North Sea Transition Authority

Containment Risk Assessment

Carbon Storage Stewardship Expectation 1

September 2025

1. Expectation

The North Sea Transition Authority ('NSTA') expects that Carbon Dioxide Appraisal and Storage Licence ('CS Licence') holders will maintain a robust approach to containment risk assessment and management throughout the project to ensure that there is no significant risk of leakage or of harm to the environment or human health under the proposed conditions of use of the storage site.

This means CS Licence holders should:

1.1 Implement a robust risk assessment methodology appropriate to carbon storage projects, considering qualitative, semi-quantitative and quantitative risk assessment methods as appropriate during the lifecycle of the project

1.2 Develop a risk classification scheme incorporating likelihood and consequence bands appropriate to carbon storage

1.3 Fully integrate containment risk assessment into the development of the Carbon Storage Development Plan ('**CSDP**'), Monitoring Plan ('**MP**') and Corrective Measures Plan ('**CMP**') and, following grant of a permit, into the Storage Site Management Plan ('**SSMP**').

1.4 Demonstrate that they are effectively managing containment risk throughout the life of the project

2. Reason for the Expectation

2.1 There is a robust regulatory framework in the UK relating to Carbon Capture and Storage ('**CCS**'), including legislation under which the NSTA operates in its role as the licensing and permitting authority for offshore carbon storage. This Expectation supports the NSTA's regulatory role in respect of carbon storage, as established by the Energy Act 2008, Energy Act 2023[2] and further elaborated by secondary legislation, including The Storage of Carbon Dioxide (Licensing, etc) Regulations 2010[3] (the '**Storage Regulations**').

2.2 Effective storage of carbon dioxide ('**CO_2**') requires a comprehensive understanding of both subsurface and surface risks that may lead to significant irregularities in store behaviour and/or leakage events. The NSTA recognises the potential risks involved in CO_2 storage and emphasises the importance of thorough risk analysis and management to maintain store integrity and public trust to support achievement of the UK government's 2050 net zero target.

2.3 Containment risk assessment is an important element of a carbon storage permit application as, before a permit can be granted, CS Licence holders need to demonstrate that "**under the proposed conditions of use of the storage site, there is no significant risk of leakage or of harm to the environment or human health**". These terms are defined in EU Directive 2009/31/EC on the geological storage of carbon dioxide[4] (the '**EU Directive**') as follows:

> **"'significant risk' means a combination of a probability of occurence of damage and a magnitude of damage that cannot be disregarded without calling into question the purpose of this Directive for the storage site concerned".**

> **"'leakage' means any release of CO_2 from the storage complex".**

2.4 CS Licence holders are expected to note that "no significant risk" is distinct from "as low as reasonably practicable" ('**ALARP**').

2.5 Containment risks will evolve during the Operational Term and Post-Closure Period. Therefore, carbon storage permit operators ('**Storage Permit Operators**') will need to demonstrate that they have the necessary systems, processes and behaviours in place to continue to identify, manage and mitigate risks related to containment throughout the project lifecycle.

3. Delivering the Expectation

A. Strategic

A.1 Throughout the lifecycle of a carbon storage project, CS Licence holders should ensure they are using the optimum dataset, as set out in CS SE 3 (Data)[5], together with appropriate modelling tools, to deliver robust risk assessments, effective risk management, and the documentation of findings, which should be regularly reviewed and updated as necessary.

A.2 CS Licence holders should evaluate containment risks using qualitative, semi-quantitative and quantitative evaluations at the appropriate times during the Appraisal and Operational Terms and the Post-Closure Period.

A.3 CS Licence holders are encouraged to develop a Risk Assessment Matrix ('**RAM**') specific to assessment of containment risk in carbon storage projects. An example is shown in Figure 1, below, and should CS Licence holders wish to use this as a starting point, it can be customised or adapted as appropriate.

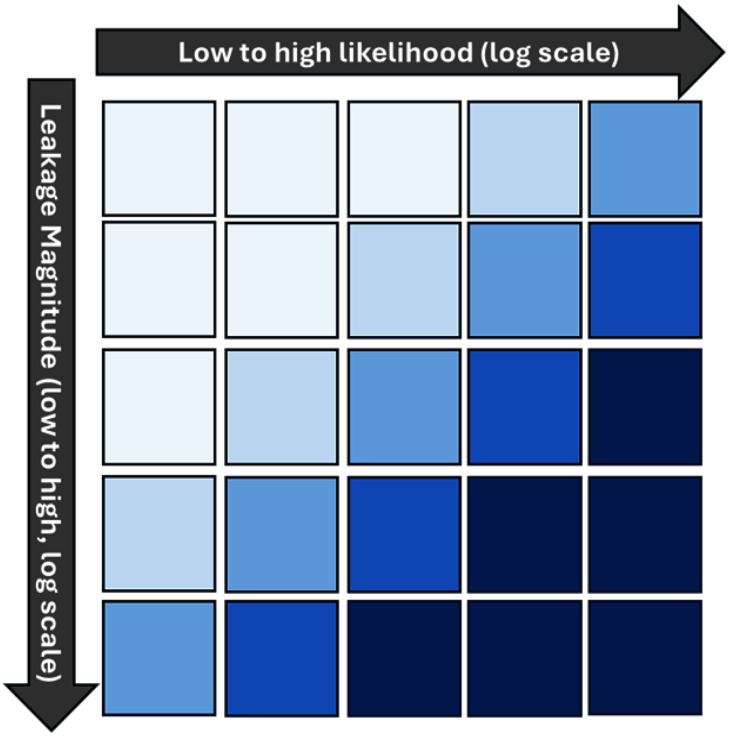
A.4 Containment risk identification and management should continue throughout the project and should include regular assessment of risks as new data become available. This should include subsurface and surface risks, including those related to injection facilities and other surface infrastructure.

A.5 CS Licence holders should have a structured risk assessment process to assess containment and other subsurface risks, encompassing the identification and evaluation of risks and hazards throughout the lifecycle, and be prepared to engage with the NSTA to demonstrate this.

A.6 CS Licence holders are expected to integrate learnings and experience from other CCS projects and any applicable academic research, either in the UK or globally, and adopt best practices that are developed as the industry experience grows.

A.7 The NSTA expects CS Licence holders to demonstrate, through their corporate culture, behaviours and actions, that they are effectively managing risks, including those relating to CO_2 containment, throughout the life of the project.

Figure 1: example RAM



B. Appraisal Term – Appraise Phase

B.1 Risks associated with CO_2 injection and storage, including those related to containment, capacity, injectivity and monitorability should be systematically identified and assessed at the Early Risk Assessment ('**ERA**') stage. An appropriate work plan should be set out to address uncertainties and identify potential mitigations.

B.2 Any data acquisition or studies required to reduce the uncertainty associated with risk assessment, or to support the identification of possible mitigations, should be executed in a timely manner, as noted in CS SE 2 (Appraisal)[6], and CS SE 3 (Data)[5].

B.3 At this stage, the RAM should be used as a risk identification and prioritisation tool, as the significance of the risks should continue to be assessed as analysis of the risks, potential leak rates, mitigations and store operating conditions mature,

B.4 CS Licence holders should utilise subsurface, well engineering and any other relevant data to identify potential leakage pathways.

B.5 Legacy wells may form a major part of the risk assessment, and the requirement for additional data to enable an appropriate risk assessment to be carried out should be considered at the earliest opportunity, in line with CS SE 2 (Appraisal)[6].

B.6 CS Licence holders are expected to engage early with the operator of any legacy wells within the proposed storage site, complex or relevant surrounding area that are not fully abandoned, in line with CS SE 5 (Stakeholder)[7], to ensure that an appropriate subsurface isolation strategy is in place. CS Licence holders should also engage with the NSTA, particularly if issues arise.

B.7 CS Licence holders should be able to demonstrate consideration of a range of possible conditions of use in the risk assessment, including, but not limited to, reservoir pressure, injection rates, well count and location and temperature variations under expected operating conditions.

B.8 A well-structured ERA incorporating a robust risk assessment methodology and regular updates will facilitate the development of the Containment Risk Assessment ('**CRA**') that is delivered as part of a storage permit application.

C. Appraisal Term – Assess and Define Phases

C.1 Any required mitigation measures identified in the Appraise Phase must be clearly outlined in the CRA and carried through, where appropriate, into other elements of a permit application including, but not limited to, the CSDP, the MP and the CMP.

C.2 Mitigations may include:

i) Engineering controls such as physical barriers to prevent leakage

ii) Process systems to prevent leakage

iii) Monitoring systems for real-time tracking of CO_2 storage integrity

iv) Systems to manage reservoir and, where appropriate, hydraulic unit pressure, within safe operating limits

v) Emergency response plans to promptly and effectively address potential failures or leaks.

C.3 CS Licence holders should explicitly evaluate the probability of occurrence, magnitude and impacts of all identified risks. The location of risks on the RAM should be accompanied by commentary describing the probability and magnitude (including leak rates and durations) of each.

C.4 Consistent language and terminology should be used across documents to aid tracking of risks and mitigations.

D. Operational Term and Post-Closure Period

To monitor the evolution of risk and update the risk assessment in the Operational Term and Post-Closure Period, Storage Permit Operators should:

D.1 Demonstrate that mitigations set out in the CRA are implemented and the risks identified as part of the CRA are monitored to ensure that storage integrity is maintained throughout the Operational Term and Post-Closure Period.

D.2 Identify and acquire the necessary data, either as part of or additional to the MP or CMP, to reduce subsurface uncertainties and make appropriate updates to the static and dynamic models, particularly if differences between predicted and actual store behaviour are observed, in line with CS SE 3 (Data)[5].

D.3 Continue to conduct detailed assessments of the storage site and associated injection facilities, incorporating data from well performance, pressure, temperature and other monitoring data as appropriate to enable the risk assessment to be updated.

D.4 Incorporate operational and monitoring data into models to improve the understanding of store behaviour and verify that the risk assessment is still appropriate, updating as required based on industry experience and best practice.

D.5 Be able to demonstrate that awareness and management of risk, particularly around the risk of leakage, and of harm to the environment and human health are embedded into the culture and structure of the Storage Permit Operator and any service providers that support it.

4. Demonstrating Delivery

Information obtained from various sources and engagements between the NSTA and CS Licence holders will help inform the NSTA of the extent to which they may be delivering against this Expectation. These may include, but not be limited to:

4.1 Reporting

The NSTA collects a range of data from CS Licence holders as part of the annual reporting in accordance with paragraph 3 of Schedule 2 of the Storage Regulations[3] and may request additional information or reports (for example using the powers in s112 of the Energy Act 2023[2]). Information may be collected in accordance with any applicable regulations or guidance.

4.2 Stewardship Engagement Meetings

The NSTA will engage with CS Licence holders during the lifecycle of a project. For any meeting, the NSTA may suggest an agenda to focus on issues that present the greatest stewardship impact, and the agenda will be based on data received, any applicable benchmarking, and delivery against this Expectation.

4.3 Sharing with Industry

CS Licence holders are encouraged to share examples of best practice and lessons learned with industry, through active participation at forums such as conferences, industry-convened workgroups, taskforces, and publications such as academic journals. The NSTA may, on occasion, convene or co-convene events, and participation is strongly encouraged to demonstrate delivery of this Expectation.

4.4 Performance Metrics

CS Licence holders are encouraged to establish and track key performance indicators related to CO_2 containment, including metrics for leakage risk and mitigation effectiveness, and this is expected to be incorporated in the SSMP.

4.5 Meeting of Permit conditions

Under the Storage Regulations, Storage Permit Operators are required to notify the NSTA immediately when they become aware of significant irregularities and leakage events and should ensure robust processes are in place to meet this requirement.

5. References

1 *Energy Act 2008*

2 *Energy Act 2023*

3 *The Storage of Carbon Dioxide (Licensing etc.) Regulations, 2010*

4 *EU Directive 2009/31/EC on the geological storage of carbon dioxide*

5 *Carbon Storage Stewardship Expectation 3 – Data acquisition and use for appraisal and monitoring*

6 *Carbon Storage Stewardship Expectation 2 – Appraisal and subsurface characterisation*

7 *Carbon Storage Stewardship Expectation 5 – Stakeholder engagement*

Appendix A: Risk Assessment During the Project Lifecycle

Project Phase:

Appraisal Term	Operational Term – Execute	Operational Term – Injection	Post-Closure Period
Identify and characterise all hazards that could lead to risk of leakage or harm to the environment or human health	Maintain detailed containment risk assessment: • update with new data as acquired • assess any new risks identified • re-assess risks against any proposed changes	Maintain detailed containment risk assessments • update regularly with operational data • assess any new risks identified • re-assess risks against any proposed operational changes	Review post-closure risks and update Post-Closure Risk Register
Assess containment risks, including those related to: • geological containment (seal, faults, spill, etc) • legacy wells (barriers, location, etc)	Deploy monitoring systems to track CO_2 plume and pressure wave as set out in the MP	Regularly collect and incorporate monitoring data related to, amongst other things • CO_2 plume distribution • pressure wave • brine movement	Ensure decommissioning plans prioritise long-term CO_2 containment
Develop risk register of all identified risks with barriers and proposed mitigations	Deploy monitoring systems to identify deviation from models, significant irregularities and/or leakage events, as set out in the MP	Re-evaluate risks for any deviations from modelled behaviour, significant irregularities or leakage events	Develop risk management plan as part of Post-Closure Plan

Appraisal Term	Operational Term – Execute	Operational Term – Injection	Post-Closure Period
Design for containment, including but not limited to: • well location and construction • facility design • operating conditions • predicted plume and pressure distribution	Leverage latest technology to maintain storage integrity and minimise risks	Implement corrective measures and actions for any risks that are evolving towards significant irregularities or leakage events.	Develop and implement post-closure monitoring plan, considering things such as long-term CO_2 plume location, containment and pressure development
Integrate identified risks into Monitoring Plan and Corrective Measures Plan	Develop emergency response plan	Maintain effective emergency response plan	Maintain effective emergency response plan

North Sea Transition Authority

The North Sea Transition Authority is the business name for the Oil and Gas Authority, a limited company registered in England and Wales with registered number 09666504 and VAT registered number 249433979.
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