



## Risk Assessment in Offshore Greenhouse Gas Injection Licences and Site Plans

All fact sheets should be read in conjunction with the [Offshore Petroleum and Greenhouse Gas Storage Act 2006](#) (the **OPGGS Act**), associated regulations, relevant guidelines and policies (available on [NOPTA's website](#)).

This fact sheet provides general information about risk assessment to be included as part of the application and assessment processes for a greenhouse gas (GHG) injection licence and site plan(s) and covers geological risks, risks to the containment of GHG substances and risks associated with engineering enhancements. Other risks, such as to infrastructure (e.g. pipelines), safety and the environment are outside the scope of this fact sheet but will need to be considered by proponents. If proponents are unsure what risks are covered under site plans they should seek advice from NOPTA. For completeness, a fact sheet about Significant Risk of Significant Adverse Impact (SROSAI) is also referenced below, however SROSAI is outside the scope of this fact sheet.

It remains the responsibility of project proponents to ensure compliance with all legal requirements for a project. Project proponents should ensure consistent information is provided to all regulators.

There are multiple legislative frameworks to regulate offshore carbon capture and storage (CCS) projects in Commonwealth waters including:

- *Offshore Petroleum and Greenhouse Gas Storage Act 2006*;
- *Environment Protection (Sea Dumping) Act 1981*; and
- *Environment Protection and Biodiversity Conservation Act 1999*.

The responsibilities for regulating offshore CCS projects are shared across the Commonwealth Government's Department of Industry, Science and Resources (DISR) and the Department of Climate Change, Energy, the Environment and Water (DCCEEW).

The four regulatory bodies that are relevant to offshore CCS projects are:

- National Offshore Petroleum Titles Administrator (NOPTA);
- National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA);
- Sea Dumping (within DCCEEW); and
- Nature Positive Regulation Division (within DCCEEW).

This fact sheet covers NOPTA and NOPSEMA's expectations for appropriate risk assessment. Further information on regulatory approvals can be found in: [Offshore Carbon Capture and Storage Regulatory Approvals](#)

Due to the complexity and interactions between the OPGGS Act and associated regulations with other legislative and regulatory frameworks, early and ongoing engagement with the relevant regulators is encouraged. Every project is unique and may require additional approvals to those outlined.

This fact sheet should be read in conjunction with the OPGGS Act and the following regulations, guidelines and fact sheets:

- [Offshore Petroleum and Greenhouse Gas Storage \(Greenhouse Gas Injection and Storage\) Regulations 2023](#) (GHG Regulations);
- Guideline: Offshore Greenhouse Gas Injection Licences (**Injection Licence Guideline**);
- [Offshore GHG Guideline - Declaration of Identified GHG Storage Formation Guideline \(DoSF Guideline\)](#);
- [NOPSEMA Guidance Note: Risk Assessment](#);
- [NOPSEMA Guidance Note: ALARP](#);



- [NOPSEMA Guidance Note: Control Measures and Performance Standards](#);
- [DISR/DCCEEW Guidance Note: Offshore Carbon Capture and Storage Regulatory Approvals 2023](#);
- [NOPSEMA Fact Sheet: ALARP and Acceptable](#);
- Fact Sheet: Developing a GHG resource - GHG Injection Licence and Site Plan applications;
- Fact Sheet: Significant Risk of Significant Adverse Impact (SROSAI); and
- Fact Sheet: Monitoring plans in Offshore Greenhouse Gas Injection Licences and Site Plans.

## Where does risk assessment fit into a site plan?

A draft site plan must accompany an application for a GHG injection licence with risk assessment forming part of the information required under the following provisions of the GHG Regulations:

- general criteria (section 18 of the GHG Regulations) covering geological risks;
- clause 13 of Schedule 1<sup>1</sup> and clause 4 of Schedule 2 of the GHG Regulations covering risks associated with engineering enhancements; and
- clause 5 of Schedule 2 of the GHG Regulations covering risks relating to the containment of GHG substances.

The draft site plan must be approved by the responsible Commonwealth Minister (**RCM**) before any operations in relation to an identified GHG storage formation specified in the licence can commence. If an approved site plan is in force the licensee must comply with the plan.

## Aims of a risk assessment

Risk assessment is undertaken to assist with planning for safe, secure and permanent storage of GHG substances.

A risk assessment included as part of the application and assessment processes for a GHG injection licence and site plan must demonstrate that all risks associated with the

geology, containment of GHG substances and engineering enhancements have been identified and that these will be eliminated or reduced to as low as is reasonably practicable (**ALARP**). If a risk is identified and is reduced but not eliminated, the remaining risk must be acceptable.

Details of the risk assessment analysis used by the applicant should include the following for each risk:

- a description of the risk;
- the possible consequences of the risk;
- an assessment of the probability of occurrence of the risk;
- the strategies for the elimination or reducing the risk to ALARP; and
- if the risk has been, or will be, reduced but not eliminated: information demonstrating that the remaining risk will be acceptable.

A rigorous and comprehensive risk assessment of the entire project should identify the various risks, evaluate potential impact of these risks and develop mitigation plans for safe, secure and permanent storage. The identified risks should be collated in a risk register, ranked to identify the most significant risks to the containment of GHG substances and mapped to the proponent's risk matrix, with a clear rationale for the ranking provided under their risk management framework.

The outcome of this risk assessment, combined with regulatory requirements should support the design of the project and drive the development of a monitoring (Monitoring, Measurement and Verification (**MMV**)) plan. The frequency of data acquisition should also be justified having regard for the timeframes required to identify if the GHG plume is behaving as predicted and undertake remedial action if required.

The probability of occurrence and associated consequence of each identified risk will generally evolve throughout a project life cycle, as will MMV technology. Accordingly, the mitigation steps, monitoring and reporting plans will also

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<sup>1</sup> Schedule 1 (Information to be set out in applications for declaration of identified GHG storage formations...) is relevant to the site plan, as section 19 requires the information set out in the site plan to be

consistent with the information provided in the application for declaration of identified GHG storage formation.



evolve. The evolution of any identified risk and the associated mitigation steps and monitoring plans will be captured in the reviews of the approved site plan which must take place at least once in each period of 5 years during which it is in force (sections 36 to 38 of the GHG Regulations) or in the circumstances mentioned in subsection 37(1) of the GHG Regulations.

Additional risks arising from GHG operations will continue to be regulated under other parts of the OPGGS Act and regulations, particularly through the requirements to prepare and have the following accepted by NOPSEMA:

- Environment Plans for environmental management of offshore GHG activities;
- Well Operations Management Plans for well activities, and
- Safety Cases to address occupational health and safety at offshore facilities.

For this reason, early engagement with both NOPTA and NOPSEMA on the draft site plan is encouraged to facilitate other OPGGS Act regulatory approvals.

### Risk assessment techniques

The NOPSEMA guidance note on risk assessment includes descriptions of various risk assessment techniques and the main considerations that should be taken into account when selecting the appropriate technique.

The risk assessment technique(s) selected should:

- be suitable for the type and complexity of the facility and nature of the hazards present;
- assist in understanding and selecting control measures; and
- be capable of assessing the potential effect of risk reduction measures.

No single technique is able to meet all of the requirements of risk assessment as all techniques have their limitations and weaknesses. A tiered approach to risk assessment is recommended where simple techniques are used initially as part of a screening process before the areas of high risk or uncertainty are addressed by more detailed risk assessment.

The risk assessment should include details of the data available, the assumptions made and areas of uncertainty to undertake the risk assessment. Consideration should also be given to how the risk assessment could change based on any new data acquired.

Descriptions of some risk assessment techniques are provided in Appendix A of the [NOPSEMA Guidance Note: Risk Assessment](#).

### Risks to include in a site plan application

The following sections describe the type of risks the proponent should consider in an application for the grant of a GHG injection licence and approval of a draft site plan. The GHG Regulations cover geological risks, risks to the containment of GHG substances and risks associated with engineering enhancements. It should be noted that some of the containment risks are related to geology and where this is the case they have been included under the geological risk section below.

In addition to these risks, proponents should also consider risks associated with facility design and structural integrity, and monitorability risks where the system (as outlined under the Monitorability risk section of this fact sheet) cannot be monitored to the degree required.

#### i) Geological risks

A geological risk assessment should consider all aspects of the geology to ensure the formation will be safe and secure for the permanent storage of the GHG substances. It should include the proposed strategies for the elimination or reduction and management of those risks. The risk assessment must demonstrate all of the following for the proposed operations for the injection or permanent storage of a GHG substance (section 18 of the GHG Regulations):

- that the geological risks associated with the operations have been identified;
- that new geological risks associated with the operations will be identified as they arise;
- that increases in the levels of existing geological risks associated with the operations will be identified as they arise;
- that the geological risks mentioned above will be eliminated or reduced to ALARP; and



- that if a geological risk mentioned above is reduced but not eliminated, the remaining risk will be acceptable.

Geological risks include the following categories:

- the containment of GHG substances;
- the capacity of the storage formation (the volume of GHG substances that can be stored);
- the injectivity of the storage formation (the rate at which GHG substances can flow into the formation); and
- the physical impacts of the injection of GHG substances on other domains including the storage formation, sealing units, any faults and the seabed.

Risks under these categories could include, but are not limited to the following:

- unexpected chemical/physical conditions during injection or within the storage formation;
- pressurization of the formation due to unexpected compartmentalisation;
- injection intermittency and fracturing of the near well zone induced by drilling or injection operations.
- critical parameters affecting potential leakage (e.g. maximum reservoir pressure, maximum injection rate, temperature and sensitivity for varying assumptions in the geological models);
- secondary effects to the injection and storage of GHG substances including displaced formation fluids and new substances created by the storing of GHG substances in the formation;
- accidental exceedance of the amount of GHG substance that may be stored in the identified GHG storage formation as set out in the fundamental suitability determinants of the identified GHG storage formation;
- induced seismicity around well bores and in the storage formation;
- physical uplift of the seabed;

- disturbance of the GHG substance due to tectonic processes;
- unexpected changes in seal properties due to chemical/physical interactions with the injected GHG substance;
- geomechanical fracturing and fault reactivation;
- migration of GHG substances through the seal due to the capillary entry pressure being exceeded;
- displacement of brine or residual fluids from the storage formation: and
- unexpected (less than 10 per cent probability of occurring based on plume migration modelling) GHG substance plume migration.

## ii) Other risks relating to the containment of GHG substances

The following are examples of non-geological factors that could pose risks to the containment of GHG substances (clause 5 of Schedule 2 of the GHG Regulations):

- a leakage into the environment or into other geological strata of a GHG substance resulting from loss of integrity in a well bore;
- a leakage of a GHG substance during its transport for the purpose of injection into the formation;
- a leakage of a GHG substance at the point of injection into the formation;
- leakage of a GHG substance from injection, monitoring, pressure maintenance or legacy wells; and
- future exploration, development, production, and injection activities including activities on overlapping or nearby permits.

When identifying the geological and non-geological risks to the containment of GHG substances within the formation consideration should be given to:

- potential leakage routes;
- potential magnitude of leakage events;
- impact of any impurities that will be contained in the GHG substances on the predicted phase behaviour and corrosion potential on proposed



transport, facility infrastructure and wells including the potential for escalation from corrosion; and

- any factors which could pose a risk to human health or the environment including the effects of exposure to elevated GHG substance concentrations in the biosphere and the effects of other substances, such as impurities or entrained hydrocarbons, that may be present in the leaked GHG substance.
- **Note:** Environmental risks are covered under the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2023* and are requirements for environmental plans. Risks to human health and environment need to be considered in the risk assessment to ensure that the monitoring plan can be developed to allow early detection and mitigation.

The risk assessment also includes information about potential risks to the containment of GHG substances, such as leakage from a well bore, during transport or at the point of injection or abandoned wells that could adversely affect the formation, that were not included in the DoSF, but have been identified as part of the site plan and proposed strategies for the elimination or reduction of those risks to ALARP.

This information is critical to demonstrate that the proposed approach to the design and implementation of the project will manage risks to ALARP when compared to other development options. Applicants should show that they have undertaken preliminary major accident events and safety integrity level assessments and have identified control measures and performance standards to underpin this evaluation.

### iii) Engineering enhancements

Engineering enhancements are any engineering solutions to change the current conditions of the storage formation to facilitate the injectivity and containment of GHG substances. If the fundamental suitability determinants set out in the declaration of identified GHG storage formation application (in sections 312 and 312A of the OPGGS Act) include engineering enhancements, the risk assessment will include a description of those engineering enhancements set out in sufficient detail to demonstrate

that, taking into account those enhancements, the risks relating to the containment of the GHG substance to be stored in the part of the geological formation are likely to be acceptable.

### iv) Facility Design and Structural Integrity

Facility risk assessment is part of the safety case risk assessment assessed by NOPSEMA and should demonstrate that the risks associated with the proposed concept have been considered and studied sufficiently to demonstrate that the risks have been reduced to ALARP and are of an acceptable level.

This should include, but not be limited to:

- comparative risk assessment of the proposed concept and suitable alternatives;
- risks associated with reuse of infrastructure, informed by current condition, and life extension studies;
- risks of failure of key elements of structural integrity as defined in Part 1.2, Division 1, Section 7 of the OPGGS Act; and
- risks associated with transient conditions, including potential process upsets and normal integrity testing and intrusive maintenance.

### v) Monitorability risks

Monitorability risk is where the system cannot be monitored to provide the required degree of assurance that the stored GHG substances are behaving as predicted.

Potential risks in this category may include:

- insufficient and/or uncertain baseline data leading to a risk not being able to make meaningful comparisons with post-injection data;
- failure of monitoring equipment or monitoring prevented due to external factors;
- monitoring inhibited by unexpected plume migration outside the monitored area;
- interaction with a saturation and/or pressure plume of injected GHG substances from a nearby CCS project that leads to uncertainty in the distribution of the injected GHG substances and its containment; and



- uncertainty in the composition of the GHG substance leading to an error in estimating the amount of GHG substances injected into the formation.

## Key considerations

The risk assessment and associated monitoring plan should be developed to include the identification of any serious situations, any reportable incidents and any events that significantly alter the approved site plan and that may lead to a variation of the approved site plan.

### *Serious situations*

The risk assessment will include the identification of any potential risks relating to any deviation from the predicted behaviour of GHG substances to be injected into and stored in the formation to allow the timely detection of serious situations (section 19 of the GHG Regulations). Serious situations need to be identified and managed to demonstrate the formation will be safe and secure for the permanent storage of GHG substances.

### *Reportable incidents*

A reportable incident in relation to an identified GHG storage formation specified in a GHG injection licence will include the following (section 49 of the GHG Regulations):

- a departure from a predicted migration pathway or rate of a GHG substance that causes, or has the potential to cause, a serious situation to exist in relation to the storage formation;
- a GHG substance injected into the identified GHG storage formation that has leaked or is leaking from the storage formation, and which involves a leakage of the GHG substance to the seabed, or a significant risk of such an event; and
- a leakage of a GHG substance, from the bore of a well that forms part of the operations carried out under the licence, that causes or has the potential to cause a serious situation to exist in relation to the formation.

### *Variations*

Apart from the review of the approved site plan at least once in each five-year period, or reviews requested by the Minister, and draft variations of the approved site plan (sections 36 and 37 of GHG

Regulations), a variation of an approved site plan is required following the occurrence of certain circumstances (section 40 of the GHG Regulations) including:

- the plan is no longer accurate and up to date because there is new information that significantly alters the determination of:
  - the fundamental suitability determinants;
  - the expected migration pathways of the GHG substance or the predictions set out in Part A of the plan for the behaviour of each GHG substance;
  - interactions between the formation and the method by which the GHG substance is injected into the formation; or
  - any other matter relevant to the safe and secure storage of GHG substance in the formation.
- the licensee proposes to make a change, or a series of changes, to the way the operations authorised by the licence are carried out, that will affect predictions set out in Part A of the plan for the behaviour of each GHG substance, or the risks associated with those operations; and
- the licensee proposes to make a significant change to the way the operations authorised by the licence are managed that will affect the integrated operations management plan.

### *Site Closure and Remediation*

Potential risks related to site closure and remediation (clause 9 of Schedule 2 of the GHG Regulations) that could pose a risk of leakage of GHG substances stored in the formation after site closure need to be considered in Part B of the site plan and assessed as part of the application for a site closing certificate.

## Engagement with Regulators

Applicants should note that information included in the draft site plan to meet the risk assessment and strategy requirements will be a critical underpinning to future operational approvals including safety cases. Further information on risk assessment considerations can be



found in the NOPSEMA guidance note on risk assessments.

Applicants should engage early with both NOPTA and NOPSEMA, including workshops in advance of submitting their draft site plan to discuss risk aspects of their project to ensure safety-by-design principles are appropriately being factored into their infrastructure proposals from an early stage of project design.

### More information

If you have any specific questions, please contact [ghg@nopta.gov.au](mailto:ghg@nopta.gov.au).

*Please note: this document is intended as a guide only. It is subject to, and does not replace or amend the requirements of, the Offshore Petroleum and Greenhouse Gas Storage Act 2006 and associated regulations, which should be read in conjunction with this guideline. It should not be relied on as legal advice or regarded as a substitute for legal advice in individual cases.*

### Version history

Version	Date	Comment
1.0	02/01/2025	New GHG fact sheet