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Petroleum and natural gas industry - Pipeline transportation systems - Geological hazards risk management for onshore pipeline (ISO/DIS 20074:2018)

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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).

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For an explanation on 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 the following URL: www.iso.org/iso/foreword.html.

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

A list all parts in the ISO 20074- series can be found on the ISO website.

Introduction

This document is used by pipeline operators and designers for the implementation and improvement of geohazard risk management of onshore pipelines.

It is used for the orderly and effective identification, assessment and mitigation of geohazards threatening the safety of the pipeline system, to reduce risk and accident loss. The pipeline system includes the pipeline, RoW and all associated buried and above ground facilities, such as valves, meters, compressor and pump stations.

Petroleum and natural gas industry — Pipeline transportation systems — Geological hazards risk management for onshore pipeline

1 Scope

This document specifies requirements and gives recommendations on the management of geohazard risks of pipeline during the design, construction and operational periods.

This document shall apply to all operators and pipeline systems (existing and proposed/under construction), unless the operator can clearly demonstrate why the document should not apply.

This document applies to onshore gathering and transmission pipelines used in the petroleum and natural gas industries[1)].

This document is applicable to all reasonable and credible natural hazards and hazards induced by human activity that manifest similarly to natural hazards, collectively referred to as "Geological Hazards" or "Geohazards". Geohazards covered by this document include, but are not limited to (not given in order of significance):

— mass wasting processes, including landslides, rockfalls, debris flows, avalanches, and similar processes whether naturally occurring or anthropogenic;

— land subsidence and/or sinkhole formation, whether naturally occurring such as from dissolution of salt or carbonate rock formations (karst formation) or human caused, such as from underground mining or withdrawal of subsurface fluids such as groundwater and oil and gas;

— seismic hazards, such as ground shaking, fault rupture, liquefaction, flow failures and lateral spreading or associated secondary effects, such as seismically triggered landslides;

— volcanic hazards, such as lahars, pyroclastic flows, lava flows, dam break, and volcanically induced seismicity (excluding ashfall), where such hazards can be reasonably predicted;

— hydrologic processes, such as flooding, vertical scour of river bottoms, channel migration and bank erosion, channel avulsion, rapid lake drainage;

— permafrost/periglacial processes and geothermal effects, such as frost heave or thaw settlement;

— surface and backfill erosion;

— expansion or collapsing process caused by expansive and collapsible soils, such as glaciomarine clays, collapsible loess, etc.

This document does not cover atmospheric effects such as:

— high winds induced from hurricanes and tornadoes and similar storms, except where such events are reasonably predictable and will induce geohazards such as landslides, erosion, etc.,

— lightning,

— forest or brush fires,

1) Piping and pipelines within well-defined plants and facilities, such as pump or compressor stations, processing facilities or refineries are not covered by this document. It is assumed that the facility site as a whole will be subject to a separate geohazard assessment to evaluate applicable natural and man-made hazards. Nevertheless, this document may provide useful guidance for assessing the geohazard threat to facilities, including the pipelines within the facility.

— ashfall from volcanic eruptions,

— tsunamis induced by seismic hazards.

Furthermore, this document does not cover so-called cascading events, where one remote event leads to a chain of events that eventually induces a geohazard near the pipeline. Only geohazards that directly affect the pipeline or RoW are covered.

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*

SY/T 6828-2017, *Technical specification for geological hazards risk management of oil and gas 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 http://www.iso.org/obp

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

3.1.1
construction period
stage where the pipeline is physically constructed with activities including, but not necessarily limited to mobilization of equipment, right-of-way surveying and clearing/grubbing/grading, access construction, pipeline stringing, welding and lowering-in, trench backfilling, off right-of-way activities such as development of borrow sites, laydown and stockpile sites, hydrotesting, erosion control, reclamation, clean-up, demobilization, pipeline filling and commissioning.

3.1.2
design period
stage consisting of preliminary engineering and route selection phase and detailed design

3.1.3
dynamic management
a geohazard management process that covers the pipeline's full life cycle, which may be implemented when a new hazard is identified or an existing hazard changed

Note 1 to entry: It allows the geohazard management plan to be adapted to deal with the new or changed circumstances of the threat.

3.1.4
geohazard inventory
a list listing all identified geohazards, may be maintained, enhanced or decreased throughout the life of the pipeline project.

Note 1 to entry: Ideally, the inventory would be computer based and linked to a geographic information system (GIS).

3.1.5
geohazard susceptibility
possibility of a geohazard event, which is an estimation of how likely or unlikely the geohazard is to occur

3.1.6
geology sensitive areas
areas potentially prone to geohazards, such as earthquake fault zones, medium and large rivers, high and steep slopes, debris flows corridors, landslide prone topography, areas prone to karst collapse, mined-out areas

3.1.7
hydrologic process
pertaining to processes associated with flowing water; i.e. river and stream processes

3.1.8
individual pipeline geohazard
specific geohazard that can be landslide, rockfall or debris flow (or any other geohazard that may impact the pipeline)

3.1.9
land subsidence
the sinking or gradual downward settling of the Earth's surface with relatively little horizontal movement.

Note 1 to entry: It may be caused by karst processes, collapsible or dispersive soils, piping erosion, upward migration of underground mining works, or other processes

3.1.10
long-term management
management activities for pipeline geohazards through monitoring and periodic reevaluation of threat levels from geohazards

3.1.11
mass wasting process
a general term for the dislodgement and downslope transport of soil and rock material under the direct application influence of gravity

3.1.12
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

3.1.13
pipeline failure consequence
social and environmental impact, as well as loss of life and property, monetary loss, including direct, indirect and consequential damages, negative impact on corporate reputation, etc., caused by leakage, damage or reduced performance of a pipeline system subject to geohazards

3.1.14
pipeline geohazard
geological processes or phenomena that has the potential to cause damage to a pipeline or RoW, including individual pipeline geohazard and regional pipeline geohazard

3.1.15
pipeline geohazard risk
combination of geohazard susceptibility, pipeline vulnerability and pipeline failure consequence

3.1.16
pipeline geohazard risk assessment
process of assessing pipeline geohazard risk and determining whether said risks are tolerable or require mitigation or an intervention

3.1.17
pipeline geohazard risk identification
process of discovery, characterization and description of credible and probable geohazards that may impact the pipeline or right-of-way.

3.1.18
pipeline geohazard risk management
coordinated activity for guiding and coping with issues related to pipeline geohazard risk

3.1.19
pipeline geohazard risk management program
a set of processes and procedures for guiding operating companies or operators to carry out pipeline geohazard risk management

3.1.20
pipeline geohazard risk mitigation
process of selecting and implementing a geohazard risk countermeasure or intervention to reduce the probability of a negative event or reduce the consequences of a negative event

3.1.21
pipeline vulnerability
likelihood of a pipeline system being subject to damage due to a geohazard, which is an estimate of how likely or unlikely the pipeline system is to be affected by geohazards and how resistant it is to damage caused by geohazards

3.1.22
operation period
stage after pipeline system is delivered to a pipeline operator, namely operation and maintenance phase, excluding the abandonment phase

3.1.23
regional pipeline geohazard
group or cluster of existing and potential geohazards located within a defined geographic area

3.1.24
right-of-way
corridor of land within which the pipeline operator has the right to conduct activities in accordance with the agreement with the land owner

[SOURCE: ISO 13623:2017, 3.1.19]

3.1.25
seismic hazard
hazards relating to the effects of an earthquake

3.1.26
subject matter expert
a practitioner experienced with evaluating and managing geohazards

Note 1 to entry: The definition of qualifications for a subject matter expert will vary by location, but for the purposes of this document will generally include someone with a degree in geology, geomorphology, hydrogeology, geotechnical engineering, geological engineering, civil engineering, or similar degree and at least five years of practical experience working with geohazards.

3.2 Abbreviated terms

GIS **geographic information system**

ILI **in-line inspection**

LiDAR **light detection and ranging**

PGMP **pipeline geohazard risk management program**

RoW **right-of-way**

SME **subject matter expert**

4 Pipeline geohazard risk management program

4.1 Key principles

A PGMP is a set of practices and procedures used to systematically identify, evaluate, and manage geohazards for the purposes of reducing the risk of damage to a pipeline system to a tolerable level. A PGMP is operated for the entire lifespan of the pipeline from conception and design, to construction, operation, and until the pipeline system is decommissioned. Thus the PGMP should be designed and implemented in such a way that critical information will be maintained and accessible for the lifetime of the pipeline.

Because a variety of different groups participate in the design, construction and operation of a pipeline, overall ownership of the PGMP rests with the operator. The operator shall designate an individual or organization (the "PGMP team") to administer the PGMP during and between the different phases. The PGMP team may be operator's personnel or a qualified third party entrusted by the operator. In the case of replacement of one organization for another, a proper handover of geohazard risk management duties shall be ensured. When the geohazard risk management is assigned to a third party, the operator shall be continuously and intimately engaged with the third party to ensure that the interests and needs of the operator and all stakeholders are being adequately addressed and protected.

It is recommended that geohazard risk management throughout the life of a pipeline shall be carried out by the same organization, which can be either an operator, or a third party entrusted by them.

Dynamic management of pipeline geohazards is required and newly identified geohazards may be included in said management. Geohazards included in dynamic management are referred to as risk management objects.

Where a PGMP is needed, operators shall establish and maintain a PGMP for the life of the asset. Operator shall update the PGMP during the life of the asset as and when conditions warrant.

All work associated with the geohazard risk identification, assessment and mitigation of the pipeline shall be carried out by a team of suitably qualified SMEs.

PGMP activities shall be documented. Geohazards may change over time, and changes in the PGMP shall be documented over time, to ensure that the most current data and assessments are identified. Out-of-date assessments may be archived or deleted.

4.2 Requirements for a PGMP

The PGMP informs an operator of how to design, construct and operate the pipeline in a safe, environmentally responsible and reliable manner.

The PGMP covers the phases of preliminary engineering and route selection, detailed design, construction, as well as operation and maintenance. It is recommended to conduct geohazard risk management as a discreet element of the pipeline design phase, beginning in the earliest phases of design.

Geohazard risk to a pipeline, and thus the need and scope of a PGMP, varies from pipeline to pipeline, due to a number of natural and human-induced factors. Geohazard risk may be higher for pipelines operated in areas of:

— steep terrain,

— active tectonics,

— high precipitation,

— high seismicity,

— geologically young terrain,

— volcanism,

— significant river crossings,

— geothermal variability such as discontinuous permafrost.

For these conditions, both the risk of geohazard damage to a pipeline may be elevated.

For example, a short pipeline in a flat, tectonically stable region with minimal rainfall might have a lower geohazard risk. In this case, the operator might demonstrate that a PGMP is not needed. Conversely a long pipeline with a 50-year service life, in a remote, steep, tectonically active tropical region would likely have a relatively high geohazard risk. In this case the operator would very likely establish a PGMP.

Because of the broad variation in geohazard risk between pipelines, this document requires an operator to assess geohazard risk of existing and future pipelines and determine whether a PGMP is necessary.

If an operator concludes that a PGMP is not necessary for a particular pipeline or section of pipeline, the conclusion shall be documented. Such documentation is required by this document. The documentation shall be a report titled:

Demonstration that Geohazard Management Program is Not Required for [name of pipeline].

It shall include without limitation, a discussion of the items listed above in Section 4.2, with an explanation why the geohazard risks are of such a low level that a PGMP is not needed. The report shall be prepared in consultations with suitable SMEs with appropriate experience in the region and type of geology in which the pipeline is, or will be installed.

If an operator concludes that a PGMP is necessary, the operator shall establish a PGMP team to design and implement the appropriate PGMP, beginning at the earliest phases of project development.

4.3 Elements of a PGMP

4.3.1 General

To prevent and reduce risks caused by geohazards, the PGMP shall be carried out throughout the life of a pipeline under the guidance of the PGMP Team. The PGMP covers four interlinked processes:

— **Identification** of potential geohazards;

— **Evaluation** of the severity of the geohazards;

— **Mitigation** of the threat from the geohazards;

— **Long-term management** of geohazards through monitoring and periodic reevaluation of threat levels from geohazards.

The four processes are needed to varying degrees throughout the life of the pipeline.

To illustrate application of the four processes, this document considers four phases of pipeline life:

— preliminary engineering and route selection,

— detailed design,

— construction,

— operation and maintenance.

Each of the phases is discussed below, with illustration of the four processes within each phase.

A typical PGMP follows the flowchart in Figure 1.

4.3.2 Preliminary engineering and route selection phase

In this phase, the effects of geohazards shall be fully considered to meet the requirements of route selection. Because this most effective mitigator of geohazards is avoidance, this phase represents an important opportunity for the operator to reduce the overall geohazard risk of the project.

Annex A provides guidelines for route selection in consideration of geohazards.

During this phase the PGMP shall follow the principles of identification, evaluation, mitigation and long-term-management:

Identification: Establish regional understanding of geohazards and determine whether regional geohazard threat level requires further development of a PGMP. For the initial corridor alternatives, severe geohazards and geology sensitive areas, such as earthquake fault zones, medium and large rivers, high and steep slopes, debris flows corridors, landslide prone topography, areas prone to karst collapse, mined-out areas should be identified. Acquire regional and local remote sensing data sets, supplement with ground investigation if warranted. LiDAR data combined with expert interpretation, has proven to be an extremely valuable tool in identifying geohazards during this phase.

Evaluation: Classify geohazards along the proposed corridors according severity of their threat to the proposed pipeline. Some geohazards may be found to be sufficiently severe that they create critical conditions and could cause a candidate corridor to be removed from consideration. Other geohazards pose less severe risk. The locations, footprints and severity of the geohazards shall be assembled in a GIS database, and shall form the geohazard inventory (Clause 5.2) that will exist for the life of the project.

Mitigation: The primary mitigator of geohazards at this phase is avoidance. An important responsibility of the PGMP team at this phase is the unambiguous assessment and presentation of geohazards and risks to the broader project team. Quantification of geohazard impacts on design, construction and operations is helpful to fully define the risks. The selection of the final corridor shall consider the impacts of geohazards, balanced against other design , construction and operational considerations. At this stage, the operator may also consider other mitigations, e.g. strain-based design of the pipe.

Long-term management: Because no asset yet exists, long-term management of geohazards at this stage consists of developing the geohazard inventory and associated GIS database, and passing it to the detailed design phase.

The recommended implement procedures in this phase is as follows:

a) Establish regional understanding of geohazards and determine corridor alternatives.

b) Select a primary corridor. Regional geohazard susceptibility (Clause 6.3) and individual geohazard risk assessment (Clause 6.4) is recommended for the primary corridor.

c) Following selection of the primary corridor, the detailed design phases may begin.

NOTE Considerable pipeline design work is also being performed in this phase, such as pipeline hydraulic studies, construction methods considered, logistics and supply assessed and other activities.