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Guidelines for the management of assets of water supply and wastewater systems

Part 2: Waterworks

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National foreword

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Partie 2: Installations de production, pompage et stockage d'eau potable

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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).

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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 224, *Service activities relating to drinking water supply, wastewater and stormwater systems*.

A list of all parts in the ISO 24516 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

This document is written within the overall concept of management of assets, which is an activity all organizations undertake in some manner and to some degree. It focuses on the details of managing the physical assets at the operational level rather than the organizational (corporate management, structural or process) level.

Drinking water utilities are reliant on their assets to deliver their services to users in their service areas. The assets (e.g. reservoirs, wells, treatment plants, pumping stations, underground pipes and storage tanks) collectively form the physical infrastructure of drinking water utilities and are the consequence of the accumulated capital investments and operational expenditures on maintenance and rehabilitation over many years. In many of these utilities, the replacement value of these past investments will amount to many millions (even billions) of US dollars depending on the size of the community served. The infrastructure represents a major societal investment in essential services contributing to public health and the protection of the environment.

In many countries, these assets have been identified as critical infrastructure and programs are in place to ensure their protection or their sustainability. Like many other organizations with assets, drinking water utilities undertake programs of activities to manage the assets to ensure they continue to meet the needs of the community for reliable delivery of drinking water. These management activities can be at the strategic, tactical or operational level. The activities can be part of a formal management system, the result of specific legislative requirements, or simply the result of due diligence by the service operators and managers.

This document can serve as a supporting document for utilities operating an asset management system regardless of whether or not the utilities make use of any management system standard, for example ISO 55001.

In many countries there is a recognized sustainability problem, sometimes referred to as the infrastructure gap, which recognizes that, for various reasons, the infrastructure has not been maintained over the years on a truly sustainable basis, i.e. funding and implementation of rehabilitation programs have been postponed, with a focus instead on short-term repairs or an allowed decrease in the level of service provided.

The condition of water infrastructures greatly influences the adequacy of the drinking water service from the aspects of quality, quantity, pressure, safety, reliability, environmental impact, sustainability, degree of treatment and efficiency. Drinking water system condition-based rehabilitation approaches serve to meet these requirements with a focus on a holistic approach of condition-based, risk-oriented maintenance.

As the installation and development of water assets matures, the optimization of drinking water infrastructure will become necessary in many places in order to compensate for ageing and wear and tear, and to respond to changing societal and economic conditions. Consequently, water infrastructure assets are subject not only to ageing and wear and tear but also to adaptation processes resulting from growth, new legislative requirements, technical innovations or users' changing service-level expectations. This requires drinking water utilities not only to focus on maintenance and rehabilitation but also to keep future requirements and developments in mind. Rehabilitation will thus become essential in the management of assets, with ever more stringent requirements on the design and execution of rehabilitation.

In recent years, much effort has been applied to the whole issue of management of assets on two levels:

— What are the principles and structure of an asset management system?

— What are the good practices that can be implemented on a technical level to assess the condition of the assets and help decide when asset interventions (repair, renovation or replacement) should take place?

This document describes the information required and how to collect and process reliable inventory, condition, operational and context data about technical assets of drinking water systems, including

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failures. These data should be the basis for a systematic management of assets and can be used for benchmarking purposes. A reliable database that supports analysis of failures and of operational data (including a description of the condition of facilities or units) is of particular significance when establishing a risk-based investigation to determine maintenance and rehabilitation priorities.

This document also provides advice on how to define a strategy for management of assets with regard to the overall performance expected by the drinking water utility and other stakeholders. It includes several aspects of operation and maintenance, including asset condition assessment and investment strategies (new assets and rehabilitation).

The usual and expected goal in the effective management of assets is to provide an appropriate service life while fulfilling given requirements in a cost-effective manner.

This document is intended to provide guidance on the assets typically owned or operated by drinking water utilities (waterworks – including collection, treatment, pumping and storage) that are expected to meet users' needs and expectations over longer (multi-generational) periods.

Additional information on objectives for management of assets of waterworks is provided in Annex A. An outline of the content of a drinking water master plan is provided in Annex B. Examples of inventory, condition and operational data are provided in Annex C. Methods for the risk-based assessment for rehabilitation are shown in Annex D.

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Guidelines for the management of assets of water supply and wastewater systems —

Part 2: Waterworks

1 Scope

This document specifies guidelines for technical aspects, tools and good practices for the management of assets of waterworks to maintain value from existing assets. This document includes the following asset types: treatment plants, sludge treatment facilities, pumping stations, reservoirs, tanks and dosing equipment, metering and ancillary infrastructure irrespective of where they are sited, in the waterworks or in the drinking water distribution network.

For further guidance on drinking water distribution networks see ISO 24516-1.

NOTE 1 The management of transmission mains is addressed in ISO 24516-1 irrespective of where these assets are sited in the drinking water system.

This document is focused on the assets typically owned or operated by drinking water utilities (drinking water systems) that in parts are expected to meet users' needs and expectations over longer (multi-generational) periods.

This document includes examples of good practice approaches on the strategic, tactical and operational levels.

This document is applicable to all types and sizes of organization and/or utilities operating drinking water systems.

NOTE 2 Depending on the size and structure of an organization, the utility can decide to what extent it applies the guidance in this document. In any case, the philosophy of this document remains applicable even to small and medium utilities.

NOTE 3 This includes all different roles/functions for the management of assets within a utility (e.g. asset owner/responsible body, asset manager/operator, service provider/operator).

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 24513, *Service activities relating to drinking water supply, wastewater and stormwater systems — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 24513 apply.

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

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

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

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4 Principle aspects of the management of assets

4.1 Objectives and requirements

4.1.1 Objectives

The key generic objectives for the management of assets of drinking water systems are identified from ISO 24510 and ISO 24512 as:

— protection of public health;

— meeting users' reasonable needs and expectations;

— providing services in standard and emergency situations;

— promoting the sustainability of the drinking water utility;

— promoting sustainable development of the community;

— protection of the environment.

Drinking water utilities should aim to manage their facilities systematically and efficiently in order to sustain their function. This takes place on the basis of clearly defined objectives, based on assessment and forecasting of the condition of their often extensive and complex facilities.

Setting objectives for the management of assets should help to ensure that the drinking water utility conforms to an agreed and sustainable level of service, while also exerting a major influence on its economic performance and taking into account risks to the achievement of those objectives. The level of service should be well defined, communicated, tied to risk, and current as customized to a particular drinking water utility.

For further information on objectives of the management of assets of waterworks see Annex A.

4.1.2 Functional requirements

Functional requirements should be established to aid the achievement of the objectives.

Functional requirements of a drinking water utility cover the acquiring of water (from catchments, wells and rivers), transmitting (pumping as necessary) and storing water prior to treatment, treating the water to a drinking water standard, storing the water prior to (and onward within) distribution via drinking water distribution networks (pumping again as necessary). A variety of equipment and facilities support the main functionalities and are also subject to management of their associated assets to ensure sustainable access to drinking water. The functional requirements should be considered in respect of the whole drinking water system to ensure that additions or modifications to the system do not result in failure to meet the target(s).

Functional requirements should be established that, while taking into account sustainable development and whole-life costs, including indirect costs (e.g. traffic congestion, military aid provided by the civil authorities), ensure that the drinking water system does not cause unacceptable environmental nuisance, risk to public health, or risk to personnel working therein.

Each functional requirement can relate to more than one objective. An indication of the relevance of each of the functional requirements to achieving the objectives is shown in Table 1.

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Table 1 — Relationship between objectives and functional requirements

Functional requirements	Objectives						
	Protection of public health and safety	Meeting users' reasonable needs and expectations	Protection of occupational health and safety	Providing services in standard and emergency situations	Promoting the sustainability of the drinking water utility	Promoting sustainable development of the community	Protection of the environ-ment
Control of water quality parameters	XXX	XX	XXX	XXX	XX	XXX	XX
Ensuring drinking water quality	XXX	XXX	XX	XX	XX	X	XX
Continuity of service	XXX	XXX	—	XXX	XXX	XXX	X
Ensuring adequate pressure	XXX	XXX	X	XX	XX	—	X
Maintainability	XX	X	XXX	XX	XX	XX	XX
Providing service in emergency situations	XXX	XXX	X	XXX	XXX	—	XXX
Suitability of products and materials for drinking water	XXX	XXX	XX	XX	XXX	X	X
Sustainability of products and materials	—	XX	—	XX	XXX		XX
Sustainable use of energy	—	X	—	XX	XXX		XX
Long design life of assets	X	XX	X	XX	XXX		XXX
Minimizing of failures	XX	X	X	X	XXX		XXX
Prevention of noise	XX	X	X	X	X		X
NOTE The number of Xs gives guidance on the importance of the requirement in achieving the objectives.							

4.1.3 Performance requirements

In order to evaluate the performance of the waterworks and to allow development of design criteria, measurable performance requirements should be determined from each functional requirement.

For each functional requirement, there can be legal requirements, public expectations and financial constraints which should influence the performance requirements. Public expectations should be reflected in the level of service set by the utility to provide to its users.

For each aspect of performance, different levels can be required, for example:

a) trigger levels which justify early upgrading action according to priority;

b) target levels to aim for in upgrading, which should be equal to the requirements for new construction, but which sometimes can only be achievable or necessary in the longer term.

Performance requirements should be reviewed periodically and updated if necessary. The performance requirements for the drinking water system should be updated after major extension, maintenance or rehabilitation.

In principle, the performance requirements for rehabilitated waterworks should be the same as those for new waterworks.

Performance indicators are essential tools for the understanding of the actual and desired performance of the infrastructure of a drinking water utility and in parallel, enable indicator-supported

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infrastructure planning and decision-making. Reasonably designed and applied, performance indicators provide information about the condition of the assets and the level of their contribution to the achievement of the objectives of a drinking water utility.

Performance indicators should be defined at strategic, tactical and operational levels, for example:

— strategic: conformity of drinking water quality with given requirements, meeting future water demand;

— tactical: meeting peak consumption;

— operational: use of chemicals and energy per m^3.

They should make clear how actions at the operational level contribute to achieving strategic-level objectives. Strategic-level performance indicators are often called “outcomes” while operational- and tactical-level performance indicators are called “inputs” “and outputs”, respectively.

4.2 General aspects

4.2.1 General

In management of assets a distinction can be made between two principal focal points:

— the wider drinking water utility or responsible body in question;

— that organization's drinking water system to be managed.

The former could include, for example: strategic financial, reputational and non-operational assets as part of ensuring the drinking water utility's overall objectives are met.

The latter should take into account:

— attention to stakeholder (e.g. users, operator, relevant authorities, responsible bodies) requirements, needs and expectations;

— sustainability of the asset system and the provided service;

— safe water quality;

— the management of risk;

— financial stability of the utility.

4.2.2 Principal aspects — Drinking water utilities

The management of the physical infrastructure of drinking water utilities is recognized as a critical activity in realizing users’ and other stakeholders’ expectations. Key activities include:

— the determination of the utility’s current and longer-term objectives;

— planning and implementing activities to achieve objectives;

— the prediction of future water demand as an additional basis for rehabilitation;

— the means of measuring the performance of the utility in meeting these objectives.

The management of the utility’s assets should be directed towards ensuring the utility’s objectives are met.

Additionally, for ensuring long and economic life cycles, proper operation and stable water service, the management should include:

— knowledge of the layout of the entire drinking water system;

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— knowledge of the entire drinking water system together with knowledge of costs (planning, constructing, operation, maintenance and decommissioning);

— knowledge of availability and need of resources;

— the selection of appropriate materials and components;

— the choice of installation technologies and installation contractors;

— quality control of technologies, facilities, materials used and both source and drinking water;

— maintenance of the drinking water system and its assets, including routine and incident-related inspection and investigation;

— monitoring of operating conditions.

Efficient management of assets ensures a continuous provision of the level of service as defined by the drinking water utility to meet users' and wider stakeholders' expectations and minimize life cycle costs.

Management of the assets includes:

— education and training of the personnel to achieve relevant competences;

— maintaining an up-to-date drinking water system inventory;

— monitoring and documenting of data;

— assessing the condition of the drinking water system;

— planning, maintaining or rehabilitating the drinking water system;

— operation of the drinking water system in a manner that increases service life while maintaining the agreed level of service;

— optimizing life cycle costs;

— identifying and managing risk;

— ensuring proper operation;

— ensuring stable water service by taking into account the timing and duration of various rehabilitation works;

— considering the environment in which the assets are functioning.

4.2.3 Principal aspects — Drinking water systems

The management of assets of drinking water systems should cover the complete drinking water infrastructure and the interrelationship between asset types and individual assets (e.g. assets for catchment, treatment, pumping, storage and distribution) and the impact on the resulting water quality. In addition, the management of assets should consider changes in needs and expectations/requirements of users and other stakeholders, change in behaviour of water users and usage of water as well as environmental effects such as climate conditions, consumption of resources, population migrations, and demography as far as data are or can be made available. This can be laid down in a drinking water master plan which can be a stand-alone document or captured within the strategic plan. See also an outline of the content of a drinking water master plan in Annex B.

Hence, this document should be used in conjunction with other standards regarding management of assets of drinking water systems, such as ISO 24516-1.

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Drinking water systems are used to provide a service to users and communities. This can be briefly (and typically) described as:

— delivery of safe drinking water of the required/agreed quality;

— supporting fire brigades with water for fire fighting if possible (depending on local regulations).

In general, a drinking water system comprises the following potential functions:

— water source;

— intake and transport;

— treatment and pumping, if necessary, and, if appropriate, disposal of residues;

— storage, transport and distribution;

— monitoring of water quality at all relevant stages in the waterworks and in the drinking water network.

4.2.4 Integrating the principal aspects

Management of assets is the application of the drinking water utility's management of asset principles, as described in this document, within the management of the drinking water system, comprising the waterworks and drinking water distribution networks, see 4.4.1.

4.3 Risks and life cycle aspects

4.3.1 Risk

Risk considerations are necessary at all levels in the management of assets — the strategic, the tactical and the operational levels.

Appropriate treatment of risks arising within the context of an organization is an important objective in the management of that organization's assets. Risk treatment is typically done by the modification of existing risk controls or introduction of new ones. Selection of the most appropriate risk controls should result from a process of assessing organizational hazards (e.g. arising from an asset's positioning or failure). Appropriate countermeasures can then be introduced in a prioritized manner. Such measures can include operation, maintenance, extension and disposal activities, as well as rehabilitation.

There are many alternative techniques for identifying, analysing, evaluating and treating risk in different fields (see IEC 31010, and the water-sector-specific EN 15975-2). The risk assessment methodology proposed in this document is based on generally recognized risk-assessment principles (e.g. ISO 31000).

These principles involve:

— risk identification (in this case principally by hazard analysis);

— risk analysis;

— risk evaluation;

— risk control.

NOTE Risk control can include risk treatment and risk mitigation.

Hazard analysis involves study of a risk event's occurrence and the likelihood that an event can occur. The drinking water utility should define its utility-specific risk analysis approach and criteria for risk evaluation, based on organizational objectives, and external and internal contexts. Risk criteria should be determined in terms of the same dimensions as the parameters used in the risk analysis. The order of priority for inspection/survey plans should be determined by risk evaluation (which considers the

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significance of each risk relative to all the risks under consideration). Typically, this comparison is conducted by comparing the 'scores' of individual risks (the product of a risk's impact × likelihood ratings against the organization's risk criteria) — using a risk matrix to present the results. Systematically monetizing the impact of individual risks can aid overall risk prioritization.

The evaluation of measures to address (prevent/reduce) the impact and/or likelihood of the occurrence of individual risks should be carried out by comparing the effectiveness of individual risk treatment measures and their related costs, practicability and acceptability to stakeholders. The outcome of this evaluation process can feed into a wider decision-making process utilizing cost-benefit-analysis techniques, see 7.3.

Drinking-water-related asset risks can be categorized into the following two groups:

a) **non influenceable risks**, such as natural disasters (e.g. earthquakes, storms, floods) or economic situations;

b) **influenceable risks**, such as events arising from accidental damage, facility deterioration, asset malfunction or malicious interference with assets.

The following are a few examples of asset data relevant for assessing impact (of failures):

— sizing;

— operating pressure;

— function;

— access constraints;

— proximity to other significant assets, infrastructure or areas;

— rehabilitation cost.

The following are examples of data reports relevant for assessing likelihood (of failures):

— abnormalities of hygiene;

— exceedance of parametric values;

— maintenance;

— telemetry;

— employees' feedback;

— incidents;

— condition;

— stakeholders' complaints,

— security;

— social behaviour;

— environmental influences.

4.3.2 Life cycle

Life cycle cost should be minimized by keeping the drinking water system in a stable operating condition as stated in the objectives.

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