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INTERNATIONAL STANDARD

ISO/FDIS 20761

Water reuse in urban areas — Guidelines for water reuse safety evaluation — Assessment parameters and methods

Réutilisation de l'eau en milieu urbain — Lignes directrices concernant l'évaluation de la sécurité de la réutilisation de l'eau — Paramètres et méthodes d'évaluation

Contents

Page

Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO 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).

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

This document was prepared by Technical Committee ISO/TC 282, *Water reuse*, Subcommittee SC 2, *Water reuse in urban areas*.

Introduction

With economic development, climate change, increases in population and rapid urbanization, water has become a strategic resource especially in arid and semi-arid regions. Water shortages are considered as one of the most serious threats to the sustainable development of society. To address these shortages, reclaimed water resources are increasingly being used to satisfy water demands. In addition, some communities are expanding water supply by employing potable reuse. These strategies have proven useful in increasing the reliability of long-term water supplies in many water-scarce areas.

The role of water reuse is growing for urban areas in many countries including: landscape irrigation; industrial uses; municipal non-potable uses such as toilet and urinal flushing; fire-fighting and fire suppression; environmental and recreational uses (ornamental water features, water bodies' replenishment); and vehicle washing. These non-potable water reuse systems have been developed to the degree that they are considered as an effective component of urban water management and are widely used in many cities and countries.

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However, there are several types of pollutants in wastewaters, including dissolved organic matter, nutrients, salts, toxic and harmful chemicals, and pathogens. Therefore, safety evaluation and public acceptance of water quality are important issues which are of high concern during water reuse in urban areas. Water reuse safety includes health safety, environmental safety and facilities safety. For different types of reclaimed water uses, exposure pathways and potential hazards are very different. The diversity of reclaimed water applications and related hazards can result in significant differences in water quality parameters for such applications.

This document provides assessment parameters and methods for safety evaluation of non-potable water reuse in urban areas. They are intended to assist water engineers, authorities, decision makers and stakeholders in determining the safety of reclaimed water for end uses.

Water Reuse in Urban Areas — Guidelines for Water Reuse Safety Evaluation — Assessment Parameters and Methods

1 Scope

This document provides water reuse safety evaluation and public acceptance parameters and methods for users who design, manage, and/or oversee the non-potable water reuse schemes or activities in urban areas from the viewpoint of water quality. The document can be used in various stages of non-potable water reuse projects such as design, operation, and post assessment.

The document is applicable to non-potable water reuse in urban areas with reclaimed water from municipal wastewater sources. The wastewater sources can also include a limited contribution of industrial wastewater input. While some communities are turning to potable reuse to meet water supply needs, discussion of safety evaluation of potable reuse is outside the scope of this document.

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 20670:—[1], *Water reuse — Terminology*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 20670 and the following apply.

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

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

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

3.1
environmental safety
freedom from the occurrence of a risk which is not tolerable and that is related to environmental change (especially scarcity and degradation) which can arise when water reuse service is prepared and/or provided according to its intended use. It includes the impact of the reclaimed water on the receiving environment — soil; groundwater and surface water; air; aquatic and terrestrial biota

4 Abbreviated terms

BOD_5	biochemical oxygen demand after 5 days
COD	chemical oxygen demand
CFU	Colony forming unit
DBPs	disinfection byproducts

[1] Under preparation. Stage at the time of publication: ISO/DIS 20670:2017.

DO	dissolved oxygen
E. coli	*Escherichia coli*
EECRW	estimation of environmental concentration at a site induced by water reuse
HPC	heterotrophic plate counts
LC_{50}	estimated concentration that is expected to be lethal to 50 % of a group of organisms
MPN	most probable number
NOEC	no observed effect concentration
NTU	nephelometric turbidity unit
TSS	total suspended solids
TDS	total dissolved solids
TN	total nitrogen
TOC	total organic carbon
UV	ultraviolet light

5 Water reuse safety

Water reuse safety generally includes health safety, environmental safety, and facilities safety. Consideration for safety and public acceptance of water reuse in urban areas are shown in Table 1. The premise of water reuse safety is to satisfy relevant water quality standards and limit risk of water degradation through implementation of good practices. When using reclaimed water, it is essential to protect human health and the environment and to prevent the degradation of the materials and assets of the distribution system, storage system and end uses. Public acceptance is also a criterion to consider when assessing water quality aesthetic parameters such as colour and odour.

Table 1 — Considerations for safety and public acceptance of water reuse in urban areas

Targets	**Considerations**
Health safety	Health risks to public and workers handling the reclaimed water
Environmental safety	Effects on aquatic and terrestrial biota Effects on receiving soil, groundwater, surface water and air
Facilities safety (such as equipment and pipes)	Scaling, fouling and corrosion of facilities Harmful effects on property of users' belongings, e.g. clothes and vehicles Adverse effects associated with the operation (exclude failures in manual operations) of processes and equipment
Public acceptance	Colour and odour

6 Water reuse safety parameters

A set of relevant water quality parameters and their interest to characterize the water reuse safety and public acceptance are proposed in Table 2. The selection of the relevant and suitable parameters for safety evaluation and public acceptance depends on local water quality standards, on reclaimed water source characteristics, on the context (climatic, environmental, occupational) and use. Selected water quality parameters can possibly include routine physical and chemical parameters, aesthetic parameters, microbial parameters, stability parameters, and toxic and harmful chemicals.

Indicators and surrogates can be selected for monitoring (instead of specific water quality parameters, for instance) when studies have shown their representativeness. In routine analysis, turbidity, disinfectant residuals and bacterial indicators such as *Escherichia coli* (*E. coli*) and heterotrophic plate counts (HPC) can be used to verify microbial safety in storage and distribution systems.

Table 2 — Relevant water quality parameters[a] and their interest to characterize water reuse safety and public acceptance

Types	Water quality parameters	Notes of significance
Routine physical and chemical parameters	pH	Affects disinfection efficiency, coagulation, metal solubility, toxicity of pollutants
	Biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), or total organic carbon (TOC)	Indicates organic pollution and also the potential of microbial growth and biofilm formation
	Ammonia	Exhibits toxicity to aquatic life and plants, causes stress corrosion in copper-based alloys
	Total nitrogen (TN), nitrate, or nitrite	Stimulates algae and bacterial growth, induces groundwater contamination
	Phosphorus	Stimulates algae and bacterial growth
	Dissolved oxygen (DO)	Can be associated with odour, corrosion, scaling, and maintenance of aquatic life
	Total dissolved solids (TDS), electrical conductivity	Can be associated with corrosion and scaling of pipes and equipment and affect plants water availability and crops yield
	Alkalinity, hardness	Can be associated with corrosion and scaling of pipes and equipment
	Turbidity or total suspended solids (TSS)	Affects disinfection efficiency and reuse equipment (e.g. clogging, fouling, odour generation) and public acceptance
	Chlorine demand	Prevents/minimizes DBP formation by adjusting chlorine disinfection levels according to chlorine demand
	Residual disinfectants (residual chlorine, etc.)	Prevents microbial growth and exhibits toxicity to aquatic life and plants
Aesthetic parameters	Colour	Affects public acceptance
	Odour	Affects public acceptance
Microbial parameters	Indicator bacteria (thermo-tolerant coliforms, *E. coli*, or total coliform, etc.)	Indicate likelihood of microbial health risk and affect public acceptance
	Environmental pathogens[b]	Can cause potential health risk, for example, *Legionella pneumophila* survives in cooling water environments
Stability parameters	Chemical stability: Specific ions (such as Ca^{2+}, Mg^{2+}, Cl^-, SO_4^{2-}), etc.[c]	Can be associated with corrosion and scaling of pipes and equipment
	Biological stability: heterotrophic plate counts (HPC), algae, etc.[d]	Can favour microbial growth, affect filtration and disinfection efficiency, induce biological fouling of facilities, and create aesthetic and nuisance problems
Toxic and harmful	Specific metal (such as Pb, Hg, Cd) [c]	Exhibits toxicity to flora and fauna
	Oil and grease	Results in toxicity to aquatic life

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chemicals	Surfactants	Results in foaming and toxicity to aquatic life

a Recommended for consideration in water reuse safety evaluation.

b Considered for selection depending on reclaimed water source characteristics and uses.

c Specific metals and ions are considered for selection depending on reclaimed water source characteristics (such as ion contribution from industrial wastewater input) and use.

d Evaluation of changes in biological stability parameters during distribution, storage and use with long hydraulic retention time is recommended. For details concerning the chemical and biological stability, see References [9] and [10].

The optional water quality parameters in terms of microbial, stability, harmful chemicals and toxicity can be considered for risk assessment on a case-by-case basis in response to a specific water quality issue, depending on the local context (e.g. uses with high risk of exposure and sensitive population, epidemiological evidence, equipment or facility degradation). Investigation studies can be carried out to support the risk assessment.

Examples of optional parameters are listed as follows and are informative.

a) Microbial organisms such as the protozoa (*Giardia* and *Cryptosporidium*) and helminths are widely detected in raw wastewater. The relevant parameters or indicator microorganisms can be introduced depending on the specific water quality application and monitoring capability.

b) Assimilable organic carbon in reclaimed water can favour microbial regrowth, induce biological fouling of facilities and distribution pipes such as in cooling water and chilled water systems. The relevant biological stability parameters or surrogates can be introduced.

c) Toxic and harmful chemicals such as disinfection byproducts (DBPs) can be detected in reclaimed water which can affect human health. The relevant parameters can be selected according to local water quality and technological conditions.

d) Aquatic toxicity can be considered for environmental uses such as habitat enhancement and stream augmentation.

The above mentioned optional parameters can be addressed due to increasing concerns on their potential risks. Under each type of parameter, there can be multiple kinds of indicators. Further investigation studies can be carried out to assist the optimal selection and evaluation of appropriate indicators according to local cases.

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7 Framework for safety evaluation of water reuse in urban areas

Water reuse safety evaluation can be performed according to the framework depicted in Figure 1. Water quality should be fit for purpose and safety evaluation should accordingly depend on specific corresponding conditions. Further, the need for the water reuse safety evaluation should be addressed for the intended purpose in order to ensure that the evaluation is suitable and useful for informed decisions. The following points indicate the considerations for establishing a framework for safety evaluation of water reuse.

a) The framework for safety evaluation is mainly based on comparison with water quality standards and best practices/feedback of experience and inspection. Safety evaluation relies on adherence with water quality standards and effectiveness of preventive measures to prevent water quality degradation.

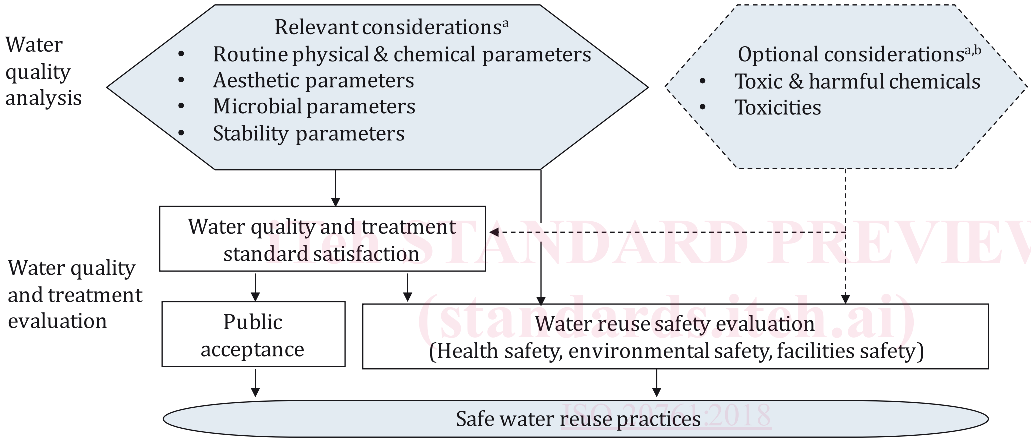
b) Water quality parameters for safety evaluation in urban areas should be selected considering various issues such as water quality characteristics of reclaimed water sources, water reuse applications as well as different exposure routes and pathways for users/populations.

c) For safety evaluation, susceptible population and those with high exposure to reclaimed water, such as children, workers who were handling the reclaimed water (such as fire-fighters, street cleaning and vehicle washing workers, operators at water reclamation facilities) should be considered.

d) Water quality parameters can be set to reduce the risk of acute and chronic health effects to a tolerable level for exposure to reclaimed water via ingestion, inhalation and/or contact.

e) Safety evaluation for protection of health, environment and facilities are performed according to water quality standard and risk assessment guidelines, see ISO 20426, References [11] and [12].

f) Long-term evaluation of water reuse safety can be performed if pollutants are present at detectable levels that can bioaccumulate, persist in the environment or tend to undergo bio-magnification in food chains or pose chronic toxicity to humans and sensitive species.



a Relevant water quality parameters are recommended for consideration in water reuse safety evaluation. Optional water quality parameters can be considered for risk assessment on a case-by-case basis in response to specific water quality issue(s).

b Research studies can be conducted to select and optimize parameters such as toxic and harmful chemicals and toxicities.

Figure 1 — Framework of water reuse safety evaluation

8 Water quality parameters selection for water reuse in urban areas

8.1 General

The selection of appropriate water quality parameters for consideration to ensure safety and public acceptances should be tailored to reclaimed water sources and fit for purpose needs.

a) Tailoring to source. Reclaimed water is obtained after proper treatment of municipal wastewater effluent or raw wastewater. For details concerning centralized water reuse system, see ISO 20760-1 and ISO 20760-2. Thus, the selection of appropriate water quality parameters involves the consideration of different influent types (e.g. municipal wastewater, small amount of industrial wastewater or stormwater, etc.) and different types of treatment technologies.

b) Fit for purpose. Different reclaimed water use approaches have different protection targets and exposure pathways which should be defined on a case-by-case basis. Protection targets and exposure pathways of water reuse should be determined. Afterwards, water quality parameters can

