
Non-sewered sanitation systems — General safety and performance requirements for design and testing

*Systèmes d'assainissement non collectifs — Exigences de performance
et de sécurité générale pour la conception et les essais*





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Foreword

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

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

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

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

For an explanation on 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 the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is the ISO/TMB, *Technical Management Board*.

Introduction

The purpose of this document is to facilitate the development of non-sewered sanitation systems in general and, in particular, for populations that currently do not have access to safe sanitation. According to the Joint Monitoring Programme (JMP), in 2015, 2,4 billion people still lack improved sanitation facilities. However, it should be noted that improved sanitation does not necessarily mean safe sanitation. The devastating consequences of these practices include an estimated 1 million preventable deaths per year, primarily from dysentery-like diarrheal diseases¹.

In March of 2013 the United Nations (UN) issued a global call to action for the comprehensive elimination of open defecation by 2025. According to the UN, countries where open defecation is most common have the highest levels of child death and disease, as a result of ingesting human fecal matter that has entered the food or water supply². 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 violence³.

In 2011, the Water, Sanitation & Hygiene program of the Bill & Melinda Gates Foundation initiated the Reinvent the Toilet Challenge to bring sustainable sanitation solutions to the 2,5 billion people worldwide who do not have access to safe, affordable sanitation⁴.

The Reinvent the Toilet Challenge criteria were as follows:

- Removes pathogens from human waste and recovers valuable resources such as energy, clean water, and nutrients.
- Operates “off the grid” without connections to water, sewer, or electrical lines.
- Costs less than USD 0.05 per user per day.
- Promotes sustainable and financially profitable sanitation services and businesses that operate in poor urban and rural settings.
- Is a truly aspirational next-generation product that everyone will want to use in developed as well as developing nations.

This document is intended to facilitate the development of sanitation systems that promote economic, social, and environmental sustainability through strategies that may include minimizing resource consumption (e.g. water, energy) and maximizing reusable output. Although this document may be applied to systems requiring connection to a networked water supply system and/or electric power grid, the aim of the document is to promote the development of sanitation systems that are independent of these networks.

¹ http://www.wssinfo.org/fileadmin/user_upload/resources/JMP-Update-report-2015_English.pdf

² United Nations, http://www.un.org/waterforlifedecade/waterforlifevoices/open_defecation.shtml

³ United Nations, <http://www.un.org/millenniumgoals/pdf/MDG%20Report%202012.pdf>

⁴ Bill & Melinda Gates Foundation – Water, Sanitation & Hygiene: Reinvent The Toilet Challenge – Fact Sheet, https://docs.gatesfoundation.org/Documents/Fact_Sheet_Reinvent_the_Toilet_Challenge.pdf

Non-sewered sanitation systems — General safety and performance requirements for design and testing

1 Scope

This document specifies technical requirements, test methods, and sustainability considerations for non-sewered sanitation systems. A non-sewered sanitation system, for the purposes of this document, is a sanitation system that 1) is not connected to a networked sewer system and 2) collects, conveys, and fully treats the specific input, to allow for safe reuse or disposal of the generated output.

This document is applicable to sanitation systems containing both frontend and backend components that are either manufactured as one package or designed to be integrated as a set of pre-fabricated elements to be assembled in one location without the use of any additional engineering and/or civil engineering structures. This document also applies to individual pre-fabricated backend components that are designed to be integrated with one or more specified frontends that meet relevant national and/or international standards without demanding any additional engineering and/or civil engineering structures. This document is not applicable to sanitation systems constructed in-situ.

NOTE Assembly without the use of any additional engineering and/or civil engineering structures means that pre-fabricated components of non-sewered sanitation systems within the scope of this document do not require further construction in order to be integrated into complete sanitation systems that can perform all of their specified operations.

This document is applicable to sanitation systems that perform their treatment processes in one location through one or more treatment units comprising the backend of the sanitation system. This document does not address transportation of treated output outside of the sanitation system (e.g. manual transport, transportation by truck or trunk pipes) for further treatment, reuse, or disposal. Furthermore, neither any treatment processes taking place at another location separate from that of the frontend and backend components, nor reuse and disposal are addressed in this document.

Figure 1 provides, within the blue dashed lines, a conceptualization of the scope of the document and the areas with which it is concerned. The document sets minimum requirements for treatable input (see 4.3.1), and excludes greywater as input aside from greywater from hand washing. Requirements for the output of sanitation systems are set forth in this document regarding solid and liquid materials as well as odor, air, and noise emissions (see 4.4).

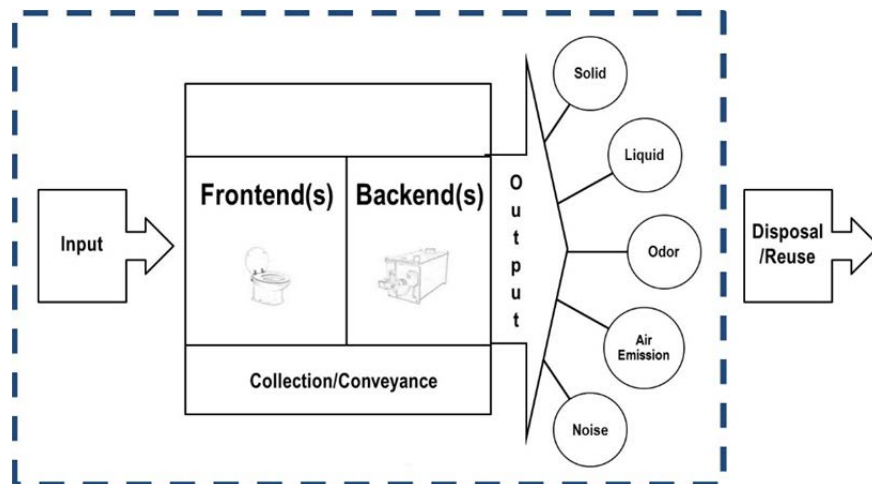


Figure 1 — Scope of document

Within sanitation systems to which this document applies, the frontend includes user interfaces such as a urinal, squatting pan, or WC pan, which may apply evacuation mechanisms ranging from conventional flush, pour flush, and dry toilets to novel evacuation mechanisms such as those employing mechanical forces requiring little to no water. Conventional and novel evacuation mechanisms are in some cases combined with urine diversion applications (e.g. urine diversion flush toilet, urine diversion dry toilet). Backend treatment technologies and processes of non-sewered sanitation systems range from biological or chemical to physical mechanisms (e.g. aerobic digestion, combustion, electrochemical disinfection, membranes). Some systems use only one of these technologies or processes while others apply various mechanisms in combination through serial treatment units.

This document is intended to serve as a basis by which to certify non-sewered sanitation systems. Such certification would convey the safety, functionality, usability, reliability, and maintainability of the system, as well as its compatibility with environmental protection goals. This document does not provide guidelines for selection, installation, operation and maintenance, and management of sanitation systems and neither incorporates nor substitutes for manufacturers' instructions and user manuals.

The technical requirements specified in this document are based on hazard and risk assessments following sound engineering practices. Thus, this document provides fundamental requirements for ensuring health and safety. A list of significant hazards addressed in this document is provided in B.2.

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 10816-1:1995, *Mechanical vibration — Evaluation of machine vibration by measurements on non-rotating parts — Part 1: General guidelines*

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

IEC 60942:2003, *Electroacoustics — Sound calibrators*

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

IEC 61672-1:2013, *Electroacoustics — Sound level meters — Part1: Specifications*

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

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

WHO Guidelines for Drinking Water Quality, 4th edition

3 Terms, definitions, units and abbreviations

3.1 Terms and definitions

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

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

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

3.1.1 System structure

3.1.1.1

non-sewered sanitation system

sanitation system that is not connected to a networked sewer system, and collects, conveys, and fully treats the specific *input* (3.1.2.1) to allow for safe reuse or disposal of the generated solid *output* (3.1.2.2) and/or *effluent* (3.1.2.6)

Note 1 to entry: Components and processes involved in reuse or final disposal of *output* (3.1.2.2), as well as those involving transportation to and/or treatment at another location, are not considered part of the sanitation system for the purposes of this document.

Note 2 to entry: Non-sewered sanitation systems can be either manufactured as one package or designed to be integrated as a set of pre-fabricated elements.

3.1.1.2

evacuation mechanism

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

3.1.1.3

frontend

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

3.1.1.4

backend

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

3.1.1.5

superstructure

additional structure added on top of the primary *non-sewered sanitation system* (3.1.1.1) structure in order to provide shelter to users

3.1.2 System inputs and outputs

3.1.2.1

input

substances entering the *non-sewered sanitation system* (3.1.1.1) primarily comprising human *feces* (3.1.2.4) and *urine* (3.1.2.3), menstrual blood, bile, flushing water, anal cleansing water, toilet paper, and, in some systems, greywater resulting from hand washing, menstrual hygiene products, and/or organic waste

Note 1 to entry: Input to *non-sewered sanitation systems* (3.1.1.1) within the scope of this document excludes greywater apart from greywater resulting from hand washing.

3.1.2.2

output

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

3.1.2.3

urine

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

3.1.2.4

feces

solid waste products of the human digestive system, including microorganisms

Note 1 to entry: Feces vary significantly in appearance (i.e. size, color, texture), according to the state of the digestive system, diet, and general health.

3.1.2.5

diarrhea

loose, watery *feces* (3.1.2.4), often resulting from viral or bacterial infection

3.1.2.6

effluent

treated liquid discharged from the *backend* (3.1.1.4)

3.1.2.7

chemical and biological additives

substances added to the *non-sewered sanitation system* (3.1.1.1) either to support the treatment process or to clean the system, including, but not limited to, chemical substances, biological agents, and other deodorants, bactericides, bacteriostats, microbiocides, chemical reactants, surfactants, or enzymatic agents

3.1.2.8

energy supply

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

3.1.2.9**electrical energy**

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

3.1.3 System safety and integrity**3.1.3.1****hazard**

potential source of harm

Note 1 to entry: Harm can include physical injury, aversive psychological experience, or damage to health.

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**

combination of the specification of the limits of the machine, hazard identification, and risk estimation

[SOURCE: ISO 12100:2010, 3.15]

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 – non-sewered sanitation system specified]

3.1.3.7**safe state**

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

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

[SOURCE: ISO 25119-1:2010, 3.43, modified – non-sewered sanitation system specified and note added]

3.1.3.8

exposed materials

materials used within the *non-sewered sanitation system* (3.1.1.1) that come into contact with human *urine* (3.1.2.3) or *feces* (3.1.2.4), or intermediate and residual products 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

[SOURCE: ISO 15821:2007, 3.6, modified – non-sewered sanitation system specified]

3.1.3.10

technical tightness

inherent characteristics of a *non-sewered sanitation system* (3.1.1.1) that prevent fluids, gases, or dusts from passing from the external through to the internal environment, or from the internal to the external environment, or both; the sanitation system or components thereof are considered technically tight if the leakage rate does not exceed 0,000 01 mbar 1/s

[SOURCE: ISO 11933-4:2011, 3.5, modified - sanitation system and leakage rate specified]

3.1.3.11

strength safety factor

ratio between the load (or pressure) 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.

[SOURCE: ISO 14622, 2.10, modified]

3.1.3.12

proven

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

3.1.4 System use and impact

3.1.4.1

intended use

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

3.1.4.2

reasonably foreseeable misuse

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

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

[SOURCE: ISO/IEC Guide 51:1999, modified – note added and sanitation system specified]

3.1.4.3**intended users**

for the purpose of this document, the intended users refer to 90% of people worldwide who currently do not have access to safe sanitation

Note 1 to entry: Meeting the needs of the intended users is expected to also ensure that non-sewered sanitation systems complying with this document meet the needs of users from all countries and contexts with regard to general safety and performance requirements.

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]

3.2 Abbreviations

AHRI	Air Conditioning, Heating, and Refrigeration Institute
APHA	American Public Health Association
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
BOD	Biological oxygen demand
CAPEX	Capital expenditure
CEN/CENELEC	European Committee for Standardization/European Committee for Electrotechnical Standardization
COD	Chemical oxygen demand
EMC	Electromagnetic compatibility
EN standards	European standards
EPA	U.S. Environmental Protection Agency
HACCP	Hazard analysis and critical control point
HAZOP	Hazard and operability study
IEC	International Electrotechnical Commission
IP	Ingress Protection
IS standards	Indian standards
JMP	Joint Monitoring Programme
MOP	Maximum operating pressure
NIOSH	National Institute of Occupational Safety and Health
NPV	Net present value
NSF	NSF International
OPEX	Operating expense
OSHA	Occupational Safety & Health Administration
PSLC	Product safety life cycle

RCD	Reliability centered design
SSF	Strength safety factors
TSS	Total suspended solids
TTC	Thermo-tolerant coliforms
UN	United Nations
UNICEF	United Nations Children's Emergency Fund
VDI	Verein Deutscher Ingenieure (Association of German Engineers)
WC	Water closet, used in "WC pan," which refers to receptacle portion of the frontend on which a user sits
WHO	World Health Organization

3.3 Units

bar	metric unit of pressure equal to 100,000 Pa and thus, approximately equal to the average atmospheric pressure at sea level.
cm	centimetre
dB	decibels
dBA	A-weighted decibels
g	gram
kg	kilogram
kJ	kilojoule
kPa	kilopascal
kWh	kilowatt hour
l	litre
m	metre
mg	milligram
mm	millimetre
MOP	maximum operating pressure
N	newton
s	second
USD	United States dollar
°C	degrees Celsius

4 General requirements

4.1 User requirements

The non-sewered sanitation system shall be designed and realized in such a way as to ensure that the intended users can use the system safely and in the manner intended by the manufacturer. The design and realization of the system shall ensure that users who are illiterate and those who do not have technical experience are able to safely and effectively use the technology.

NOTE Additional requirements for specific users, such as people with disabilities or small children, are provided, for example, in CEN/CENELEC-Guide 6 (Guidelines for standards developers to address the needs of older persons and persons with disabilities), ISO/IEC Guide 71 (Guide for addressing accessibility in standards) and ISO TR 22411 (Ergonomics data and guidelines for the application of ISO/IEC Guide 71 to products and services to address the needs of older persons and persons with disabilities).

4.2 Metric system

Design and construction of non-sewered sanitation systems shall be specified and realized in metric units of measurement.

4.3 Design capacity

4.3.1 Treatable input

Non-sewered sanitation systems shall be capable of treating, at a minimum, feces, urine, menstrual blood, bile, flushing water, anal cleansing water, and toilet paper.

NOTE Systems treating greywater, aside from greywater from hand washing, are outside the scope of this document.

4.3.2 Treatment capacity

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

EXAMPLE A 2014 international report on fecal sludge management [Strande, Ronteltap, and Brdjanovic, 2014], measured the average fecal 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 1 000 to 1 300 ml/person/day.

4.3.3 Menstrual hygiene products

Mechanisms and/or devices for disposal of menstrual hygiene products should be incorporated into the design of the sanitation system or the superstructure.

4.3.4 Overload protection

A reasonable safety factor shall be incorporated into the design and indicated by the manufacturer in order to prevent overload. In order to indicate when the system is nearing maximum capacity (design capacity plus safety factor) the system shall be equipped with a mechanism indicating to the user that the system is overloaded and therefore not usable. Should overload occur, the system shall enter into a safe state that prevents any hazards due to overload.

4.3.5 Operability following non-usage or short-term shutdown

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

Following short-term shutdown of a minimum period of 60 h, the system shall be usable immediately.

NOTE Potential periods to which 4.3.5 applies include non-usage when the user is traveling or shutdown for maintenance.

4.3.6 Long-term shutdown

The sanitation system manufacturer shall provide precise instructions for preparing the system 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.

The sanitation system shall be usable immediately following long-term shutdown.

4.3.7 Continuous use

The sanitation system shall allow continuous use of the system without unreasonable waiting times between users.

4.4 Performance requirements

4.4.1 General

When operated, maintained, and used in accordance with the manufacturer's instructions, the following requirements shall be met under all potential operating conditions (see 4.8). Continuous monitoring or regular testing of output requirements may be implemented after installation.

4.4.2 Solid output and effluent requirements

Solid output and effluent shall be fully treated within the sanitation system allowing for its safe reuse or disposal. Solid output and effluent shall meet the requirements specified in 7.2.9.2.1 and 7.2.9.2.2 at all times.

4.4.3 Odor emissions requirements

In order to minimize odor emissions from the sanitation system, the requirements in 7.2.9.3 shall be met when tested according to A.3.5.

NOTE Potential origins of odor emissions from the sanitation system include fecal odors (feces and urine, and aging of feces and urine), and process odors such as those emerging during drying, pyrolysis, combustion, and discharge of output.

4.4.4 Noise requirements

Noise emissions from the non-sewered sanitation system shall not pose risks to the health and psychological wellbeing of the user. When tested according to A.3.7, the sanitation system shall meet the requirements specified in 7.2.9.4.

4.4.5 Air emissions requirements

Potential air emissions from non-sewered sanitation systems can be classified as pollutants or explosive gases. The monitoring of explosive gases during operation is addressed in 4.13.2. The following provision addresses air pollutants. Air pollutants from the non-sewered sanitation system released indoors and outdoors shall not exceed a level that poses risks to the health of the user. When tested according to A.3.6, the sanitation system shall meet the requirements specified in 7.2.9.5.

4.5 Expected design lifetime

Non-sewered sanitation systems shall be designed for a serviceable life of not less than 10 years, assuming use and maintenance according to the manufacturer's specifications. See 4.14 for maintenance requirements and Annex C for user manual requirements.

4.6 Aspirational and ergonomic design

Non-sewered sanitation systems shall be designed and realized not only for functionality but also for comfort. Non-sewered sanitation systems should also be designed for aesthetic satisfaction and sensory appeal. Designers should strive to evoke cleanliness in the appearance and user experience of the frontend.

4.7 Secure design

In order to prevent theft or tampering, all accessories, parts, and components of the non-sewered sanitation system shall be assembled or affixed in such a way as to deter removal or dismantling by unauthorized parties.

EXAMPLE Design requiring the use of tools for removal or dismantling of any accessories, parts, and components can help to deter theft.

4.8 Operating conditions

4.8.1 Ambient temperature range

Non-sewered sanitation systems shall operate safely and reliably in environments with ambient temperatures between 5°C and 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 above or below this range shall additionally demonstrate their capability to operate safely and reliably in these expanded ambient temperature ranges.

4.8.2 Ambient air humidity

Non-sewered sanitation systems shall operate safely and reliably in ambient air humidity conditions between 20% and 100%.

4.8.3 Atmospheric pressure

Non-sewered sanitation systems shall operate safely and reliably under atmospheric pressure conditions ranging from sea level (101 kPa) to 2 500 m altitude (76 kPa).

4.9 Sanitary requirements

4.9.1 General

Non-sewered sanitation systems shall operate safely and reliably within sanitation environments such as those involving wastewater or sludge. Relevant materials, equipment, components, connections, and joining elements of the non-sewered sanitation system shall be selected based on their suitability for such applications, and should be explicitly designed or approved for application in sanitation systems. Proof of appropriateness shall be provided for any relevant materials, equipment, components, connections, and joining elements not explicitly designed or approved for use in sanitation systems and can be demonstrated through risk assessments or other commonly accepted methods (e.g., failure mode and effects analysis, material testing, material safety data sheets).

4.9.2 Hygienic design

Non-sewered sanitation systems shall be designed and realized in such a way as to mitigate any risk of infection due to potential pathogens from human urine or feces or the intermediate and residual products of the sanitation system.

Non-sewered sanitation systems shall be closed systems that minimize the entry of insects and vermin to the subsystems.

4.9.3 Tightness

All installations that contain, transport, or store liquids shall achieve water tightness, at a minimum. In cases in which 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 Flood resistance of non-sewered sanitation systems is an additional consideration for flood-prone areas.

Related testing procedures are provided in A.3.1.

4.9.4 Cleanability of surfaces

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

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

Surfaces of exposed materials shall be designed and realized in such a way as to ensure that feces and residual substances can be removed by common cleaning methods and without requiring the use of specialized chemical cleaning agents. Overall cleanability should be equal to or exceeding that of a No. 3 100 to 120 grit finish on stainless steel.

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

Non-sewered sanitation systems should not necessitate the use of chemical and/or biological additives. Systems that do require such additives shall not necessitate their use in a manner or to a degree that exceeds acceptable health or environmental risks. The manufacturer of the sanitation system shall provide documentation concerning risks and instructions on proper use and handling of any additives necessary for system function (e.g. safety data sheets from the manufacturer of the relevant additives) and declaring compliance with the relevant national regulations and laws (see Annex C).

4.10 Material requirements

4.10.1 Durability of materials

Materials used for non-sewered sanitation systems shall be structurally stable, durable, and, where relevant, watertight, and shall be resistant to the effects of:

- a) any potentially damaging or corrosive substances to which they are exposed in the course of operation in sanitation environments, such as those involving wastewater or sludge (e.g., municipal wastewater, aerosols, sewage gases, and other atmospheric or micro-atmospheric influences);
- b) extended use of any chemical and/or biological additives associated with normal operation and maintenance of the system;
- c) typical chemical agents used for regular cleaning and disinfection;

- d) fatigue, ageing, and degradation; and
- e) stresses and wear during shipping, assembly, installation, operation, and maintenance.

Durability shall be achieved either through the use of materials inherently resistant to corrosion (e.g., stainless steel) or through the application of 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 sanitation system, 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) shall be prevented.

4.10.2 Fire resistance of materials

Non-sewered sanitation systems shall achieve acceptable fire resistance. Relevant surfaces shall not ignite, progressively glow, smolder, or show evidence of being functionally impaired when exposed to a source of ignition. Materials shall be certified in accordance with ISO 10295 or equivalent.

4.11 Connections and joining elements

Connections (e.g. welds, joints) within non-sewered sanitation systems shall be durable and capable of withstanding stresses and wear during shipping, 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 (e.g. stainless steel of class A2 or A4; for more information see ISO 3506-1, ISO 3506-2, ISO 3506-3).

Applied connection methods shall conform to proven state-of-the-art approaches. Connections identified as essential to safe operation or process reliability (see 5.1) shall be maintenance free. Location, type, and specification of relevant connections should 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 realization. The direction of movement or conveyance of moving parts and transition components of the sanitation system 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 non-sewered sanitation systems with which users or service personnel can come into contact shall not present hazards in the form of rough or sharp edges or unduly sharp points.

4.12.2 Fire and explosion protection

Non-sewered sanitation systems shall be designed and realized in such a way as to avoid any risk of fire or overheating caused by operation or malfunctions of the non-sewered sanitation system itself, or by gases, liquids, dust, vapors, or other substances generated or used in the process of the system's operation.

Non-sewered sanitation systems shall be designed and realized in such a way as to avoid any risk of explosion caused by explosive atmospheres or substances generated by the backend treatment technologies and processes including gases, liquids, dust, vapors, or other substances produced.

Hazardous accumulations of potentially explosive gases, liquids, dust, vapors or other substances 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 realized either through appropriate design of the sanitation system 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 sanitation system 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, and/or guarded in such a way as to contain any hazards. Installations and pipes, whether rigid or flexible, that carry fluids and/or gases shall be capable of withstanding the defined internal and external stresses, and shall be firmly attached and/or protected to ensure that no risk is posed by a rupture.

Strength safety factors (SSF) shall be proven to achieve the following levels (see ISO 14622 for further information):

- 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 Reuse of effluent

Sanitation systems that do not meet effluent requirements for flushing or handwashing (see 7.2.9.2.2) shall prevent this type of reuse in the design of the system through reasonably practical means.

4.12.5 Underground systems

Components of non-sewered sanitation systems 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.

4.12.6 External impacts

Non-sewered sanitation systems and their components and fittings shall be stable 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 4.15.5).

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 non-sewered sanitation systems shall be provided through clear and unambiguous symbols or pictograms to ensure the intended user's comprehension.

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

- a) expected number of users and uses per day (users/day and uses/day); (see 4.3.2),
- b) expected daily capacity for further input such as water, menstrual hygiene products, and organic waste (kg/day or l/day); (see 4.3.2),
- c) common items that shall not be added to the system, and
- d) instructions for obtaining service.

Additionally, if the effluent of the system does not meet drinking water requirements (see 7.2.9.2.2), a data plate, label, or sticker shall be placed in a location visible to the user in the vicinity of the backend warning the user that the effluent is not drinkable.

Plates and labels shall be permanent and clearly legible.

Written information and warnings shall be composed at the reading level of the intended users and shall incorporate all information specified in Annex C. Information shall be provided a) in the official local language(s) of the country of use and additionally b) in the English language. Warnings shall clearly indicate the extent of the safety risk.

4.13.2 Marking and labeling

Non-sewered sanitation systems shall have permanent and legible data plates. The information shall be provided a) in the official local language(s) of the country of use and additionally b) in the English language.

Data plates shall include, at a minimum,

- a) manufacturer's name and address,
- b) model number,
- c) serial number,
- d) date of manufacture, and
- e) tare weight of the system.

4.14 Maintenance

4.14.1 Reasonable configuration, adjustment, and maintenance activities

Non-sewered sanitation systems shall be designed and realized 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 intended users.

See D.2 to determine the suitability of a sanitation system 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

Configuration, adjustment, and maintenance points shall be located separate from any hazardous areas. Removal of system blockages, when necessary, shall be processed from the outside of the sanitation system and shall not necessitate any disassembly.

Non-sewered sanitation systems shall be designed and realized in such a way as to ensure that configuration, adjustment, and maintenance can be performed while the sanitation system is in a safe state. Configuration, adjustment, and maintenance shall not necessitate contact with feces, urine, intermediate process products, or residual products.

NOTE The provisions of 4.15.2 relate to preventing contamination and minimizing risk of infection.

4.14.3 Discharge and cleaning

Non-sewered sanitation systems shall facilitate the complete discharge of liquids, gases and aerosols, and solids from the system, including those deriving from the system's use as well as those derived from cleaning, disinfecting, and rinsing. Sanitation systems should include a safe state mode for this purpose. Systems shall provide a clear and distinctive indication when discharge is completed.

If it is necessary to discharge partially treated materials, either liquid or solid, these partially treated materials need not meet the requirements for solid output and effluent put forth in this document.

4.14.4 Tools and devices

If specialized tools are required for emptying and maintaining the non-sewered sanitation system, then these specialized tools shall be addressed in the user manual (see 4.14.5) and 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 non-sewered sanitation system 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 to keeping the system safe and operational. Detailed requirements for user manuals are provided in Annex C.

4.14.6 Handling and transport of the sanitation system

Non-sewered sanitation 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 sanitation system can withstand during handling and 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 gears or fixation points shall be provided to ensure the safe transport of the system.

NOTE Although 4.14.6 is not intended to represent non-sewered sanitation systems as primarily mobile systems, it does apply to such mobile solutions.

5 Technical requirements

5.1 Safety assessment

The manufacturer of a non-sewered sanitation system shall carry out either an iterative risk assessment or an equally effective assessment capable of demonstrating proven safety of sanitation systems. 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; and
- c) demonstrate the safety of the product.

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

Additional requirements for risk assessments are provided in B.1.

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). PSLC requirements are provided in B.3.

5.2 Operational requirements

5.2.1 General

The sanitation system shall meet basic functionality requirements such as starting of sanitation system operation, stopping of sanitation operation, and activating an emergency stop.

5.2.2 Intentional starting of sanitation system operation

Starting and restarting of the system through voluntary actuation, including restarting after a 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 sanitation system operation requires mechanical force to be applied by users, this force shall be no greater than 75 % of the maximum physical force that can reliably be generated by a female in the 5th percentile of size within the intended users. If no data is available, a maximum physical force between 20 N and 25 N can be assumed.

NOTE The 5th percentile value relates to the distribution of anthropometric values. This subclause is intended to ensure that the system can be comfortably operated by adults in the intended users, including its smallest women.

5.2.3 Intentional stopping of sanitation system operation

The non-sewered sanitation system 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 system 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.

5.2.4 Emergency stop

If relevant and applicable, the non-sewered sanitation system shall be equipped with one or more emergency stop devices that safely halt all mechanical and electrical processes and operations and cut off energy supply. Manufacturers of non-sewered sanitation systems should consult ISO 13850 for additional guidance concerning emergency stop functions.

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 redundant source of energy. The minimum capacity of the redundant source of energy should be sufficient to allow the safe preparation of the system for a long-term shutdown (see 4.3.6). The amount of energy supplied by the redundant source shall be indicated to the user.

In sanitation systems in which photovoltaic energy serves as the primary energy source, the capacity of the redundant source of energy shall reflect the specific solar radiation disruptions in the geographic setting for which the non-sewered sanitation system is designed.

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 state-of-the-art safety devices such as circuit power switches, fuses, or other proven 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 non-sewered sanitation system is plugged into an electrical outlet, removal of the plug is 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 non-sewered sanitation system 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 in accordance with 5.2.4.

Subsystems of the sanitation system that autonomously 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

Non-sewered sanitation systems deriving energy from sources other than electrical energy shall be designed, realized, and equipped in such a way as to ensure that hazards associated with the energy supply are prevented. If applicable, the requirements given in 5.3.2 shall be met for systems deriving their primary energy supply from non-electrical sources.

5.4 Mechanical requirements

5.4.1 Pressurized equipment

Pressurized equipment with a nominal operation pressure higher than 0,5 bar shall be designed and realized so as to withstand the mechanical loading pressure to which the equipment is subjected, including appropriate structural strength safety factors.

Overpressures shall be controlled by appropriate and proven safety relief valves.

5.4.2 Pipes, hoses and tanks

Pipes and hoses shall be positioned and, if necessary, 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.

NOTE Some cosmetic damage is expected during the lifetime of the tanks and storage vessels.

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 sanitation system shall be minimized either through design that prevents human contact with such parts or through the application of appropriate guards or protective devices.

Non-sewered sanitation systems shall be designed and realized so as to prevent accidental blockage of moving parts.

5.4.4 Backflow prevention

If the sanitation system is connected to the water supply system, then backflow shall be prevented in accordance with ASME A112.1.2 or an equivalent national or international standard.

5.5 Requirements for radiation

5.5.1 High temperatures of parts and surfaces

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

5.5.3 Other sources of radiation

Undesirable radiation emissions from the sanitation system shall be eliminated or be reduced to safe levels.

NOTE Other sources of radiation include laser, ultraviolet, or infrared radiation.

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. These safety requirements shall be achieved by appropriate safety devices such as circuit breakers and fuses. Requirements of applicable equipment standards (such as applicable parts of IEC 60335) should be met.

Minimum safety requirements shall provide, 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 61140); and
- c) compliance with the requirements of electromagnetic compatibility (EMC), i.e. sanitation system operation shall not be disturbed by any external source of a relevant electromagnetic field, nor shall the electromagnetic field of the sanitation system 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 non-sewered sanitation system 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 specified at an early design stage and shall reflect operation and installation conditions and the results of the assessment described in 5.1.

The control system shall ensure that:

- a) devices of conveyance and treatment processing shall not start unexpectedly if by doing so they would pose a hazard to the user or professional service personnel; further, their startup shall be indicated on the control display;
- b) automatic or manual stopping of the controlled moving parts of sanitation system shall be unimpeded;
- c) protective devices identified as necessary (see 5.1) shall remain fully effective or issue a stop command; and
- d) the signaling 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.

The control system shall be capable of detecting, at a minimum:

- failure of electrical and mechanical components critical to the treatment processes, and shall deliver a visible or/and audible failure signal to the user; and
- the overall availability for use, and shall deliver a visible or/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 and realized in such 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 in consideration of the principles contained in ISO 13849-1 and ISO 13849-2.

The safety-related functions shall be designed and realized 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.

5.7 Reliability of conveyance devices

The mechanical and hydraulic design of conveyance devices (e.g., internal pipework, connections and screws) shall prevent back flows, blockage, and surcharging during normal operation. Conveyance devices shall be designed and realized 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 system's integrity.

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

When tested according to ISO 10816-1, the vibration level in the XYZ-axis at any possible area of the frontend user interface of non-sewered sanitation systems shall not exceed 0,5 m/s².

6 Additional requirements for the frontend

6.1 General

Requirements specific to the frontend apply to non-sewered sanitation systems 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 intended users. Anthropometric data of the intended users should inform the design of all areas and parts accessed by the users, in accordance with ISO 7250.

The sanitation system shall be easy to use. The frontend shall meet the usability needs of the intended users. Designers shall ensure that a) the intended users regards the system controls as intuitive, b) the actions required to control operations follow a logical sequence, and c) complexity is minimized with respect to control panel signals.

The system shall achieve the following usability conditions:

- a) suitable complexity and transparency;
- b) self-descriptiveness and intuitive design (look-and-feel);
- c) controllability;
- d) conformity with user expectations; and
- e) error tolerance.

The manual control elements (e.g., hand levers, pedals, switches) and indicators shall be chosen, designed, realized, 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; and
- the activation forces are comfortable for the intended users.

6.2.2 Requirements for ease of cleaning

The frontend and connected installations that are accessible to the user (e.g., pipes and chutes), shall be designed and realized 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 indicated and provided by the manufacturer.

6.2.3 Requirements for ease of operation

The design and realization of the non-sewered sanitation system shall minimize demands on the user with respect to the performance of periodically recurring operational activities (e.g. usage of rake, adding of bacteria) needed to keep the sanitation system 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 provided by the manufacturer (see Annex C).

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 sanitation system is designed, including:

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

If changes to user practices 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.3.

6.3 Visibility of feces

The frontend squatting or WC pan shall ensure a visual barrier to prevent the user from seeing an accumulation of deposited feces from previous users when looking directly into the frontend squatting or WC pan with a viewing angle perpendicular to the floor. If the barrier is formed from a water seal, this seal should be of a minimum depth of 20 mm.

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

6.4 Evacuation performance

Urinals, squatting pans, or WC pans applied as part of the frontend of non-sewered sanitation systems 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 with the requirements specified in A.3.3.

Example standards are provided in Table 1; equivalent national standards may be applied.

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 non-sewered sanitation system, the flushing mechanism shall meet the requirements for the adapted flushing tests specified in A.3.3.

Table 1 — Examples of applicable national standards for evacuation mechanisms

Frontend user interface	Evacuation mechanism			
	Conventional flushing mechanisms (cistern/ flush valve*)	Pour-flush	Dry	Novel evacuation mechanisms
WC pan	EN 997	See A.3.3.4 and A.3.3.6		
Squatting pan	IS 2556-3	See A.3.3.5 and A.3.3.6		
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. The requirements of NSF 41, Clause 5.2.1, or equivalent, shall be applied and a static load test shall be conducted.

6.6 Slipping, tripping or falling

Frontend areas of the non-sewered sanitation system in which users and/or service personnel are expected to move about, stand, or sit shall be designed and realized 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 that are fixed relative to the entrants and that enable them to maintain their stability.

7 Performance testing

7.1 General testing requirements

Non-sewered sanitation systems shall be tested for performance according to the classifications provided in Table 2.

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 the minimum distance specified by the manufacturer. The system as installed shall be classified as Class 1, Class 2, or Class 3 according to Table 2. Testing related to requirements specific to the frontend (Clause 6) need not be performed for backend-only products.

Table 2 — Classification of non-sewered sanitation systems

Class	Testing Requirements
Class 1: Non-sewered sanitation systems – one frontend – backend non-biological	Controlled laboratory testing as outlined in 7.2 and field testing according to 7.3.1
Class 2: Non-sewered sanitation systems – one frontend – backend includes one or more biological treatment processes	Controlled laboratory testing as outlined in 7.2 and field testing according to 7.3.2
Class 3: Non-sewered sanitation systems – more than one frontend	Testing procedures as outlined in 7.2, which may be modified to account for alternative testing environment if the system cannot be installed in a laboratory; additional field testing procedures (see 7.3.2) for systems incorporating biological treatment processes. 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 odor (7.2.9.3), noise (7.2.9.4), and air emissions (7.2.9.5). 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 odor (7.2.9.3), noise (7.2.9.4), and air emissions (7.2.9.5).

7.2 Controlled laboratory testing

7.2.1 General

Class 1 and Class 2 systems, and Class 3 systems 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 certification process are specified in A.1.

7.2.2 Assembly, installation, operation, and maintenance

Assembly and installation of sanitation systems shall be conducted according to the manufacturer's instructions. Sanitation systems 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. For these sanitation systems that do not include superstructures as part of the manufactured product, the added superstructure shall be removed prior to odor testing (see A.3.5) and noise testing (see A.3.7) and the tests shall be adapted as described in A.3.5 and A.3.7. The presence or absence of a superstructure during odor and noise testing shall be clearly indicated on the test report.