A NEW RISK MANAGEMENT METHODOLOGY FOR LARGE-SCALE CO_2 STORAGE: APPLICATION TO THE FORT NELSON CARBON CAPTURE AND STORAGE PROJECT

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In order to move the carbon capture and storage (CCS) industry forward and assure stakeholders that the geologic storage of CO_2 can be done safely and reliably, it should be demonstrated that the risks associated with a specific CCS project can be consistently identified, treated, and monitored throughout the life of that CCS project. The management of potential risks that may be incurred from the long-term effects of storing large amounts of CO_2 in a particular geological formation starts with proper site selection, followed by a more rigorous risk-based examination of the site, including consideration of the uncertainty of the storage capacity and injectivity in relatively unevaluated, noncommercial deep saline formations.

Although some large-scale enhanced oil recovery projects such as Weyburn use CO_2, apart from a few existing large-scale operations such as Sleipner and In Salah, to date, very few projects designed specifically for CO_2 storage have reached the commercial scale necessary to validate CCS as a viable technology. In that respect, with an anticipated storage volume of 1.3 to 2 Mt/yr of CO_2, the proposed Fort Nelson CCS project operated by Spectra Energy is among the most promising industrial-scale CCS projects being considered in North America. As demonstration to local and federal governments that the sour CO_2 can be safely injected and stored on the long term is important, the Fort Nelson CCS project presents an opportunity for the implementation of a comprehensive risk management approach.

This abstract describes the application of an original, CCS-specific risk management methodology to the subsurface technical risks of the Fort Nelson CCS project:

- Phase 1: Establishment of a risk management policy utilizing input from key project stakeholders to help define a project-specific metric system (frequencies, physical consequences, severities) for the estimation of technical risks.

- Phase 2: A first-risk assessment of the subsurface technical risks, including risk mapping and evaluation of high-criticality risks.

- Phase 3: A risk treatment plan and first recommendations for a risk-based monitoring, verification, and accounting (MVA) plan based on the results of the risk assessment.

Phase 1: Risk Management Policy

The risk management policy defines the organization and rules that will be used to manage the technical risks throughout the life of a CCS project, including any existing regulations. The cornerstone of the risk management policy is the early involvement of all major stakeholders, through a process of interviews, in order to identify their concerns and level of risk aversion. The material collected is essential for the definition of the policy, which features:

- Scope and objectives of the risk management process.
- Definition of the risk management process itself, used to assess the risks on a continual basis.
- A reporting and communication schedule.
- Frequency of updates and evaluations of the risk management policy itself.

A key component of the risk management policy is the project-specific metric system used during the risk assessment. This includes a frequency matrix that defines frequencies of occurrence over a reference period and a severity matrix that defines severity levels for the relevant strategic stakes of the project.

A common challenge of technical risk assessments is linking technical risks, e.g., CO_2 leakage, to a strategic severity (e.g., public perception). For the Fort Nelson CCS project, this was dealt with using a table of physical consequences that allows a physical rating of the risks and transfer matrices that connect the physical consequences to the strategic severity levels. The transfer matrices were developed with internal project stakeholders, and they reflect the specific concerns of those stakeholders.

Phase 2: Risk Assessment

A first-round risk assessment was performed using three steps: identification, estimation, and evaluation.

Three different sources were utilized for risk identification. First, publicly available databases were used to create a list of generic CCS risks. Next, a functional analysis of the Fort Nelson CCS project subsurface system was performed, resulting in a list of potential failure modes, causes, and consequences. Finally, a cross-disciplinary CCS expert panel was used to review and validate the risk register.

The risk estimation phase utilized two types of modeling. A detailed geologic model of the project area, including dynamic simulations, allowed a first evaluation of the potential behavior of the sour CO_2 during the injection and postinjection periods. Additionally, simplified leakage models were used to estimate risk of leakage outside of the reservoir model area. A frequency of occurrence and physical consequence was assigned to the identified risks, followed by input and validation from an expert panel. In the instances when the availability was limited, and quality of the data was too uncertain to allow a precise estimation, a range of values was assigned.

Risk evaluation consisted of converting the physical consequences into strategic severities using the transfer matrices. The resulting risk mapping was reviewed and validated by internal stakeholders to assist in the identification of the high-criticality risks to be treated.

Phase 3: Risk Treatment Plan and Risk-Based MVA

As a result of the Fort Nelson CCS project being in the feasibility stage, and the high uncertainty and knowledge gaps in the available data, the risk treatment plan contained recommendations for further studies and data acquisition to reduce the uncertainty of the critical risks, all of which are typical of the exploratory nature of evaluating noncommercial deep saline formations.

Additionally, a preliminary risk-based MVA plan was proposed by identifying available MVA techniques and analyzing their relevance for monitoring the project-specific high-criticality risks.

The successful application of this original risk management framework to the Fort Nelson CCS project provides a step forward for the development of CCS. It supports the idea that a risk management framework, including technical risk assessment, can be effectively implemented for large-scale CCS projects. It provides an invaluable decision-making and communication tool that can support validation of the project, communication with stakeholders, and the demonstration of safety and reliability that is essential for the success of CCS as a viable climate change mitigation option.