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

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

1 Scope

1.1 This document specifies requirements and gives recommendations on the integrity assessment of pipeline systems.

1.2 This document is mainly applicable to onshore pipeline systems, 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 purpose, which complies with ISO 19345-1. The principles can also be used for offshore pipelines.

1.3 This document may also be used on pipelines that designed, operated, and maintained using other standards besides the referenced ISO standards.

1.4 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.

1.5 This document does not cover all conditions which might be related to pipeline integrity. A competent pipeline integrity engineer can evaluate whether additional requirements are necessary.

1.6 This document does not cover pipeline defect(s) found during fabrication/construction or installation, which shall be assessed in accordance with the standards of design, construction, material procurement and welding process.

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 19345-1:2019, *Petroleum and natural gas industry — Pipeline transportation systems — Pipeline integrity management specification — Part 1: Full-life cycle integrity management for onshore pipeline*

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 https://www.electropedia.org/

3.1.1
alternating current attenuation survey
a method of measuring the current attenuation along the pipeline to assess general quality of the coating by applying the electromagnetic field propagation theory.

3.1.2
comprehensive assessment
evaluation using two or more separate integrity data sets.

3.1.3
corrosion
deterioration of a material, usually a metal that results from an electrochemical reaction with its environment.

[SOURCE: ISO 19345-1:2019, 3.1.5]

3.1.4
crack
planar flaw, or linear discontinuity, with a sharp tip radius.

[SOURCE: ISO 19345-1:2019, 3.1.6]

3.1.5
data transferability
use data on similar pipelines (geometry, material, service, environment etc.) to replace data that cannot, or are difficult, to obtain on the pipeline to be evaluated.

3.1.6
deformation
change in shape of the pipe or component, such as a bend, buckle, dent, 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.

[SOURCE: ISO 19345-1:2019, 3.1.9]

3.1.7
defect
imperfection of a type or magnitude exceeding acceptable criteria.

[SOURCE: ISO 19345-1:2019, 3.1.10]

3.1.8
degradation modelling
models to evaluate degradation of materials.

3.1.9
dent
change in pipe wall curvature resulting in plastic deformation, caused by contact with a foreign body.

[SOURCE: ISO 19345-1:2019, 3.1.11]

3.1.10
direct inspection
methodology used to detect and characterize pipeline defects and condition at a specific location.

3.1.11
failure
event in which a component or system does not perform according to its operational requirements.

[SOURCE: ISO 19345-1:2019, 3.1.14]

3.1.12
fitness for purpose
engineering assessment that is performed to demonstrate the structural integrity of an in-service component that can contain an imperfection, defect or damage.

[SOURCE: ISO 19345-1:2019, 3.1.15]

3.1.13
gouge
metal loss defect or imperfection caused by contact with a foreign object that has scraped (gouged) material out of the pipe.

[SOURCE: ISO 19345-1:2019, 3.1.16]

3.1.14
in-line inspection
internal inspection of a pipeline using specific tools.

[SOURCE: ISO 19345-1:2019, 3.1.19]

3.1.15
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.

[SOURCE: ISO 19345-1:2019, 3.1.20]

3.1.16
leak test
a pipeline test designed to determine the presence or absence of leaks in a pipeline system.

3.1.17
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 pipe wall. The magnetic flux leakage pattern is then used to detect and characterize anomalies.

[SOURCE: ISO 19345-1:2019, 3.1.24]

3.1.18
maximum allowable operating pressure
maximum internal pressure at which a pipeline system, or parts thereof, is allowed to be operated in compliance with this International Standard. The MAOP is derived from the maximum pressure achieved during testing.

[SOURCE: ISO 19345-1:2019, 3.1.27]

3.1.19
metal loss
pipe wall 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.

[SOURCE: ISO 19345-1:2019, 3.1.28]

3.1.20
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: The terms non-destructive inspection (NDI) and non-destructive evaluation (NDE) are also commonly used to describe this technique.

[SOURCE: ISO 19345-1:2019, 3.1.29]

3.1.21
pressure test
means of assessing the integrity of a new or existing pipeline that involves filling the pipeline with water, dry air or nitrogen, and pressurizing to a level reasonably in excess of the MAOP of the pipeline to demonstrate that the pipeline is fit for service at the MAOP.

3.1.22
safe operating pressure
pressure, calculated using remaining strength of defective pipeline formulas, where all defective regions will withstand a pressure equal to a stress level of the MAOP according to different safety factors or formula chosen.

3.1.23
sizing accuracy
accuracy with which an anomaly dimension or characteristic is reported.

Note 1 to entry: typically, accuracy is expressed by tolerance and certainty. As an 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).

[SOURCE: ISO 19345-1:2019, 3.1.40]

3.1.24
stress corrosion cracking
cracking of a material produced by the combined action of corrosion and sustained tensile stress.

3.2 Abbreviated terms

AC/DC	alternating current/direct current
ACAS	alternating current attenuation survey
ACVG	alternating current voltage gradient
CIPS	close interval potential survey
DCVG	direct current voltage gradient
EMAT	electromagnetic acoustic transducer
FFP	fitness for purpose
ILI	in-line inspection
IMP	integrity management program
IMU	inertial measurement unit
LSM	large standoff magnetometry

MAOP	maximum allowable operating pressure
MFL	magnetic flux leakage
NDT	non-destructive testing
POD	probability of detection
POI	probability of identification
SCC	stress corrosion cracking
SCT	stress concentration tomography
TEM	transient electromagnetic method
TFI	transverse flux inspection
USCD	ultrasonic crack detection
USCCD	ultrasonic circumferential crack detection
UT	ultrasonic compression wave tool

4 General

4.1 Key principles

Pipeline operators shall assess the integrity condition and safety state of their operated pipelines by using a suite of inspection, monitoring and evaluation techniques/methodologies. The integrity assessment shall follow all applicable local laws and regulations. New technologies should be encouraged for application, when they are proved to be effective, safe and to follow industry practices. As a supplement of ISO 19345-1, the key principles for integrity assessment are listed below.

a) Threats and degradation modes shall be identified accurately for the integrity assessment.

b) All kinds of relevant data shall be collected, as it constitutes the fundamental basis for a sound integrity assessment. Data sets shall be used to determine the defect types and failure mechanisms of the pipeline and to provide a basis for the selection of the most appropriate assessment methods. The pipeline assessment method shall be selected according to the damage mechanisms, type, dimensions, distribution, expected activity and progression rates of defects affecting the pipeline and the purpose of the assessment.

c) One or more assessment methods shall be selected based on data collected from ILI, direct inspection, pressure test or others. When ILI is applicable, it shall be selected as a priority.

d) Historical records of past failures and executed repairs shall be considered for assessment method selection.

e) The interval of pipeline integrity assessment shall be determined by previous assessment result. If leaks or ruptures occur in between integrity assessments, then, the interval shall be immediately re-evaluated based on the results of failure analysis (e.g. cause and contributing factors).

f) Practitioners shall be properly qualified related to integrity assessment.

g) Other international practice standards should be considered as technical support.

4.2 Pipeline integrity assessment process

4.2.1 The pipeline integrity assessment process shall be continuously improved. Experience obtained from each assessment assists in determining the most appropriate method for subsequent assessments.

4.2.2 The recommended pipeline integrity assessment process is shown in Figure 1, including:

a) data collection and analytics;

b) pipeline condition inspection and monitoring;

c) hazard identification;

d) fitness for purpose;

e) assessment report.

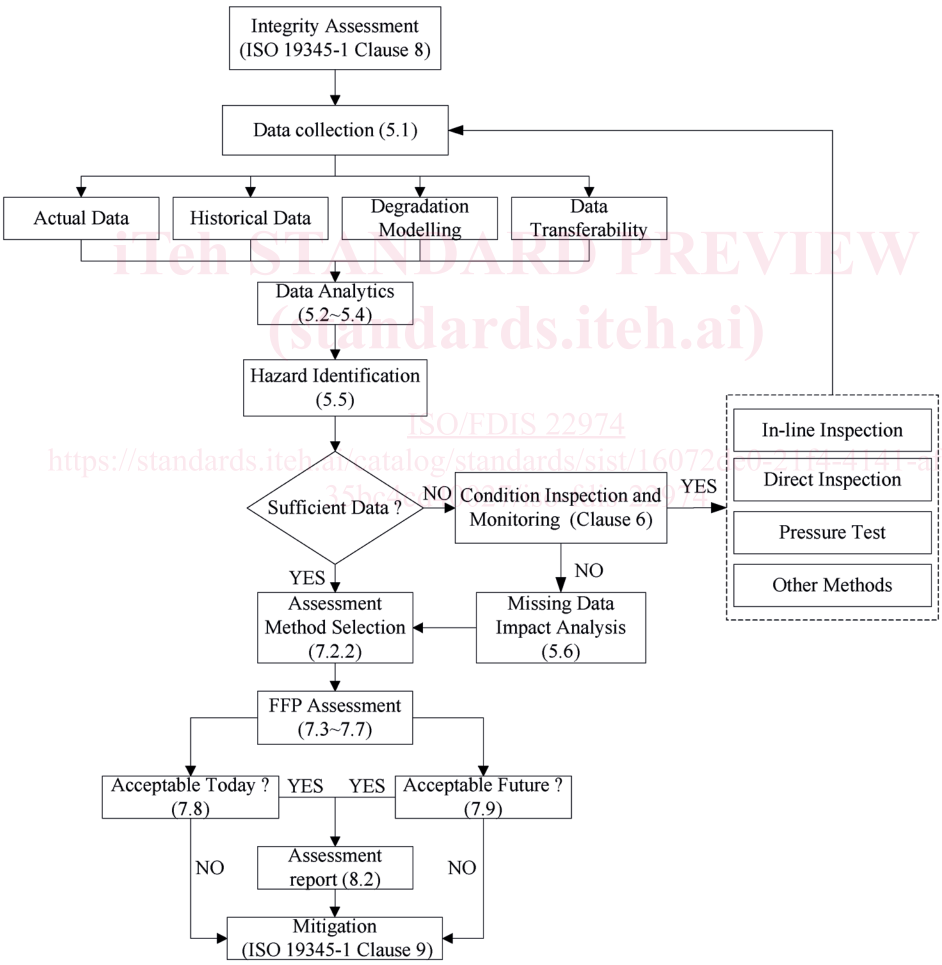

Figure 1 — Recommended pipeline integrity assessment process

4.2.3 The assessment of the remaining pipeline strength and remaining life affected by the presence and type of defects is the core of integrity assessment, and shall be carried out by considering factors related to service history and external environment.

4.2.4 Comprehensive assessment should be carried out given multiple data generated from different sources, such as various inspection methods or time periods.

5 Data collection and analytics

5.1 Data collection

5.1.1 The scope of data collection should be determined according to the pipeline properties, potential damage mechanism, assessment methodologies, etc. to evaluate threats, or potential threats, and damage mechanism(s) for the pipeline. Relevant data and information can be collected along the entire pipeline life cycle such as design, construction, operation and maintenance phases. When the pipeline data is deemed insufficient for the integrity assessment, other relevant data such as failure analysis and integrity assessment reports of pipelines with similar operating conditions should also be collected as reference. An appropriate reliability factor should be considered when data transferability is used in this way.

For example, the pipeline whose material properties cannot be obtained can refer to the test results of pipelines with similar construction years, same steel grade, same manufacturing processes, same pipe manufacturer, same quality control applied during construction and any other relevant information.

5.1.2 The data used for pipeline integrity assessment should include:

a) Pipeline attributes: steel grade, diameter, wall thickness, weld type, coating type and cathodic protection, accessory infrastructures, burial conditions.

b) Mechanical properties, such as tensile properties, engineering stress/strain curve, fracture toughness.

c) Inspection reports and data, such as ILI, NDT, direct inspection and SCT.

d) Design and operating parameters, such as fluid composition, maximum allowable operating pressure, maximum/minimum operating temperature.

e) Construction data, such as welding records, pressure testing, welding procedure specifications, NDT results.

f) Historical data, such as in-service pressure testing, excavation verification, repair, failure(s) and maintenance data.

g) Load data, such as service load, environmental load, construction load or other additional load not stated.

h) Degradation modelling, such as corrosion growth model, fatigue model, crack extension model, SCC model.

i) Environmental conditions, such as crossing of railways, highways and rivers and as well as geotechnical and geographical information.

j) Data transferability.

k) Other data, such as regional grades, critical consequence areas, risk assessment results.

5.2 Data quality

Data quality should be clearly defined to make sure the data is appropriate for the requirements, which should conform to the dimensions outlined below, as applicable:

a) Accuracy: Data accuracy should be examined by analysis and verified between different data sources.

b) Completeness: It should be checked that all needed data is available.