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Performance evaluation of treatment technologies for water reuse systems —

Part 10: Guidelines for evaluation of dependability of treatment systems

Évaluation des performances des techniques de traitement des systèmes de réutilisation de l'eau —

Partie 10: Lignes directrices pour l'évaluation de la sûreté de fonctionnement des systèmes de traitement

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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.

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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 Technical Committee ISO/TC 282, *Water reuse*, Subcommittee SC 3, *Risk and performance evaluation of water reuse systems*.

A list of all parts in the ISO 20468 series can be found on the ISO website.

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.

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Introduction

The purpose of this document is to define a methodology to evaluate the dependability of treatment systems, which is listed as one of “treatment technology non-functional requirements” in ISO 20468-1. Although the targeted performance requirement can be selected depending on the purpose, functional requirements related to water quality should be targeted with high priority in conventional water reuse projects.

As a consequence, the dependability of a treatment system can be represented and evaluated by availability as the ability to perform long-term operation without a failure and the fulfilment of functional requirements related to the water quality target to be conformed with. As well, dependability as a “non-functional requirement” can be evaluated by benchmarking for making comparisons or improving treatment system performance.

Performance indicators other than dependability for the non-functional requirements of treatment systems have already been specified in ISO 20468-2 for environmental performance based on greenhouse gas (GHG) emissions and in ISO 20468-8 for economic evaluations based on life cycle cost (LCC). If functional requirements related to water quality performance are satisfied, dependability can provide appropriate information on operation and maintenance used for calculating GHG emissions and LCC.

A comprehensive evaluation of dependability, environmental, and economic performance can be used to select an appropriate and cost-effective treatment system in the planning phase and to identify improvement for operations and optimization opportunities on a life cycle basis. A variety of stakeholders, including managers of water reuse projects and owners of water infrastructure and facilities can find beneficial opportunities and options through a comprehensive performance evaluation using the guidelines in the ISO 20468 series.

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Performance evaluation of treatment technologies for water reuse systems —

Part 10:
Guidelines for evaluation of dependability of treatment systems

1 Scope

This document provides guidelines for evaluating the dependability represented by the availability of treatment systems for water reuse.

The document specifies methodologies for both qualitative and quantitative assessments of availability on a life cycle basis.

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, *Water reuse — Vocabulary*

3 Terms, definitions, and list of abbreviated terms

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

3.1.1
availability
ability of a treatment technology to be in a state to perform a required function under given conditions at a given instant of time or over a given time interval

Note 1 to entry: This ability depends on the combined aspects of *reliability* (3.1.11) performance, *maintainability* (3.1.7) performance, and *maintenance support performance* (3.1.8). *Preventive maintenance* (3.1.10) can extend reliability and improve availability.

[SOURCE: ISO 20468-1:2018, 3.1.1, modified — “assuming that the required external resources are provided” was removed from the definition; “Preventive maintenance can extend reliability and improve availability” was added to Note 1 to entry; Note 2 to entry was removed.]

3.1.2
benchmarking
tool for performance improvement through systematic search and adaptation of leading practices

[SOURCE: ISO 20468-1:2018, 3.1.2]

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3.1.3
corrective maintenance
maintenance carried out after fault detection to effect restoration

[SOURCE: IEC 60050-192:2015, 192-06-06, modified — Note 1 to entry was removed.]

3.1.4
dependability
ability of a system represented by the *availability* (3.1.1) performance and its influencing factors, namely *reliability* (3.1.11) performance, *maintainability* (3.1.7) performance and *maintenance support performance* (3.1.8)

[SOURCE: ISO 20468-1:2018, 3.1.5, modified — "collective term used to describe" was replaced with "ability of a system represented by"; the list of influencing factors was added to the definition.]

3.1.5
downtime
amount of time that a system or a component is not able to operate or meet required functions

[SOURCE: ISO 20468-1:2018, 3.1.6]

3.1.6
failure
state in which a treatment technology does not meet a functional or a *non-functional requirement* (3.1.9)

[SOURCE: ISO 20468-1:2018, 3.1.7]

3.1.7
maintainability
ability of a treatment technology, under given conditions of use, to be retained in, or restored to, a state in which it can perform a required function, when maintenance is performed under given conditions and using stated procedures and resources

[SOURCE: ISO 20468-1:2018, 3.1.9]

3.1.8
maintenance support performance
ability of a maintenance organisation, under given conditions and maintenance policy, to provide, upon demand, the resources required to maintain the treatment technology

[SOURCE: ISO 20468-1:2018, 3.1.10, modified — Notes to entry were removed.]

3.1.9
non-functional requirement
requirement that specifies criteria or constraints on the design or implementation of a treatment technology

[SOURCE: ISO 20468-1:2018, 3.1.12]

3.1.10
preventive maintenance
maintenance carried out to mitigate degradation and reduce the probability of *failure* (3.1.6)

[SOURCE: IEC 60050-192:2015, 192-06-05, modified — Notes to entry were removed.]

3.1.11
reliability
ability that a device, system or process will perform its prescribed function without *failure* (3.1.6) for a given time when operated correctly in a specified environment

[SOURCE: ISO 20670:2023, 3.79, modified — "probability" was replaced with "ability".]

3.1.12
uptime
amount of time that a system or a component is able to operate or meet required functions

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3.2 Abbreviated terms

NF	nanofiltration
PCP	performance control point
RO	reverse osmosis
TMP	transmembrane pressure
UV	ultraviolet

4 Concept of dependability evaluation of treatment systems

4.1 Dependability evaluation by availability

The dependability of a treatment system is evaluated mainly from the availabilities of unit processes, which make up the system facility, to achieve functional requirements related to water quality over the course of operation. In planning or design stage, inherent availability is generally expressed by Formula (1) with two influencing factors: reliability and maintainability.[9] The introduction of preventive maintenance to prevent failures of the treatment system facility can extend the reliability represented by mean time between failures and improve the inherent availability. While preventive maintenance is usually more effective and preferable, corrective maintenance for the rapid recovery from a failure can reduce mean time to recovery and lead to improved maintainability, which in turn contribute to increased availability.

$$A_{\mathrm{i}} = \frac{T_{\mathrm{b}}}{T_{\mathrm{b}} + T_{\mathrm{r}}} \tag{1}$$

where

A_{i} is the inherent availability;
T_{b} is the mean time between failures (in d);
T_{r} is the mean time to recovery (in d).

The primary functional requirement of a treatment system is to produce reclaimed water that fulfils quality and quantity requirements, and a failure can be in the context of water quality or quantity. As a result, dependability represented by availability can be explained as an ability related to the duration of system operation without intervention or failure and fulfilment of functional requirements related to a water quality target. As well, dependability as a non-functional requirement can usually be evaluated by benchmarking for making comparisons or improving treatment system performance.

4.2 Treatment system and critical unit processes as performance control points (PCPs)

For a treatment system, the use of treatment processes as multiple barriers is an effective and commonly used strategy to reduce residual health risks in reclaimed water. The required level of treatment is determined based on the degree of required water quality, which is ultimately associated with intended end-use.

The availability of a treatment system depends on the availability of each of the individual unit treatment processes that make up the system, and the way in which these processes are integrated. To fulfil the requirements for the high reclaimed water quality of a treatment system, in addition to monitoring water quality, ISO 20426 recommends a risk control approach by setting process PCPs. The availability of each of the unit processes determined as PCPs should be assessed for practical and effective assessments of treatment system availability.

The availability of unit processes can be assessed by selecting water quality criteria or surrogate parameters and the measurable control numerical limits that are set for each PCP. For monitoring the fulfilment of functional requirement of processes as possible PCPs, the ISO 20468 series guidelines for evaluating the performance of treatment technologies can be used to select appropriate monitoring parameters.

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