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Buildings and constructed assets — Service life planning —

Part 7: Performance evaluation for feedback of service life data from practice

Bâtiments et biens immobiliers construits — Prévision de la durée de vie —
Partie 7: Évaluation de la performance de l'information en retour relative à la durée de vie, issue de la pratique

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ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

Contents

Page

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 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 ISO Technical Committee ISO/TC 59, *Buildings and civil engineering works*, Subcommittee SC 14, *Design life*.

This second edition cancels and replaces the first edition (ISO 15686-7:2006), which has been technically revised.

A list of all the parts in the ISO 15686 series can be found on the ISO website.

Introduction

The ISO 15686 series, including this document, is an important contribution to the development of a policy for design life. A major impetus for the preparation of the ISO 15686 series is the concern over the inability to predict service life, costs of ownership and maintenance of buildings and constructed assets. Common methods and standards for performance assessment and proper feedback of data from practice are decisive in order to make experience data from the building stock more consistent and comparable.

This document provides a framework to channel information, collected as part of building performance surveys and assessments, into structured data that can be used in various aspects of the service life planning process.

By applying the generic protocol and terms from this document, to evaluate the service life performance during a building's life cycle, practitioners can generate "in-use" service life data, as referenced in ISO 15686-2 and ISO 15686-8.

The inspection and reporting procedures described in this document, acknowledge that both the condition, of any given building, component or system, as well as performance requirements, can change during the lifecycle. Those changes typically result in corrective actions, maintenance or re-commissioning, to rectify the performance gaps. While commissioning, re-commissioning and maintenance planning are beyond the consideration of this document, the interactions and significance of initial inspection data, maintenance-driven inspections, changed performance expectations, performance surveys, service life predictions and service life planning are discussed.

ISO 15686-10 stipulates that functional performance is to be assessed at various stages during the whole life, most critically during the project delivery phase, and at commissioning. Functional performance assessments are to continue during the property management phase and when considering disposal, to compare actual serviceability profile of the facility to the generic or typical functional requirement profile of potential occupants or buyers. This document provides essential input to the functional performance review process of ISO 15686-10 and as such is of importance to all members of the building team.

ISO 15686-4 lays out procedures for the application of Building Information Modelling (BIM), specifically to provide a consistent computerized structure for the retention and use of service life planning information and service life predictions. Coupled with the emergence and inherent capabilities of BIM, the techniques described in this document will become more useful, lead to better service life estimations and generally improve service life planning.

This document is intended for all members of a building team, e.g. building owners and developers, professional advisors, constructors, assessors, manufacturers of building products, insurers, managers of both publicly and privately owned constructed assets.

Buildings and constructed assets — Service life planning —

Part 7: Performance evaluation for feedback of service life data from practice

1 Scope

This document provides a generic basis for performance evaluation for feedback of service life data from existing buildings and constructed assets, including a definition of the terms to be used and the description of how the (technical) performance can be described and documented to ensure consistencies.

The purpose of this document is to describe the principles for service life performance surveys and evaluation with an emphasis on technical recommendations. It describes a generic methodology, including the terms to be used, that provides guidance on the planning, documentation and inspection phases, as well as on analysis and interpretation of performance evaluations, both on the object (single building) and network (stock of buildings) level. While maintenance planning is outside the scope of this document, maintenance-driven inspections and subsequent recommended actions could have significant effects upon service life and performance.

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 15686-1:2011, *Buildings and constructed assets — Service life planning — Part 1: General principles and framework*

ISO 15686-2:2012, *Buildings and constructed assets — Service life planning — Part 2: Service life prediction procedures*

ISO 15686-8:2008, *Buildings and constructed assets — Service-life planning — Part 8: Reference service life and service-life estimation*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 15686-1 and ISO 15686-2 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 http://www.iso.org/obp

3.1
commissioning
systematic process of functional performance testing, verification, documentation and training intended to ensure that the building and its systems operate in accordance with the defined objectives and criteria of the project

Note 1 to entry: Commissioning is an integral part of the design and construction process and is also intended to be undertaken throughout the service life.

3.2
consequence degree
expression of the significance and impact(s) of failure, or failures, or loss of performance, relative to a defined reference level

Note 1 to entry: Impacts that should be considered include any changes to aesthetics, structural integrity, the provision of healthy and safe surroundings, economic factors and environmental loadings.

3.3
network level
stock of objects under management and maintenance of an owner

Note 1 to entry: Objects could include facilities, for example, bridges, tunnels, power plants, and buildings.

3.4
object level
basic unit of the network serving a specific function

3.5
performance survey
total review (defining of the task, planning, examination, evaluation and reporting) at a given time in accordance with this document)

3.6
performance assessment
all material that accounts for an item's capability to provide a quality or function throughout its service life

3.7
performance degree
expression of the capability of an item to provide functionality in relation to a defined reference level

3.8
performance control
comparison between capability to provide functionality and predefined functional requirements

3.9
refurbishment
modification and improvements to an existing item to bring it up to an acceptable condition

[SOURCE: ISO 6707-1:2014, 7.1.50]

3.10
repair
return a product/component/assembly/system to an acceptable condition by *renewal* (3.11) or *replacement* (3.12) of worn, damaged or degraded parts

[SOURCE: ISO 6707-1:2014, 7.1.52]

3.11
renewal
demolition and rebuilding of an existing item

3.12
replacement
change of parts of an existing item to regain its functionality

3.13
risk
probability of an event occurring multiplied by its consequences

Note 1 to entry: Events can include failure, or damage.

Note 2 to entry: Consequences can include cost, fatalities, or exposure to personal or environmental hazard.

3.14
symptom
indicator of the loss of performance of an item

3.15
in-use condition
any circumstance that can impact the performance of a building or a constructed asset, or a part thereof under normal use

[SOURCE: ISO 15686-8:2008, 3.5]

3.16
usage conditions
in-use conditions (3.15) due to users of a building/constructed assets and human activity adjacent to a building/constructed assets

3.17
factor category
label of an *in-use condition* (3.15) indicating which factor of the Factor method the condition will influence

Note 1 to entry: See Clause 4 for the Factor method.

3.18
in-use condition grading
act of applying collective judgement of all qualitative information of an *in-use condition* (3.15) within a *factor category* (3.17)

[SOURCE: ISO 15686-8:2008, 3.6]

3.19
in-use condition grade
designation representing a qualitative description of an *in-use condition* (3.15)

[SOURCE: ISO 15686-8:2008, 3.7]

4 Methodological framework

4.1 Service life planning

In ISO 15686-1:2011, 3.22, the concept of reference service life (RSL) is defined as the “service life of a product, component, assembly, or system which is known to be expected under a particular set, i.e a reference set, of in-use conditions and which can form the basis of estimating the service life under other in-use conditions”.

A person working with the service life planning (SLP) of a design object is faced with the challenge of forecasting the service life of its components. Even if there are certain service life data available, i.e. RSLs, these can rarely be used directly. This is because the project-specific in-use conditions, to which

the object's components are subjected, are usually different from those under which the service life data are valid, i.e. the reference in-use conditions.

In ISO 15686-8, the Factor method is described as a means to overcome this problem. The Factor method is used to modify an RSL to obtain an estimated service life (ESL) of the components of a design object, while considering the difference between the project-specific and the reference in-use conditions. This is carried out by multiplying the RSL by a number of factors, each of which reflect the difference between the two sets of in-use conditions within a particular factor category:

ESL = RSL × Factor A × Factor B × Factor C × Factor D × Factor E × Factor F × Factor G

The factor categories are given in Table 1.

Table 1 — Factor categories of the Factor method

Factor category	Designation
A	quality of components
B	design level
C	work execution level
D	indoor environment
E	outdoor environment
F	usage conditions
G	maintenance level

The evaluation of an ESL according to the Factor method requires the input of an RSL as well as the numbers of the Factor categories A to G. A proper choice of the numbers of the factors depends on the difference between the project-specific and the reference in-use conditions. Therefore, in order to enable estimations of the Factor categories A to G jointly with RSL, the reference in-use conditions in terms of the factor categories should, as far as possible, be included when providing data.

There are a limited number of systematic studies on service life prediction and there is a need for data. For the provision of RSL data, the capturing of existing data of any kind is acceptable. ISO 15686-2:2012, 5.4.3.3 identifies methodology to evaluate the service life of building components through inspection of buildings and suggests that, by means of statistical sampling methods, as many buildings as necessary be included in the study. See also ISO 15686-2:2012, A.2.3.1.2.

In addition, ISO 15686-2:2012 stipulates that a critical review of service life planning studies is to be conducted whenever the results are to be publically disclosed and discretionary in other instances. The critical review process, as described in ISO 15686-2:2012, Clause 6, ensures the technical and scientific validity, consistency of the service life planning methods implemented, as well as the appropriateness and soundness of external data used.

4.2 Performance assessment of service life in the course of the construction life cycle

4.2.1 Relation to service life design and reference service life (RSL)

The performance levels of the construction and its components change during the life cycle of the construction (see Figure 1). The in-use conditions can also be subject to change. Therefore, a proper assessment of the service life during the construction life cycle should include a thorough assessment of the existing in-use conditions, and record any changes to the levels used in the design process, if applicable.

A main objective of this document is to provide a basis for objective assessment and to describe how information retrieved during performance assessments can become new input in the RSL data, as described in ISO 15686-8. As such, this document adds further to the data generation via inspection.

4.2.2 Life cycle performance of construction

Figure 1 illustrates scenarios in the development of the performance (bold line) of construction works from delivery through the operation and maintenance phase. There is a deviation (gap) in performance from the client's expectations and requirements from the brief (initial) phase until the delivery ("as built") phase, often due to failures or damage during fabrication. The expectation gap is increased further due to the continuous rise in new requirements and upgrading, business development, etc.

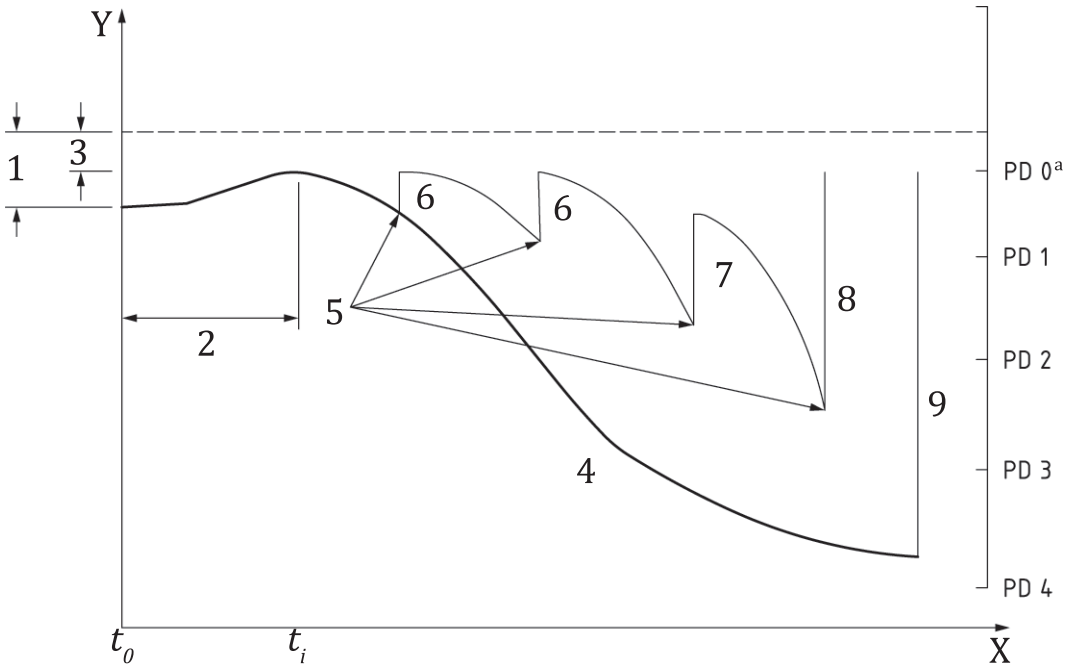
After the delivery, performance decreases during operation, due to wear and tear, or simply the age factor, if left with no maintenance. Therefore, the construction and its components are subjected to various corrective actions, or maintenance, in order to keep up with required performance. These actions can be proactive, which is preferred, or reactive, which is largely the current practice. In both cases, inspections and performance assessments should be the basis for maintenance planning. This applies to all functionalities.

This document defines a generic protocol and terms for how to evaluate the service life performance during this life cycle. Maintenance planning is outside the scope of this document, but for the sake of illustration, Figure 1 relates the assessed performance levels to various known maintenance actions, as defined in ISO 15686-1. The content of, and relations between, such levels and actions should be defined by users separately.

Commissioning is a systematic verification, documentation and training process undertaken to increase the likelihood that the built work operates in conformity with the owner's project requirements and the basis of design as described in the contract documents.

Commissioning (when executed thoroughly) is applied to all activities during the design, construction, static verification, start-up, and functional performance testing of building equipment and systems. It ensures that the building operates as intended and that the operation and maintenance team is adequately prepared to keep the building performing as intended.

As a building enters its service life, the expectations of the level of performance that it needs to provide could shift (positively or negatively) either as a result of public and market driven pressures or due to changed business demands. Typically, these new requirements, as graphically depicted by the dashed line (10) in Figure 2, will eventually rise until upgrading is warranted at t_j to the meet the new requirements. See 5.3.5.1.



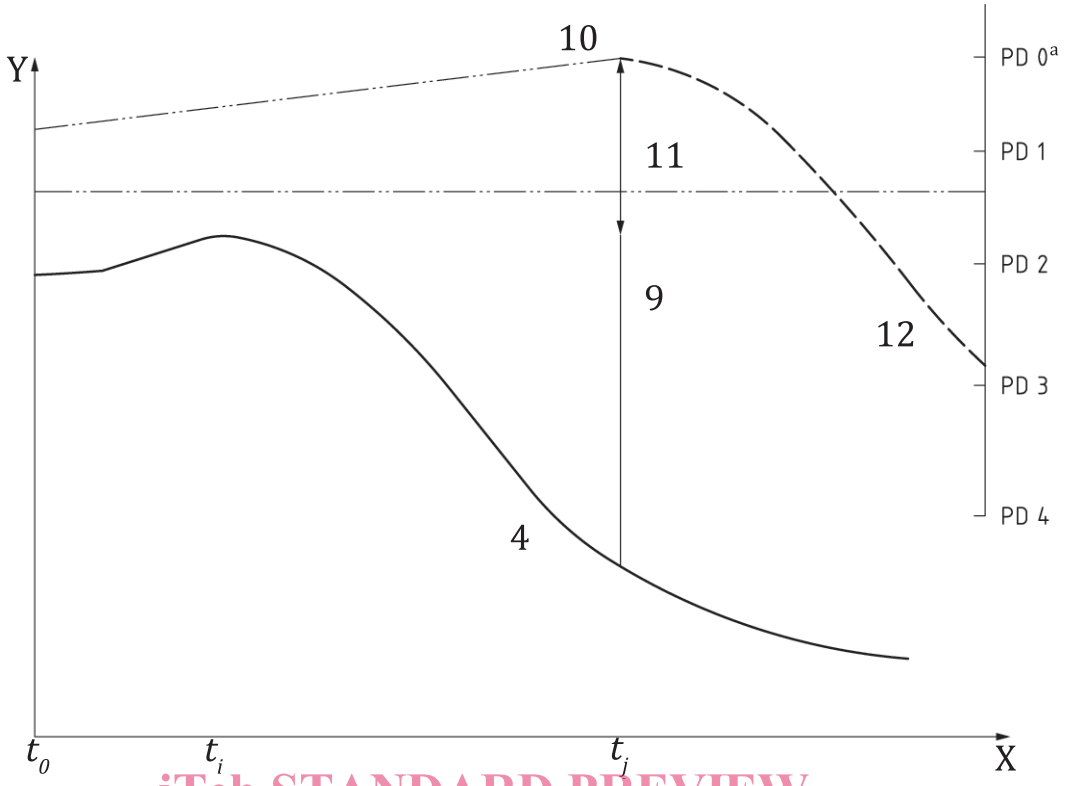
Key

Y	quality/function	7	refurbishment or repair
X	time	8	replacement
1	expectation/achievement gap	9	renewal
2	commissioning	a	Performance degrees (PD) are defined in 5.3.4.2.2.
3	initial performance gap	t_0	time of initial "as built"
4	performance without preventative actions	t_i	time at start of "in-use" (operation and maintenance) stage
5	limit states		
6	preventative and periodic maintenance		

Figure 1 — Life cycle performance of construction

NOTE 1 Dependent upon the legal and contractual framework governing the building and its operation, performance degree 0 could be required at t_0, the time of initial as-built. In such instances, the y-axis of Figure 1 is effectively shifted to the right and t_0 and t_i coincide.

NOTE 2 When considering commissioning for domestic systems installed in typical single family dwellings, the duration between t_0, the time of initial as-built, and t_i, the time to occupancy and operation, can be very short (hours or days rather than months and years) in comparison to industrial or commercial systems.



Key

Y	quality/function	a	Performance degrees (PD) are defined in 5.3.4.2.2.
X	time	t_0	time of initial "as built"
4	performance without preventative actions	t_i	time at start of "in-use" (operation and maintenance) stage
9	renewal	t_j	time of redevelopment/upgrading
10	new requirements (public, market, business)		
11	construction upgrade		
12	performance projection following upgrade		

Figure 2 — Life cycle performance expectation following construction upgrade

5 Performance surveys

5.1 General

The main purpose of this document is to be an aid in the planning and preparation of required general and specific working documents for the performance survey of items of various character and different purpose. General and specific working documents supplementary to carrying out performance surveys can be described in three levels, as given in Table 2.

General working documents provide reference levels for performance of building products, materials and assemblies.

Specific working documents provide function-based direction on how specific items should be addressed (refer to Table 2) as well as providing performance degree reference levels for that item.