BS EN ISO 19345-2:2019

BSI Standards Publication

# Petroleum and natural gas industry - Pipeline transportation systems - Pipeline integrity management specification

Part 2: Full-life cycle integrity management for offshore pipeline

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# National foreword

This British Standard is the UK implementation of EN ISO 19345-2:2019. It is identical to ISO 19345-2:2019.

BSI, as a member of CEN, is obliged to publish EN ISO 19345-2:2019 as a British Standard. However, attention is drawn to the fact that during the development of this European Standard, the UK committee voted against its approval.

The UK committee voted against the publication of EN ISO 19345-2:2019 because, although it is intended as guidance to help users develop an integrity plan, it gives detailed, prescriptive requirements that are not compatible with the goal-setting approach to pipeline integrity management provided in the *Pipelines Safety Regulations 1996*. The committee advises that users in the UK refer to the PD 8010 series for appropriate guidance.

The UK participation in its preparation was entrusted to Technical Committee PSE/17/2, Transmission pipelines.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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# Petroleum and natural gas industry - Pipeline transportation systems -Pipeline integrity management specification - Part 2: Full-life cycle integrity management for offshore pipeline (ISO 19345-2:2019)

Industries du pétrole et du gaz naturel - Systèmes de transport par conduites - Spécification de gestion de l'intégrité des conduites - Partie 2: Gestion de l'intégrité des conduites en mer pendant leur cycle de vie complet (ISO 19345-2:2019)

Erdöl- und Erdgasindustrie - Fernleitungstransportsysteme - Leitfaden für das Integritätsmanagement von Fernleitungen - Teil 2: Integritätsmanagement des vollständigen Lebenszyklus von Offshore Fernleitungen (ISO 19345-2:2019)

This European Standard was approved by CEN on 9 February 2019.

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## European foreword

This document (EN ISO 19345-2:2019) has been prepared by Technical Committee ISO/TC 67 "Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries" in collaboration with Technical Committee CEN/TC 12 “Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries” the secretariat of which is held by NEN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2019, and conflicting national standards shall be withdrawn at the latest by December 2019.

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## Endorsement notice

The text of ISO 19345-2:2019 has been approved by CEN as EN ISO 19345-2:2019 without any modification.

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document 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*.

A list of all parts in the ISO 19345 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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# Introduction

This document addresses the integrity of petroleum and natural gas pipelines through their entire life-cycle, from design to eventual abandonment. For this reason, considerations relating to design, construction and abandonment have been included. This approach supports the development and implementation of a holistic and integrated pipeline integrity management program that bridges between life-cycle elements and thereby avoids compartmentalizing of the pipeline life-cycle into essentially independent data and functional silos, which has traditionally been the case. The integrated approach was developed on the basis of extensive research and examination of best practices and results from pipeline integrity audits world-wide.

This document is intended to be used by companies that have not yet developed an official program or are developing a program for new pipelines. This document can also be used to guide continual improvement of existing programs by both operating companies and regulators to evaluate integrity management program effectiveness.


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# Petroleum and natural gas industry — Pipeline transportation systems — Pipeline integrity management specification —

## Part 2:
## Full-life cycle integrity management for offshore pipeline

## 1 Scope

This document specifies requirements and gives recommendations on the management of integrity of a pipeline system throughout its life cycle, which includes design, construction, commissioning, operation, maintenance and abandonment.

This document is applicable to offshore pipelines for transporting petroleum and natural gas. It is applicable to rigid steel pipelines. It is not applicable to flexible pipelines, dynamic risers or those constructed from other materials, such as glass-reinforced plastics.

NOTE 1 An offshore pipeline system extends to:

— the first valve, flange or connection above water on platform or subsea mechanical connector with subsea structure (i.e. manifold or dynamic riser);

— the connection point to the offshore installation (i.e. piping manifolds are not included);

— the first valve, flange, connection or isolation joint at a landfall, unless otherwise specified by the onshore legislation.

NOTE 2 The components mentioned above (valve, flange, connection, isolation joint) include also any pup pieces, i.e. the offshore pipeline system extends to the weld beyond the pup piece, see Figure 1.

This document is used for integrity management, which is initiated at the design and construction stage of the pipeline. Where requirements of a design and construction standard (e.g. ISO 13623) are different, the provisions of this document will enhance the design and construction from an integrity perspective.

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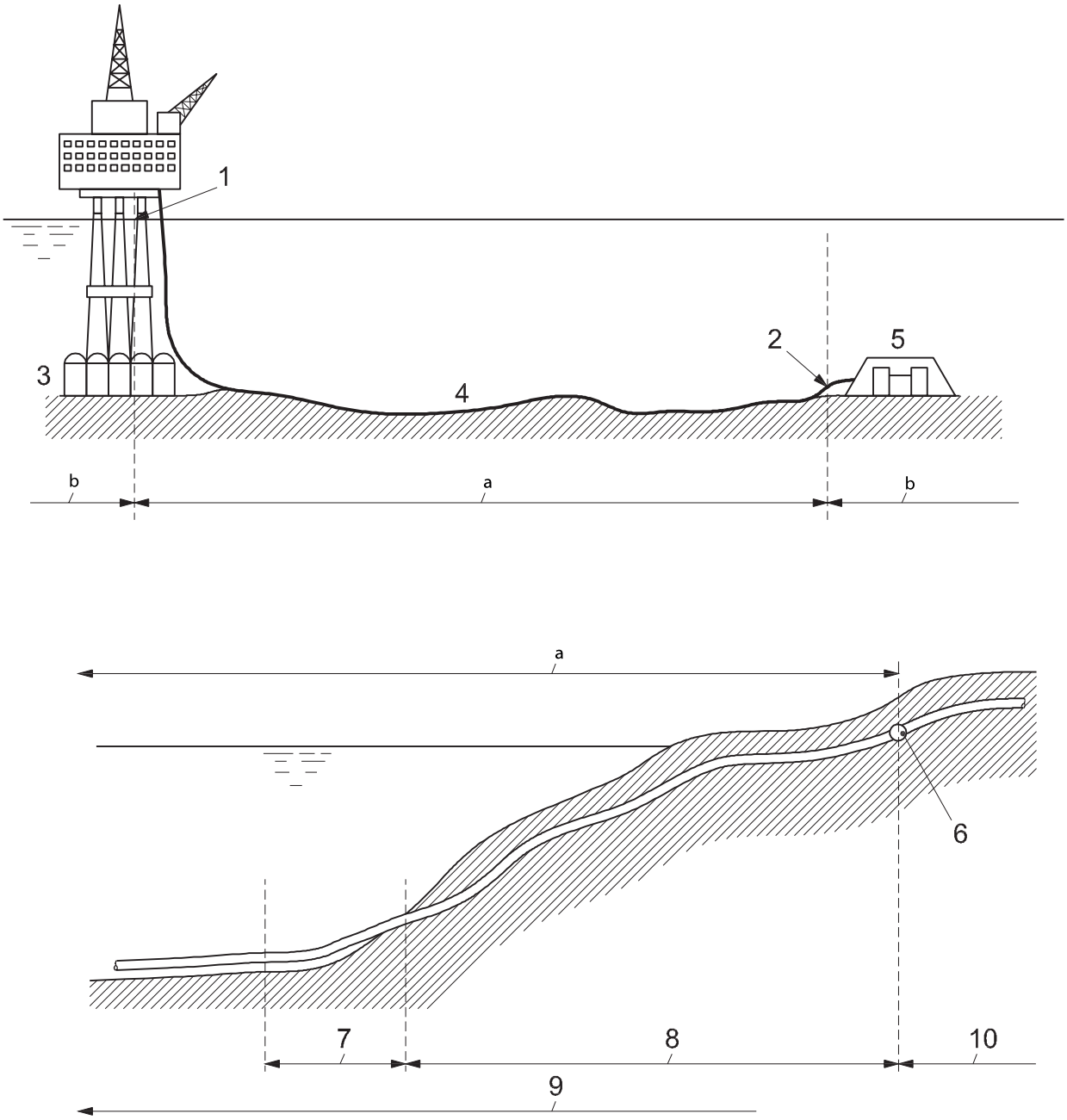


**Key**

| | | | |
|---|---|---|---|
| 1 | first valve, flange, connection or isolation joint | 7 | nearshore section |
| 2 | connector point to subsea piping | 8 | shore approach |
| 3 | topside | 9 | offshore section |
| 4 | pipeline system | 10 | onshore section |
| 5 | pipeline subsea structure | a | covered by this document |
| 6 | first valve, flange, connection or isolation joint | b | not covered by this document |

**Figure 1 — Extent of pipeline systems covered by this document**


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## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 13623, *Petroleum and natural gas industries — Pipeline transporting system*

ISO 15589-2, *Petroleum, petrochemical and natural gas industries — Cathodic protection of pipeline transportation systems — Part 2: Offshore pipelines*

ISO 31000, *Risk management — Guidelines*

IEC 31010, *Risk assessment techniques*

## 3 Terms, definitions and abbreviated terms

### 3.1 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

**3.1.1**
**abandonment**
activities associated with taking a pipeline permanently out of operation

Note 1 to entry: An abandoned pipeline cannot be returned to operation.

Note 2 to entry: Depending on the legislation abandonment can require cover or removal.

**3.1.2**
**anomaly**
possible deviation from pipe material or weld soundness

Note 1 to entry: The identification of an indication of an anomaly can be generated by non-destructive inspection, such as in-line inspection.

**3.1.3**
**baseline assessment**
first integrity assessment prior to or after operation

**3.1.4**
**cathodic protection**
corrosion control technique to prevent or reduce the external corrosion of metal pipelines by transferring an electrical current onto the pipe to achieve increased negative electrical potentials

**3.1.5**
**corrosion**
deterioration of a material, usually a metal that results from an electrochemical reaction with its environment

**3.1.6**
**crack**
planar flaw, or linear discontinuity, with a sharp tip radius

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**3.1.7**
**critical consequence area**
location where a pipeline release might have a significant adverse effect on public safety, property and the environment

Note 1 to entry: The pipeline segments in CCAs are of particular interest in risk assessment and integrity assessment evaluations and prioritizations.

**3.1.8**
**deactivation**
removal of a pipeline from service, though the pipeline might be returned to service after a proper assessment

Note 1 to entry: Also defined as decommissioning or suspension.

**3.1.9**
**deformation**
change in shape of the pipe or component, such as a bend, buckle, *dent* (3.1.11), ovality, ripple, wrinkle, or any other change that affects the roundness of the pipe or original cross-section or straightness of the pipe or component

**3.1.10**
**defect**
imperfection of a type or magnitude exceeding acceptable criteria

**3.1.11**
**dent**
depression which produces a disturbance in the curvature of the pipe wall, caused by contact with a foreign body resulting in plastic deformation of the pipe wall

**3.1.12**
**design life**
period for which the design basis is planned to remain valid

[SOURCE: ISO 13623:2017, 3.1.2]

**3.1.13**
**failure**
event in which a component or system does not perform according to its operational requirements

**3.1.14**
**fitness for purpose**
quantitative engineering evaluation that is performed to demonstrate the structural integrity of an in-service component that can contain an imperfection, *defect* (3.1.10) or damage

**3.1.15**
**gouge**
surface damage to a pipeline caused by contact with a foreign object that has scraped (gouged) material out of the pipe, resulting in a metal loss defect or imperfection

**3.1.16**
**incident**
unintentional release of gas or liquid due to the *failure* (3.1.13) of a pipeline

Note 1 to entry: Some regulatory authorities define “incident” as an event occurring on a pipeline for which the operator is required to make a report to the concerned regulatory authority.

**3.1.17**
**in-line inspection**
inspection of a pipe wall from the interior of the pipe using specialized tools


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**3.1.18**
**integrity assessment**
process that includes the inspection and testing of a pipeline in order to determine physical characteristics and assess its integrity condition by combination of an analysis of data, use of reliability assessment methodologies of the structure and an evaluation of the safety state of the pipeline

**3.1.19**
**integrity management program**
documented program that specifies the practices used by the operating company to proactively manage the safe, environmentally responsible, and reliable service of a pipeline system throughout its lifecycle and which incorporates a continuous improvement process

**3.1.20**
**life extension**
additional period of time beyond the original design or *service life* (3.1.36) (but within the assessed remnant life) for which permission to continue operating a pipeline system is granted by the regulatory bodies

Note 1 to entry: Life extension is considered as a modification to the design basis.

[SOURCE: ISO/TS 12747:2011, 3.7]

**3.1.21**
**magnetic flux leakage**
type of in-line inspection technology in which a magnetic field is induced in the pipe wall between two poles of a magnet

Note 1 to entry: Anomalies affect the distribution of the magnetic flux in the wall. The magnetic flux leakage pattern is used to detect and characterize anomalies.

**3.1.22**
**management of change**
process that systematically recognizes and communicates to the necessary parties changes of a technical, physical, procedural or organizational nature that can impact system integrity

**3.1.23**
**manufacturing defect**
*defect* (3.1.10) in the pipe body or coating created during the pipe or component manufacturing or coating processes

**3.1.24**
**maximum allowable operating pressure**
maximum internal pressure at which a pipeline system, or parts thereof, is allowed to be operated

Note 1 to entry: The MAOP is established by the maximum pressure achieved during testing (see ISO 13623).

**3.1.25**
**metal loss**
pipe anomaly in which metal has been removed

Note 1 to entry: Metal loss is usually the result of corrosion, but gouging, manufacturing defects erosion, or mechanical damage can also result in metal loss.

**3.1.26**
**non-destructive testing**
wide group of analysis techniques used to evaluate the properties of a material, component or system without causing damage

Note 1 to entry: “Non-destructive inspection” (NDI) and “non-destructive evaluation” (NDE) are also commonly used to describe this technology.

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**3.1.27**
**offshore pipeline**
part of a pipeline system that, except for pipeline risers, is laid on the seabed or below it inside a trench

Note 1 to entry: The pipeline might be resting wholly or intermittently on, or buried below, the seabed.

**3.1.28**
**operator**
person or organization who owns or operates a pipeline system or facilities who is ultimately responsible for the operation and integrity of the pipeline system

**3.1.29**
**pipeline integrity management**
set of processes and procedures that proactively assures incident-free safe and environmentally responsible transportation of fluids through a pipeline system

**3.1.30**
**pipeline integrity management program**
continuous improvement closed-loop system using information technology to realize functions such as data acquisition and integration, integrity and *risk assessment* (3.1.33), mitigation and repair activity and maintenance decisions, with comprehensive management of change and continual review and improvement processes

**3.1.31**
**pressure test**
means of assessing the integrity of a new or existing pipeline that involves filling the pipeline with water and pressurizing to a level in excess of the MAOP of the pipeline to demonstrate that the pipeline is fit for service at the MAOP for a given time frame dependent on the identified integrity hazards

Note 1 to entry: See ISO 13623:2017, 6.7.

**3.1.32**
**risk**
measure of loss, either qualitative or quantifiable, in terms of both the likelihood of incident occurrence and the magnitude of the consequences of the incident occurrence

**3.1.33**
**risk assessment**
systematic, analytical process in which potential hazards from the pipeline system are proactively identified, and the likelihood and consequences of potential adverse events are determined

**3.1.34**
**risk management**
coordinated activities to direct and control an organization with regard to *risk* (3.1.32)

[SOURCE: ISO Guide 73:2009, 2.1]

**3.1.35**
**safe operating pressure**
pressure, calculated using the appropriate analysis and mathematical formulas for the specific type of *defect* (3.1.10) identified

EXAMPLE For corrosion defects using recognized remaining strength of corroded pipeline formulas, where all corroded regions will withstand a calculated safe operating pressure.


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**3.1.36**
**service life**
length of time over which the pipeline system is intended to operate

[SOURCE: ISO/TS 12747:2011, 3.21]

Note 1 to entry: Service life is considered the actual operational life to date, but can include any planned future use of the line. Service life can be less or longer than design life.

**3.1.37**
**sizing accuracy**
accuracy with which an anomaly dimension or characteristic is reported

Note 1 to entry: Typically, accuracy is expressed by tolerance and certainty.

EXAMPLE Depth sizing accuracy for metal loss using NDT methods, such as an ILI tool, is commonly expressed as +/−10 % of the wall thickness (the tolerance) and 80 % of the time (the certainty).

**3.1.38**
**third-party damage**
damage done to the pipeline as a result of activities by personnel not associated with the pipeline

**3.1.39**
**threat**
activity or condition than can adversely affect the pipeline system if not adequately controlled

[SOURCE: ISO/TS 12747:2011, 3.23]

## 3.2 Abbreviated terms

| | |
|---|---|
| AC | alternating current |
| CP | cathodic protection |
| CCA | critical consequence area |
| CoF | consequence of failure |
| DA | direct assessment |
| ECDA | external corrosion direct assessment |
| FFP | fitness for purpose |
| GIS | geographic information system |
| HIC | hydrogen-induced cracking |
| ICDA | internal corrosion direct assessment |
| ILI | in-line inspection |
| IMP | integrity management program |
| MAOP | maximum allowable operating pressure |
| MFL | magnetic flux leakage |
| NDT | non-destructive testing |
| PIM | pipeline integrity management |

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| | |
|---|---|
| PoF | probability of failure |
| SCC | stress corrosion cracking |
| SCCDA | stress corrosion cracking direct assessment |
| SMYS | specified minimum yield strength |
| SSC | sulphide-stress cracking |

# 4 General

## 4.1 Key principles

The operator uses integrity management programs (IMPs) to enable it to manage its pipeline systems in a safe, environmentally responsible and reliable manner. An effective IMP anticipates and mitigates or eliminates integrity issues before they lead to incidents or failures.

Key principles for an effective IMP are listed below:

a) Pipeline system integrity shall be viewed as a lifecycle approach from initial planning, design, construction, operation and maintenance up to and including abandonment.

b) The operator shall provide adequate resources in terms of funds, equipment and competent personnel to implement the IMP.

c) Clearly defined roles and responsibilities with clear communication processes are necessary.

d) Document and records control and retention and data gathering are key mandatory elements that enable informed decisions.

e) Performance measures of the IMP's effectiveness should include both leading and lagging indicators to identify trends and areas for continuous improvement.

f) An effective IMP uses risk-based decisions to prioritize integrity-related actives.

## 4.2 Integrity management program

### 4.2.1 General

The operator shall establish, implement, maintain and document an IMP or equivalent, and continually review its adequacy and implementation and improve its effectiveness.

The pipeline IMP shall be part of a comprehensive management system which includes, as a minimum, integration with safety and environment programs.

To facilitate the development and implementation of the initial IMP for a pipeline system, the operator shall develop an integrity management plan, which includes a plan for initial data acquisition, threat and hazard consequence identification and risk assessment, and improve it with integrity elements introduced in 4.2.2. If applicable, the operator can also choose to incorporate mature IMP elements from other pipeline systems, and customise them to their pipeline system or segment.

### 4.2.2 Introduction to IMP elements

The pipeline IMP shall address operators' approach to the following elements, as illustrated in Figure 2.

a) Life cycle phases for integrity management:

Integrity shall be applied through the entire life cycle of pipeline, including:


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1) feasibility;

2) design;

3) procurement;

4) installation;

5) transportation and storage;

6) construction;

7) pre-commissioning and commissioning;

8) handover;

9) operation and maintenance;

10) modification;

11) suspension/abandonment.

b) Pipeline integrity management process:

As part of the continuous improvement process, the inputs into these elements shall be routinely updated, as required, to reflect the dynamic nature of pipeline systems:

1) data acquisition, review and integration;

2) risk assessment (threat, consequence, probability, CCAs);

3) inspection and monitoring;

4) integrity assessment;

5) mitigation activity;

6) performance measurement and improvement.

NOTE 1 Understanding the pipeline's integrity and threats in the context of the surrounding environment is key to making informed integrity management decisions.

NOTE 2 Performance measurement can verify that the goals, targets and objectives of the integrity program are being met and can be used during management reviews to identify improvement opportunities.

The following elements shall be developed for the operational phase to ensure that adequate management practices are in place to assess failures and manage and respond to emergencies:

— failure assessment plan;

— emergency response plan;

— remaining life assessment plan.

NOTE 3 The failure assessment plan considers failure causes and contributing factors and provides critical information to the IMP. The goal is to prevent recurrence of similar failures.

NOTE 4 The emergency response plan is designed to ensure that the operator is prepared to deal with accidents and incidents in a timely manner to aid in the reduction of consequences. These accidents or incidents can occur because the IMP did not foresee or was unable to effectively mitigate the threat. Emergency response plans also include contingency repair plans and procedures.

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NOTE 5 The remaining life assessment provides input into the economic viability assessment of the pipeline. As the pipeline ages, the operational risks and mitigation costs increase until continuing the operation is no longer viable.

c) Management elements:

The following elements shall form part of an IMP and might be written to encompass more than one pipeline or system. These elements usually interact with other management systems within an organization:

1) policy and commitment;

2) scope of the IMP;

3) organizational structure including key roles and responsibilities.

The following mandatory elements predominately deal with information flow, providing the core of the data system providing information for assessment and review. They are usually presented as plans with procedures:

— communication;

— records and documents control;

— management of change;

— management review and audit;

— training and skills.

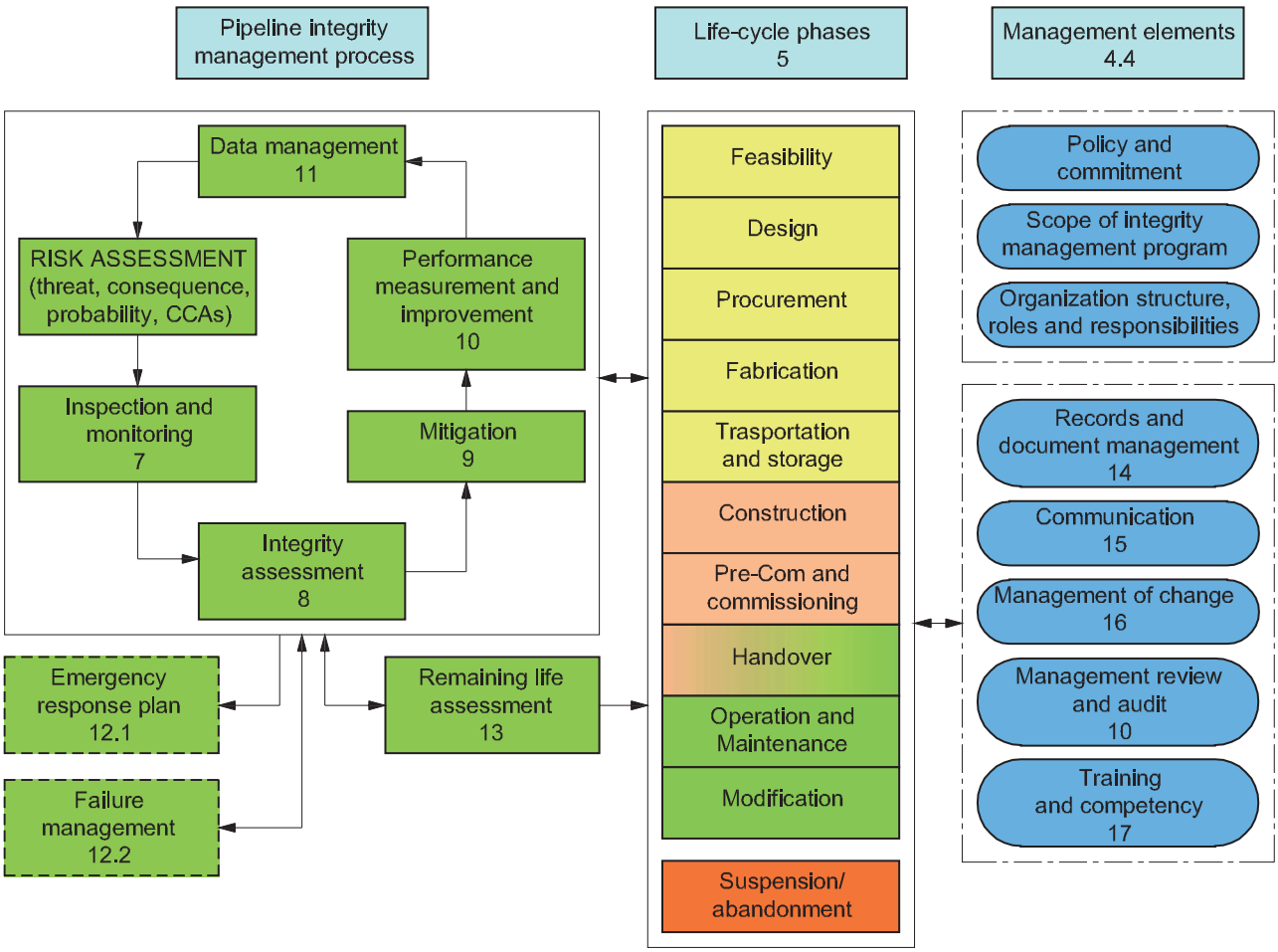


**Figure 2 — Pipeline integrity management program structure**


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## 4.3 Integrity management process elements

### 4.3.1 Data acquisition, review and integration

The first step in evaluating the potential threats for a pipeline system or segment is to define and gather the necessary data and information that characterize the segments and the potential threats to that segment. A plan for collection of historical data shall be established and maintained for the pipeline system lifecycle. The operator shall perform the initial collection, review and integration of relevant data and information from pipeline design, construction, operation, maintenance, monitoring, inspection and failure investigation data. Data acquisition is needed to understand the condition of the pipeline, identify the location-specific threats to its integrity; and understand the public, environmental, and operational consequences of an incident.

### 4.3.2 Risk assessment

Risk analysis is an analytical process through which the operator considers the likelihood of the threats occurring and the nature and severity of the resulting consequences.

Risk assessment shall be performed for all scenarios including low consequence—high likelihood and critical consequence—low likelihood events. Every plausible failure mode shall be listed and assigned risk evaluation. Where multiple consequences occur from a single failure mode, multiple assessments are required.

The operator shall consider all the threats and any interactive threats that can be applicable to its system. It can be appropriate to consider risks in pipeline segments where the consequence of failure is particularly high and where explicit integrity management measures have to be implemented.

Completed risk assessment shall be reviewed at regular intervals and when substantial changes occur to the pipeline. The assumptions and variables used in the risk assessment shall be validated and updated, where applicable as part of the review.

### 4.3.3 Inspection and monitoring

The operator shall select and conduct appropriate inspection and monitoring based on the risk assessment made in the previous step, typically including in-line inspection, pressure testing, direct assessment, or other inspection and monitoring methods based upon the threats that have been identified. More than one inspection or monitoring method can be required to address all the threats to a pipeline segment.

### 4.3.4 Integrity assessment

Integrity assessment will implement the following hierarchy of controls:

— physical controls;

— procedural controls;

— elimination.

Where risks cannot be sufficiently controlled, mitigation activities shall be implemented until the risk is considered satisfactory.

The process of establishing and implementing effective preventive and mitigation measures requires suitable data collection, data integration, and informational analysis within the IMP. Data integration and the analysis can identify aspects of the operator's operations and maintenance that allow the operator to address the threats. Most importantly, local knowledge of the operational environment around the pipeline and the incident history associated with certain components or circumstances should be considered.

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### 4.3.5 Mitigation activity

Where a threat cannot be controlled, the operator shall develop appropriate actions to mitigate the threat to an acceptable level of risk.

The results of mitigation assessments shall be used to determine what additional prevention or mitigation measures are required to reduce unacceptable risks identified in the assessment. Prevention and mitigation activities should be applied to reduce the likelihood of failure and/or the consequence of the failure to an acceptable level. Preventative measures typically involve activities to reduce the likelihood of an event.

The operator shall perform mitigation activities to ensure the pipeline system remains safe for its intended service. Where applicable, these mitigation activities shall provide a factor of safety that is notionally similar to the design factor of safety. This notional equivalent design factor of safety shall be maintained, throughout the life of the pipeline. The mitigation activities can include activities such as increased internal and external inspections and survey and pressure reductions.

### 4.3.6 Performance measurement and improvement

The operator shall develop procedures to regularly measure and evaluate the adequacy of implementation and effectiveness of IMP and its conformity to relevant standards.

The operator shall also evaluate the effectiveness of its other related management programs and processes in supporting integrity management decisions.

A combination of performance measures and system audits can be necessary to evaluate the overall effectiveness of a pipeline integrity system.

Performance measurement results shall be used to continuously identify areas for improvement of the IMP. In addition, advances in technology and industry best practices shall be considered.

### 4.3.7 Emergency response plan

Plans and response procedures for emergency situations shall be established and maintained based on a systematic evaluation of possible scenarios that can affect the safe and reliable operation of the pipeline system. Plans and procedures for contingency repair of the pipeline shall be established depending on the criticality of the pipeline system, based on factors such as safety, environmental, legislative or commercial considerations.

### 4.3.8 Failure management plan

The operator shall develop procedures for pipeline failure investigation to ensure that a structured approach is adopted and all aspects of a failure are reviewed. The failure investigation shall aim to determine the root cause and contributing factor of a pipeline failure and recommend corrective actions to prevent similar failures. This can include a targeted risk management program for causes that are not isolated. The operator shall setup a database to record relevant pipeline failure information to support failure management.

### 4.3.9 Remaining life assessment

The operator shall develop a remaining life assessment for all pipeline segments and systems and apply updates as new integrity information is gathered e.g. ILI, or when the operational parameters change (e.g. pressure or temperature). The remaining life assessment shall be reviewed at regular intervals, such as at the end of the design life and after pipeline failures, or when changes in key operating design parameters occur.

The remaining life assessment will be used to enable lifecycle management processes to balance the risks of ongoing operation with safety and protection of the environment and associated costs of operations and management.


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## 4.4 Management elements

### 4.4.1 Policy and commitment

The operator shall have a policy that expresses management commitment for developing, implementing, reviewing and continuous improvement of a pipeline IMP. The operator shall instruct personnel to meet its requirements.

### 4.4.2 Scope of integrity management program

The operator shall determine the scope of the IMP, including identifying the applicable pipeline systems and the goal and objectives of the IMP for the identified pipeline system.

The operator shall maintain a documented IMP that addresses the management of the pipeline integrity and specific treatment for all unacceptable risk.

### 4.4.3 Organization structure, roles and responsibilities

The operator shall have a clearly defined organizational structure to implement the IMP. Pipeline integrity management shall be carried out by personnel with clearly defined roles, responsibilities, authority and accountability in implementing and reviewing the IMP.

Where applicable, the organizational structure shall identify the linkages to other related management system programs, such as the safety and environmental programs.

The organizational structure should also take into account both upstream and downstream system inputs/outputs to ensure no changes in one system can have a negative effect on an adjacent system not within the control of the operator.

### 4.4.4 Records and document control plan

The IMP shall be documented and effectively updated. Program items to be documented shall include the following:

— documents and records needed by the operator to ensure the effective operation and control of its processes;

— statements of integrity management policy and objectives;

— procedures required by the implementation of integrity management.

A records and documents control plan shall be developed to facilitate the storing and retrieving of records and documents in a timely manner. The plan shall include means to confirm accuracy and quality of inputs.

### 4.4.5 Communication plan

A plan for reporting and communication to all stakeholders, including but not limited to employees, management, authorities, customers, public, local officials and responders, shall be established and maintained.

### 4.4.6 Management of change plan

A systematic process shall be used to ensure that, prior to implementation, changes to the pipeline system product being shipped, design, operation or maintenance are documented and evaluated for their potential risk impacts, and to ensure that changes are documented and evaluated.

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#### 4.4.7 Management review and audit plan

Management review and audit of the pipeline IMP shall be conducted at regular intervals to determine the adequacy, implementation and effectiveness of the integrity program. The focus of management reviews and audits shall be on evaluating the following:

— effectiveness and adequacy of the IMP to meet its stated goals and targets;

— implementation of the IMP;

— conformity to regulatory and operator's requirements;

— identification of corrective actions for continual improvement.

#### 4.4.8 Training and skill plan

The IMP shall establish clear skill requirements for all roles involved in pipeline integrity management, including operators, contractors, engineers, and other persons using this document.

Training needs shall be identified and training shall be provided for relevant personnel in relation to management of pipeline integrity.

# 5 Integrity management for the pipeline lifecycle phases

## 5.1 General

### 5.1.1 Objectives

Pipeline system design (including material procurement and selection) and installation (including installation testing and commissioning) along with operations and maintenance activities have an impact on pipeline integrity.

Although these activities follow recognized standards, it is important to realize that conformity to a minimum standard might not identify potential long-term integrity issues. Therefore, it is important to review pipeline risks at handover from each pipeline phase and throughout the integrity lifecycle.

Designers, procurers, constructors, operators and maintenance personnel and integrity management practitioners shall be aware of 5.3, that highlight the interrelation between the pipeline lifecycle phases (which entails includes components such as design, procurement, installation, commissioning, operation and maintenance) and integrity. 5.3 identifies areas where changes in each of the pipeline lifecycle phases could be needed to aid in long-term integrity management.

### 5.1.2 Principles

The following high-level principles shall be considered during each of the pipeline lifecycle phases:

a) Risk-based approaches to integrity management shall be applied. Clause 6 provides guidance on risk assessment methodologies.

b) Functional requirements for integrity management shall be incorporated into each lifecycle phase.

c) The concepts and requirements of IMP shall be regarded as the basis for long-term asset management.

d) Any deviations shall be reviewed to evaluate impacts on integrity.

e) Pipeline segments shall be designed according to ISO 13623, or a similar standard, to accommodate in-line inspection (ILI) tools. Where ILI accommodation is not practical, e.g. short service life, short connections or off-takes, the operator shall identify an appropriate alternative integrity assessment method.


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f) Data is regarded as the foundation of a pipeline integrity management and the operator shall have a comprehensive plan for collecting, managing, retrieving and analysing all data sets.

## 5.2 Key lifecycle integrity processes

Integrity assessment is an ongoing process that utilizes data from the various pipeline lifecycle phases to enable the operator to determine the integrity or soundness of the pipeline for its continued operation or design purpose.

The integrity assessment process for new pipelines utilizes construction inspection data and for operating pipelines utilizes data from pipeline condition monitoring activities, such as seabed movement monitoring, ILI, and pressure test to identify threats. The potential consequence and likelihood of identified threats are further evaluated using the appropriate method to determine fitness for purpose that includes a notional factor of safety. The operator shall determine the appropriate integrity assessment methods based on the threat and the capabilities and limitations of the integrity assessment method.

An integrity assessment can be conducted to evaluate the risk, and the interval for the next integrity assessment shall be determined based on the findings.

For pipelines already in operation, an integrity assessment shall be completed within 3 years if no previous integrity assessment has been performed.

## 5.3 Lifecycle phases for integrity management

### 5.3.1 General

Integrity management occurs throughout the whole lifecycle of an asset from the initial feasibility studies through to abandonment and heavily influences the design considerations and the ongoing maintenance/management techniques.

All threats to the integrity of the asset shall be identified and controlled throughout the lifecycle; therefore, the elimination of the threats by improvements in design can provide a significant advantage to the on-going safe and reliable operations of the pipeline.

Each of the lifecycle phases has opportunities to mitigate or control integrity threats and each life cycle phase shall be adequately designed and controlled to optimise the integrity oversight.

The personnel responsible for each lifecycle phase should be familiar with basic pipeline integrity issues and concepts. In addition, a process shall be developed where the pipeline integrity subject matter experts will review each lifecycle phase to determine if there are potential pipeline integrity issues that need resolution.

### 5.3.2 Feasibility

#### 5.3.2.1 Objectives

At the feasibility phase of the integrity management lifecycle, the key integrity risks are associated with the physical attributes of the route. Proactive avoidance of threats is a critical design objective, and action at this phase in the lifecycle can provide significant benefits during construction. This could reduce the level of future mitigation being applied throughout the pipeline lifecycle leading to improved reliability and reduced operating cost.

#### 5.3.2.2 Principles

At this phase in pipeline development, the basic route selection is often a straight line between supply and delivery points. Modifying the route would typically increase the overall pipeline length, but reduced operation and maintenance costs can warrant the increased installation cost.

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Optimized routing can take into account many of the key potential threats by avoiding obvious difficulties during installation. Improved routing at landfalls shall determine: seabed geology and topography specific to landfall and costal environment, environmental conditions caused by adjacent coastal features. Other considerations at this phase include access to the pipeline for pressure test activities and pipeline drying. In addition, areas of critical consequences associated with safety of the public or damage to the environment would be avoided.

Realistic route selection at this phase will improve the cost estimates for the proposal enabling more realistic evaluation of the project costs.

### 5.3.3 Design

#### 5.3.3.1 Objectives

At the design phase, all of the integrity threats that the pipeline system will be exposed to during its lifetime are anticipated. The operator shall also anticipate future sea area/landfall use activities and encroachment that can lead to elevated consequences and a change in the original risk profile or have a direct impact on pipeline integrity, due to third party damage. In addition, the pipeline designer should consider designing the pipeline to enable condition monitoring of the pipe wall, using applicable inspection technologies, such as ILI.

#### 5.3.3.2 Principles

At the design phase, CCAs analysis shall be implemented. Routing selection shall be optimized to avoid CCAs where practical. To confirm that suitable physical and procedural protective methods have been implemented, pipeline segments, especially CCAs, shall be validated including consideration of future changes to the environment, e.g. future projects or possible field congestion.

Where special construction methods or processes are utilized, they shall be assessed to determine any impact on future integrity and necessary mitigation that might be required.

### 5.3.4 Procurement

#### 5.3.4.1 Objectives

At the procurement phase of the integrity management lifecycle, the key integrity risks are associated with meeting the quality and functionality of the materials detailed by the designer. Proactive avoidance of inappropriate or defective material at this phase in the lifecycle can reduce the risks associated with failure during testing and operation.

In the operating phase poor procurement decisions can lead to substandard equipment reducing functionality or safety and can be significant to the economic performance of the assets.

#### 5.3.4.2 Principles

At this phase in the lifecycle, the quality of the final asset can be directly related to the material supplied. During design, specific materials will have been selected for the required operation envelope and might have been specified to deal with the risk from identified threats. Failure to obtain the desired material quality during procurement could lead to substandard materials being installed which could introduce integrity threats to the pipeline.

Data management during procurement is essential to facilitate verification of the material received and its source and specification to ensure they meet design specifications. These records shall be maintained throughout the life of the asset.


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### 5.3.5 Fabrication

#### 5.3.5.1 Objectives

At the fabrication phase of the integrity management lifecycle, the key integrity risks are associated with poor quality in the fabrication processes and not meeting design specifications.

#### 5.3.5.2 Principles

At this phase in the lifecycle, the quality of the final asset can directly relate to the fabricated items and its dimensional tolerances. Where fabricated items are incorrectly built, this could lead to long-term operational and integrity threats.

### 5.3.6 Transportation and storage

#### 5.3.6.1 Objectives

At the transportation and storage phase of the integrity management lifecycle, the key integrity risks are associated with pipeline components suffering damage and no longer being suitable for construction or fit for purpose.

#### 5.3.6.2 Principles

At this phase in the lifecycle, the quality of the final asset can be directly impacted by the transportation and storage of each of the pipeline system components such as pipe, coating and fittings. Care is required during handling and storage techniques shall be suitable for the items being handled to ensure that they do not sustain impact and are correctly stored to protect against environmental damage. Appropriate handling techniques shall be designed specified and used with correctly designed storage facilities. Any delays that can impact pipeline integrity during transportation and storage shall be reviewed and their potential impact on the pipeline materials assessed and mitigated.

### 5.3.7 Integrity during installation

#### 5.3.7.1 Objectives

At the installation phase of the integrity management lifecycle, the key integrity risks are associated with failing to build the asset to the specification laid down by the designer.

#### 5.3.7.2 Principles

At this phase in the lifecycle, the quality control of the installation works and records management are the key aspects for management activities. Failing to build the asset to the design specifications and standards for valid reasons shall be managed and assessed on a case-by-case basis. Installation re-works and even the repair of major defects developed during installation can significantly increase both the time line and costs for installation.

In all cases management of change will be required to confirm the suitability of any design changes and can require adjustment to the arrangements for ongoing integrity and reliability Risk assessments shall be carried out to identify any necessary mitigation adjustments to the integrity management planning.

As-built documentation shall reflect the exact details of the final build to ensure that integrity issues in future years can be investigated without requiring inspection. In the event of any change in the route during the installation phase, CCAs shall be re-identified and re-assessed for the design optimization. Relevant information shall be updated from time to time in the event of any change to pipeline segmentation identified during the installation phase.

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### 5.3.8 Pre-commissioning and commissioning

#### 5.3.8.1 Objectives

At the pre-commissioning and commissioning phases of the integrity management lifecycle, the key integrity risks are associated with failing to design and implement appropriate procedures during the pressure test which might lead to insufficient testing or in an extreme case damage to the pipeline and/or its coating from excessive strain. Additional integrity issues might arise due to incomplete cleaning, drying, purging, or preservation prior to start-up.

#### 5.3.8.2 Principles

The pre-commissioning and commissioning phases require an appropriate checking and proving procedure. Significant damage can be caused to the asset from incorrect testing and the personnel shall be aware and conform to the detailed requirements.

Pressure testing has the potential to impact safety and the environment, therefore a pressure testing plan shall be developed and a risk assessment shall be completed. The risk assessment shall examine the potential consequences associated with a pressure test such as worker safety and failures. In addition, contingency plans shall be put into place in the event of a pipeline failure during the pressure testing.

Gauging is an important check to verify the geometric condition of the pipeline. It can be used to detect dents and other deformations in pipeline.

Data records and retention of the records of the pressure testing are critical requirements that demonstrate initial safety of the pipeline and provides a degree of ongoing proof of ongoing safety, particularly where future changes to operating pressure are being considered and pipeline defects are being assessed.

Following pressure test the pipeline shall be protected from all threats regardless of whether it has been fully pressurised.

### 5.3.9 Handover — Preparation for operation

#### 5.3.9.1 Objectives

At the handover phase of the integrity management lifecycle, the pipeline systems are implemented to ensure that key integrity threat mitigation is adequate and records are retained.

#### 5.3.9.2 Principles

Operation personnel and integrity management practitioners shall be informed of any mitigation aspects built into the design of the pipeline including the interrelation between any particular integrity aspects built into the operational activities and the resultant integrity control.

The following principles shall be considered:

— All data collected from the design, fabrication, installation, and commissioning phases shall be gathered, maintained and updated throughout the lifecycle of the pipeline. The constructor shall provide full design, installation and "as-built" documentation in a format to suit the operator.

— Installation design requirements to ensure pipeline integrity shall be incorporated into the pipeline operating procedures and shall be maintained.

— At this phase operators shall review all records for completeness and data quality and shall ensure the necessary records are preserved for the life of the asset. Storage methods shall utilise electronic systems where possible, while taking into consideration the impact of future changes to computer operating systems and programs.


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— Designed threat mitigation shall be reviewed to ensure that the pipeline risks have been adequately considered and all necessary threat mitigation implemented. Assumptions regarding pipeline segments within the critical consequence areas shall be validated and confirmed prior to the commissioning. If changes or variances are identified, the risk assessment and treatment of the CCA shall be updated and this might include commissioning plans that consider CCAs and safety during the commissioning phase.

— The operator shall review/determine the planned maintenance requirements for new pipeline assets and schedule the maintenance into a documented maintenance system.

— Where geology information system is being used, the data shall be uploaded within a suitable timeframe to enable integrity management practices to commence.

### 5.3.10 Operation and maintenance

#### 5.3.10.1 Objectives

Pipeline system operation and maintenance activities can directly impact pipeline integrity. Thus, all activities executed on or in the vicinity of a pipeline, either by third-party companies or the operator itself, shall be adequately designed and controlled throughout operation to ensure that integrity is not compromised.

Integrity management during operation shall primarily be pro-active to prevent damage and failure incidents. The operator shall put in place an adequate organization to gather all relevant changes from the original data used for the first integrity assessment. Potential issues shall be identified to enable consideration of any necessary mitigation activities for every risk and threat during the operational period.

#### 5.3.10.2 Principles

The following principles shall be considered for pipeline operation and maintenance.

— The operator shall be adequately resourced to monitor operational conditions to detect and assess any relevant changes impacting integrity on an ongoing process.

— Relevant changes in operation (pressure cycles, etc.) shall be assessed to identify any specific integrity threats.

— The impact of any deviation from operating procedures shall be recorded and assessed to identify any immediate or long-term implications to pipeline integrity.

— The operator shall collect sufficient data to perform threat analysis, consequence analysis and risk assessments. Implementation of the IMP will drive the collection and prioritization of additional data elements required to more fully understand and prevent/mitigate pipeline threats.

— Any threats to integrity and issues identified during operation shall be recorded and used to consider whether additional mitigation activities are required.

— Any change to the operating environment of the pipeline including sea area/landfall use shall be assessed and mitigated as necessary.

— Any incident during the operational period shall be recorded and mitigation against further instances shall be considered and implemented as necessary.

— The performance/efficiency of the IMP shall be reviewed periodically using key performance indicators (KPI).

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#### 5.3.11 Modifications during operations

##### 5.3.11.1 Objectives

During operations, pipelines might be modified for various reasons. These modifications might employ different processes design specification and standards from the original design. For example, the modifications can use different material grades and thickness, installation and joining techniques and, coating. Modifications also include changes to the original design basis or production or operating parameters such as production fluid, flow rate, pressure, or temperature. These modifications shall be evaluated and shall be managed, relevant to integrity, in accordance with procedures applied to a new construction.

##### 5.3.11.2 Principles

Modified pipelines shall be designed appropriately utilizing similar processes to a new pipeline to ensure that any adverse change to threat levels are eliminated or avoided where possible. New or changed threats and/or consequences shall be documented and mitigated.

Pipeline as-built drawings and abandonment details shall be stored and maintained in association with the original records and all existing drawings and drawing systems updated as necessary.

#### 5.3.12 Abandonment

##### 5.3.12.1 Objectives

When a pipeline is abandoned in place and not removed, the abandoned sections shall be appropriately decommissioned, such that, they are left in a condition that is safe for the public and the environment.

##### 5.3.12.2 Principles

When pipeline is abandoned in place and not removed, the following shall be considered:

— internal cleaning;

— local ambient regulation;

— maintaining signage.

# 6 Risk assessment

## 6.1 Definition of objectives and requirements

### 6.1.1 General

Risk assessment shall be applied throughout the entire pipeline lifecycle to identify and quantify risk to enable identification and prioritization of mitigation activities. There are several approaches to pipeline risk assessment that range from a qualitative to a quantitative risk approach. The operator can choose any model that supports its objectives and meets regulatory requirements, while still meeting a minimum level of technical justification. The approach should be selected according to data sufficiency and objectives of the assessment. Annex A shows an example of a semi-quantitative approach.

The outcome of a risk assessment should be presented in terms of likelihood and consequence, the categories for which shall be defined in quantitative terms where possible. An example of likelihood and consequence is shown in in Annex B.

If the pipeline system information is insufficient or very limited, conservative assumptions on the system conditions shall be taken into account.


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