



BSI Standards Publication

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

National foreword

This British Standard is the UK implementation of ISO 30500:2025. It supersedes BS ISO 30500:2018, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee B/505, Wastewater engineering.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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**International
Standard**

ISO 30500

**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 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).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

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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.

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] 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 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] 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](#), 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 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.

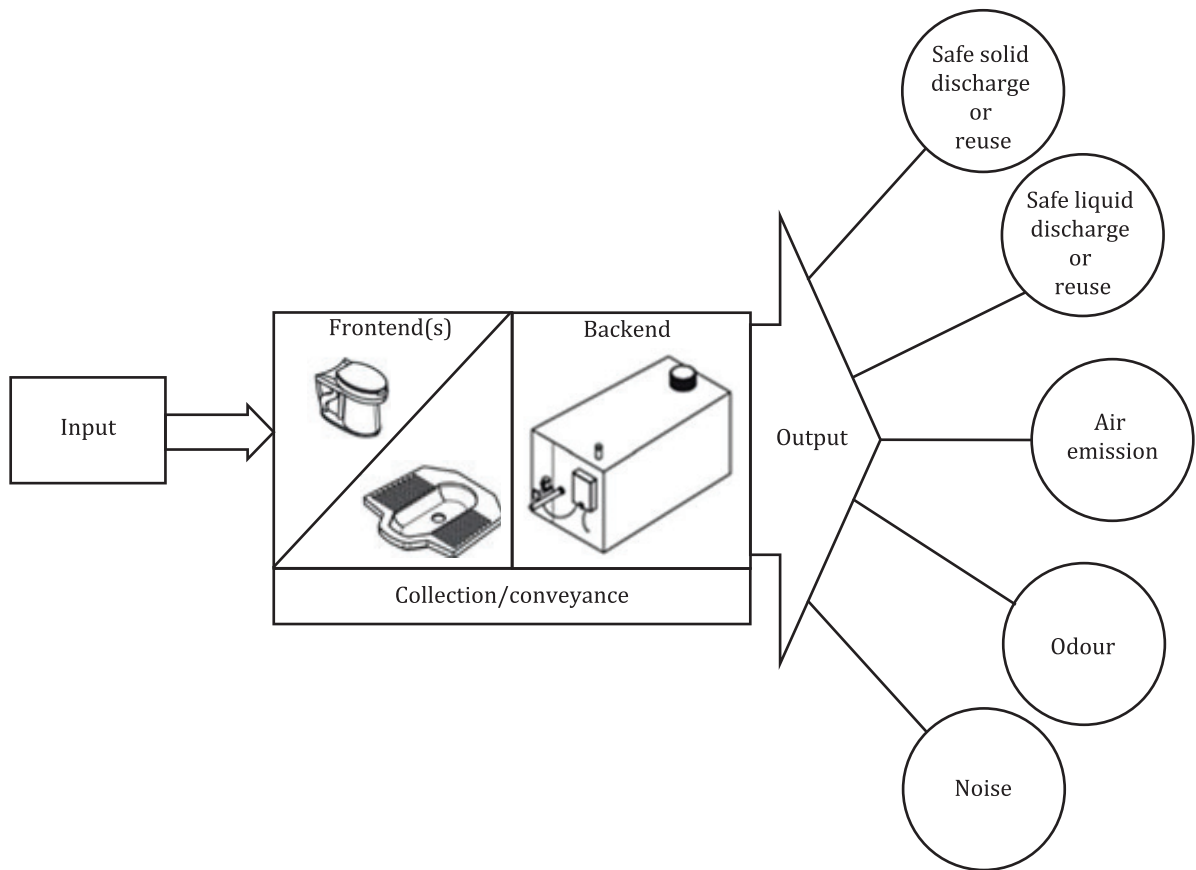


Figure 1 — Concept of a NSSF

In NSSF, the frontend includes user interfaces such as a urinal, squatting pan, or sitting pan, which 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 can be combined with urine diversion applications (e.g. urine diversion flush toilet, urine diversion dry toilet). Backend treatment technologies and processes of NSSF range from biological or chemical to physical unit processes (e.g. anaerobic and aerobic digestion, combustion, electrochemical disinfection, membranes). Some systems can use only one of these technologies or processes while others 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) 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) 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

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) to allow for safe reuse or disposal of either the generated solid *output* (3.1.2.2) or *effluent* (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](#).

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)

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

3.1.1.3

frontend

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

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

3.1.1.4 backend

combined set of system components encompassing the physical parts 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)

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).

3.1.2 System inputs and outputs

3.1.2.1 input

substances entering the *non-sewered sanitation system* (3.1.1.1)

Note 1 to entry: Inputs primarily comprise 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.

Note 2 to entry: During controlled laboratory testing, the input may include an *alternative feedstock* (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 output

substances exiting the *non-sewered sanitation system* (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 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 faeces

excreta products of the human digestive system

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 diarrhoea

condition in which *faeces* (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 effluent

treated liquid discharged from the *backend* (3.1.1.4) into the environment

3.1.2.8

recirculated water

treated liquid for internal reuse within the *non-sewered sanitation system* ([3.1.1.1](#))

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

3.1.2.9

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

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

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](#))

EXAMPLE mechanical storages, pressurized air reservoirs or windmills

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

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

alternative feedstock

input ([3.1.2.1](#)) used to simulate real human *faeces* ([3.1.2.4](#)) and *urine* ([3.1.2.3](#)) used during controlled laboratory testing of the *non-sewered sanitation system* ([3.1.1.1](#))

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]

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 25119-1:2018, 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

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 “NSSS”, “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: 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.

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

maximum capacity

the treatment capacity plus a safety factor specified by the manufacturer

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 specified by 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, 3.7, modified — The term “product or system” has been replaced by “NSSS”, Notes have been deleted and a new Note 1 to entry has been added.]

3.1.4.3

surface water

water which flows over, or rests on, the surface of a land mass

[SOURCE: ISO 6107:2021, 3.553]

3.1.4.4

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 82:2019, 3.1, modified — Notes to entry have been deleted.]

3.1.4.5

reasonably practicable

level that represents the point, at which the time, trouble, difficulty, and cost of further improvements become unreasonably disproportionate to the benefit obtained

[SOURCE: ISO/TS 16901:2022, 3.1, modified — The term “reduction” has been replaced by “improvements”.]

3.1.4.6

normal operating state

condition of a fully functioning *non-sewered sanitation system* (3.1.1.1), with no alarms activated, subjected to the anticipated typical loading frequency, and operating within any specified parameters of temperature, atmospheric pressure, humidity and location

3.2 Abbreviated terms

ATCC	American Type Culture Collection
BL	batch liquid
BOD	biological/biochemical oxygen demand
BS	batch solid
CAPEX	capital expenditure

ISO 30500:2025(en)

CFU	colony-forming units
COD	chemical oxygen demand
EMC	electromagnetic compatibility
EPA	US Environmental Protection Agency
FMEA	failure mode effects analysis
FMECA	failure mode effects and criticality analysis
GHG	greenhouse gas
HACCP	hazard analysis and critical control point
HAZOP	hazard and operability study
IP	ingress protection
LRV	log reduction values
MPN	most probable number
MOP	maximum operating pressure
NIOSH	US National Institute of Occupational Safety and Health
NPV	net present value
NSSS	non-sewered sanitation systems
OPEX	operating expense
OSHA	US Occupational Safety and Health Administration
PAH	polycyclic aromatic hydrocarbons
PCU	platinum colour units
PFU	plaque-forming units
PL	periodic liquid
PPBV	parts per billion by volume
PPMV	parts per million by volume
PS	periodic solid
PSLC	product safety life cycle
Pt-Co	platinum-cobalt colour
SSF	strength safety factors
TN	total nitrogen
TP	total phosphorous
TS	total solids

TSS	total suspended solids
UN	United Nations
UNICEF	United Nations Children's Emergency Fund
VOC	volatile organic compound
VS	volatile solids
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 NSSS 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. The frontend should be user acceptable and hygienic.

NOTE 1 Additional guidance for specific users, such as persons with disabilities and small children, are provided, for example, in Reference [26], Reference [33] and Reference [40].

NOTE 2 Additional design considerations are found in [Annex E](#).

4.2 Metric system

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

4.3 Design capacity and operability

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 and hand cleaning agents, menstrual and personal hygiene products, 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 (defecation events/day and urination events/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 additional categories of 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 [75] 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.

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 NSSS is nearing maximum capacity (design capacity plus safety factor) the NSSS shall be equipped with a visual and audible mechanism indicating to the user that the NSSS is overloaded and therefore not usable. The determination of the safety factor should take into account the possibility of infrequent multi-person or multi-family events. Should overload occur, the system shall enter into a safe state that prevents any hazards due to overload (see [A.3.8.6](#)).

4.3.5 Operability following non-usage

The NSSS shall remain operable after a period of system non-usage of 60 h or more without causing malfunctions or requiring additional efforts to resume operation that exceed normal operating procedures.

Non-usage is when there is no intentional shut down of the NSSS by the user. In addition, the system is not used nor has had any human interaction for a period of 60 h or more.

4.3.6 Operability following short-term shutdown

Following restart after a short-term shutdown specified by the manufacturer, the NSSS shall be able to immediately accept input and return to normal operating state.

4.3.7 Operability following long-term shutdown

The NSSS manufacturer shall provide precise instructions for preparing the NSSS for long-term shutdown (i.e. more than 60 h). The instructions shall describe the procedures for achieving safe and stable system shutdown conditions.

The manufacturer shall clearly indicate the duration of time necessary to complete the long-term shutdown process. The long-term shutdown process should not require more than 10 h for completion. Required user interaction during shutdown should be minimized.

Following restart after long-term shutdown, the NSSS shall be able to immediately accept input and be capable to return to normal operating state within the time specified by the manufacturer.

4.3.8 Continuous use

The NSSS shall allow continuous use without unreasonable waiting times. Waiting time shall not exceed 10 minutes between uses. The manufacturer shall specify the minimum wait time between uses in the user manual or as part of the equipment label or data plate.

4.3.9 Safe state

Means of indication (visual or audible) or instruction to determine if the NSSS is in a safe state (see [3.1.3.7](#)) shall be provided by the manufacturer.

4.4 Performance requirements

4.4.1 General

The NSSS shall be such that when operated, maintained and used, the requirements in [4.4.2](#) to [4.4.5](#) are met under all operating conditions (see [4.8](#)).

4.4.2 Solid output, effluent and recirculated water requirements

Input shall be fully treated within the NSSS allowing for safe reuse or disposal. At all times including the start-up and restart period, solid output shall meet [7.2.9.3](#) and effluent and recirculated water shall meet [7.2.9.4](#) when tested in accordance with [A.3.4](#).

4.4.3 Odour emissions requirements

In order to minimize odour emissions from the NSSS, the requirements in [7.2.9.5](#) shall be met when tested in accordance with [A.3.5](#).

NOTE Potential origins of odour emissions from the NSSS include faecal odours (faeces and urine, aging of faeces and urine, and system parts contaminated by usage), and process odours such as those formed during processing, e.g. drying, pyrolysis, combustion, etc. and discharge of output.

4.4.4 Noise requirements

Noise emissions from the NSSS shall not pose risks to the health and psychological wellbeing of the user. When tested in accordance with [A.3.7](#), the NSSS shall meet the requirements specified in [7.2.9.6](#).

4.4.5 Air emissions requirements

Potential air emissions from NSSS may be classified as pollutants or explosive gases. The monitoring of explosive gases during operation is addressed in [4.12.2](#). Air pollutants from the NSSS released indoors and outdoors shall not exceed a level that poses risks to the health of the user. When tested in accordance with [A.3.6](#), NSSS shall meet the requirements specified in [7.2.9.7](#).

The design of the NSSS (frontend and backend) shall be such that emissions of bioaerosols and endotoxins are minimized. For NSSS with a backend that discharges directly in the indoor environment, and where bioaerosol or endotoxins, or both, can reasonably be expected, testing for pathogenic bioaerosols and for endotoxins is recommended.

4.5 Expected design lifetime

NSSS shall be designed for a serviceable life of a minimum of 10 years, at the loading rates or frequency stipulated by the manufacturer, assuming use and maintenance according to the manufacturer's specifications. Maintenance requirements are specified in [4.14](#) and user manual requirements are specified in [Annex C](#).

4.6 Ergonomic design

NSSS should be designed not only for functionality but also for comfort. The NSSS should also be designed to be aesthetically pleasing. Designers should strive to evoke cleanliness in the appearance and user experience of the frontend (see [6.2](#), [E.2](#) and [Annex H](#)).

4.7 Secure design

In order to prevent theft or tampering, critical accessible components of the NSSS shall be assembled or affixed in such a way as to deter removal or dismantling by unauthorized parties.

It is recommended to engage stakeholders within the intended user communities to discuss potential locational measures for securing the NSSS against vandalism of the facilities.

NOTE Design requiring the use of tools for removal or dismantling of any components can help to deter theft.

4.8 Operating conditions

4.8.1 Ambient temperature range

NSSS shall operate safely and reliably in environments with ambient temperatures at a minimum range from 5 °C to 50 °C, which shall be understood as the requisite primary range for all systems complying with this document. Technologies designed for use in environments with ambient temperatures outside this range shall additionally demonstrate their capability to operate safely and reliably in these expanded ambient temperature ranges.

4.8.2 Ambient air humidity

NSSS shall operate safely and reliably in ambient air humidity conditions at a minimum range from 20 % to 100 %. Technologies designed for use in environments with ambient air humidity below 20 % shall additionally demonstrate their capability to operate safely and reliably in these expanded ambient air humidity ranges.

4.8.3 Atmospheric pressure

NSSS shall operate safely and reliably under atmospheric pressure conditions at a minimum range from sea level (101 kPa) to 2 500 m altitude (76 kPa). Technologies designed for use in environments with atmospheric pressure outside this range shall additionally demonstrate their capability to operate safely and reliably in these expanded atmospheric pressure ranges.

4.9 Requirements for NSSS components

4.9.1 General

Critical materials, equipment, connections, and joining elements of the NSSS that are indispensable to the proper operation of the system shall be selected based on their suitability for sanitation applications.

Documentation of the performance adequacy shall be provided for any essential materials, equipment, components, connections, or joining elements that are not explicitly designed, commonly used or approved for use in NSSS. Performance adequacy can be demonstrated through risk assessments or other commonly accepted methods (e.g. failure mode and effects analysis, material testing, material safety data sheets).

When testing is conducted as part of the product certification process, the laboratory performing material testing shall meet the requirements in A.1.

4.9.2 Hygienic design

The NSSS shall be designed in such a way as to mitigate any risk of infection due to potential pathogens from human urine, faeces or other human bodily fluids or the intermediate and residual products of the NSSS.

The NSSS shall minimize the entry and release of insects and vermin to the subsystems, except where they are used as part of the treatment process. In such a case their introduction and release shall be controlled to avoid risk of infection transmission.

4.9.3 Tightness

All installations that contain, transport, or store liquids shall achieve water tightness, at a minimum. In cases where the results of a safety assessment (see [5.1](#)) indicate hazards that require mitigation through a higher degree of system tightness (e.g. potentially dangerous gases), technical tightness shall be achieved.

NOTE Resistance to the effects of flooding, such as inundation and the lateral force of floodwater, is an additional consideration for NSSS in flood-prone areas.

Some tightness testing procedures are provided in [A.3.1](#).

4.9.4 Cleanability of surfaces

Visibly exposed materials and related joining elements, reservoirs and piping shall be smooth and easily cleanable. Thus, surfaces shall be:

- a) clear of pits and occlusions and have neither ridges nor crevices where organic materials could accumulate;
- b) designed in such a way as to minimize projections, edges, and recesses.

Visibly exposed materials shall be designed in such a way as to ensure that faeces and residual substances can be removed by domestic household cleaning methods readily available to the users and without requiring the use of specialized chemical cleaning agents. Regardless of the material used, the overall cleanability of the visibly exposed material should have a minimum value equivalent to that of a No. 3 100 to 120 grit finish on stainless steel, equivalent to Roughness Average (Ra) of 1,6 µm or less.

NOTE No. 3 100 to 120 grit steel is stainless steel featuring short, relatively coarse, parallel polishing lines, which extend uniformly along the length of the coil, achieved with 100 to 120 grit abrasives.

4.9.5 Chemical and biological additives

NSSS utilizing chemical or biological additives shall limit their use in a manner or to a degree that does not exceed acceptable health or environmental risks. The manufacturer of the NSSS shall provide documentation concerning risks and instructions on proper use, handling, frequency of addition and storage of any additives necessary for system function (e.g. safety data sheets from the manufacturer of the relevant additives) (see [Annex C](#)). The system shall warn the user, with an alarm, to add more when needed.

4.9.6 Requirements for ease of operation

The design of the NSSS shall minimize demands on the user with respect to the performance of periodically recurring operational activities (e.g. usage of rake, adding of bacteria, removal of treated solid residue) needed to keep the NSSS safe and operational. These operational activities shall meet usability requirements defined in [6.2.1](#). If relevant, clear instructions for performing operational activities shall be addressed in the user manual (see [4.14.5](#) and [Annex C](#)).

4.10 Material requirements

4.10.1 Durability of materials

Materials used for NSSS shall be structurally stable, durable, and, where relevant, water tight, and shall be resistant to the effects of local conditions for the intended use (see [3.1.4.1](#)) and reasonably foreseeable misuse (see [3.1.4.2](#)).

Durability shall be achieved either through the use of materials inherently resistant to corrosion or through the application of a suitable coating. Where possible, anti-corrosion protection shall be integrated into the system manufacturing process.

If two or more different materials are connected within the NSSS, detrimental galvanic corrosion shall be prevented. If components that bear mechanical loads are made of plastic material, detrimental effects of the environment (e.g. UV radiation, temperature) on such components shall be prevented (see [E.3.3.3](#)).

4.10.2 Fire resistance of materials

Parts that are or may be exposed to processes with high heat or fire, verified by a risk assessment, shall be made of fire-resistant materials. Such materials shall not ignite, progressively glow, smoulder, or show evidence of being functionally impaired when exposed to a source of ignition. Materials should conform to ISO 10295 (all parts) or equivalent.

4.11 Connections and joining elements

Connections (e.g. welds, joints) within NSSS shall be durable and capable of withstanding stresses and wear during transport, assembly, installation, operation, and maintenance. Connections shall resist corrosion. Joining elements applied (e.g. nuts, bolts, washers, screws) that are in contact with sanitation environments such as those involving wastewater or sludge shall be corrosion resistant (for more information see ISO 3506-1, ISO 3506-2 and ISO 3506-3).

Applied connection methods shall conform to proven engineering approaches. Connections identified as essential to safe operation or process reliability via the safety assessment (see [5.1](#)) shall not require regular

maintenance activity. Location, type, and specification of such connections shall be clearly indicated by the manufacturer in schematic diagrams provided with the system.

Reasonably foreseeable errors in applying connections and joining elements that could be a source of risk shall be prevented, primarily by the selection and combination of these elements, as well as their design and implementation. The direction of movement or conveyance of moving parts and transition components of the NSSS shall be clearly indicated by the manufacturer in schematic diagrams. Where a faulty connection (e.g. electric wiring or pipework) could pose a risk, incorrect connections shall be made impossible by design (e.g. by means of mechanical coding).

4.12 General safety design requirements

4.12.1 Safety of edges, angles, and surfaces

Surfaces and parts of NSSS shall have no jagged or sharp edges, other than those necessary for the functioning of the NSSS, which could create a hazard for users or service personnel in normal use or during maintenance.

4.12.2 Fire and explosion protection

The NSSS shall be designed in such a way as to minimize any risk of fire or overheating caused by operation or malfunctions of the NSSS itself, or by gases, liquids, dust, vapours, or other substances generated or used in the process of the system's operation.

The NSSS shall be designed in such a way as to minimize any risk of explosion caused by explosive atmospheres or substances generated by the backend treatment technologies and processes including gases, liquids, dust, vapours, or other substances produced. Hazardous accumulations of potentially explosive gases, liquids, dust, vapours or other substances during operation shall be monitored reliably, and appropriate mitigation measures shall be taken by the manufacturer, accounting for, at a minimum, the lower explosive limit and the evaluation of the potential sources of ignition. This protection can be achieved either through appropriate design of the NSSS that makes safety inherent, or through incorporation of safety-related installations and equipment that control any risk of explosion.

In systems in which combustion/incineration processes are applied, relevant fire and explosion hazards shall be controlled through safety-related functions with proven reliability (see 5.6.3).

NOTE Potential sources of hazards include slagging, blockage of the exhaust, and inferior quality of the fuel material.

4.12.3 Structural integrity

Materials, equipment, components, connections and joining elements within the NSSS shall be capable of withstanding both static and dynamic stresses of expected operation.

Where a risk of rupture or disintegration remains despite countermeasures, the parts concerned shall be mounted, positioned or guarded (or a combination of these methods) in such a way as to contain any hazards. Installations and pipes, whether rigid or flexible, that carry either fluids or gases or both shall be capable of withstanding the defined internal and external stresses, and shall be either firmly attached or protected or both to ensure that no risk is posed by a rupture.

If such risks remain despite countermeasures, strength safety factors (SSF) shall be proven to achieve the following levels (further information on strength safety factors calculation can be found in ISO 14622):

- for hazards that can cause injuries and fatalities, $SSF \geq 3$;
- for hazards that halt backend operations, $SSF \geq 2$;
- for hazards that cause inconvenience, $SSF \geq 1,5$.

4.12.4 Prevention of hazardous contact with partially treated liquids and reuse

Although [subclause 7.2.9.4](#) specifies the final requirements for recirculated water, partially treated liquids shall not come into contact with users.

Sanitation systems that are designed for recirculated water within the system (rather than safe discharge to the environment) shall meet the necessary requirements for the type of reuse (e.g. flushing, handwashing) (see [7.2.9.4](#)).

4.12.5 Underground systems

Components of NSSS that are designed to be positioned below ground level (e.g. for protection against extreme low temperatures):

- shall be capable of withstanding exposure to geotechnical impacts such as earth and hydrostatic pressures throughout the course of operation without loss of structural integrity; and
- should allow access for monitoring to detect leakages and groundwater or soil pollution, or both.

4.12.6 External impacts

NSSS and their components and fittings shall be stable enough to prevent tilting, overturning, falling, or uncontrolled movements. If the shape or structure of the system does not offer both sufficient tilting stability and sufficient stability under mechanical load, then appropriate means of anchorage shall be incorporated in the manufactured product and their use shall be specified in the user manual (see [4.14.5](#)). The system shall reliably resist reasonably expected external mechanical impacts incurred during transport, installation, normal operation, and maintenance.

4.13 Information and marking

4.13.1 Information and warnings

Information and warnings on NSSS shall be provided through clear and unambiguous symbols or pictograms to ensure the user's comprehension (see [E.3.2](#)). In addition, information and warnings on NSSS shall also take into account user requirements (see [4.1](#)).

A data plate or label visible to the user in the vicinity of the frontend and near to the failure signal shall include, at a minimum:

- a) estimated number of users and uses per day (users/day and uses/day) (see [4.3.2](#)) and manufacturer defined wait time between uses (see [4.3.8](#));
- b) expected daily capacity for additional input as appropriate (see [4.3.2](#));
- c) common items that shall not be added to the system;
- d) instructions for obtaining service and contact information;
- e) minimum and maximum operating temperature.

When a backend is supplied without a frontend, a data plate or label, consisting of the information listed in a) through to e), shall be provided by the manufacturer such that it can be placed securely in the vicinity of the frontend by the site owner or operator.

A visible data plate or label shall be placed close to any location where a user may have access to recirculated water, warning the user that recirculated water is not drinkable.

Additionally, if the system is designed to produce treated output suitable for reuse, the manufacturer shall:

- specify the intended purpose/application of either solid output, effluent or off-gas or all;
- provide information on the quality of the reusable output (e.g. nutrient content).

This information shall be in the form of a data plate or label placed in a location visible to the user in the vicinity of the backend.

Plates and labels shall be permanent and clearly legible.

Written information and warnings shall be composed at the reading level of the users and shall incorporate all information specified in [Annex C](#). Information shall be provided in the official language(s) of the country of use. Warnings shall clearly indicate the extent of the safety risk.

4.13.2 Marking and labelling

The NSSS shall have permanent and legible data plates. The information shall be provided in the official language(s) of the country of use.

Data plates shall include, at a minimum:

- a) manufacturer's name and address;
- b) model number;
- c) serial number;
- d) date of manufacture;
- e) total unit mass when operational;
- f) parameters of primary electric circuits, including voltage and amperage.

4.14 Maintenance

4.14.1 Reasonable configuration, adjustment, and maintenance activities

The NSSS shall be designed in such a way that frequency and complexity of configuration, adjustment, and maintenance activities to be performed by the user and the professional service personnel are reasonable with respect to the expectations, technology, and level of professional training present in the setting of users.

See D.3 to determine the suitability of an NSSS for a given location and users regarding frequency and complexity of configuration, adjustment, and maintenance activities.

4.14.2 Location and access of configuration, adjustment, and maintenance points

To prevent contamination and minimize the risk of infection, configuration, adjustment, and maintenance points should be located separate from any hazardous areas. Removal of system blockages, when necessary, should be processed from the outside of the NSSS and should not necessitate any disassembly. Configuration, adjustment, and maintenance points that require working space adjacent to the NSSS shall be clearly identified, and the depth, width, and height of such working space provided in the user manual.

The NSSS shall be designed in such a way as to ensure that components requiring service can be accessed and if sanitation system access is required, re-configuration can be performed safely. Configuration, adjustment, and maintenance should not unnecessarily involve contact with input materials, intermediate process products, or residual products.

4.14.3 Discharge and cleaning

Cleaning and regular maintenance activities conducted by the user shall not require discharge of partially treated materials. Discharge of partially treated materials may be necessary for maintenance activities conducted through service personnel. If maintenance activities require discharging partially treated materials, either solid, liquid, or gas, these partially treated materials need not meet the requirements for outputs to the environment specified in this document. The service personnel shall be responsible for appropriate disposal of the partially treated material. Discharge of partially treated material for maintenance shall not be a substitute for treatment by the system.

The volume of in-process or partially treated material remaining after shutdown for a service interval can vary due to the prior loading conditions, treatment approach (batch, continuous, other) and timing of shutdown procedure. It is intended to ensure that systems deliver full on-site treatment (as far as practicable) and as such the partially treated materials needing to be disposed of should be minimized.

The manufacturer should provide clear instructions to service personnel to dispose of discharged partially treated material in a way that minimizes risk for health, safety and environment.

4.14.4 Tools and devices

Where tools are required for emptying and maintaining the NSSS, they shall all be described in the user manual (see [4.14.5](#)) and any specialized tools supplied with the system.

4.14.5 User manual

A user manual with clear and definitive instructions to users and service personnel for configuration, adjustment, and maintenance of the NSSS shall be provided. At a minimum, the user manual shall clearly define all necessary procedures, activities, and schedules for configuration, adjustment, and maintenance that are essential for keeping the system safe and operational. Detailed requirements for user manuals are specified in [Annex C](#)

4.14.6 Handling and transport of the NSSS

The NSSS, including primarily mobile systems, shall be capable of safely withstanding handling and transport to another location and, if required, withstanding storage safely and without incurring damage. The manufacturer shall clearly indicate which ambient conditions the NSSS can withstand during handling and properly secured transport if the values differ from those specified in [4.8.1](#).

When transported, systems shall not produce sudden movements or unintended discharge of tanks, pipes, or any instability-related hazards. If required, appropriate attachments for lifting equipment or fixation points shall be provided to ensure the safe transport of the system.

5 Technical requirements

5.1 Safety assessment

The manufacturer of a NSSS shall carry out either an iterative risk assessment or an equally effective assessment capable of demonstrating proven safety of NSSS. The safety assessment shall:

- a) determine the particular health and safety requirements that apply to the product;
- b) determine risk-mitigating measures to be taken;
- c) demonstrate the safety of the product by documenting the results of the safety assessment.

This assessment should be carried out during the design process; however, the assessment may be carried out after the design process. The assessment shall cover the relevant life cycle of NSSS, giving consideration to its expected use and reasonably foreseeable misuse.

Additional requirements for risk assessments are specified in [Annex B](#).

A product safety life cycle (PSLC) should be implemented as part of a risk management process that considers all relevant progressions within the general product development process (e.g. research and development, procurement and production, quality assurance, quality management). If a PSLC is conducted, the requirements specified in [B.3](#) apply.

5.2 Operational requirements

5.2.1 General

The NSSS shall meet basic functionality requirements such as starting of NSSS operation, stopping of sanitation operation, and activating an emergency stop (see also [A.3.2.3](#)).

5.2.2 Intentional starting of NSSS operation

The start up and restarting of the entire NSSS through voluntary actuation, including restarting after a system stoppage, shall either be enabled through a single dedicated control device or, in systems in which the backend treatment processes prevent the use of a single dedicated device, shall be enabled through a logical sequence of control actions that is clearly indicated by the manufacturer.

If the starting of the NSSS operation requires mechanical force to be applied by users, this force shall be no greater than 25 N.

5.2.3 Intentional stopping of NSSS operation

The NSSS shall be equipped with a control device or clearly indicated sequence of control actions that brings relevant processes and operations safely to a complete stop and safe state. If a safe state cannot be immediately achieved upon activation of the control device/sequence and requires a transition period following initiation of the stop control(s), the duration of this transition period shall be clearly indicated by the manufacturer. The safety of the NSSS during this transition period shall be ensured by a safety-related function (see [5.6.3](#)). The stop control shall retain priority over the start and operational controls.

If the stopping of the NSSS operation requires mechanical force to be applied by users, this force shall be no greater than 25 N.

5.2.4 Emergency stop

If relevant and applicable, the NSSS shall be equipped with one or more emergency stop devices that safely halt all mechanical and electrical processes as well as operations and cut off energy supply. Manufacturers of NSSS should refer to ISO 13850 for additional guidance concerning the design of emergency stop functions.

If the emergency stop of the NSSS operation requires mechanical force to be applied by users, this force shall be no greater than 25 N.

5.3 Reliability and safety requirements for energy supply

5.3.1 Security of energy supply

Failure of the primary energy supply (e.g. through deficiency, absence, or failures in energy return) shall not trigger hazardous system conditions. This hazard prevention may be realized through automatic system transition to a safe state or through the provision of an appropriate backup source of energy. If applicable, the minimum capacity of the backup source of energy should be sufficient to allow the safe preparation of the system for a long-term shutdown (see [4.3.7](#)). The amount of energy supplied by the backup source shall be indicated to the user.

5.3.2 Safety requirements for electrical energy supply

5.3.2.1 Separation and isolation

The energy supply shall be separable and isolatable from the sanitation system through proven safety devices such as circuit power switches, fuses, or other interlock devices. Isolators shall be made clearly noticeable by marking and arrangement and shall be capable of being locked if reconnection could endanger humans (e.g. during configuration, adjustment and maintenance).

If the NSSS is plugged into an electrical outlet, removal of the plug may be sufficient to satisfy these requirements for separation and isolation of the energy source, provided that the operator can verify from any of the points to which he or she has access that the plug remains removed.

5.3.2.2 Energy discharge

The NSSS shall be equipped with a means of discharging any energy remaining or stored in the system following isolation from the energy supply (see [5.3.2.1](#)) in order to achieve a safe state and prevent hazards.

Subsystems of the NSSS that supply or store energy need not be discharged if these subsystems can be separated from the system (e.g. through separation switches) in such a way as to ensure that the safe state of the system is not affected and hazards do not emerge from the subsystem.

5.3.3 Safety requirements for non-electrical primary energy supply

The NSSS deriving energy from sources other than electrical energy shall be designed and equipped in such a way as to ensure that hazards associated with the energy supply are prevented. If applicable, the non-electrical primary energy supply shall include a reliable means of isolation, and a means of discharging the stored energy in a safe way.

NOTE Suitable methodologies to achieve safety include Failure Mode Effects Analysis (FMEA), Failure Mode Effects and Criticality Analysis (FMECA), Product Safety Life Cycle (PSLC) and Risk Assessments. Details of how these relate to NSSS are in [Annex B](#).

5.4 Mechanical requirements

5.4.1 Pressurized or vacuum equipment

Pressurized equipment with a nominal operation gauge pressure higher than 50 kPa or vacuum equipment with a nominal operation gauge pressure lower than 50 kPa vacuum shall be designed so as to withstand the mechanical loading pressure to which the equipment is subjected, including appropriate structural strength safety factors. Manufacturers of NSSS should refer to EN 13445 for additional guidance.

Overpressures shall be controlled by appropriate and proven safety relief valves. Discharge points shall be located in positions safe to the user during pressure release.

5.4.2 Pipes, hoses and tanks

Pipes and hoses shall be positioned and restrained to minimize deterioration resulting from contact with other elements of the system (e.g. hot surfaces, sharp edges). Pipes, hoses, and fittings shall be safely accessible for visual inspection.

Tanks and other storage vessels shall be capable of withstanding the stresses of prolonged containment of the relevant substances without breakage or other structural damage or deformation. Access to tanks should be easy for maintenance inspections and operations.

Storage vessels shall be provided with means of determining their fluid levels (e.g. fluid level indicators). Excessive pressure in storage vessels exceeding MOP shall be automatically compensated via a suitable device (e.g. vent, safety valve).

5.4.3 Moving and rotating parts

Risks associated with moving and rotating parts of the NSSS shall be minimized either through design that prevents human contact with such parts or through the application of appropriate guards or protective devices.

The NSSS shall be designed to prevent accidental obstruction of moving parts.

5.4.4 Backflow prevention

If the NSSS is connected to the water supply system, then backflow shall be prevented. The test method should be in accordance with an applicable national or international standard, such as ASME A112.1.2.

5.5 Requirements for radiation

5.5.1 High temperatures of parts and surfaces

Accessible parts or surfaces of the NSSS that exceed the temperature of 60 °C shall be equipped with protection measures or fixed guards sufficient to prevent burn injuries.

5.5.2 Low temperatures of parts and surfaces

Accessible parts or surfaces of the NSSS that fall below the temperature of –20 °C shall be equipped with protection measures or fixed guards sufficient to prevent injuries due to low temperatures.

5.5.3 Other radiation emissions

Other radiation emissions from the NSSS shall not exceed safe levels.

5.6 Electrical and electronic equipment

5.6.1 Safety and reliability of electrical and electronic equipment

Electrical equipment such as pumps, drives, fans, or control systems shall be durable, require minimal maintenance, be adequately protected from any aggressive environment, and be capable of being easily serviced. To achieve such requirements, applicable equipment standards should be followed, and controls shall include circuit breakers and appropriate fuses.

Safety requirements shall include at a minimum:

- a) adequate insulation and protection against hazards of direct and indirect live parts, and appropriate protection measures against short circuits and arcs;
- b) electrical protection appropriate to the operating conditions, at a minimum complying with IP44 where required (further information on electric protection classes can be found in IEC 60529);
- c) compliance with the requirements of electromagnetic compatibility (EMC), i.e. NSSS operation shall not be disturbed by any external source of a relevant electromagnetic field, nor shall the electromagnetic field of the NSSS disturb the operation of external electrical equipment (further information on EMC and suitable thresholds can be found in IEC 61000-6-1 and IEC 61000-6-3).

5.6.2 Control system

The NSSS should incorporate a control system that serves to acquire and process data and information regarding the safe, reliable, and efficient operation of the system. Information on relevant safety requirements can be found in ISO 13849-1.

Necessary control actions and required measurements shall be documented and shall reflect operation and installation conditions and the results of the safety assessment described in [5.1](#). It is recommended that the control actions and required measurements should be specified at an early design stage.

If a control system is incorporated, it shall ensure that:

- a) conveyance and treatment devices and processes shall not start unexpectedly if by doing so they pose a hazard to the user or professional service personnel; further, their start-up shall be indicated on the control display;
- b) automatic or manual stopping of the controlled moving parts of NSSS shall be unimpeded;

- c) protective devices identified as necessary from the safety assessment (see [5.1](#)) shall remain fully effective or issue a stop command;
- d) the signalling system shall indicate status and include failure modes to inform the user of system availability or operational failure (e.g. electrical, mechanical, or hydraulic failure) of the system; the manufacturer shall indicate the type of failure corresponding to each alarm.

If a control system exists, it shall be capable of detecting, at a minimum:

- failure of electrical and mechanical components critical to the treatment processes, and shall deliver a visible and audible failure signal to the user;
- the overall availability for use, and shall deliver a visible and audible signal to notify the user of system unavailability.

Further control points should be defined based on HACCP, HAZOP or a comparable proven method. Control systems shall be designed in such a way as to ensure functional robustness with respect to external impacts, component failure (hardware and software), and human-machine interface. Failure shall reliably bring the system into safe state mode.

5.6.3 Safety-related function of the control system

If the safety assessment (see [5.1](#)) reveals the need for additional safety-related functions within the control system, then these control functions should be developed, designed, verified, and validated according to the principles contained in ISO 13849-1 and ISO 13849-2.

The safety-related functions shall be designed in such a way as to meet the safety integrity requirements and effectively mitigate the risks identified in the safety assessment (see [5.1](#)).

NOTE Safety integrity requirements relate to architecture, diagnostic capacity, and reliability of the safety-related function.

5.6.4 Remote Monitoring

The NSSS should incorporate a communications system that can acquire and store information for transmission at least once daily to one or more authorized recipients of such information regarding the current status of the system for purposes of verifying its safety and availability for use.

If a remote monitoring system is incorporated, it shall be capable of conveying at least the following information:

- a) the manufacturer, product model, and unique identifier (e.g. serial number) of the individual NSSS;
- b) an indication that the NSSS is or is not in a safe state;
- c) an indication that the NSSS is activated and available for use;
- d) alarms or signals indicating failure of mechanical or electronic components;
- e) alarms or signals indicating that the NSSS is overloaded;
- f) alarms or signals indicating that an essential maintenance task has not been performed.

Information acquired and stored for transmission shall be stored in non-volatile memory to protect against a loss of electric power. Following an unscheduled loss of connectivity, a remote monitoring system should, upon restoration of connectivity, retrieve and send all information collected for transmission during the period in which connectivity was lost.

If a remote monitoring system is incorporated, its operation shall be described in the user manual, including its modes of communication, the NSSS operating parameters it will monitor, and the procedures for activating the monitoring system, including restart after planned shutdown or loss of power.

NOTE More information on remote monitoring can be found in [Annex G](#).

5.7 Reliability of conveyance devices

The mechanical and hydraulic design of conveyance devices (e.g. internal pipework, connections and augers) shall prevent back flows, blockage, and surcharging during normal operation. Conveyance devices shall be designed so that transport capacity and performance meet the requirements of [4.3.2](#).

5.8 Transitions from the backend

Process transitions produced by the backend shall not provoke sensations of discomfort for the user nor result in hazards to the NSSS's integrity.

NOTE Typical transition phenomena include vibration, shock, cold, or heat.

When tested in accordance with ISO 20816-1, the vibration level in the XYZ-axis at any possible area of the frontend user interface of NSSS shall not exceed 0,5 m/s².

6 Additional requirements for the frontend

6.1 General

Requirements specific to the frontend apply to NSSS in which frontend components are included as part of the manufactured product.

6.2 Use and operation

6.2.1 General usability requirements

The design of the frontend shall meet ergonomic requirements of the users. Anthropometric data of the users should be used for the design of all areas and parts accessed by the users, in accordance with the ISO 7250 series.

The NSSS shall be easy to use. The frontend shall meet the usability needs of the users. Designers shall ensure that:

- a) the users regard the frontend controls as intuitive;
- b) the actions required to control operations follow a logical sequence;
- c) complexity is minimized with respect to control panel signals.

The frontend shall achieve the following usability conditions:

- self-descriptiveness and intuitive design (look-and-feel);
- controllability;
- conformity with user expectations;
- user or maintenance error tolerance.

The manual control elements (e.g. hand levers, pedals, switches) and indicators shall be chosen, designed, and arranged, so that:

- they are easy to access and locate according to user expectations;
- neutral positions of the manual control elements are automatically reset after triggering;
- the movement of the manual control elements to activate the flush functions correspond to the intended effect or to common practice, whenever possible;
- the activation forces are comfortable for the users.

6.2.2 Accessibility

Adjacent to the frontend facility (seat or squatting pans), there should be installed suitable mechanical devices (such as grab bars) to facilitate the use of the facility by persons who have a physical condition that limits movements or activities.

6.2.3 Requirements for ease of cleaning

The frontend and connected installations that are accessible to the user (e.g. pipes and chutes) shall be designed in such a way as to ensure that the degree of cleaning necessary after use is no greater than that of conventional flushing toilets.

Frontend surfaces shall have curves with a radius sufficient to allow thorough cleaning with common cleaning methods and without requiring the use of specialized chemical cleaning agents. If specialized cleaning tools are required, they shall be addressed in the user manual (see [4.14.5](#)) and supplied with the system.

6.2.4 Cultural requirements

The design of the frontend shall anticipate and reflect cultural preferences and common practices. The design of the frontend should aim to accommodate preferences and practices prevalent in the cultural setting for which the NSSS is designed, including:

- a) mode of operation (water use, dry);
- b) seating/squatting position;
- c) personal cleansing material (washers/wipers).

If changes to common practices of users are inevitable in order to ensure improved sanitation, these demands on the user should not exceed reasonable levels and should be clearly explained by user manuals provided by the manufacturer (see [Annex C](#)). Further details can be found in [D.4](#).

6.3 Visibility of faeces

The frontend shall ensure a visual barrier to prevent the user from seeing an accumulation of deposited faeces from previous users when looking directly, straight down, into the frontend squatting or seat pan.

NOTE This requirement refers to the visibility of collected faeces that has accumulated in the system as part of its normal operation, not to smudges or streaks within the squatting or seat pan.

6.4 Evacuation performance

Urinals, squatting pans, or seat pans applied as part of the frontend of NSSS may employ evacuation mechanisms ranging from conventional flush (cistern/flush valve), pour flush, and dry flush, to novel evacuation mechanisms such as those employing mechanical forces.

Evacuation mechanisms that comply with relevant international or national standards are deemed to conform to the requirements specified in [A.3.3](#).

Examples of applicable standards are provided in [Table 1](#).

Where there are no relevant international or national standards for the evacuation mechanism, requirements specified in [A.3.3](#) shall be met. Following assembly of the NSSS, the flushing mechanism shall meet the requirements for the adapted flushing tests specified in [A.3.3](#).

Table 1 — Examples of applicable standards for evacuation mechanisms

Frontend user interface	Evacuation mechanism				Dry
	Conventional flushing mechanisms (cistern/flush valve)	Pour-flush		Novel evacuation mechanisms	
Seat pan	EN 997	See A.3.3.4 and A.3.3.6			A.3.3.4
Squatting pan	IS 2556-3	See A.3.3.5 and A.3.3.6			A.3.3.5
Urinal	EN 13407	—		—	ASME A112.19.19

6.5 Integrity against external impacts

The frontend shall reliably resist mechanical loads incurred during transport, installation, normal operation, and maintenance. A static load test shall be conducted based on the requirements of NSF/ANSI 41:2011, 5.2.1.

6.6 Slipping, tripping or falling

Frontend areas of the NSSS in which either users, service personnel, or both are expected to move about, stand, or sit shall be designed in such a way as to prevent slipping, tripping, or falling on, or off these areas. Where appropriate, these areas shall be fitted with handholds.

6.7 Water seal

If input is evacuated from the frontend through a trap with a water seal, this seal shall be a minimum depth of 20 mm.

7 Performance testing

7.1 General testing requirements

The NSSS shall be tested for performance according to the classifications provided in [Table 2](#).

The test methods and additional testing requirements listed in [Annex A](#) shall be followed to ensure conformity with this document.

If the product to be tested is limited to a backend component, then the backend shall be installed for testing purposes with the number and type of frontends specified for average and peak flow by the manufacturer. The distance between the frontend(s) and backend shall be specified by the manufacturer. The NSSS as installed shall be classified as Class 1, Class 2, Class 3, or Class 4 according to [Table 2](#). Testing related to requirements specific to the frontend ([Clause 6](#)) need not be performed for backend-only products that do not provide recirculated water for toilet flushing.

Table 2 — Classification of NSSS

Class	Testing requirements
Class 1: NSSS – one frontend – backend non-biological	Controlled laboratory testing as outlined in 7.2 (may be modified to account for alternative testing environment if the system cannot be installed in a laboratory) and field testing in accordance with 7.3.2 .
Class 2: NSSS – one frontend – backend includes one or more biological treatment processes	Controlled laboratory testing as outlined in 7.2 (may be modified to account for alternative testing environment if the system cannot be installed in a laboratory) and field testing in accordance with 7.3.3 .
Class 3: NSSS – more than one frontend – backend includes one or more biological treatment processes	Controlled laboratory testing as outlined in 7.2 (may be modified to account for alternative testing environment if the system cannot be installed in a laboratory) and field testing according to 7.3.3 . For systems with 2 to 5 frontends, a minimum of 2 frontends (chosen randomly) shall be tested for all requirements involving the frontend, including those of Clause 6 and odour (7.2.9.5), noise (7.2.9.6), and air emissions (7.2.9.7). For systems with more than 5 frontends, a minimum of 3 frontends (chosen randomly) shall be tested for all requirements involving the frontend, including those of Clause 6 and odour (7.2.9.5), noise (7.2.9.6), and air emissions (7.2.9.7).
Class 4: NSSS – more than one frontend – backend non-biological	Controlled laboratory testing as outlined in 7.2 (may be modified to account for alternative testing environment if the system cannot be installed in a laboratory) and field testing in accordance with 7.3.2 . For systems with 2 to 5 frontends, a minimum of 2 frontends (chosen randomly) shall be tested for all requirements involving the frontend, including those of Clause 6 and odour (7.2.9.5), noise (7.2.9.6), and air emissions (7.2.9.7). For systems with more than 5 frontends, a minimum of 3 frontends (chosen randomly) shall be tested for all requirements involving the frontend, including those of Clause 6 and odour (7.2.9.5), noise (7.2.9.6), and air emissions (7.2.9.7).

7.2 Controlled laboratory testing

7.2.1 General

All NSSS that can be installed in a laboratory (see [Table 2](#)), shall be subject to controlled testing in a laboratory. Requirements for laboratory testing as part of the product certification process are specified in [A.1](#).

7.2.2 Assembly, installation, operation, and maintenance

Assembly and installation of NSSS shall be conducted according to the manufacturer's instructions. NSSS shall be started, loaded, operated, and maintained in accordance with the manufacturer's instructions.

If the manufacturer does not supply a superstructure as part of the manufactured product, then a superstructure shall be installed according to the manufacturer's recommendations (e.g. with regard to size and materials) prior to testing. The superstructure should satisfy the requirements of [A.3.6.6](#). The specifications of the superstructure shall be clearly indicated in the test report. For sanitation systems that do not include superstructures as part of the manufactured product, then noise measurements shall be taken without a superstructure installed and only at the external measurement points (see [A.3.7.4.1.2](#)). The tests shall be adapted as described in [A.3.7](#). The presence or absence of a superstructure during noise testing shall be clearly indicated in the test report.

7.2.3 Documentation of input

Tests shall be conducted with actual human urine and faeces, where specified or an alternative feedstock (see [Annex I](#)). Alternative feedstocks shall only be used if procuring sufficient quantities of real human faeces and urine is not feasible due to legal, logistical, or safety concerns. In case alternative feedstock is used, the type and characteristics of this feedstock shall be clearly described, and the testing laboratory shall provide a justification for its use. For helminth spiking (see [A.3.4.4.1](#)), if suitable human faeces are insufficient for spiking, pig faeces and required microbial cultures to achieve required minimum concentration, may be

used. Faeces and urine shall either be directly deposited by users defecating and urinating into the system or be separately collected and subsequently deposited into the system. If faeces and urine are collected separately for later use, the method of storage and storage duration shall not substantially alter their characteristics. If users directly use the system during testing, these users should document faecal and urinary events following each use of the NSSS. For the privacy of those users, the recording document should be kept within the enclosed frontend area, or where required by ethics board of the testing facilities or the country where testing is conducted. If an alternative feedstock is used, preparation and use shall be conducted according to [Annex I](#).

7.2.4 Generated output

During the tests, the generated output shall meet the solid output, effluent and recirculated water requirements for the intended reuse or disposal defined in [7.2.9.3](#) and [7.2.9.4](#), and the odour, noise and air emissions requirements defined in [7.2.9.5](#), [7.2.9.6](#) and [7.2.9.7](#). The manufacturer shall indicate the intended purpose of solid output and effluent designated for reuse.

7.2.5 Test observations

During and after testing, the following elements shall be observed and recorded:

- a) any fractures, cracks, or permanent deformations of the NSSS;
- b) any back flows, blockages, or surcharging of conveyance devices (see [5.7](#));
- c) any ruptures or leakages;
- d) all safety or overload shutdowns and process malfunctions.

7.2.6 Laboratory conditions

Laboratory temperatures shall be between 15 °C and 30 °C. The laboratory shall indicate in the test report that the temperature, atmospheric pressure and humidity ranges during the conducted test are in accordance with good laboratory practices.

7.2.7 Testing sequence and duration

The NSSS shall be tested according to the testing sequence provided in [Table 3](#), columns 1 (testing procedure) and 2 (pattern). The duration of the testing period shall be no less than 22 days and may be extended beyond the suggested 22-day schedule to accommodate backend processes that require more time. The backend processes shall reach a steady state (continuous process) or stable conditions (cyclical process) prior to testing. For continuous processes, steady state is reached when key parameters remain within nominal range (specified by the manufacturer) over time. For cyclical processes, stable conditions are reached when key parameters remain within nominal range (specified by the manufacturer) at specific points across each cycle. Due to the test methods and required pathogen spiking for human health parameters, factors such as residence time, treatment cycles, breakthrough etc. shall be taken into consideration in the testing schedule. The testing schedule shall be determined before testing commences. The test sequence of [Table 3](#) includes days during which no test procedure is indicated (e.g., Day 8, 14). These days are intended to allow the NSSS to return to steady state after one or more preceding perturbations (e.g. short-term shutdown Day 9). They are an integral part of the test sequence and may only be eliminated if it can be demonstrated that their elimination does not affect the testing outcome. Day 3 (loading with diarrhoea, but no testing until Day 4) shall not be eliminated.

The tests specified in [6.4](#), [6.5](#), [6.6](#), [A.3.1](#), [A.3.2](#), and [A.3.3](#) shall be conducted prior to commencing the testing sequence in [Table 3](#).

Specifications for the testing procedures listed in [Table 3](#) can be found in [A.3.8](#).

Table 3 — Test sequence of relevant testing procedures

Testing procedure	Pattern	Suggested schedule	Suggested timeframe
Initial start-up: Follow start-up procedure according to the manufacturer's instructions		Initial start-up duration specified by manufacturer	The timeframe depends on the duration of the initial start-up period required to achieve system operability and stability. This duration shall be specified by the manufacturer.
— Intentional stopping of NSSS operation — Intentional starting of NSSS operation — Emergency stop — Restart	Normal	Day 1	1 day
— Solid output, effluent and recirculated water (health and environmental parameters)	Normal	Day 2	1 day
[none]	Diarrhoea	Day 3	1 day
— Solid output, effluent and recirculated water (health and environmental parameters)	Diarrhoea	Day 4	1 day
— Non-usage of NSSS	No load	Day 5 to Day 7	3 days
[none]	Normal	Day 8	1 day
— Short-term shutdown of NSSS	No load	Day 9	1 day
— Solid output, effluent and recirculated water (health and environmental parameters)	Normal	Day 10	1 day
— Long-term shutdown of NSSS	No load	Day 11 to Day 13	3 days
[none]	Normal	Day 14	1 day
— Solid output, effluent and recirculated water (health and environmental parameters) — Visibility of faeces — Normal odour day test	Normal	Day 15	1 day
— Simulant odour day test	Simulant faeces (Refer to A.3.5.6.4.2)	Day 16	1 day
— Noise and air emissions	Normal	Day 17	1 day
— Normal odour day test	Normal	Day 18	1 day
— Overload protection and continuous use	Overload (use of simulant faeces acceptable, see A.3.8.6)	Day 19	1 day