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Buildings and constructed assets — Service life planning —

Part 2: Service life prediction procedures

Bâtiments et biens immobiliers construits — Prévision de la durée de vie —
Partie 2: Procédures pour la prévision de la durée de vie

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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 3.

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 part of ISO 15686 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 15686-2 was prepared by Technical Committee ISO/TC 59, *Building construction*, Subcommittee SC 14, *Design life*.

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

— *Part 1: General principles*

— *Part 2: Service life prediction procedures*

— *Part 3: Performance audits and reviews*

— *Part 4: Data requirements*

— *Part 5: Life cycle costing*

— *Part 6: Life cycle assessment*

Annex A of this part of ISO 15686 is for information only.

Introduction

The ISO 15686 series on “Buildings and constructed assets — 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 reuse value of the obsolete building components.

The purpose of this part of ISO 15686 is to describe the principles for service life predictions (SLPs) of building components, 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 of which the knowledge of their performance is limited, or 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 complimentary studies are necessary.

This part of ISO 15686 is intended primarily for

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

— test houses, technical approval organizations, etc., and

— those who develop or draft product standards.

While this part of ISO 15686 could be used as a stand-alone document, for an improved understanding of its context it is recommended to read the other parts of ISO 15686, 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 a forecast service life for a specific object via the factor method (or directly), as described in ISO 15686-1. The factor method aims to find an estimated service life of a component (ESLC) in the specific planning case, taking all case-specific conditions affecting the service life into consideration. Accordingly, this part of ISO 15686 interfaces with ISO 15686-1 as a crucial means of attaining the knowledge necessary for the service life planning process as described in ISO 15686-1.

This part of ISO 15686 will also interface with ISO 15686-4, which will specify in detail the way SLP data are formatted, stored and presented.

The SLP methodology does not cover estimation of service life limited by obsolescence or other non-measurable or unpredictable performance states. The methodology also does not cover prediction of the economic service life, but will yield data needed as input for such evaluations.

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 and the Canadian Standards Authority. 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 working jointly with CIB[2)] W80.

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. It provides a general framework, principles and requirements for conducting and reporting such studies. This part of ISO 15686 does not describe the techniques of service life prediction of building components in detail.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 15686. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 15686 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 6241:1984, *Performance standards in building — Principles for their preparation and factors to be considered*.

ISO 6707-1:1989, *Building and civil engineering — Vocabulary — Part 1: General terms.*

ISO 15686-1:2000, *Buildings and constructed assets — Service life planning — Part 1: General principles.*

3 Terms and definitions

For the purposes of this part of ISO 15686, the terms and definitions given in ISO 6707-1 and ISO 15686-1 and the following apply. The terms are ordered by concepts for the assistance of users of this part of ISO 15686.

3.1 Service life and performance

3.1.1
ageing
degradation due to long-term influence of agents related to use

3.1.2
degradation indicator
deficiency which shows when a performance characteristic fails to meet 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.

3.1.3
terminal critical property
in an established set of critical properties for a building or a part, the critical property that first fails to maintain the corresponding performance requirement when subjected to exposure in a particular service environment

3.1.4
performance characteristic
quantity that is a measure of a critical property, or a magnitude of that quantity

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

3.2 Service life forecasting

3.2.1
accelerated short-term exposure
short-term exposure in which the intensity of the agents is raised above the levels expected in service

3.2.2
ageing exposure
procedure in which a building product is exposed to agents believed or known to cause degradation for the purpose of service life prediction (or comparison of relative performance)

3.2.3
control sample
sample retained in an environment that is believed or known not to induce degradation for the purpose of comparison between exposed and non-exposed samples

3.2.4
feedback from practice
inspection of buildings
performance evaluation or assessment of residual service life of building parts in actual buildings

3.2.5
long-term exposure
ageing exposure under in-use conditions and with a duration of the same order as the service life

3.2.6
predicted service life distribution
probability distribution function of the predicted service life

3.2.7
reference sample
sample of known performance which are exposed simultaneously and under identical conditions as a sample under study for the purpose of comparison

3.2.8
service life prediction
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

3.2.9
short-term exposure
ageing exposure 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.

3.3 Environment and environmental characterization

3.3.1
agent intensity
measure of the extent to or level at which an agent is present

NOTE In this part of ISO 15686 the term “agent intensity” refers figuratively to any quantity that meets the requirements for a measure as specified in the definition above, 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.

3.3.2
building context
description of a building and its parts in terms of influences from design, service environment and usage

3.3.3
dose
agent dose
mean of the agent intensity during a time period multiplied by the length of this time period

3.3.4
dose-response function
function that relates the dose(s) of a degradation agent to a degradation indicator

3.3.5
in-use condition
environmental condition under normal use

3.4 Acts and actors

3.4.1
commissioned specialist
person or organization capable of conducting a service life prediction study

3.4.2
commissioning client
person or organization that orders the service life prediction study

4 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

5 Methodology

5.1 Brief description of SLP

The methodology described is intended to be generic and aims, for a particular or any appropriate set of performance requirements, to facilitate an SLP of any kind of building components for the use in a particular or range of in-service environment.

NOTE In practice an SLP is usually restricted to cover 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 combinations 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 SLP of building components described includes the identification of needed information, the selection or development of test procedures (exposure programmes and evaluation methods), testing (exposure and evaluation), 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 permits 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 pretesting 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. In any case, it is of the greatest importance to account for all assumptions and judgements made.

Normally the service life for a particular set of performance requirements is not predicted as a single value – a 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 find a PSLC only.

See also A.1.1.

5.2 Connection to ISO 15686-1

This part of ISO 15686 refers to ISO 15686-1 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 required when an estimated service life of the component (ESLC) for a specific design object is to be assessed in accordance with the factor method as described in ISO 15686-1. 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 specific condition prevailing at the design object in order to estimate the factors of the factor method.

The choice of the single value RSLC from the distribution established depends on the safety margin required 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, requirements on 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 required, 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 for the component.

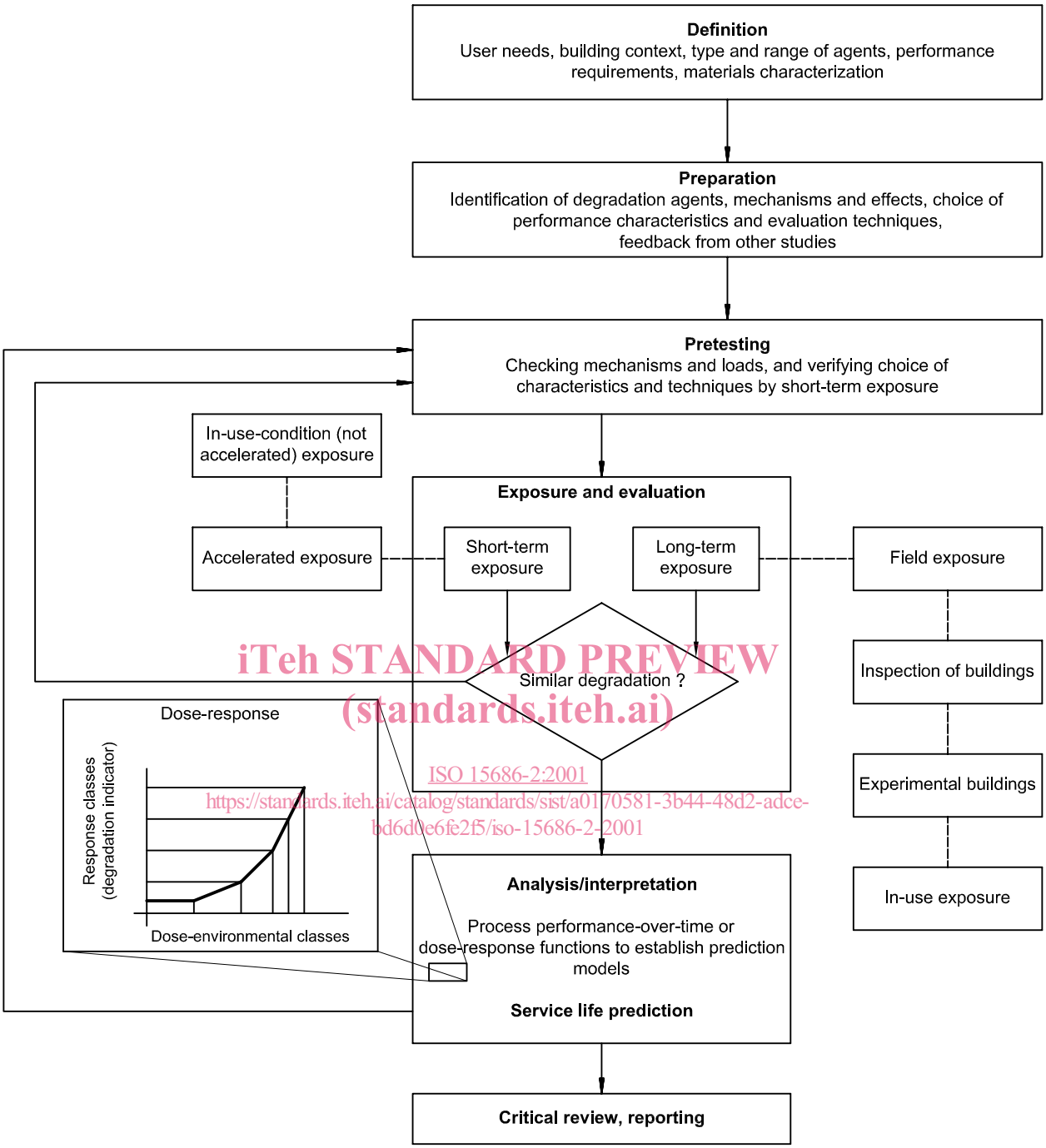

Figure 1 — Systematic methodology for SLP of building components

When the SLP utilized to obtain the RSLC for the specific design object has been carried out under various conditions, the PSLDC obtained under the condition which deviates the least from the specific 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 one taking into account the difference between the specific and the reference outdoor environment. This can be accomplished by interpolation/extrapolation techniques.

6 Methodological framework

6.1 Range of SLP and problem definition

6.1.1 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 may 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.

6.1.2 Definition of a specific study

6.1.2.1 Identification of service environment and usage

A reference building context (see ISO 6241 and CIB Master List) shall be identified according to the information given on the specific case. This shall account for the specific use of the component, covering the design consequences, and comprise a description of the environment, including static and dynamic mechanical stress, at the site where a building is planned to be located. A description on 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.

6.1.2.2 Quantification of the set of performance requirements

The set of performance characteristics shall be identified and the corresponding requirements quantified according to critical properties specified.

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

The set of performance requirements shall conform to the information obtained in accordance with 6.1.2.1.

6.1.3 Definition of a general study

6.1.3.1 Specification of ranges of service environment and usage

All types of environments where the component is intended to be used or being within the range of the study shall be specified, 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 6.2.3).