

Life extension for transportation systems

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Foreword

The NORSOK standards are developed by the Norwegian petroleum industry to ensure adequate safety, value adding and cost effectiveness for petroleum industry developments and operations. Furthermore, NORSOK standards are, as far as possible, intended to replace oil company specifications and serve as references in the authorities' regulations.

The NORSOK standards are normally based on recognised international standards, adding the provisions deemed necessary to fill the broad needs of the Norwegian petroleum industry. Where relevant, NORSOK standards will be used to provide the Norwegian industry input to the international standardisation process. Subject to development and publication of international standards, the relevant NORSOK standard will be withdrawn.

The NORSOK standards are developed according to the consensus principle generally applicable for most standards work and according to established procedures defined in NORSOK A-001.

The NORSOK standards are prepared and published with support by The Norwegian Oil Industry Association (OLF), The Federation of Norwegian Industry, Norwegian Shipowners' Association and The Petroleum Safety Authority Norway.

NORSOK standards are administered and published by Standards Norway.

Introduction

The transport system in this context is facilitating transport through pipelines, risers and loading hoses intra-field, inter-field and as trunk pipelines offshore and onshore. For more description on application of this NORSOK standard, see clause 1 and 5.6. This NORSOK standard is prepared for the industry as a means to support the process of assuring technical integrity of the transportation system beyond the service life, which is a premise in the original consent for operation of the system from the authorities (PSA and NPD).

OLF is developing standards and guidelines to provide requirements for the industry. The following segments are defined with the purpose of life extension:

Segment	Status
• Load bearing structure • Transport systems (pipelines, risers) • Subsea systems • Drilling and well systems	• NORSOK N-006 • This NORSOK standard • Under development • Checklist developed by OLF "Drilling Managers Forum" • Check list developed by OLF
• Risk management, technical safety systems and working environment • Topsides process and utility systems	• Check list developed by OLF

Formalities regarding application process toward authorities are prepared through OLF guideline no. 122.

There are multiple design standards in the industry that provide requirements for transport systems. There is also a wide range of materials that are used for pipe, with new materials being continuously qualified. The main groups of pipes are identified as

- metallic pipes,
- unbonded flexible pipes,
- bonded flexible pipes.

Each of these groups has a range of properties that characterise the transportation system, and which need to be assessed when quantifying the expected lifetime.

Transportation systems on the Norwegian Continental Shelf are dominated by offshore systems. The onshore sections of the systems are generally short in comparison. This NORSOK standard is a national standard and

the identified requirements are based on available knowledge and experience provided by the systems in the national domain.

The difference between service life and design life may be illustrated by the following example: The design life of a system is 25 years. However, the system was intended to operate 15 years (limited by the reservoir predictions), and the operator applied for a 15 years permission, which becomes the original service life.

Later the operator wants to extend the service life with 5 years, for a total of 20 years.

Service life and design life are defined slightly differently in identified standards. Some examples are quoted below:

Pipeline design standards:

ISO 13623:2009	Design life is the period for which the design basis is planned to remain valid.
DNV-OS-F101:2007	Design life is the initially planned time period from initial installation or use until permanent decommissioning of the equipment or system. The original design life may be extended after a re-qualification.
ASME 31.8:2003	<i>(does not define a design life, but uses design life and service life as dimensional limits for design with respect to cyclic loading and cathodic protection systems.)</i>
ASME 31.4:2006	Design life is a period of time used in design calculations selected for the purpose of verifying that a replaceable or permanent component is suitable for the anticipated period of service. Design life does not pertain to the life of the pipeline system because a properly maintained and protected pipeline system can provide liquid transportation indefinitely.

Metallic risers:

DNV-OS-F201	Service life, the length of time assumed in design that a component will be in service
API RP 2RD	Service life is defined as the length of time that a component will be in service. Design fatigue life is the life predicted by cumulative fatigue damage ratio calculations.

Unbonded flexible pipe design standards:

API 17J	Service life: The period of time during which the flexible pipe fulfils all performance requirements
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Bonded flexible pipe guideline:

OCIMF	<i>(does not define design life and service life.)</i>
UKOOA	<i>(Flexible Hose Management Guidelines does not define design life and service life.)</i>

1 Scope

This NORSOK standard defines general principles for assessing an extension of the service life beyond the original service life of risers and pipeline transportation systems, see Figure 1.

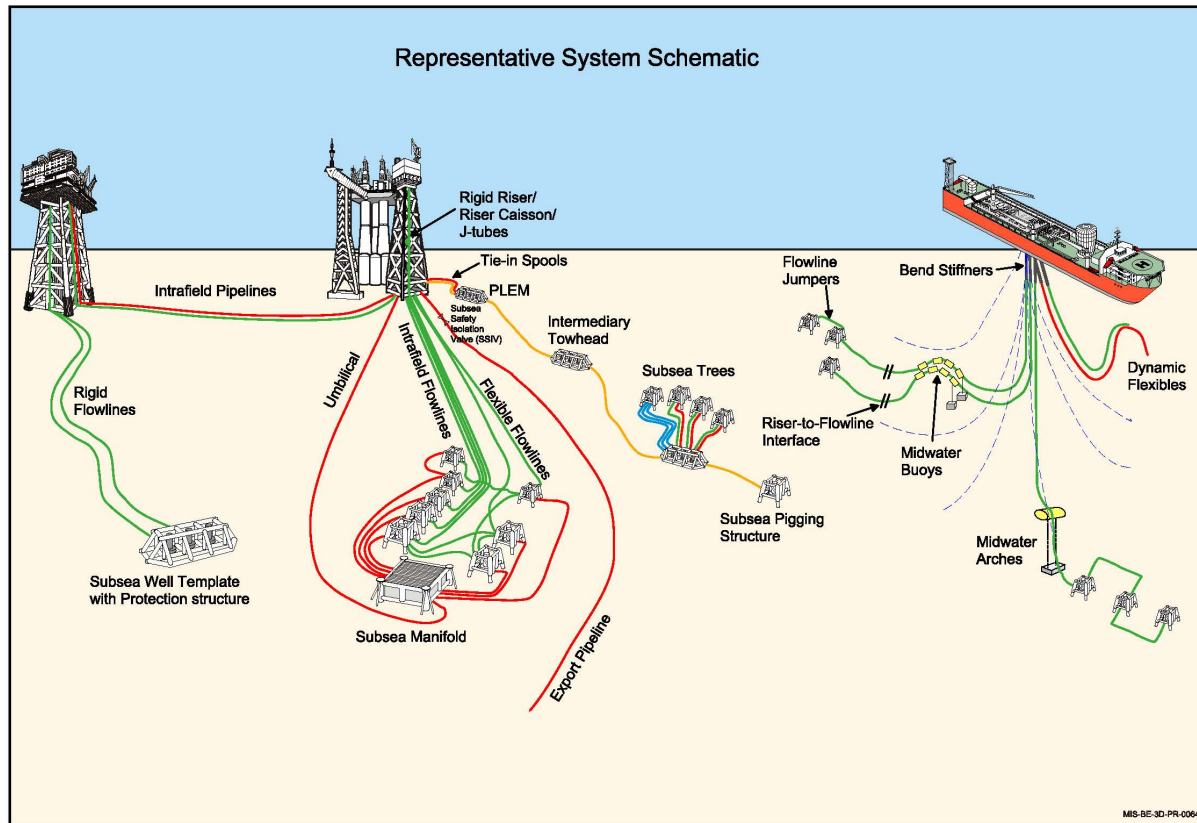


Figure 1 - Overview of transportation systems applicable for this NORSOK standard

2 Normative and informative references

The following standards include provisions and guidelines which, through reference in this text, constitute provisions and guidelines of this NORSOK standard. Latest issue of the references shall be used unless otherwise agreed. Other recognized standards may be used provided it can be shown that they meet the requirements of the referenced standards.

2.1 Normative references

NORSOK N-006,	Assessment of structural integrity for existing offshore load bearing structures
OLF guideline no. 122,	Recommended guidelines for the assessment and documentation of service life extension of facilities

2.2 Informative references

API RP 2RD,	Design of Risers for Floating Production Systems (FPSs) and Tension Leg Platforms (TLPs)
API 17J,	Unbonded Flexible Pipe
ASME 31.4,	Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids
ASME 31.8,	Gas Transmission and Distribution Piping Systems
DNV OS-F-201,	Dynamic Risers

DNV-RP-F101,	Corroded Pipelines, 2004
DNV-RP-F113,	Pipeline Subsea Repair, 2007
ISO 13623:2009,	Petroleum and natural gas industries – Pipeline transportation systems
OCIMF,	Guidelines for the handling, storage, inspection and testing of hoses in the field, Rev. 2 1995
OLF Process,	Topside process and utility systems (Check list developed by OLF)
OLF Drilling,	Drilling and well systems (Check list developed by OLF "Drilling Managers Forum")
OLF HSE	Risk management, technical safety systems and working environment (Check list developed by OLF)
OLF Subsea,	Subsea systems (Under development)
UKOOA,	Flexible Hose Management Guidelines. 2003

3 Terms, definitions and abbreviations

For the purposes of this NORSOK standard, the following terms, definitions and abbreviations apply.

3.1 Terms and definitions

3.1.1

acceptance level

maximum level of risk that is acceptable for the system at any time during its operation

NOTE A defined acceptance level is based on governmental regulations, design code or company requirements.

3.1.2

can

verbal form used for statements of possibility and capability, whether material, physical or casual

3.1.3

degradation

gradual breakdown of components or of a material, as a result of being exposed, i.e. to time and environment

NOTE Sections and components degrade as a function of time and exposure, and the rate of degradation will vary. The components in the system have been qualified as a minimum to the design life.

A system may also consist of components that are not intended to be in service for the design life. These components are planned to be replaced throughout the operational life based on specific intervals or condition based intervals. They are then a part of a maintenance plan.

3.1.4

degradation model

model which shall describe how the integrity level of the system evolves over time and exposure

NOTE The degradation model can also be called "risk evolution model". Typically the integrity will decrease, in other words the risk inherent in the system will increase.

The degradation model is typically centered on the structural integrity of the system. Important factors are corrosion, fatigue, stress levels, temperature, pressure, erosion, operational environment etc.

The degradation model is usually defined by the design standard, known technology and industry practice. This model can change over time, due to new technology and research, as well as changes in industry practice and updated design standards.

In cases where the risk to/integrity of the system is defined more broadly (i.e. not only structural integrity, but also operational integrity, economic performance etc), other factors may play an important role in the degradation model.

3.1.5**design life**

specified period for which the integrity of the system is documented in the original design with anticipated maintenance, but without requiring substantial repair

3.1.6**integrity assessment**

documents the present system integrity level, and forms a basis for further life extension work

3.1.7**integrity life**

period during which the system or component may be operated without infringing the integrity acceptance level

NOTE The integrity life is longer than the design life, and in most cases the integrity life can not be documented.

Conservatism in design and material data is the background for much of the difference between integrity life and design life. In the design process the focus is on documenting an acceptable integrity level for the specified design life. The design process is often conservative when choosing parameters for calculations and qualifications.

The integrity life is the upper theoretical limit for the design life.

3.1.8**integrity level**

expression of the absence of risk inherent in the system

NOTE The risk can be of various natures; human, environmental, economic or political. Different systems have different failure modes or critical situations, and the risk associated with each of these can vary from system to system.

3.1.9**life extension**

documented justification for operating a system beyond its original service life

3.1.10**may**

verbal form used to indicate a course of action permissible within the limits of this NORSOK standard

3.1.11**modification**

changes, improvements or repairs of a system

3.1.12**re-qualification**

re-assessment of design due to modified design premises and/or sustained damage

NOTE Life extension is a design premise modification.

3.1.13**service life**

time length the system is intended to operate

NOTE The service life is a part of the application toward authorities.

EXAMPLE:

The design life of a system is 25 years. However, the system was intended to operate 15 years (limited by the reservoir predictions), and the operator applied for a 15 years permission. Later the operator wants to extend the service life with 5 years, for a total of 20 years. In this case the design supports the application for service life extension with respect to design life.

3.1.14**shall**

verbal form used to indicate requirements strictly to be followed in order to conform to this NORSOK standard and from which no deviation is permitted, unless accepted by all involved parties

3.1.15**should**

verbal form used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required

3.2 Abbreviations

API	The American Petroleum Institute
ASME	American Society of Mechanical Engineers
CP	cathodic protection
DNV	Det Norske Veritas
HSE	health, safety and working environment
ID	identification
IMS	integrity management system
ISO	International Organization for Standardization
NPD	Norwegian Petroleum Directorate
OLF	Oljeindustriens Landsforening
OCIMF	Oil Companies International Marine Forum
PoF	probability of failure
PSA	Petroleum Safety Authority
UKOOA	United Kingdom Offshore Operators Association

4 Assessment methodology**4.1 Objective**

This clause describes the general methodology to be applied to a life extension process. The remaining sections of this NORSOK standard are built up according to this methodology.

4.2 Integrity management system (IMS)

The operators follow up the transportation systems through an IMS. The objective of the IMS is to ensure that the technical integrity of the transport system is continuously maintained at an acceptable level. The structure of an IMS is illustrated in Figure 2.

The activities and assessments carried out as a part of the IMS is not part of the life extension process. A continuous integrity assessment is an inherent part of the integrity management process, where data from inspection, monitoring and testing are evaluated against the need for mitigation, intervention or repair. The integrity management process is carried out within the constraints of the original design, and is not necessarily sufficient to document and justify a life extension. However, the data provided by the IMS is beneficial in order to perform a life extension process.

INTEGRITY MANAGEMENT SYSTEM

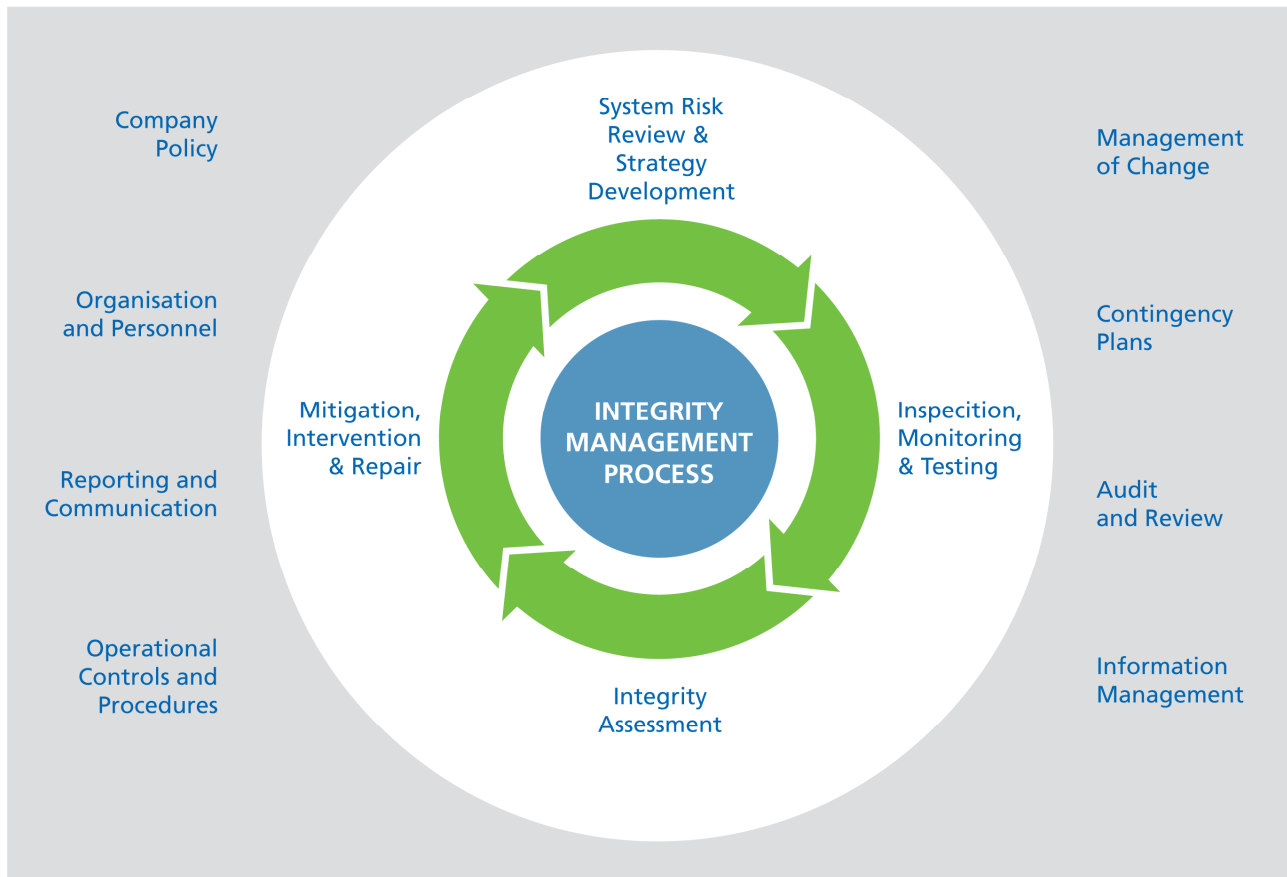


Figure 2 - The structure of an IMS and process

4.3 Life extension process

The life extension process can also be called a re-qualification. It is triggered by the decision that the operation of the system will be continued beyond the original service life. The process that may be followed in a life extension is outlined in Figure 3.

The purpose of the life extension process is to document an acceptable system integrity to the end of the extended service life.

The overall life extension process is as follows:

- define the premise for the extended operation, and identify new threats to the system;
- assess the integrity of the system, in other words as far as possible quantify the current condition;
- carry out a reassessment of the system based on the available information from integrity assessment and established life extension premises, current industry practice and available technology;
- the reassessment can conclude that the integrity of the system is acceptable up to the end of the extended life, in which case the process moves on to documentation and implementation. If the integrity is not acceptable, modifications shall be considered together with the feasibility of the entire life extension.

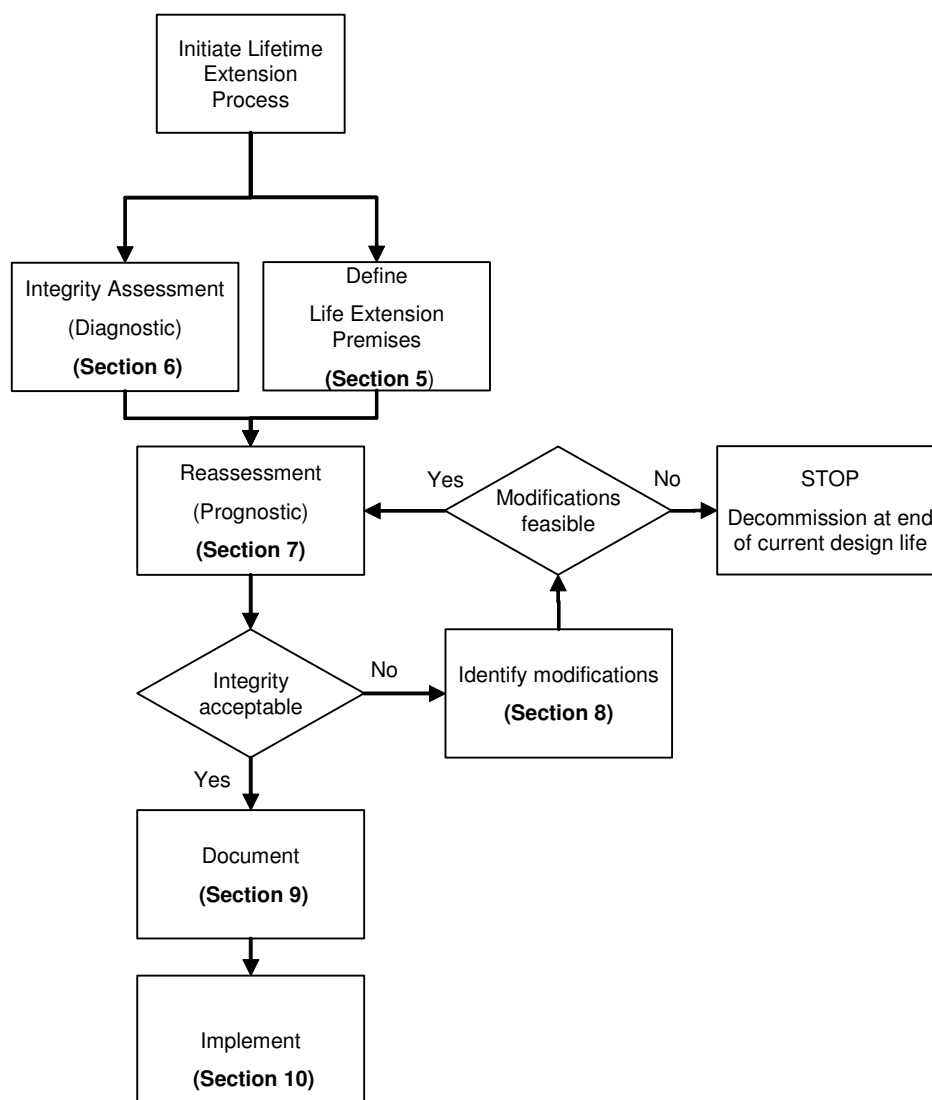


Figure 3 - Life extension process

The following subclauses in this NORSOK standard are based on this work process, and references are included in the relevant boxes.

4.4 Degradation

The life extension process shall take into account the degradation that has taken place since the installation of the system.

Figure 4 is an example of degradation and integrity assessment. A life extension evaluation is initiated well ahead of the end of the original service life. Figure 4 illustrates that the original service life is not limited by the original design life, but the operator requested service life shorter than design life. In the original design, a given degradation model was used, which does not provide sufficient design life for the desired extended service life.

At the time of the life extension evaluation, an integrity assessment is performed. In this example it was found that the degradation model was conservative, and the current condition of the system is actually better than anticipated. In the reassessment, a new degradation model is introduced based on new technology and/or industry practice. Based on this new degradation model, the new extended design life is established, which exceeds the desired extended service life. Subsequently a life extension application for the system can be submitted to the authorities, and service life for this system may be extended toward the extended design life without requirements to repair or modifications.

Note that in this example the first degradation model limited the original design life. Without the integrity assessment and the new degradation model, the life extension would not have been possible, since the extended service life was beyond the original design life.

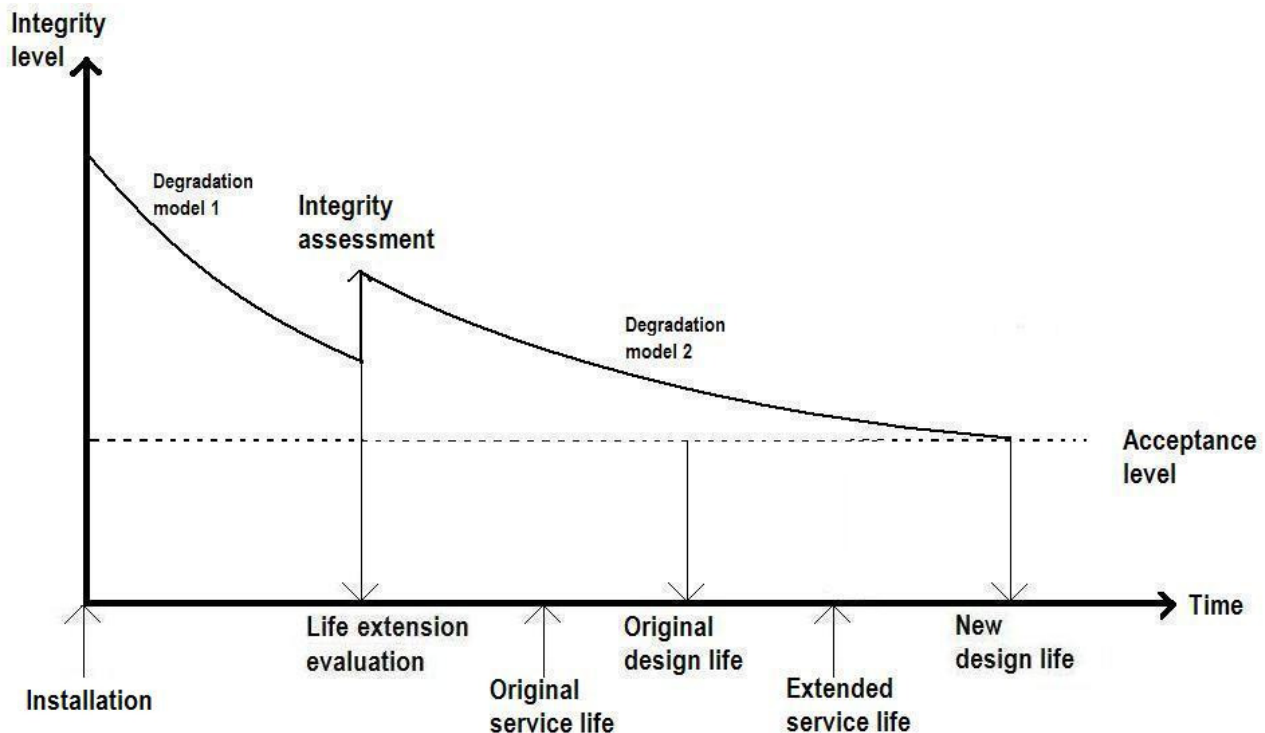


Figure 4 - A schematically sketch of the identified integrity level vs. time

5 Life extension premises

5.1 Objective

The original design premises shall be reviewed to assess whether they are still applicable for the life extension period. Revisions may be required, e.g. authority regulations. Changes or updates to the premises can lead to solutions that are more reliable and more cost-effective.

5.2 Authority regulations

The latest authority regulations apply to the transportation system.

Implementation of a life extension for a transportation system requires consent from the authorities, which are represented by the PSA.

The consent application process is presented in OLF guideline no. 122.

5.3 Design standards

The transportation system is designed according to applicable standards that were selected at time of design. The same design standards may be used throughout operation of the system, also when changes to this system are introduced. This includes life extension.

When initiating a life extension process other standards may be commonly used for design of new transportation systems. Gaps between the original design standard (original revision shall be used) and applicable other standards at time of life extension shall be identified. Such gaps can indicate changes in the integrity acceptance level, and the transportation system operator shall assess the risk associated with these gaps.