TECHNICAL SPECIFICATION

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Petroleum and natural gas industries — Pipeline transportation systems — Recommended practice for pipeline life extension

Industries du pétrole et du gaz naturel — Systèmes de transport par conduites — Pratique recommandée pour une longue durée des conduites

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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.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of normative document:

— an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;

— an ISO Technical Specification (ISO/TS) represents an agreement between the members of a technical committee and is accepted for publication if it is approved by 2/3 of the members of the committee casting a vote.

An ISO/PAS or ISO/TS is reviewed after three years in order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn. If the ISO/PAS or ISO/TS is confirmed, it is reviewed again after a further three years, at which time it must either be transformed into an International Standard or be withdrawn.

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/TS 12747 was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 2, *Pipeline transportation systems*.

Introduction

Within ISO/TC 67/SC 2 there has been a series of discussions concerning both the needs and level of prescription required to address pipeline life extension issues. These have highlighted that

— operators are applying differing approaches, which leads to inefficient use of both operator and authority resources;

— the assessment and upgrading of existing facilities have been based on probabilistic or reliability-based methods;

— the level of detail delivered varies.

The purpose of this Technical Specification is to address the above concerns by providing a consistent approach to pipeline life extension assessment that can be applied by operators (or parties acting on their behalf) across the industry.

This Technical Specification is concerned with the proof of technical integrity of the pipeline system for the justification of extended operation. Integrity management is not covered in detail. However, the interface between a PIMS and the life extension process is considered because

— a PIMS, where present, forms an integral part of the integrity assessment of the pipeline system;

— a PIMS of some form is required for operation in extended life.

Factors affecting the future operability of the system but not the technical integrity, such as the loss of a control umbilical, are flagged as requiring assessment but are not addressed in full in this Technical Specification.

Whilst this Technical Specification is aimed primarily at the pipeline operators, it can also be of interest to other stakeholders such as

— regulators approving the life extension application;

— members of the public affected by the life extension application, such as landowners and developers.

In light of this, an overview of the life extension process and the key principles involved is given in Clause 5. The remainder of the document is intended to provide detailed guidance to those performing the life extension assessments.

All guidance is provided for use in conjunction with sound engineering practice and judgment. This Technical Specification is not intended for use as a design code.

Petroleum and natural gas industries — Pipeline transportation systems — Recommended practice for pipeline life extension

1 Scope

This Technical Specification gives guidance to follow, as a minimum, in order to assess the feasibility of extending the service life of a pipeline system, as defined in ISO 13623, beyond its specified design life. Pump stations, compressor stations, pressure-reduction stations and depots are not specifically addressed in this Technical Specification, as shown in Figure 1.

This Technical Specification applies to rigid metallic pipelines. It is not applicable to the following:

— flexible pipelines;

— pipelines constructed from other materials, such as glass reinforced plastics;

— umbilicals;

— topsides equipment;

— structures and structural components.

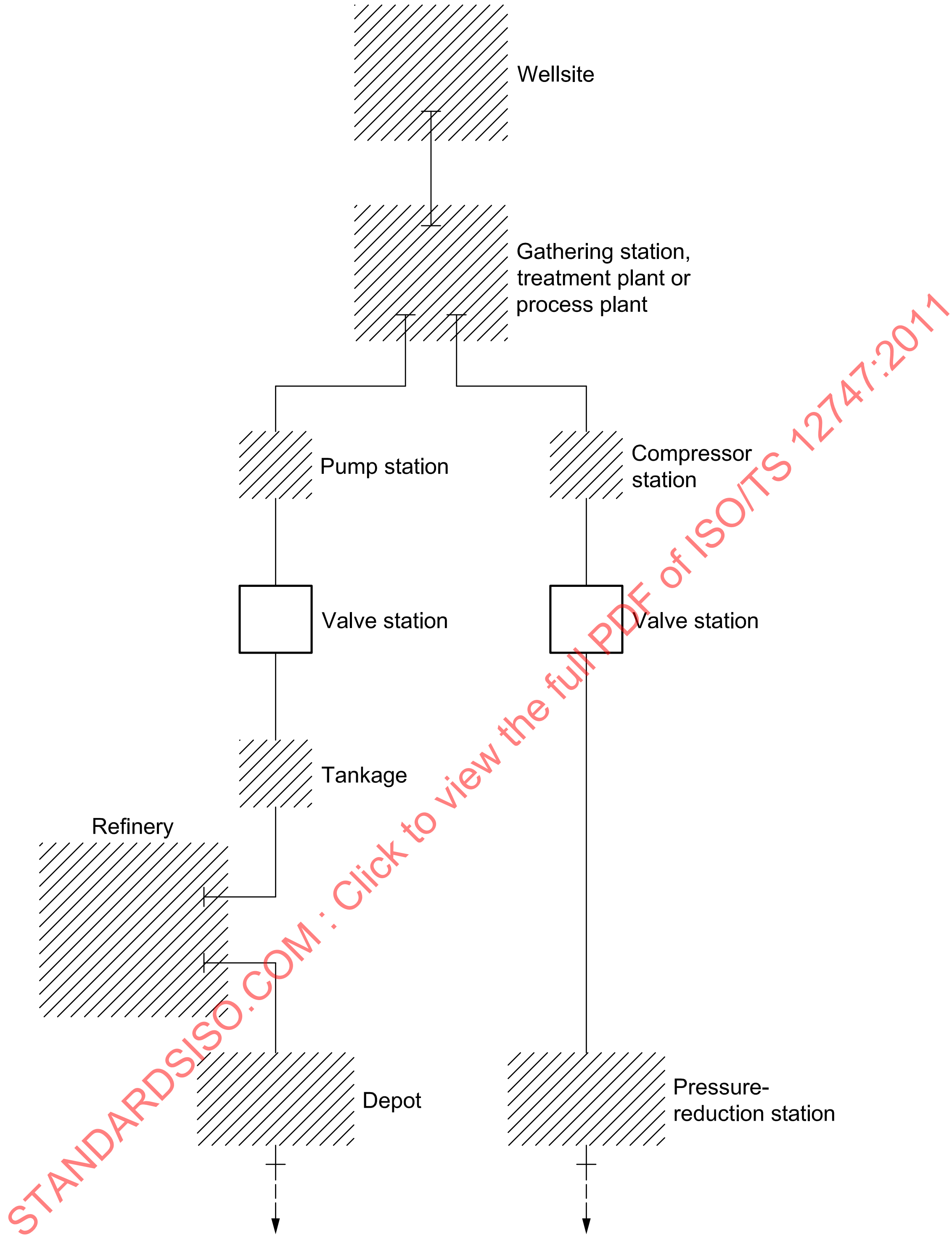
This Technical Specification is limited to life extension, which is an example of a change to the original design. Other changes, such as MAOP up-ratings, are excluded.

NOTE The assessment methodology is applicable to other changes to the design at the discretion of the user.

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 13623, *Petroleum and natural gas industries — Pipeline transportation systems*



Key

- pipeline systems covered by ISO/TS 12747
- connection with other facilities
- pipeline not covered by ISO/TS 12747
- station/plant area or offshore installation not covered by ISO/TS 12747
- station/plant area covered by ISO/TS 12747

Figure 1 — Extent of pipeline systems covered by this Technical Specification

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
acceptance criteria
specified indicators or measures employed in assessing the ability of a component, structure, or system to perform its intended function

3.2
anomaly
discrepancy or deviation of an element of the pipeline system from the established rules and limits

3.3
design life
period for which the design basis is planned to remain valid

[ISO 13623]

3.4
failure
event in which a component or system does not perform according to its operational requirements

3.5
flow assurance
ensuring successful and economical flow of fluid through the pipeline system

3.6
high integrity pressure protection system
mechanical overpressure protection system that rapidly isolates the pipeline if there is a risk of exceeding the maximum allowable operating pressure (MAOP)

3.7
life extension
additional period of time beyond the original design or service life (but within the assessed remnant life) for which permission to continue operating a pipeline system is granted by the regulatory bodies

NOTE Life extension is considered as a modification to the design basis.

3.8
location class
geographic area classified according to criteria based on population density and human activity

[ISO 13623]

3.9
maximum allowable operating pressure
maximum pressure at which the pipeline system, or parts thereof, is allowed to be operated

[Adapted from ISO 13623]

3.10
operation
activities involved with running and maintaining the pipeline system in accordance with the design premise

3.11
operator
party ultimately responsible for the operation and integrity of the pipeline system

3.12
pipeline integrity management system
management system designed to ensure the safe operation of a pipeline system in accordance with the design intent, by control of the physical condition of a pipeline, the operating conditions within the system and any changes made to the system

3.13
pipeline
those facilities through which fluids are conveyed, including pipe, pig traps, components and appurtenances, up to and including the isolating valves

[Adapted from ISO 13623]

3.14
pipeline
⟨offshore⟩ pipeline laid in maritime waters and estuaries seaward of the ordinary high water mark

[ISO 13623]

3.15
pipeline
⟨onshore⟩ pipeline laid on or in land, including lines laid under inland water courses

[ISO 13623]

3.16
pipeline system
pipelines, stations, supervisory control and data acquisition system (SCADA), safety systems, corrosion protection systems, and any other equipment, facility or building used in the transportation of fluids

[ISO 13623]

3.17
remnant life
assessed period of time (irrespective of the defined design life) for which a pipeline system can be operated safely, based on time-dependent degradation mechanisms such as corrosion and fatigue

3.18
required life
desired operational life of the pipeline, accounting for continued operation beyond the original pipeline design life

3.19
risk
qualitative or quantitative likelihood of an event occurring, considered in conjunction with the consequence of the event

3.20
risk management
policies, procedures and practices involved in the identification, assessment, control and mitigation of risks

3.21
service life
length of time over which the pipeline system is intended to operate

3.22
technical integrity
ability of the pipeline system to function in accordance with the design basis

3.23
threat
any activity or condition that can adversely affect the pipeline system if not adequately controlled

3.24
topsides
structures and equipment placed on a supporting structure (fixed or floating) to provide some or all of a platform's functions

4 Abbreviated terms

CP	Cathodic protection
ECA	Engineering critical assessment
ESD	Emergency shut-down
ESDV	Emergency shut-down valve
HIPPS	High integrity pressure protection system
ILI	In-line inspection
IP	Intelligent pig
MAOP	Maximum allowable operating pressure
PIMS	Pipeline integrity management system
QRA	Quantitative risk assessment
ROW	Right of way
SCADA	Supervisory control and data acquisition
VIV	Vortex-induced vibration

5 Life extension overview

5.1 General

The design life of a pipeline is derived to prevent failure during operation due to time-dependent degradation mechanisms such as corrosion and fatigue. However, the expiry of the design life does not automatically mean that the pipeline system is not fit-for-purpose because

— corrosion rates determined during the design process could have been conservative and/or corrosion defects could have been repaired;

— the anticipated operational fatigue damage could have been overestimated.

Extended operation beyond the pipeline design life can be desirable when recoverable oil and gas remain, or where additional operational assets are tied (or will be tied) into the pipeline system.

NOTE There are alternatives to pipeline life extension, such as installing a replacement pipeline. Therefore, a business case is required to determine the most suitable option by comparing the cost of the mitigation necessary to achieve the desired life extension with the cost of a new pipeline.

5.2 Assessment process

If the intention is to operate a pipeline system beyond its specified design life, a life extension assessment shall be performed. The aim of this assessment is to demonstrate that by extending the life of the pipeline system, the operator is not exposing society to unacceptable risk.

Figure 2 illustrates the pipeline system life extension assessment process. The shaded boxes highlight the distinct stages of the assessment and cross-references to the clause of this Technical Specification dealing with a particular stage are provided.

The process begins with a requirement for pipeline extension (item 1) and an assessment of the current integrity of the pipeline system (item 2). The life extension needs should then be defined (item 3), prior to commencement of the life extension assessment (item 4).

The life extension assessment shall consider conditions found during the normal operational life that were not considered in the design. Examples are time-dependent cracking mechanisms (e.g. SCC) and manufacturing flaws that can grow under the effect of cyclic loading. The requirements of the life extension assessment are discussed in more detail in 5.3.

Once an acceptable life extension has been determined, the assessment process shall be fully documented (item 5). If life extension is not possible (or if a replacement pipeline is the most economical solution), the pipeline should be decommissioned at the end of the design life as originally planned.

5.3 Assessment requirements

The life extension process illustrated in Figure 2 involves an assessment of the current pipeline system integrity and an assessment to determine the suitability of the pipeline system for life extension.

The assessment of the current integrity (item 2) shall include, but not be limited to, the following:

— review of the pipeline system operational history;

— detailed assessment of the current technical integrity of the pipeline system.

The life extension assessment (item 4) shall include, but not be limited to, the following:

a) risk assessment for extended operation;

b) review of the pipeline system design, including a gap analysis to identify the additional requirements of the current design codes;

c) assessment of the remnant life of the system, including the following:

  — corrosion assessment, accounting for both accumulated and future corrosion in combination with a defect assessment;

  — fatigue assessment, accounting for both accumulated and future fatigue damage;

  — coating breakdown and CP system degradation assessment;

  — identification and assessment of any other time-dependent degradation mechanism active in the pipeline;

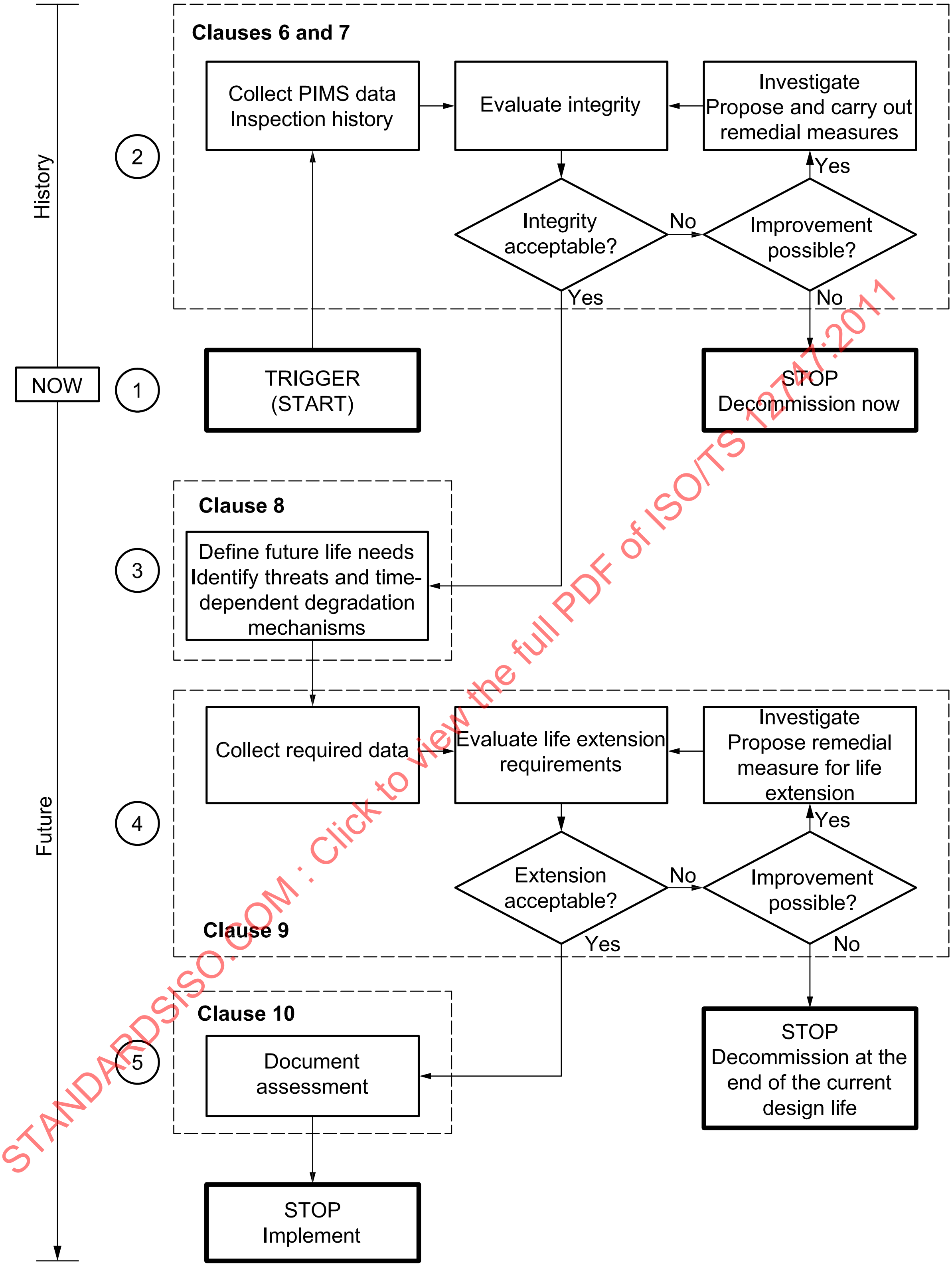


Figure 2 — Pipeline system life extension process

d) revision or introduction of the PIMS for the extended operating period, including update of the anomaly limits;

e) identification of any tenure issue (e.g. expiry of permit to occupy land) or statutory requirements (e.g. pipeline license renewal), including a gap analysis to identify any additional regulatory requirements introduced during the pipeline design life;

f) review of the adequacy of the safety and operating systems;

g) review of the adequacy of the operating and maintenance, emergency response and safety and environmental procedures.

Additional studies shall be performed as required, in order to determine the need for remedial measures to mitigate the threats to the pipeline system anticipated during the extended operational period.

5.4 Limitations on life extension

The allowable life extension is governed by the assessed remnant life of the pipeline system, as illustrated in Figure 3.

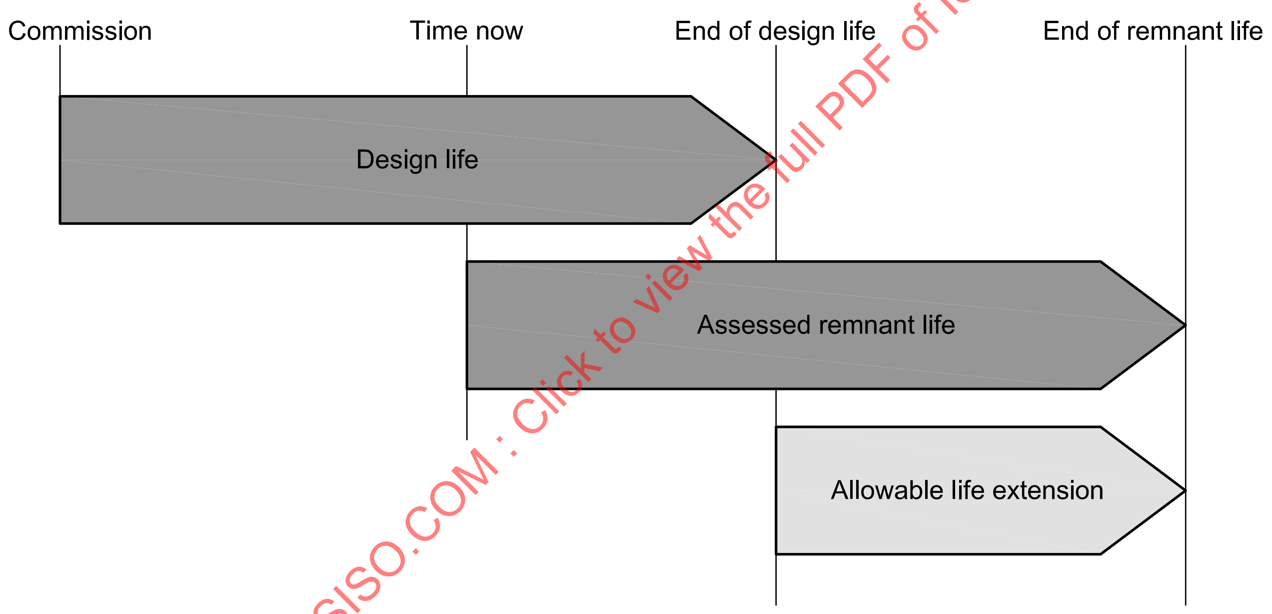


Figure 3 — Life extension and remnant life

If the required life of the pipeline system exceeds the remnant life, the remnant life assessment may be repeated considering the implementation of remedial measures, such as

— replacement of pipeline components;

— reassessment of anomaly limits and rectification of any anomalies;

— derating of the pipeline system.

Alternatively, it is possible to perform the life extension in stages. This is illustrated by the following examples.

EXAMPLE 1 A life extension of 20 years is required for a pipeline system, following the tie-in of a new asset, but the remnant life of the pipeline system is only 5 years due to excessive riser corrosion. In this case, an initial 5-year life extension can be made, followed by a further extension of 15 years upon replacement of the riser at the end of its remnant life.

EXAMPLE 2 A life extension of 20 years is required for a pipeline system, but due to the predicted corrosion rates, a reduction in MAOP will be required in 2 years. In a fashion similar to Example 1 above, an initial 2-year life extension can be made, with a further extension of 18 years subject to favourable results from an ILI run. If the ILI run confirmed the predicted corrosion rate, reduction in MAOP or rectification of the unacceptable defects would still be required after 2 years in order to achieve the required 20-year life extension.

5.5 Pipeline system availability

The guidance given in this Technical Specification is concerned with the proof of technical integrity of the pipeline system. However, the availability of the pipeline system during the life extension is also of critical importance. As such, a separate assessment of the integrity of the following should be carried out as part of the life extension process, as applicable:

- pipeline system facilities, such as
  - platform topsides,
  - pump stations,
  - compressor stations,
  - processing plants and terminals;
- instrumentation;
- control systems and equipment, such as SCADA;
- ancillary equipment.

6 Data compilation

6.1 General

Typical data required for a life extension assessment of a pipeline system are listed in 6.2. This does not constitute an exhaustive list; therefore, additional data should be gathered as required. The use of accurate data is vital and the level of confidence in the data source shall be considered as part of the assessment.

When performing the life extension assessment, the degree of missing data shall be assessed and remedial actions, such as additional pipeline inspections or risk assessments, shall be identified where appropriate.

NOTE 1 When considering aging pipelines, data are often missing, especially if the operatorship has passed through several organizations.

NOTE 2 In specific instances, such as for CP surveys, the use of the most recent inspection results is appropriate.

6.2 Data

6.2.1 Original design

Original design data should include

a) original codes and standards, including edition number and date;

b) design, fabrication and installation details;

c) design basis;

d) material specification and certification;

e) analysis calculations and reports;

f) hydrotest certificates;

g) environmental impact assessments;

h) risk assessments, including ECAs;

i) pressure safety systems;

j) inspection and test certification and reports;

k) documents relating to authorization and permits to operate;

l) regulatory requirements;

m) land ownership details;

n) surveys and route documentation, including location of other services and addition of third party services;

o) as-built route alignment maps, special crossing details, detailed pipework and instrumentation diagrams;

p) deviations and non-conformities.

6.2.2 Operations data

Operations data should include

a) pipeline process philosophy and data sheets;

b) operations philosophy;

c) operating cycles, including pressure, temperature, flow and content analysis;

d) operational pigging frequency and results, including liquid hold up and pig trash analysis;

e) corrosion monitoring;

f) erosion/sand monitoring;

g) microbial monitoring;

h) chemical management, including dosing regimes;

i) process monitoring records, including gas composition;

j) leak detection;

k) safety systems, e.g. HIPPS;

l) control systems, e.g. SCADA;

m) pressure systems;

n) incident records;

o) service conversions, including fluid content, dew point at inlet and outlet, liquid, hydrogen sulfide content, carbon dioxide content.

6.2.3 Maintenance and inspection data

Maintenance and inspection data should include

a) pipeline and material specifications;

b) acoustic/video records;

c) cathodic protection surveys;

d) thermography;

e) ground penetrating radar;

f) geographic information;

g) settlement monitoring;

h) crossing surveys;

i) span monitoring;

j) metocean data;

k) pigging runs (operational and intelligent pigging);

l) coating;

m) anomaly records, including all pipeline system anomalies identified since construction;

n) reports of all leaks and accidents;

o) repairs and modifications, including operational changes, e.g. change in operating temperature, pressure or flow rate;

p) mechanical integrity of pig traps, valves and other components;

q) inspection methods and techniques;

r) corrosion records.

6.2.4 External data

External data should include

a) regulations;

b) design codes (national and international);

c) pipeline registration documentation, permits and licenses;

d) building development and proximity distances changing the class of the pipeline system;

e) geological faults;

f) earthquakes, mudslides, subsidence.

7 Technical integrity of the pipeline system

7.1 General

7.1.1 The integrity of the pipeline system can have deteriorated since installation. The level of information available to characterize the deterioration experienced depends upon the monitoring and management systems implemented by the operator.

NOTE Integrity management practice varies with different operators in different parts of the world. In some cases, an ongoing risk assessment process is adopted, whilst in other cases, assessments are performed less frequently. Consequently the level of assessment required to justify life extension varies.

In order to determine whether the current technical integrity of the pipeline system is acceptable for life extension, an integrity assessment shall be performed based on the data and documentation detailed in Clause 6. There are numerous codes and standards that cover the assessment of pipeline integrity and these should be consulted for further guidance.

EXAMPLE API Std 1160, ASME B31.8S and DNV-RP-F116 address pipeline integrity assessment.

7.1.2 The technical integrity assessment shall evaluate

a) the internal and external pipeline condition;

b) the effects of any repairs or modifications to the technical integrity of the pipeline system;

c) the status of the CP system;

d) the effect of any defects or anomalies on the technical integrity of the pipeline system and the requirement for remediation;

e) the status and condition of the safety systems;

f) the fitness-for-purpose of the pipeline system.

7.1.3 The integrity assessment should also consider the installation and commissioning of the pipeline system, paying particular attention to

a) any new or non-standard construction methods that were used;

b) the presence of components (such as mitred bends) that are no longer accepted by current design codes;

c) any difficulties or unforeseen events that occurred (e.g. the presence of hydrotest water in the pipeline for longer than anticipated).

If sufficient data are not available to determine the technical integrity of the pipeline, further inspection, testing or analysis shall be carried out.

NOTE In practice, this involves ILI, hydrotest or direct assessment.

7.2 PIMS review

If the integrity of a pipeline system is governed by a PIMS, which is not always a requirement, the information provided should form the basis of the technical integrity assessment. The application of a PIMS is discussed in more detail in 9.4.

7.3 Remediation requirements

Following the assessment of the technical integrity, remedial actions can be required to ensure the fitness-for-purpose of the pipeline system for the remainder of the original design life. Typical remedial measures are discussed in 9.3.4.

NOTE In extreme cases, where remediation is not possible, the technical integrity assessment can result in decommissioning of the pipeline system prior to the end of the design life.

8 Future threat identification

8.1 General

Threats to the pipeline system during the extended life period shall be identified and used as the basis of the risk assessment.

Common threats to a pipeline system are listed in 8.2 to 8.4. This list is not exhaustive and additional threat lists are presented in many design codes (e.g. API Std 1160, ASME B31.8S and DNV-RP-F116).

NOTE 1 Threats can be categorized as either time-dependent or event-based. It is the time-dependent threats that are of specific concern during life extension. Event-based threats typically pose no additional risk during extended life than during the design life.

NOTE 2 Threats experienced by specific pipeline systems differ greatly and, consequently, not all of the threats listed are applicable.

8.2 Generic threats

Generic threats common to both onshore and offshore pipeline systems that are applicable to life extension assessments include

— design, fabrication and installation issues;

— incorrect operation;

— internal and external corrosion;

— erosion;

— fatigue;

— overpressure;

— spans;

— global buckling;

— subsidence;

— deterioration of supporting structures and infrastructure;

— natural events such as earthquakes and volcanic eruptions;

— munitions.

8.3 Threats specific to offshore pipeline systems

Additional threats to offshore pipeline systems include

- instability;
- collapse;
- scour;
- fishing interaction;
- dropped objects;
- vessel impact;
- dragged anchors.

8.4 Threats specific to onshore pipeline systems

Additional threats to onshore pipeline systems include

- excavation damage;
- changes in land use surrounding the pipeline ROW;
- vehicle impact;
- vandalism or terrorism;
- unauthorized hot-tapping.

9 Life extension assessment

9.1 Risk assessment

9.1.1 Process

Risk assessment is the process of identifying threats to the integrity of the pipeline system, estimating the probability and consequence of failure before determining the acceptability of the risk. This diagram is shown in Figure 4.

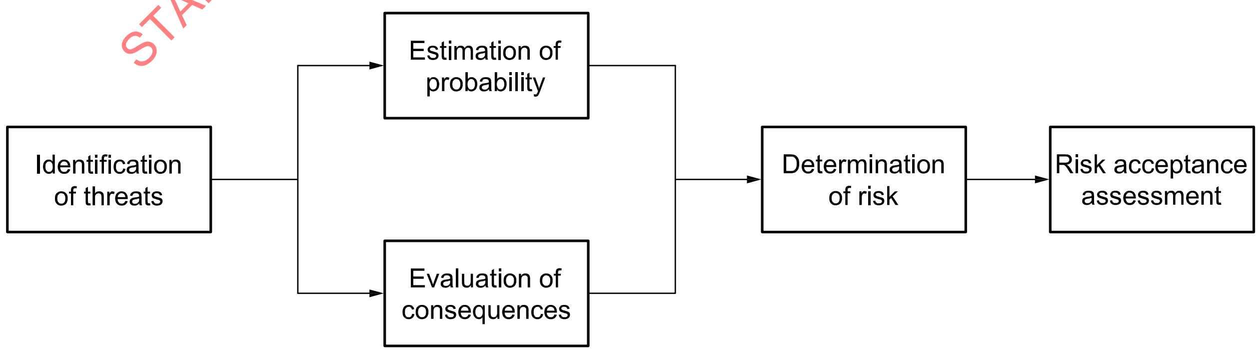


Figure 4 — Risk assessment process

Risk assessment can be qualitative or quantitative. Qualitative risk assessment is subjective, whilst quantitative risk assessment provides a direct numerical measure of risk.

NOTE ISO 31000 provides further guidance on the risk assessment process.

9.1.2 Use of risk assessment in life extension

The pipeline life extension assessment shall be based on a thorough understanding of the threats that the pipeline is subject to and the consequent risk to technical integrity. A risk assessment, considering the threats to the pipeline system during the extended operating period, shall, therefore, form a major part of the life extension assessment.

The following approach shall be adopted.

a) Perform an initial qualitative risk assessment to identify the major threats to the system.

b) Perform a QRA of the major threats identified by the qualitative assessment.

The outcome of the risk assessment shall be an estimate of how long the pipeline system can be operated before the risk of failure exceeds an acceptable level.

9.1.3 Acceptability of risk

The acceptability of the risks identified by the risk assessment shall be assessed and remedial measures prescribed where necessary to reduce risks to acceptable levels. The assessment of risk acceptability for a pipeline life extension, however, is not a trivial process.

— Operators, regulators and the general public have different views on acceptability of risk.

— The acceptability of risk changes with time and what was acceptable 20 years ago may not be now.

— The acceptability of risk changes with geographical location.

NOTE Further guidance on the acceptability of risk and target failure probabilities is given in ISO 16708.

9.1.4 Risk management

Risk management is the process of risk assessment, mitigation and periodic review as shown in Figure 5.

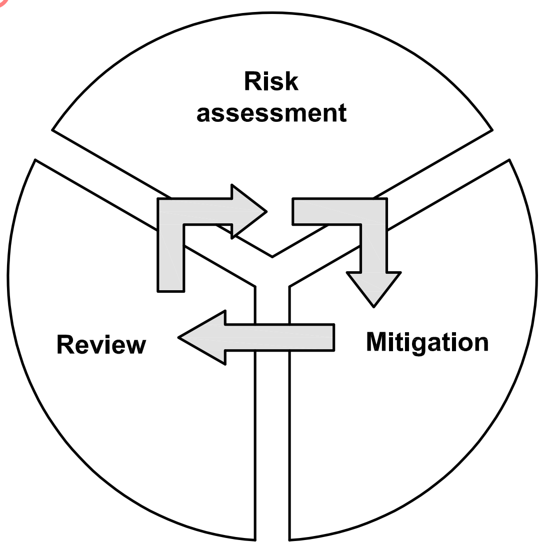


Figure 5 — Risk management process

The risk management process for the extended life period should be defined within the PIMS, as discussed in 9.4.1.

9.2 Pipeline system design review

9.2.1 Design codes

9.2.1.1 Original design method

Design codes generally adopt either an allowable stress or limit-state approach to pipeline design. The design code used for the original pipeline design has a significant effect on the life extension process.

Pipelines designed to an allowable stress design code, such as PD 8010, are generally easier to assess than those designed using a limit-state design approach, such as that adopted in DNV-OS-F101. Allowable stress design codes are usually more conservative, resulting in a greater wall thickness to resist corrosion during operation. In addition, a pipeline designed using an allowable stress design code may still be considered as fit-for-purpose if the appropriate factors of safety are satisfied.

9.2.1.2 Updates to design codes

It is likely that the design codes to which the pipeline system was originally designed have been updated during the operational period. This can result in non-conformance of the original design due to the following:

— change in the design methodology or safety factors;

— prohibition of the use of components allowed in previous versions of the design codes, such as mitred bends.

A gap analysis shall be performed to identify any changes in design code requirements since installation and determine the compliance of the pipeline design with the current design codes. Where non-conformances are identified, risk assessment shall be used to determine the requirement for remedial actions.

9.2.2 Changes to the design basis

9.2.2.1 General

The life extension assessment shall account for any changes to the original design basis. The consequences of any changes that have occurred during the design life or are anticipated as a result of life extension shall be addressed. Typical changes are discussed in 9.2.2.2, 9.2.2.3 and 9.2.2.4.

9.2.2.2 Process conditions

Changes in process conditions can have a significant influence on pipeline corrosion rates and applied loads. These typically include

— changes in operating pressure, temperature and flow rate;

— changes in corrosion regime (e.g. sweet to sour);

— increased water cut;

— process shut-downs;

— increased sand content;

— increased wax deposition.

9.2.2.3 Design loads

An assessment shall be performed to identify any changes to the original pipeline design loads. Such changes include

— an increase in environmental loading acting upon the pipeline system, including wave and current loading, wind loading and soil motion and deformation;

— an increase in interference loading (e.g. increase in fishing interaction loads on subsea pipelines due to the use of larger fishing gear);

— fatigue loading due to changes in process conditions (e.g. slugging);

— additional loading due to modifications and repairs.

The effect of any changes to the design loads on the acceptability of the pipeline design (in accordance with current codes and standards) shall be assessed. Remedial measures shall be identified as required.

9.2.2.4 Safety class

Increases in population density, changes in land use and changes in the pipeline corridor requirements over the design life can result in the enforcement of a more stringent location class (and hence safety class) in regions of the pipeline system. This can result in the non-conformance of the pipeline design with the requirements of the design codes.

In such cases, the additional risk to society shall be assessed and appropriate mitigation measures applied. This can result in the requirement to reduce the MAOP.

9.2.3 Additional data requirements

Any missing data required for the life extension assessment shall be identified. If the data cannot be obtained from other sources, remedial measures shall be considered. These may include

— specification of additional inspection workscope to obtain the required information;

— use of advanced numerical modeling techniques;

— use of conservative assumptions in any assessments performed;

— use of a risk assessment to mitigate the consequences of the missing data.

9.3 Assessment of remnant life

9.3.1 General

The assessed remnant life of the pipeline system governs the allowable life extension, as shown in Figure 3. The assessment of remnant life shall account for all of the time-dependent threats identified in Clause 8. The most common of these threats are addressed in 9.3.2 and 9.3.3.

9.3.2 Corrosion assessment

Corrosion is usually the most significant internal degradation mechanism for pipelines, resulting in the loss of steel from the pipe wall. A corrosion assessment shall be carried out to determine the acceptability of any corrosion defects present for the remnant life of the pipeline system, including

— assessment of external corrosion protection, including pipeline coatings and CP systems;

— determination of the corrosion rate, by corrosion modeling (deterministic or probabilistic) or comparison of defect dimensions between successive ILI runs;

— review of ILI data or direct assessment results as appropriate;

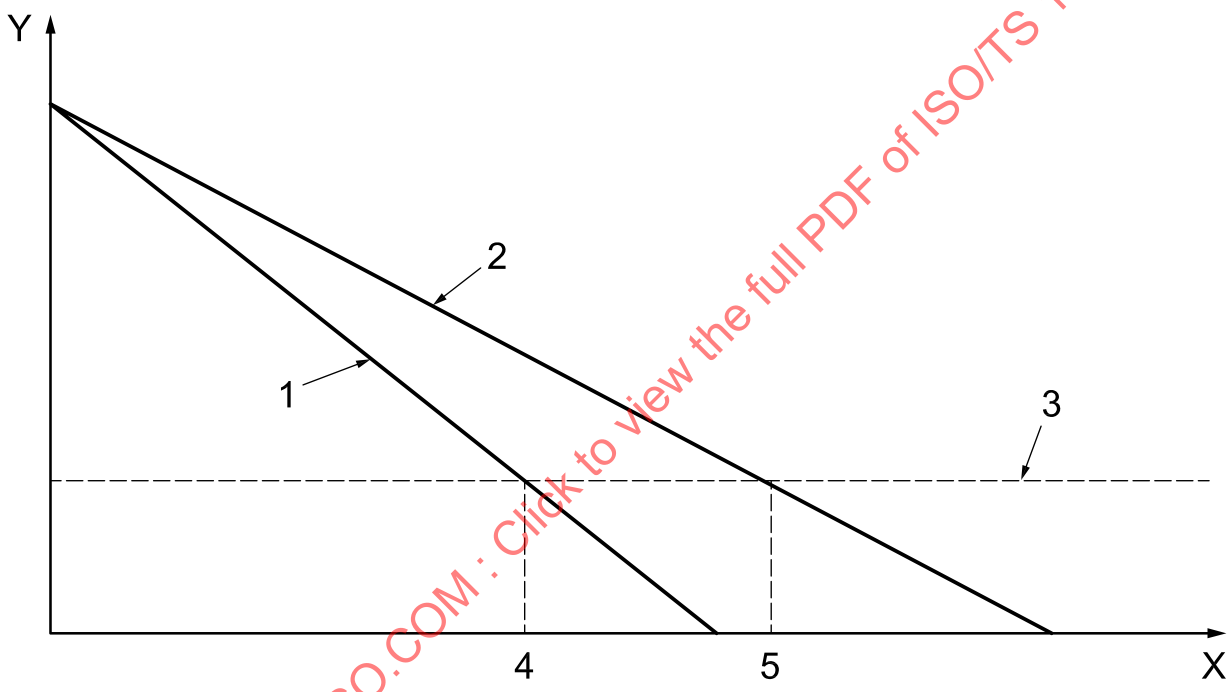
— acceptability assessment of the remaining pipeline wall thickness using current design codes;

— defect assessment;

— assessment of the remnant life of the pipeline system based on the above corrosion rate.

NOTE Guidance on corrosion defect assessment is given in ASME B31G, BS 7910 and DNV-RP-F101.

The degree of uncertainty in the calculated corrosion rate (and therefore the remnant life) shall be determined, for example, through the calculation of upper and lower bounds as shown in Figure 6.



Key

X time

Y wall thickness

1 upper bound corrosion rate

2 lower bound corrosion rate

3 minimum allowable wall thickness

4 earliest end of life

5 latest end of life

Figure 6 — Use of upper and lower bound corrosion rates

Further confidence in the results can be obtained from corrosion probe readings, inspections of pig traps and a review of the corrosion management system.