INTERNATIONAL STANDARD

ISO 27914

First edition
2017-10

Carbon dioxide capture, transportation and geological storage — Geological storage

Capture, transport et stockage géologique du dioxyde de carbone — Stockage géologique

Reference number
ISO 27914:2017(E)

Contents

Page

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

This document was prepared by Technical Committee ISO/TC 265, *Carbon dioxide capture, transportation, and geological storage*.

Introduction

Geological storage of carbon dioxide (CO_2) is recognized as a key technology for abatement of CO_2 emissions to the atmosphere or ocean and is an essential component in the process of carbon dioxide capture and storage (CCS)[1]. The objective of this document is to provide recommendations for the safe and effective storage of CO_2 in subsurface geologic formations through all phases of a storage project life cycle (see Figure 1). While CCS is a nascent industry, this document is supported by a wide range of operational experiences in pilot to commercial scale carbon dioxide storage projects that have used methods and technologies mostly developed and widely deployed by the oil and gas industry including CO_2-enhanced oil recovery (EOR). This document applies to injection of CO_2 into geologic units for the sole purpose of storage and does not apply to CO_2 injection for hydrocarbon recovery, or storage of CO_2 that occurs in association with carbon dioxide enhanced hydrocarbon recovery. [ISO 29716 is in development to address carbon dioxide storage using enhanced oil recovery (CO_2-EOR)]. This document is supplemented by recommended practice manuals for CO_2 storage and numerous standards and technical recommendations developed for the oil and gas industry. [See Bibliography for selected references (References [1] to [12])].

Carbon dioxide capture, transportation and geological storage — Geological storage

1 Scope

This document

a) establishes requirements and recommendations for the geological storage of CO_2 streams, the purpose of which is to promote commercial, safe, long-term containment of carbon dioxide in a way that minimizes risk to the environment, natural resources, and human health,

b) is applicable for both onshore and offshore geological storage within permeable and porous geological strata including hydrocarbon reservoirs where a CO_2 stream is not being injected for the purpose of hydrocarbon production or for storage in association with CO_2-EOR,

c) includes activities associated with site screening and selection, characterization, design and development, operation of storage sites, and preparation for site closure,

d) recognizes that site selection and management are unique for each project and that intrinsic technical risk and uncertainty will be dealt with on a site-specific basis,

e) acknowledges that permitting and approval by regulatory authorities will be required throughout the project life cycle, including the closure period, although the permitting process is not included in this document,

f) provides requirements and recommendations for the development of management systems, community and other stakeholder engagement, risk assessment, risk management and risk communication,

g) does not apply to, modify, interpret, or supersede any national or international regulations, treaties, protocols or instruments otherwise applicable to the activities addressed in this document, and

h) does not apply to or modify any property rights or interests in the surface or the subsurface (including mineral rights), or any pre-existing commercial contract or arrangement relating to such property.

The life cycle of a CO_2 geological storage project covers all aspects, periods, and stages of the project, from those that lead to the start of the project (including site screening, selection, characterization, assessment, engineering, permitting, and construction), through the start of injection and proceeding through subsequent operations until cessation of injection and culminating in the post-injection period, which includes a closure period. Figure 1 illustrates the limits of this document.

NOTE 1 This document does not address any post-closure period or specify post-closure period requirements.

This document does not apply to

— the post-closure period,

— injection of CO_2 for enhancing production of hydrocarbons or for storage associated with CO_2-EOR,

— disposal of other acid gases except as considered part of the CO_2 stream,

— disposal of waste and other matter added for purpose of disposal,

— CO_2 injection and storage in coal, basalt, shale and salt caverns, or

— underground storage using any form of buried container.

NOTE 2 This document may not be suitable for research projects, for example, those with a primary objective to test technologies or methods of monitoring.

NOTE 3 The closure period in this document does overlap with the post-closure phase of the EU regulatory definition. This document, however, is not concerned with transfer of liability.

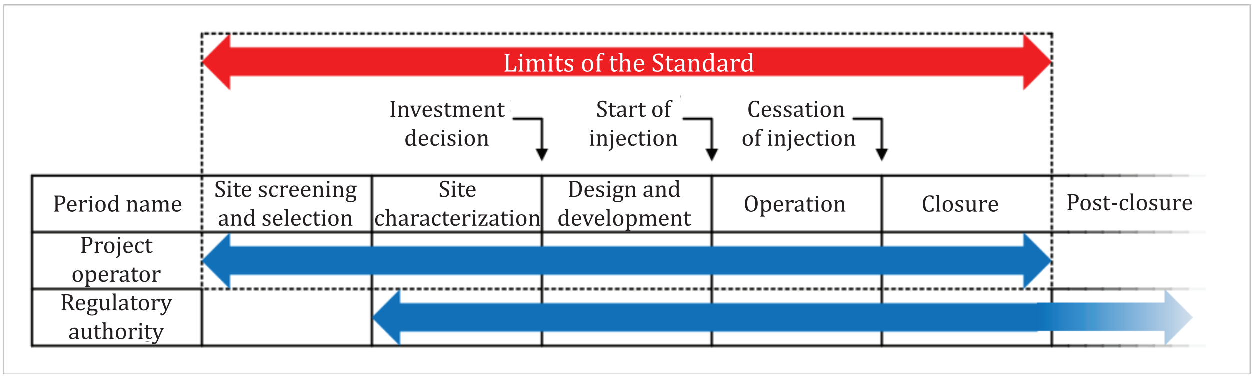

Figure 1 — Entities involved in the storage project life cycle

2 Normative references

There are no normative references in this document.

3 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:

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

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

3.1
abandonment
process and procedures used to permanently end the operation of a well

Note 1 to entry: Well abandonment is designed to eliminate the physical hazard of the well (the hole in the ground), eliminate a pathway for migration of contamination, and prevent changes in the hydrogeologic system, such as the changes in hydraulic head and the mixing of formation fluids between hydraulically distinct strata.

3.2
acceptable risk
risk (3.39) borne by the *project operator* (3.33) and others, having regard to legal obligations and management policies

3.3
area of review
geographical area(s) of a *storage project* (3.56), or part of it, designated for assessment of the extent to which a storage project, or part of it, could affect life and human health, the environment, competitive development of other resources, or infrastructure

Note 1 to entry: The delineation of an area of review defines the outer perimeters on the land surface or seabed and water surface within which assessments will be conducted as may be required by regulatory authorities.

3.4
baseline
reference basis for comparison against which project performance is monitored or measured

3.5
biosphere
realm of living organisms including the atmosphere, on the ground surface and in soils, in oceans and seas, in surface waters such as rivers and lakes, and in the subsurface above the *storage complex* (3.54)

3.6
carbon dioxide (CO_2) plume
region within geologic strata where CO_2 is present in free phase

3.7
carbon dioxide (CO_2) stream
stream consisting overwhelmingly of carbon dioxide

Note 1 to entry: The stream is a fluid mixture that may include any incidental associated substances derived from the source materials or the capture process and any substances added to the stream to enable or improve the injection process and/or trace substances added to assist in CO_2 migration detection.

3.8
casing
pipe material placed inside a drilled hole to prevent the surrounding strata from collapsing into the hole

Note 1 to entry: There are many acceptable variations on casing design but typical types of casing in most injection wells are:

a) surface casing, i.e. the outermost casing that extends from the surface to the base of the lowermost *protected groundwater* (3.37);

b) intermediate casing is one or more strings of casing installed between the surface and long-string casing for various design reasons;

c) long-string casing, which extends from the surface to or through protected groundwater to the bottom of the well.

3.9
casing shoe
reinforcing steel collar that is screwed onto the bottom joint of the *casing* (3.8) to prevent abrasion or distortion of the casing when it is forced past obstructions on the wall of the borehole

3.10
closure period
period between the cessation of injection and the demonstration of compliance with the criteria for *site closure* (3.52)

3.11
containment
retention of CO_2 and formation fluids within a *storage complex* (3.54)

3.12
corrective action
action taken to correct material irregularities or to contain breaches in order to prevent or minimize damage to, or release of CO_2 from, a *storage complex* (3.54)

Note 1 to entry: Corrective actions are implemented after an irregularity has occurred to help prevent or minimize damage.

3.13
decommission
take an engineered system or component out of service, render it inoperative, dismantle and decontaminate it

3.14
element of concern
valued element or objective for which *risk* (3.39) is evaluated and managed

3.15
elevated pressure zone
zone within a *storage complex* (3.54) where there is sufficient pressure to cause flow of formation fluids through a pathway from the *storage unit(s)* (3.59) to outside the storage complex into economic resources, *protected groundwater* (3.37), or the *biosphere* (3.5)

3.16
event
material occurrence or change in a particular set of circumstances

3.17
geological storage
long-term *containment* (3.11) of *CO2 streams* (3.7) in subsurface geological formations

Note 1 to entry: Long-term means the minimum period necessary for CO_2 geological storage to be considered an effective and environmentally safe climate change mitigation option.

Note 2 to entry: The term “sequestration” has been used by a number of countries and organizations instead of “storage” (e.g. the international “Carbon Sequestration Leadership Forum”). The two terms are considered to be synonymous, and only “storage” is used in this document.

Note 3 to entry: Within the context of this document, geological storage

a) is applicable to permeable and porous strata that do not contain *protected groundwater* (3.37),

b) is applicable to nonproducing hydrocarbon reservoirs, and

c) does not apply to

1) CO_2 injection and storage in unmineable coal beds, basalt formations, shales, and salt caverns,

2) CO_2 injection and storage in any formations containing producible hydrocarbons, and

3) underground storage in materials involving the use of any form of man-made containers.

3.18
geosphere
solid earth below the ground surface and bottom of rivers and other bodies of water on land, and below the sea bottom offshore

3.19
injectivity
rate and pressure at which fluids can be pumped into the *storage unit* (3.59) without fracturing the storage unit

3.20
leakage
unintended release of fluid out of a pre-defined *containment* (3.11)

Note 1 to entry: In this document, the pre-defined containment is the *storage complex* (3.54).

3.21
legacy well
pre-existing well within the *area of review* (3.3) of a CO_2 *storage project* (3.56) that was drilled for a different purpose than CO_2 injection or *monitoring* (3.27) of the respective CO_2 storage project

3.22
likelihood
chance of something happening, expressed qualitatively or quantitatively and described using general terms or mathematically, e.g. by specifying a probability or frequency of occurrence over a given period

3.23
liner
casing (3.8) string that does not extend to the surface

3.24
management of change
procedure used when making a change to the process equipment or operating procedures to detail changes made and to document steps taken to inform and train operating personnel and relevant stakeholders on process changes

3.25
mechanical integrity
mechanical condition of a well, such that engineered components maintain their original dimensions and functions, solid geological materials are kept out of the wellbore, and fluids including CO_2 are prevented from uncontrolled flow into, out of, along, or across the wellbore, cement sheath, annulus, *casing* (3.8), *tubing* (3.62), and/or *packers* (3.30)

3.26
mechanical integrity test
MIT
test performed on a well to confirm that it maintains internal or external *mechanical integrity* (3.25)

Note 1 to entry: MITs are a means of measuring the adequacy of the construction of a well and a way to detect problems within the well system.

3.27
monitoring
continuous or repeated checking, supervising, critically observing, measuring or determining the status of a system to identify change from *baseline* (3.4) or variance from an expected performance level

Note 1 to entry: In case of *geological storage* (3.17), monitoring is not restricted to the technical infrastructure of an operator. It also includes the wider surroundings of the surface and/or subsurface *storage site* (3.58).

3.28
operational period
period enduring from CO_2 stream first entering the wellhead for storage until injection ceases

3.29
overburden
geological material overlying an area or geological formation of interest in the subsurface

3.30
packer
mechanical device that seals the outside of *tubing* (3.62) to the inside of *casing* (3.8), isolating an annular space

3.31
post-closure period
period that begins after the demonstration of compliance with the criteria for *site closure* (3.52)

Note 1 to entry: In some countries, demonstration of compliance may need approval from a third party.

3.32
primary seal
continuous geological unit (known in reservoir engineering as caprock and in hydrogeology as aquitard or aquiclude) above a *storage unit* (3.59) that is part of a *storage complex* (3.54) and effectively restricts migration of fluids out of the storage unit and *leakage* (3.20) out of the storage complex

3.33
project operator
entity that is legally responsible for the CO_2 *storage project* (3.56)

3.34
project organization
project operator (3.33) and any subcontractor or other person or organization acting under the project operator's control or on behalf of the project operator

3.35
project personnel
person or persons employed by any member of the *project organization* (3.34)

3.36
project stakeholder
individual, group of individuals, or organization whose interests are or could be affected by a *storage project* (3.56)

Note 1 to entry: Stakeholders can include decision makers, employees, shareholders, academia, insurance companies, banks, community residents, suppliers, customers, non-governmental organizations, governments, regulators, labour unions, and other individuals or groups.

3.37
protected groundwater
water found beneath the water table in fully saturated soils and geologic formations that is used for human consumption, agricultural, or industrial uses or is protected from contamination by legislation or regulation

3.38
regulatory authority

entity that has legal authority to permit, approve, or otherwise authorize the siting, construction, testing, operation, *monitoring* (3.27), modification, plugging, or closure of a *geological storage* (3.17) site, well, unit, complex, or project and monitors compliance with the terms of the permit, approval, or authorization

3.39
risk
effect of uncertainty on project objectives [e.g. on performance metrics for an *element of concern* (3.14)], expressed in terms of the severity of consequences (negative impacts) of an *event* (3.16) and the associated *likelihood* (3.22) of their occurrence

Note 1 to entry: An effect is a deviation from the expected and can be either positive or negative.

Note 2 to entry: Objectives can have different aspects (such as financial, health and safety, and environmental goals) and can apply at different levels (such as strategic, organization-wide, project, product and process).

3.40
risk analysis
process for understanding the nature and level of *risk* (3.39)

3.41
risk assessment
overall process of *risk identification* (3.45), *risk analysis* (3.40), and *risk evaluation* (3.43)

3.42
risk control
measure whose purpose is to reduce a specific *risk* (3.39) or avoid escalation of risk

3.43
risk evaluation
process of comparing the results of a *risk analysis* (3.40) with *risk evaluation criteria* (3.44) to determine whether the *risk* (3.39), its magnitude, or both are acceptable or treatment is required to reduce the risk

3.44
risk evaluation criteria
terms of reference against which the significance of *risk* (3.39) is evaluated

3.45
risk identification
process of finding, recognizing, and describing *risk* (3.39)

3.46
risk management plan
scheme specifying the approach, management components, and resources to be applied to the management of *risk scenarios* (3.48)

3.47
risk owner
person or entity with the accountability and authority to manage *risk* (3.39)

3.48
risk scenario
combination or a chain of circumstances through which a *threat* (3.60) can cause an *event* (3.16) to occur and through which the consequences of an event can have a negative impact on *elements of concern* (3.14)

3.49
risk treatment
process to reduce a specified *risk* (3.39) through implementation of *risk controls* (3.42)

3.50
secondary seal
geological unit that effectively restricts migration of fluids in the sedimentary succession between the *primary seal(s)* (3.32) and *protected groundwater* (3.37), protected resources, or the seabed

3.51
site characterization
detailed evaluation of one or more candidate sites for CO_2 storage identified in the screening and selection stage of a CO_2 *storage project* (3.56) to confirm and refine *storage complex* (3.54) integrity, storage capacity, and *injectivity* (3.19) estimates and provide basic data for initial predictive modelling of fluid flow, geochemical reactions, geomechanical effects, *risk assessment* (3.41), and *monitoring* (3.27) and *validation* (3.65) program design

3.52
site closure
end of the *closure period* (3.10), which occurs when the *project operator* (3.33) has demonstrated compliance with criteria for site closure

3.53
site screening and selection
initial evaluation of the suitability of geologically storing CO_2 at the regional or sub-regional scale by identifying, assessing, and possibly comparing candidate storage formations or sites

3.54
storage complex
subsurface geological system extending vertically to comprise *storage unit(s)* (3.59) and identified seal(s), and extending laterally to the defined limits of the CO_2 *storage project* (3.56)

Note 1 to entry: Limits can be defined by natural geologic boundaries, regulation, or legal rights.

