



BSI Standards Publication

## Lifecycle risk management for integrated CCS projects

---

## National foreword

This Published Document is the UK implementation of ISO/TR 27918:2018.

The UK participation in its preparation was entrusted to Technical Committee PSE/265, Carbon Capture Transportation and Storage.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© The British Standards Institution 2018

Published by BSI Standards Limited 2018

ISBN 978 0 580 89701 6

ICS 13.020.40

**Compliance with a British Standard cannot confer immunity from legal obligations.**

This Published Document was published under the authority of the Standards Policy and Strategy Committee on 30 April 2018.

### Amendments/corrigenda issued since publication

Date	Text affected
------	---------------

---

---

---

## **Lifecycle risk management for integrated CCS projects**

*Gestion du risque du cycle de vie des projets CSC intégrés*





## **COPYRIGHT PROTECTED DOCUMENT**

© ISO 2018

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office  
CP 401 • Ch. de Blandonnet 8  
CH-1214 Vernier, Geneva  
Phone: +41 22 749 01 11  
Fax: +41 22 749 09 47  
Email: [copyright@iso.org](mailto:copyright@iso.org)  
Website: [www.iso.org](http://www.iso.org)

Published in Switzerland

# Contents

Page

<b>Foreword</b>	<b>v</b>
<b>Introduction</b>	<b>vi</b>
<b>1 Scope</b>	<b>1</b>
<b>2 Normative references</b>	<b>2</b>
<b>3 Terms and definitions</b>	<b>2</b>
<b>4 General information on lifecycle risk management for CCS</b>	<b>2</b>
4.1 Usefulness and benefits of lifecycle risk management	2
4.2 Defining lifecycle for an integrated CCS project	2
4.3 Examples of overarching risk assessment processes conducted for CCS projects	5
4.4 Examples of ISO risk standards that may be applied to CCS projects	8
4.5 Description of how risk is addressed in other standards and regulations	9
4.5.1 General	9
4.5.2 Treatment of CCS risk in international agreements	9
4.5.3 CSA Standard (Z741-12, Geological Storage of Carbon Dioxide)	12
4.5.4 US DOE Best Practices for Risk Analysis and Simulation for Geologic Storage of CO <sub>2</sub>	13
4.5.5 WRI CCS Guidelines	13
4.5.6 IEA Carbon Capture and Storage Model Regulatory Framework	14
4.5.7 United States EPA regulations	14
4.5.8 EU Directive 2009/31/EC on the geological storage of carbon dioxide	15
4.5.9 Regulation of geological storage in Japan	16
4.5.10 Technical guidelines for CCS in China	16
4.5.11 Summary of key features of CCS risk assessment requirements	17
<b>5 Overarching and crosscutting aspects of risk management in CCS projects</b>	<b>18</b>
5.1 Introduction	18
5.1.1 Scope	18
5.1.2 Terms relating to risk	18
5.1.3 Project components and phases	19
5.1.4 Responsibilities and risk ownership	19
5.2 Risk identification	19
5.2.1 General	19
5.2.2 Identifying overarching and crosscutting (OA-XC) risks	20
5.3 Rating and evaluating risk	24
5.3.1 Risk assessment, risk tolerance, and risk evaluation processes	24
5.3.2 Risk scales and expert judgment	24
5.3.3 Risk evaluation for overarching or crosscutting risks	25
5.4 Risk treatments	25
5.4.1 General	25
5.4.2 Aspects of risk treatment that are overarching and/or crosscutting	25
<b>6 Inventory of overarching and crosscutting risks</b>	<b>25</b>
6.1 General	25
6.2 Identification of overarching and crosscutting risks over the lifecycle of CCS projects	26
6.3 Overarching risks	26
6.3.1 Over-arching risks	26
6.3.2 Policy uncertainties	27
6.3.3 Uncertain cost or regulations for integrated project	28
6.3.4 Engagement	29
6.3.5 Project permits not obtained	29
6.3.6 Lack of or changes in financial driver	30
6.3.7 Changes in financial factors external to the project/Insufficient project financial resources/Changes to the cost of capital	31
6.3.8 Unexpected construction or operational cost changes	32

6.3.9	Uncertainty in CO <sub>2</sub> supply .....	32
6.3.10	Lack of emissions accounting .....	34
6.3.11	Technology scale-up .....	34
6.3.12	Lack of knowledge or qualified resources for operating the unit .....	35
6.3.13	Project impacts on the environment .....	35
6.3.14	External natural impacts on project .....	36
6.3.15	External man-made impacts on project .....	36
6.3.16	Conflicts with other land-use rights .....	37
6.4	Crosscutting risks .....	39
6.4.1	General .....	39
6.4.2	Accidental or intentional interruption or intermittency of CO <sub>2</sub> supply, CO <sub>2</sub> intake or transportation .....	40
6.4.3	Shared infrastructure by multiple projects (uncertain ownership, performance or lack of coordination) .....	41
6.4.4	Using existing facilities .....	42
6.4.5	Unintended phase change variations in quality and quantity of the CO <sub>2</sub> stream .....	43
6.4.6	CO <sub>2</sub> out of specifications/Source gas composition not as expected .....	44
6.4.7	Mismatched component performance .....	48
6.4.8	Lower capture efficiency due to the upstream plant flexible operation .....	50
6.4.9	Insufficient storage resource .....	51
6.4.10	Reservoir not performing as predicted .....	52
6.4.11	Model uncertainties regarding the storage performance .....	53
6.4.12	Lack of maintenance and emergency control procedures/safety-related accidents .....	55
6.4.13	Corrosion and material problems .....	58
6.4.14	Pipeline crosscutting risks .....	59
7	<b>Considerations for a potential ISO standard addressing lifecycle risks for integrated CCS projects</b> .....	63
	<b>Annex A (informative) List of acronyms</b> .....	65
	<b>Bibliography</b> .....	68

## 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](http://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](http://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](http://www.iso.org/iso/foreword.html).

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

## Introduction

Carbon Capture and Storage (CCS) is a process that can mitigate the CO<sub>2</sub> emissions from power plants and other industrial sources of CO<sub>2</sub>. CCS draws on many decades of experience in the electricity generation, industrial gas separation, chemical and manufacturing industries, and oil and gas industries, including substantial experience with subsurface injection techniques.

Many of the individual processes (or project phases) that are linked together to comprise a CCS chain have been proven for some time, albeit often in different contexts. Others are still being developed or adapted to this new application. Additionally, bringing them together in a CCS configuration represents a new application, with which there is limited global experience to date. As a result, there is an important need for knowledge development as real experience is gained in the comprehensive application of these technologies.

As with most technologies, CCS has inherent risks which need to be analysed and managed. Integrated projects, given their especially long-term and multi-component aspects, impose particular importance and challenge upon comprehensive risk identification. Risk assessment (detailed risk description and quantification) is completed using all available data, and assessment refreshed with updated numerical simulations which enable comprehensive risk analysis throughout the project lifecycle. The project lifecycle extends across all project phases from business development to site selection through post-closure. Together, risk identification, assessment, analysis, evaluation, management, and treatment are integrated into a risk management plan. The risk management plan aids in decision-making by the owner/operator and, to the extent the results of planning are communicated, aids other stakeholders in evaluating the project.

Keys to the success of the risk management plan are the integration and iterative application of risk assessment, risk data, and risk analysis. Risk analysis and numerical simulation help to identify, estimate and mitigate risks that may arise from CCS projects. These tools are also useful to optimize the design and operation of the monitoring, verification, and accounting aspects of the projects and can serve to inform and facilitate more effective site characterization and model improvement. Importantly, risk tools can be used to shape the design and operation of preventive and remediation options at every stage in the project lifecycle. Effective risk management communication to stakeholders who may be affected is crucial to the success of the project. The risk management plan can serve as a key component of the information handled through the public outreach and communication plan.



# Lifecycle risk management for integrated CCS projects

## 1 Scope

This document is designed to be an information resource for the potential future development of a standard for overall risk management for CCS projects. The risks associated with any one stage of the CCS process (capture, transportation, or storage) are assumed to be covered by specific standard(s) within ISO/TC 265 and other national and/or international standards. For example, the risks associated with CO<sub>2</sub> transport by pipelines are covered in ISO 27913. The scope of this document is intended to address more broadly applicable lifecycle risk management issues for integrated CCS projects. Specifically, the focus of this document is on risks that affect the overarching CCS project or risks that cut across capture, transportation, and storage affecting multiple stages. It needs to be noted that environmental risks, and risks to health and safety should be very low for CCS projects provided the project is carefully designed and executed. Risk identification and management is part of the due diligence process.

A list of acronyms is included in [Annex A](#).

[Clause 5](#) includes an analysis of how a CCS standard could address aspects of risk analysis that apply to all elements of the CCS chain, such as:

- risk identification (identifying the source of risk, event, and target of impact)<sup>1)</sup>;
- risk evaluation and rating;
- risk treatment;
- risk management strategy and reporting.

[Clause 6](#) comprises an inventory of the overarching and crosscutting risks. These include issues such as:

- environmental impact assessment;
- risk communication and public engagement;
- integration risks between capture, storage, and transportation operators, such as risk of non-conformance of CO<sub>2</sub> stream to required specifications;
- integration risks associated with shared infrastructure (hubs of sources, common pipelines, hubs of storage sites);
- risks resulting from interruption or intermittency of CO<sub>2</sub> supply and/or CO<sub>2</sub> in-take;
- risks associated with policy uncertainty;
- incidental risks from activities related to the capture, transportation or storage processes without being specifically covered in the respective standards (e.g. management or disposal of water produced as a by-product of CO<sub>2</sub> storage).

[Clause 7](#) describes implications and considerations for a potential standard on lifecycle risks for integrated CCS projects.

---

1) As defined in ISO 31000.