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

Part 1: Full-life cycle integrity management for onshore pipeline

PNGI — Spécifications de gestion de l'intégrité des pipelines —

Partie 1: Gestion de l'intégrité des pipelines terrestres durant leur cycle de vie complet

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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 traditionally has 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 incorporates a combination of prescriptive and performance-based requirements. In some cases where there are prescription requirements, it provides the user the option to arrive at a solution using performance-based requirements. However, the level of safety achieved by following the prescriptive requirements gives the minimum performance-based requirements. The ability to use performance-based solutions allows companies to use new equipment or innovative practices to achieve the same goal.

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 for 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 1:
Full-life cycle integrity management for onshore pipeline

1 Scope

1.1 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.

1.2 This document is applicable to onshore pipeline systems used in transportation in the petroleum and natural gas industries, connecting wells, production plants, process plants, refineries and storage facilities, including any section of a pipeline constructed within the boundaries of such facilities for connection purposes. The extent of pipeline systems covered by this document is illustrated in Figure 1. This document does not deal specifically with the integrity of non-pipe elements. The pipeline segment between the wellsite and the gathering station, treatment plant or process plant (between Facilities 1 and 2 in Figure 1) is included in this document, though many mandatory elements of this document are not practical due to characteristics such as diameter, operating parameters, etc.

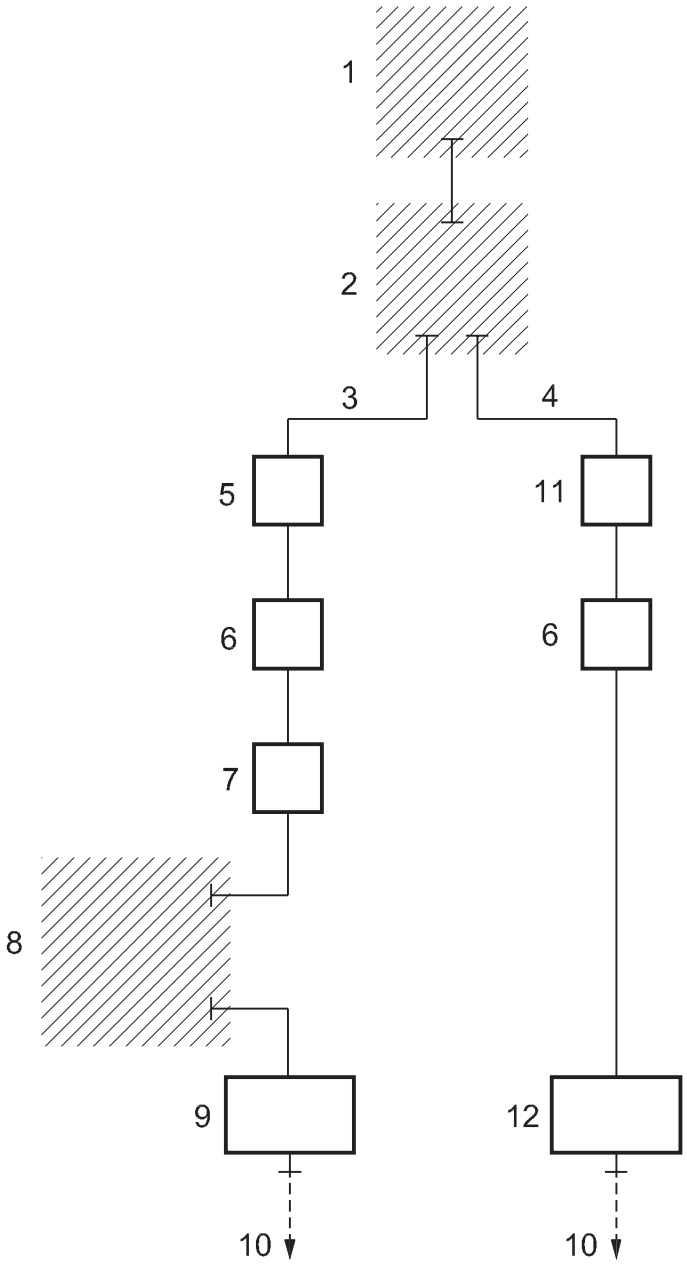
1.3 This document applies to rigid, steel pipelines. It is not applicable for flexible pipelines or those constructed from other materials, such as glass-reinforced plastics.

1.4 This document does not cover all conditions nor engineers' competency which might be related to pipeline integrity. The user can evaluate whether additional requirements are necessary.

1.5 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

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different, the provisions of this document will enhance the design and construction from an integrity perspective.



Key

1	wellsite	5	pump station	9	depot
2	gathering station, treatment plant or process plant	6	valve station	10	distribution
		7	tankage	11	compressor station
3	liquid	8	refinery	12	pressure-reduction station
4	gas				

pipeline elements covered by this document

connections with other facilities

pipeline elements not covered by this document

station/plant area 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 transportation systems*

ISO 15589-1, *Petroleum, petrochemical and natural gas industries — Cathodic protection of pipeline systems — Part 1: On-land pipelines*

ISO 21809 (all parts), *Petroleum and natural gas industries — External coatings for buried or submerged pipelines used in pipeline transportation systems*

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 commission

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

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

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 location and scope of critical consequence areas will change over time as new population and environmental resource data becomes available. 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
external corrosion direct assessment
integrity assessment process used for locating possible external corrosion, damaged coating, or deficiencies in *cathodic protection* (3.1.4) on a pipeline by making aboveground measurements and validating with excavations to examine the pipe where appropriate

3.1.14
failure
event in which a component or system does not perform according to its operational requirements

3.1.15
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

3.1.16
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

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3.1.17
hard spot
localized increase in hardness through the thickness of a pipe, produced during hot rolling or welding

3.1.18
incident
unintentional release of gas or liquid due to the *failure* (3.1.14) 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.

3.1.19
in-line inspection
inspection of a pipe wall from the interior of the pipe using specialized tools

3.1.20
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

3.1.21
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

3.1.22
life extension
additional period of time beyond the original design or *service life* (3.1.39) (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]

3.1.23
location class
geographic area classified according to criteria based on population density and human activity

[SOURCE: ISO 13623:2017, 3.1.10]

3.1.24
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.

3.1.25
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

3.1.26
manufacturing defect
defect (3.1.10) in the pipe body or coating created during the pipe or component manufacturing or coating processes

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3.1.27
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).

3.1.28
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.

3.1.29
non-destructive testing
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.

3.1.30
operator
person or organization who owns or operates a pipeline system or facilities and is ultimately responsible for the operation and integrity of the pipeline system

3.1.31
pipeline
components of a pipeline system connected together to convey fluids between stations and/or plants, including pipe, launchers and receivers, components, appurtenances, isolating valves, and sectionalising valves

3.1.32
pipeline integrity management
set of processes and procedures that proactively assures incident-free safe and environmentally responsible transportation of fluids through a pipeline system

3.1.33
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* (3.1.36), mitigation and repair activity and maintenance decisions, with comprehensive management of change and continual review and improvement processes

3.1.34
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.

3.1.35
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

3.1.36
risk assessment
systematic, analytical process in which potential hazards from pipeline system are proactively identified, and the likelihood and consequences of potential adverse events are determined

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3.1.37
risk management
coordinated activities to direct and control an organization with regard to *risk* (3.1.35)

[SOURCE: ISO Guide 73:2009, 2.1]

3.1.38
safe operating pressure
pressure, calculated using the appropriate analysis and mathematical formulas for the specific type of defect identified

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

3.1.39
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.

3.1.40
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).

3.1.41
third party damage
damage done to the pipeline as a result of activities by personnel not associated with the pipeline

3.1.42
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
GIS	geographic information system
HIC	hydrogen-induced cracking
ICDA	internal corrosion direct assessment

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ILI	in-line inspection
IMP	integrity management program
MAOP	maximum allowable operating pressure
MFL	magnetic flux leakage
NDT	non-destructive testing
PIR	potential impact radius
PoF	probability of failure
SCADA	supervisory control and data acquisition system
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 integrity requires a lifecycle approach from initial feasibility studies to abandonment.

b) Adequate resources in terms of funds, equipment and competent personnel to implement the requirements of the IMP are necessary.

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

d) Document management including gathering and retention requirements are critical 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 IMP forms part of a comprehensive asset management system operating alongside safety and environmental programs. The operator shall establish, implement and maintain a documented IMP and routinely review and improve its adequacy.

To facilitate the development and implementation of the initial IMP for pipeline systems, the operator shall develop processes for initial data acquisition, threat and consequence identification and risk

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