~~
risk assessment
overall process comprising a *risk analysis* (3.1.3.3(~~3.1.3.3~~)) and a *risk evaluation* (3.1.3.4(~~3.1.3.4~~))

[SOURCE: ISO 12100:2010, 3.17]

3.1.3.6 ~~**3.1.3.6**~~
guard
physical barrier, designed as part of a *non-sewered sanitation system* (3.1.1.1(~~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 ~~**3.1.3.7**~~
safe state
operating mode of a *non-sewered sanitation system* (3.1.1.1(~~3.1.1.1~~)) with an acceptable level of *risk* (3.1.3.2(~~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~~2018, 3.43, modified — The word “system” has been replaced by “NSSS”, “for users and professional service personnel" and the note to entry have been added.]

3.1.3.8 ~~**3.1.3.8**~~
exposed material
material used within the *non-sewered sanitation system* (3.1.1.1(~~3.1.1.1~~)) that comes into contact with human *urine* (3.1.2.3(~~3.1.2.3~~)) or *faeces* (3.1.2.4(~~3.1.2.4~~),), or intermediate products and residual waste in the course of operation of the system

3.1.3.9 ~~**3.1.3.9**~~
water tightness
ability of the closed *non-sewered sanitation system* (3.1.1.1(~~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 “NSSS”, “and prevent leakage” has been added.]

3.1.3.10 ~~**3.1.3.10**~~
technical tightness
inherent characteristics of a *non-sewered sanitation system* (3.1.1.1(~~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: Subsystems, components, or boundaries that require technical tightness are to be identified in the safety assessment (see 5.1~~5.1~~).).

3.1.3.11 ~~**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.

3.1.3.12 ~~**3.1.3.12**~~
proven
demonstrated through testing and validation, systematic analysis of operational experience, or other suitable verification methods to be safe, effective, and reliable for the intended use

3.1.3.13 ~~**3.1.3.13**~~
maximum capacity
the treatment capacity plus a safety factor specified by the manufacturer

3.1.4 System use and impact

3.1.4.1 ~~**3.1.4.1**~~
intended use
use of a *non-sewered sanitation system* (3.1.1.1(~~3.1.1.1~~)) in accordance with the information for use provided in the instructions and the design limits specified by the manufacturer

3.1.4.2 ~~**3.1.4.2**~~
reasonably foreseeable misuse
use of a *non-sewered sanitation system* (3.1.1.1(~~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.