INTERNATIONAL STANDARD

ISO 15686-2

Second edition
2012-06-01

Buildings and constructed assets — Service life planning —

Part 2: Service life prediction procedures

Bâtiments et biens immobiliers construits — Conception prenant en compte la durée de vie —

Partie 2: Procédures pour la prévision de la durée de vie

Reference number
ISO 15686-2:2012(E)

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 15686-2 was prepared by 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 15686-2:2001), which has been technically revised.

ISO 15686 consists of the following parts, under the general title *Buildings and constructed assets — Service life planning*:

— *Part 1: General principles and framework*

— *Part 2: Service life prediction procedures*

— *Part 3: Performance audits and reviews*

— *Part 5: Life-cycle costing*

— *Part 6: Procedures for considering environmental impacts*

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

— *Part 8: Reference service life and service-life estimation*

— *Part 9: Guidance on assessment of service-life data* [Technical Specifiation]

— *Part 10: When to assess functional performance*

The following parts are under preparation:

— *Part 4: Service Life Planning using IFC based Building Information Modelling* [Technical Report]

— *Part 11: Terminology*

Introduction

The ISO 15686 series on buildings and constructed assets, including service life planning, is an essential contribution to the development of a policy for design life. A major impetus for the preparation of the ISO 15686 series is the current concern over the industry's inability to predict costs of ownership and maintenance of buildings. A secondary objective of service life planning is to reduce the likelihood of obsolescence and/or to maximize the re-use value of the obsolete building components.

The purpose of this part of ISO 15686 is to describe the principles of service life prediction (SLP) of building components and their behaviour when incorporated into a building or construction works considering various service environments. The SLP methodology is developed to be generic, i.e. applicable to all types of building components, and is meant to serve as a guide to all kinds of prediction processes. The methodology may be used in the planning of SLP studies regarding new and innovative components, whose performance is little known, or may be the guiding document in the assessment of already performed investigations in order to appraise their value as knowledge bases for SLP and reveal where complementary studies are necessary.

This part of ISO 15686 is intended primarily for

— manufacturers who wish to provide data on in-use performance of their products,

— test houses, technical approval organizations, etc.,

— those who develop or draft product standards, and

— users who may not be directly involved in making service life predictions, but who use them as inputs to reference service lives, within audits or reviews of service life planning, as information in environmental product declarations (EPDs), as inputs to service life prediction of assets and facilities in life-cycle costing, etc.

NOTE For this part of ISO 15686 to be used for service life evaluation at the scale of complex products or at the scale of construction works, a guidance document could be necessary.

For an improved understanding of the context of this part of ISO 15686, it is useful to read the other parts, in particular ISO 15686-1, which is the umbrella document of the ISO 15686 series.

Data obtained in accordance with the methodology described in this part of ISO 15686 can be used in any context where appropriate, and specifically to obtain reference or estimated service life data as described in ISO 15686-8.

Predictions can be based on evidence from previous use, on comparisons with the known service life of similar components, on tests of degradation in specific conditions or on a combination of these. Ideally, a prediction will be given in terms of the service life as a function of the in-use condition. In any case, the dependence of the service life on the in-use condition will be quantified in a suitable way. The reliability of the predicted service life of a component (PSLC) will depend on the evidence it is based on.

The methods described in the ISO 15686 series are based on work carried out in many countries. In general terms, they are a development of the current standards on durability published by the Architectural Institute of Japan, the British Standards Institution (BSI), the Canadian Standards Association (CSA), and the Italian Organization for Standardization (UNI). Specifically, this part of ISO 15686 is an extension and modification of the RILEM recommendation 64, "Systematic Methodology for Service Life Prediction", developed by RILEM[1] TC 71-PSL and TC 100-TSL. It also results from the work carried out in the CIB[2] W080.

1) The International Union of Testing and Research Laboratories for Materials and Structures.

2) International Council for Building Research, Studies and Documentation.

Buildings and constructed assets — Service life planning —

Part 2:
Service life prediction procedures

1 Scope

This part of ISO 15686 describes procedures that facilitate service life predictions of building components, based on technical and functional performance. It provides a general framework, principles and requirements for conducting and reporting such studies.

It does not cover limitation of service life due to obsolescence or other non-measurable or unpredictable performance states.

2 Normative references

The following referenced documents are indispensable for the application 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 6241:1984, *Performance standards in building — Principles for their preparation and factors to be considered*

ISO 6707-1, *Building and civil engineering — Vocabulary — Part 1: General terms*

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

ISO 15686-7, *Buildings and constructed assets — Service life planning — Part 7: Performance evaluation for feedback of service life data from practice*

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

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 6707-1, ISO 15686-1 and the following apply.

3.1.1
accelerated short-term exposure
short-term exposure (3.1.19) in which the **agent intensity** (3.1.5) is raised above the levels expected in service

3.1.2
ageing
degradation due to long-term influence of **agents** (3.1.4) related to use

3.1.3
ageing exposure
procedure in which a product is exposed to **agents** (3.1.4) believed or known to cause ageing for the purpose of undertaking/initiating a **service life prediction** (3.1.18) or comparison of relative performance

3.1.4
agent
whatever acts on a building or its parts to adversely affect its performance

EXAMPLE Person, water, load, heat.

3.1.5
agent intensity
measure of the extent to or level at which an **agent** (3.1.4) is present

NOTE In this part of ISO 15686, the term "agent intensity" refers figuratively to any quantity that conforms to the requirements for a measure, i.e. not only to UV radiation and rain intensity, etc., but also to relative humidity, SO_2 concentration, freeze–thaw rate and mechanical pressure, etc.

3.1.6
component
product manufactured as a distinct unit to serve a specific function or functions

[ISO 6707-1:2004, definition 6.1.3]

3.1.7
degradation
process whereby an action on an item causes a deterioration of one or more properties

NOTE Properties affected can be, for example, physical, mechanical or electrical.

[ISO 15686-8:2008, definition 3.4]

3.1.8
degradation indicator
deficiency which shows when a **performance characteristic** (3.1.14) fails to conform to a requirement

EXAMPLE When gloss is a performance characteristic, gloss loss is the corresponding degradation indicator. When mass (or thickness) is a performance characteristic, mass loss is the corresponding degradation indicator.

3.1.9
dose-response function
function that relates the dose(s) of a **degradation** (3.1.7) **agent** (3.1.4) to a **degradation indicator** (3.1.8)

3.1.10
inspection of buildings
performance evaluation or assessment of residual service life of building parts in existing buildings

3.1.11
in-use condition
any circumstance that can impact the performance of a building or other constructed asset, or a part thereof under normal use

3.1.12
long-term exposure
ageing exposure (3.1.3) under **in-use conditions** (3.1.11) and with a duration of the same order as the service life anticipated

3.1.13
mechanism
process causing change over time in the composition or microstructure of a component or material that can cause degradation

3.1.14
performance characteristic
physical quantity that is a measure of a critical property

EXAMPLE A performance characteristic can be the same as the critical property, for instance reflectance. On the other hand, if the critical property is strength, then thickness or mass can in certain cases be utilized as a performance characteristic.

3.1.15
performance requirement
performance criterion
minimum acceptable level of a critical property

3.1.16
predicted service life
service life predicted from recorded performance over time

EXAMPLE As found in service life models or ageing tests.

3.1.17
predicted service life distribution
probability distribution function of the **predicted service life** (3.1.16)

3.1.18
service life prediction
SLP
generic methodology which, for a particular or any appropriate performance requirement, facilitates a prediction of the service life distribution of a building or its parts for the use in a particular or in any appropriate environment

3.1.19
short-term exposure
ageing exposure (3.1.3) with a duration considerably shorter than the service life anticipated

NOTE A term sometimes used and related to this type of exposure programme is "predictive service life test". A predictive service life test is a combination of a specifically designed short-term exposure and a performance evaluation procedure.

3.1.20
terminal critical property
‹in an established set of critical properties for a building or a part› critical property that first fails to maintain the corresponding performance requirement when subjected to exposure in a particular service environment

3.1.21
time acceleration factor
number or function used to transform the results of ageing of a component(s) derived from accelerated short-term exposure testing to a predicted service life or predicted service life distribution

3.2 Abbreviated terms

ESLC estimated service life of a component

PSLDC predicted service life distribution of a component

PSLC predicted service life of a component

RSLC reference service life of a component

SLP service life prediction

4 Methodology

4.1 Brief description of service life prediction (SLP)

The methodology described is intended to be generic and aims, for a particular or any appropriate set of performance requirements, to facilitate a service life prediction (SLP) of any kind of building component for use in a particular, or range of, in-service environment(s).

NOTE In practice, an SLP is usually restricted to covering a few typical service environments or a single reference environment complemented by an analysis on the sensitivity of intensity variations of degradation agents.

The term “prediction” of an SLP study refers to one of four ways, or any combination of these, to assess the service life, as follows:

— speeding-up of the time dimension (at accelerated short-term exposures);

— interpolation/extrapolation using data of similar components;

— interpolation/extrapolation using data from similar service environments;

— extrapolation in the time dimension (at short-term in-use exposures).

The systematic approach or methodology for the SLP of building components described includes the identification of necessary information, the selection or development of test procedures (exposure programmes and evaluation methods), testing, interpretation of data, and reporting of results. The essential steps in an SLP process are outlined in Figure 1. The methodology employs an iterative research or decision-making process which enables improved predictions to be made as the base of knowledge grows, as illustrated by the outermost loop in Figure 1. It is often not necessary to perform every step, for instance the pre-testing procedure can often be excluded or shortened due to already available knowledge of the component under study. While not illustrated, sub-loops between steps within a cycle may be necessary. Normally, the service life for a particular set of performance requirements is not predicted as a single value, a predicted service life of a component (PSLC). Instead, a predicted service life distribution of a component (PSLDC) is determined. The PSLDC is described by at least two parameters, the expectation value and the standard deviation. For very costly tests, however, the aim may be limited to finding a PSLC only.

The choice of the single-value reference service life of the component (RSLC) from the distribution established depends on the safety margin expected for the component. For replaceable, non-structural components, in most cases, the expectation value (i.e. the mean) PSLC of the distribution could be employed as the RSLC. However, scheduled maintenance plans, interlocking with other replaceable components or other circumstances, may suggest a more conservative choice. For non-replaceable and/or structural components, for which a safety margin is requested, a more, and frequently a significantly more, conservative choice has to be made. In such cases, though, normally the safety margin is directly or indirectly regulated by standards or codes specifically applicable to the component.

See also A.1.1.

4.2 Connection to ISO 15686-1 and ISO 15686-8

This part of ISO 15686 refers to ISO 15686-1 and ISO 15686-8 and aims, in this context, to describe a tool to achieve a reference service life of the component (RSLC) as accurately as possible (or, alternatively, to achieve a forecast service life directly). An RSLC is necessary when an estimated service life of the component (ESLC) for a particular design object is to be assessed in accordance with the factor method as described in ISO 15686-8. Thus, the RSLC can be obtained from the PSLDC as established in accordance with this part of ISO 15686. The condition at which the PSLDC has been established then becomes the reference condition, which is compared to the particular condition prevailing at the design object in order to estimate the factors of the factor method.

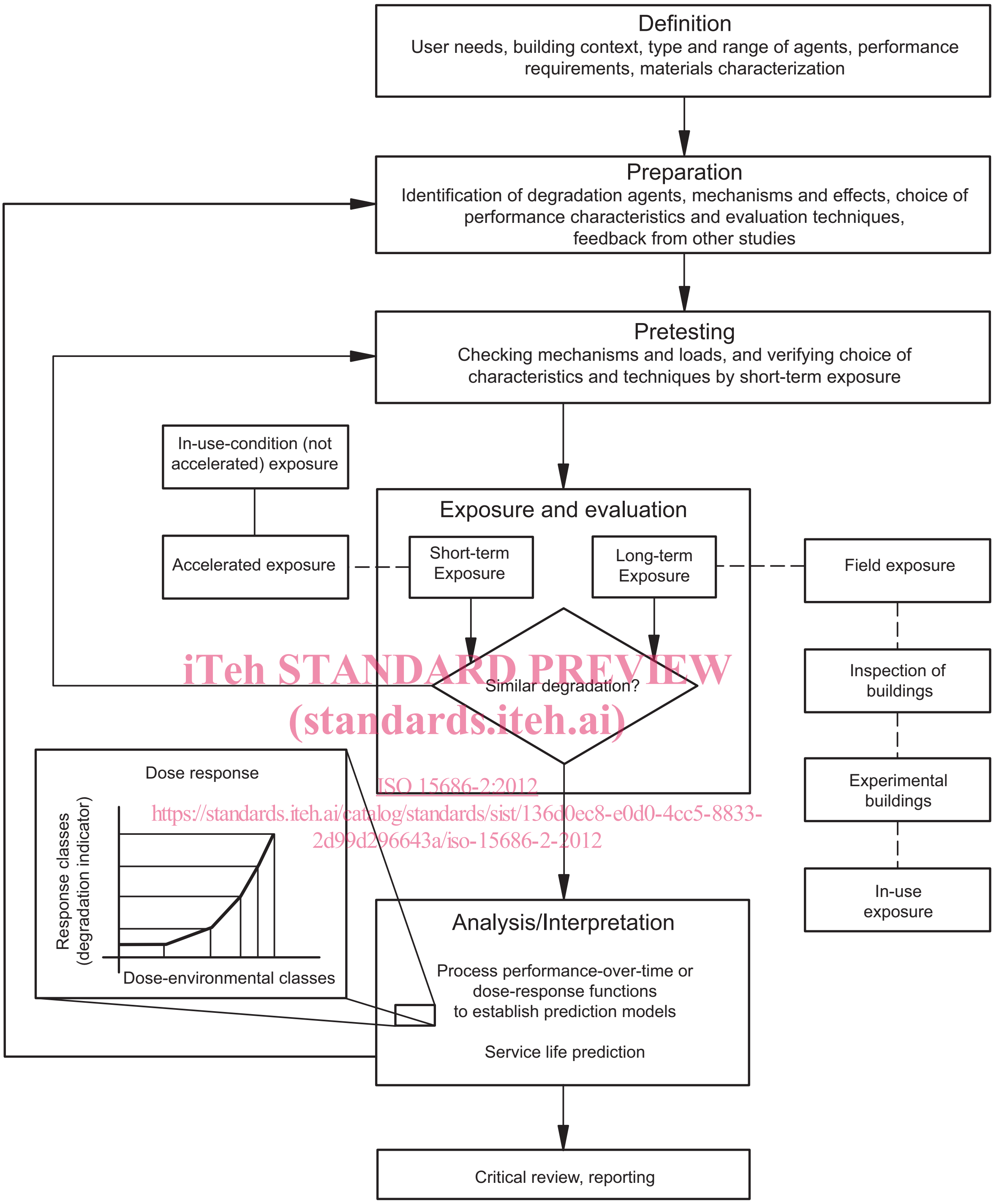

Figure 1 — Systematic methodology for SLP of building components

When the SLP utilized to obtain the RSLC for the particular design object has been carried out under various conditions, the PSLDC obtained under the condition that deviates the least from the particular condition is used for that purpose. An SLP carried out under various conditions also implies a means to estimate factors of the factor method, in most cases particularly the factor taking into account the difference between the specific and the reference outdoor environment. This can be accomplished by interpolation/extrapolation techniques.

5 Methodological framework

5.1 Range of SLP and problem description

5.1.1 General

Initially, the problem to be solved shall be defined and the range of the study established, including identification or specification of essential data.

NOTE These issues can vary from case to case depending on the aim and ambition of the SLP and on the level of existing knowledge of the component.

Two extreme ranges are as follows.

a) **Specific study:** this is intended to focus on a rather specific application of the component tested in terms of service environment and usage with a specified set of performance requirements. The aim is to establish the PSLDC (or PSLC) and determine the sensitivity of the PSLDC (or PSLC) on moderate variations from these presumptions.

b) **General study:** this is intended to cover a broad application of the component tested in terms of service environment and usage with an unspecified or a loosely specified set of performance requirements. The aim is to establish performance-over-time functions for the performance characteristics chosen in the whole range of applications.

5.1.2 Definition of a specific study

5.1.2.1 Specification of the service life environment

When presenting service life predictions for products or components, a specific or generic set of in-use conditions shall be identified for documenting the specific study. This shall account for the specific use of the component, covering the design consequences, and shall comprise a description of the environment, including static and dynamic mechanical stress, at the site where a building is planned. A description of the effects of occupancy (such as water vapour, heat or abrasion) and the principles on which the building is operated (e.g. high or low thermal inertia) shall also be included if appropriate.

5.1.2.2 Quantification of the set of performance requirements

The set of performance characteristics shall be identified and the corresponding requirements quantified in accordance with critical properties specified.

NOTE This can take the form, for example, of a failure mode and effect analysis (FMEA). See 5.6.

The set of performance requirements shall conform to the information obtained in accordance with 5.1.2.1.

5.1.3 Definition of a general study

5.1.3.1 Specification of ranges of service life environments

All types of environments where the component is intended to be used, or being within the range of the study, shall be described, including static and dynamic mechanical stress.

The various types of environments may be grouped into a discrete number of classes, each class being representative for certain ranges of agent intensities.

Care shall be taken regarding the effect of various usages and positions of the component, as this can strongly govern the in-use conditions and possible synergistic effects of the degradation agents. See 5.2.3.

NOTE The actual in-use condition relevant to materials degradation is the micro-environment, i.e. the prevailing environmental condition in a layer adjacent to or at a component's surface (e.g. pollutant concentration and driving rain), and within the component (e.g. mechanical stress).

