International Standard

ISO 27914

Carbon dioxide capture, transportation and storage — Geological storage

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

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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Foreword

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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 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 265, *Carbon dioxide capture, transportation, and storage*.

This second edition cancels and replaces the first edition (ISO 27914:2017), which has been technically revised.

The main changes are as follows:

— revision of Clause 3 in alignment with other revisions of this document;

— deletion of the former Clause 4 regarding management systems, to remove content that is well-covered by other standards;

— addition of a new Clause 4 regarding integrated project management, to provide guidance on how to navigate this document;

— addition of Clause 10 regarding quantification and verification.

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.

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 CO_2 capture and storage (CCS)[1]. This document aims to address the need for safe and effective long-term storage of CO_2 (see Figure 1) and to be able to quantify stored CO_2.

The life cycle of a CO_2 geological storage project covers all phases and activities of the project, from the start of the project including site screening, feasibility investigation, 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 phase, which concludes with project termination.

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 References [1] to [12]).

This document does not address the quantification of greenhouse gases (GHGs) other than CO_2 for CO_2 storage projects. CCS projects quantifying CO_2 according to this document can address quantifying, monitoring, reporting, and validating or verifying other GHG emissions reductions or removals through the application of ISO 14064-2 and other parts of the ISO 14064 series as appropriate. Results from the quantification of CO_2 stored according to this document can be used according to ISO 14064-2.

NOTE The post-injection phase in this document corresponds with the post-closure phase defined in the EU CCS Directive[1] and with the post-injection site closure (PISC) period in the US under the Class VI rule[65]. Termination in this document corresponds with the end of the EU Directive[1] post-closure period.

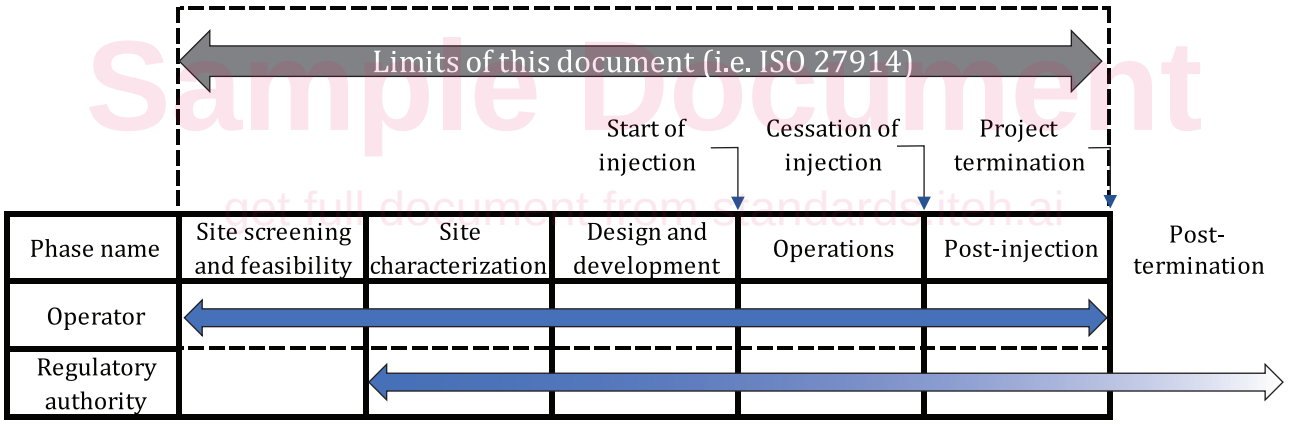

Figure 1 — Entities involved in the storage project life cycle

Carbon dioxide capture, transportation and storage — Geological storage

1 Scope

1.1 This document:

a) establishes requirements for the geological storage of CO_2 streams in a way that minimizes risk of CO_2 losses;

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 enhancing hydrocarbon production;

c) includes activities associated with site screening and feasibility investigation, characterization, design and development, operation of storage projects, and preparation for project termination;

d) recognizes that the geological characteristics, physical boundaries, management, intrinsic technical risk and uncertainties, of each site are likely to be unique for each project and that intrinsic technical risk and uncertainty will be dealt with on a site-specific basis;

e) provides requirements for integrated project management, including elements of risk management unique to the geological storage of CO_2 streams; and

f) establishes a methodology for quantifying the net mass of CO_2 that geological storage projects store in storage unit(s).

Figure 1 illustrates the limits of this document.

1.2 This document does not apply to:

a) temporary storage in tanks or by other means;

b) the post-termination phase;

c) injection of CO_2 for enhancing production of hydrocarbons or for storage associated with CO_2-EOR;

d) disposal of other acid gases except as considered part of the CO_2 stream;

e) disposal of waste and other matter added for purpose of disposal; or

f) underground storage using any form of buried container.

If production of hydrocarbons in commercial quantities occurs from the storage unit(s), the storage project is outside of the scope of this document and ISO 27916 applies to CO_2 storage. A CO_2-EOR project that has stored CO_2 in association with CO_2-EOR can transition to operate under this document after all production of hydrocarbons from the storage unit(s) has ceased.

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 terminology 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
abandonment
process and procedures used to permanently end the operation of a well in a manner that meets *project objectives* (3.30)

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 leakage and prevent changes in the hydrogeological system, such as the changes in hydraulic head and the mixing of formation fluids between hydraulically distinct strata.

3.2
area of review
geographical area(s) designated for assessment of the extent to which a *storage project* (3.47) can 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 can be required by regulatory authorities.

3.3
baseline
reference basis for comparison against which variance of a measured parameter is monitored or measured

3.4
CO_2 plume
carbon dioxide plume
region within geological strata where injected CO_2 is present in free phase

3.5
CO_2 stream
carbon dioxide stream
stream consisting overwhelmingly of CO_2

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

3.6
confining unit
geological strata that are part of a *storage complex* (3.45) and effectively restrict migration of fluids out of the *storage unit* (3.50) and *leakage* (3.16) out of the storage complex

Note 1 to entry: Described in reservoir engineering as caprock and in hydrogeology as aquitard or aquiclude.

3.7
compartment
portion of a *storage unit* (3.50) that is geologically and hydraulicly separated from other portions of the storage unit

3.8
containment
retention of CO_2 within a *storage complex* (3.45)

3.9
custody transfer meter
measurement instrument that furnishes quantity and quality information used for quantification and the basis for a change in responsibility for the CO_2 stream

3.10
decommission
process of taking an engineered system or component out of service, render it inoperative, dismantle and decontaminate it

3.11
detection threshold
smallest value of a property of a substance or effect that can be reliably detected by a specific method of measurement in a specified context

3.12
element of concern
project objective (3.30) for which *risk* (3.36) is evaluated and managed

3.13
elevated pressure zone
geographical area where there is sufficient pressure in the *storage unit* (3.50) to cause flow of formation fluids from the storage unit through the *confining unit* (3.6) along an accessible pathway

3.14
geological storage
safe, long-term *containment* (3.8) of *CO_2 stream* (3.5) 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”). While the two terms are considered to be synonymous, only “storage” is used in this document.

3.15
injectivity
sustainable rate at which fluids can be pumped into the *storage unit(s)* (3.50) given pressure constraints

3.16
leakage
unintended release of CO_2 out of a pre-defined *containment* (3.8)

[SOURCE: ISO 27917:2017, 3.2.14, modified — "CO_2" has been removed from the term and Note 1 to entry has been deleted.]

3.17
legacy well
pre-existing well within the *area of review* (3.2) of a CO_2 *storage project* (3.47)

3.18
likelihood
chance of something happening, expressed qualitatively or quantitatively

3.19
loss
leakage (3.16), intended and unintended releases of CO_2 from a *storage facility* (3.46), and transfers of the *CO_2 stream* (3.5) to outside of the *storage site* (3.49)

Note 1 to entry: Refer to 10.2 for the usage within quantification.

3.20
management of change
process used when making changes to equipment or procedures, which includes *risk* (3.36) management, technical assurance, documentation and communication of changes to relevant personnel and *stakeholders* (3.44)

3.21
mechanical integrity
mechanical condition of a well, such that its ability to function properly and safely is maintained

3.22
mechanical integrity test
MIT
test performed on a well to confirm that it maintains *mechanical integrity* (3.21)

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.

3.23
monitoring
continuous or periodic checking, supervising, observing, measuring or determining the status of a system to identify change from *baseline* (3.3)

3.24
native CO_2
native carbon dioxide
CO_2 present within and indigenous to the *storage unit(s)* (3.50) prior to any CO_2 injection

3.25
operations phase
time and activities from CO_2 stream first entering the wellhead for storage until injection ceases

3.26
overburden
geological material between the top of the *storage complex* (3.45) and the ground surface or seabed

3.27
project well
newly constructed well or a converted *legacy well* (3.17) that is operated in support of the *storage project* (3.47)

3.28
post-injection phase
time and activities between the cessation of injection and the demonstration of conformity with the criteria for *project termination* (3.33)

3.29
post-termination phase
time and activities that begin after the demonstration of conformity with the criteria for *project termination* (3.33)

3.30
project objective
specific goal the *project operator* (3.31) pursues towards ensuring the safe, long-term *containment* (3.8) of stored CO_2

Note 1 to entry: Objectives can have different aspects (such as financial, health, safety and environmental goals, research, technology development, public engagement and job creation) and can apply at different levels (such as strategic, organization-wide, project, product and process).

3.31
project operator
entity that is legally responsible for the CO_2 *storage project* (3.47)

3.32
project personnel
person or persons employed by the *project operator* (3.31), or anyone acting under the project operator's control or on behalf of the project operator

3.33
project termination
end of the *post-injection phase* (3.28), which occurs when the *project operator* (3.31) has demonstrated conformity with criteria in 11.2

3.34
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

3.35
regulatory authority
entity or entities that have the authority to permit, approve or otherwise authorize one or more *storage project* (3.47) activities, or monitor conformity with the terms of a permit

3.36
risk
effect of uncertainty on *project objectives* (3.30)

Note 1 to entry: Level of risk is commonly expressed in terms of both the severity of consequences (negative impacts) of an event and the associated *likelihood* (3.18) of their occurrence.

Note 2 to entry: An effect is a deviation from the expected and can be either positive or negative.

3.37
risk assessment
process of identifying, analysing and evaluating *risk scenarios* (3.40)

3.38
risk control
measure that maintains or modifies *risk* (3.36)

[SOURCE: ISO 31000:2018, 3.8, modified — "risk" has been added to the term, "and/or" has been changed to "or" in the definition and Notes 1 and 2 to entry have been deleted.]

3.39
risk evaluation criteria
terms of reference used to define the magnitude of *risk* (3.36)

3.40
risk scenario
combination of circumstances that can cause negative impacts on *elements of concern* (3.12)

3.41
risk treatment
process of using *risk controls* (3.38) to reduce a specified *risk* (3.36)

3.42
site characterization
detailed evaluation of one or more candidate *storage sites* (3.49) for CO_2 storage identified in the screening and feasibility investigation phase of a CO_2 *storage project* (3.47) to confirm and refine *storage complex* (3.45) integrity, *storage resource* (3.48) and *injectivity* (3.15)

3.43
site screening and feasibility investigation
evaluation of the suitability of candidate *storage sites* (3.49) by identifying, assessing and possibly comparing candidate storage formations or sites

3.44
stakeholder
individual, group of individuals or organization whose interests are or can be affected by a *storage project* (3.47)

[SOURCE: ISO 27917:2017 3.5.1, modified — "CCS project" has been replaced with "storage project in the definition.]

3.45
storage complex
subsurface geological strata that comprise the *storage unit* (3.50) and the *confining unit* (3.6), and extending laterally to the defined limits of the CO_2 *storage site* (3.49)

3.46
storage facility
infrastructure and equipment, including surface facilities, wells and *monitoring* (3.23) equipment, that are used for the geological storage of CO_2 within the *storage site* (3.49)

3.47
storage project
sequence of activities associated with the development of a *storage facility* (3.46), such as site feasibility investigation and characterization as well as design, construction, operation and termination

3.48
storage resource
estimated ultimate storage capacity, in units of mass, for a CO_2 stream in a *storage unit(s)* (3.50) at *project termination* (3.33)

3.49
storage site
physical space that includes the surface area within the *area of review* (3.2), *storage unit(s)* (3.50) and the subsurface volume extending from the surface to the bottom of the *storage complex* (3.45)

3.50
storage unit
geological stratum (or strata) into which CO_2 is injected and contained for the purpose of *geological storage* (3.14)

3.51
surface facility
equipment used or proposed to be used for geological storage, including wellheads, *monitoring* (3.23) equipment, distribution lines and other equipment used to connect injection wells, and equipment used to accept or process *carbon dioxide streams* (3.5) received at a *storage facility* (3.46), but not pipelines used to transport carbon dioxide to a storage facility

3.52
validation
confirmation that the system under consideration meets, in all respects, the specification of that system

3.53
verification
confirmation by examination and provision of objective evidence that specified criteria are met

3.54
verifier
person or entity with responsibility for performing and reporting on the *verification* (3.53) process

[SOURCE: ISO 14064-2:2019, 3.3.4, modified — "competent and impartial person" has been replaced with "person or entity" and "on a verification" has been replaced with "on the verification process" in the definition.]

3.55
well barrier
engineered feature or element installed or constructed in the well to prevent unintended release of fluid or gas

3.56
well operation
activity during the lifecycle of a well, including drilling, cementing, operation, maintenance and *abandonment* (3.1)

4 Integrated project management

4.1 General

The lifecycle of a geological storage project is a series of integrated phases (see Figure 1). This document describes the processes and requirements within each phase. Integrated project management connects project activities through the project phases and provides an auditable trail of decisions, processes, procedures and records. Integrated project management is essential for the implementation and public credibility of geological storage projects and processes. Successful management systems are flexible, enabling the project operator to adapt to changes that occur during the project and robust enough to meet site-specific project and regulatory needs.

NOTE For further information on project management refer to, for example, ISO 10006 and ISO 21500.

4.2 Storage project

4.2.1 Project phases

Geological storage projects follow a sequence of phases as shown in Figure 1:

a) site screening and feasibility investigation (see Clause 5);

b) characterization of the storage site (see Clause 5);

c) storage facility design and development (see Clause 7);

d) injection operations (see Clause 8); and

e) post-injection to project termination (see Clause 11).

4.2.2 Project activities that run across multiple phases

Within each project phase, activities may be undertaken simultaneously, in sequence or iteratively. Activities that transcend project phases include:

a) integrated project management (see Clause 4);

b) assessment and treatment of risk (see Clause 6);

c) monitoring and verification (see Clause 9);

d) quantification and verification of the injected CO_2 stream (see Clause 10); and