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IEAGHG Risk Management Network:

"Risk Management Over Time at Operating and Future CCS Projects"

A Webinar & Discussion Panel

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IEAGHG would like to thank the IEAGHG Monitoring Network Steering Committee for their efforts in facilitating this webinar:

- James Craig, IEAGHG (Chair)
- Samantha Neades, IEAGHG (Co-Chair)
- Eric Cauquil, Total (France)
- Myles Culhane, Occidental (USA)
- Marcella Dean, Shell (The Netherlands)
- Robert Dilmore, NETL (USA)
- Thomas Le Guenan, BRGM (France)
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- Curt Oldenburg, LBL (USA)
- Philip Ringrose, Equinor (Norway)
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- Simon O'Brien, Shell (Canada)
- Eric Cauquil, Total (France)
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IEAGHG Risk Management Network

"Risk Management Over Time at Operating and Future CCS Projects"

A Webinar & Discussion Panel

In the interim before its next in-person meeting (to be hosted by Total in Pau, France, details to be confirmed), the IEAGHG Risk Management Network held a webinar aimed primarily at those involved or interested in the risk management of CCS projects. This webinar heard from the operators at Shell's Quest project about their experiences with risk management at the project, which was followed by a panel discussion between representatives from leading CCS developers, as well as experts in the area of risk management.

This webinar and virtual discussion panel was held on Wednesday 2nd December 2020 at 9pm GMT and attracted an audience of 59, plus 10 panellists and IEAGHG staff.

Welcome

James Craig, IEAGHG, welcomed all to the virtual event and noted that the IEAGHG Risk Management Network first started meeting in 2005. This IEAGHG network has held 7 subsequent meetings all over the world since the initial event. The 9th in the series was originally planned for June 2020, but due to the COVID-19 pandemic this has had to be postponed to 2021 (TBC). IEAGHG would like to thank the panellists for their informative and engaging participation in the webinar:

Simon O'Brien, Shell (Canada), who also provided the keynote presentation at the webinar,

Eric Cauquil, Total (France),

Curt Oldenburg, Lawrence Berkeley National Laboratory (USA),

Philip Ringrose, Equinor (Norway),

Marcella Dean, Shell (The Netherlands),

Myles Culhane, Occidental (USA).

Quest: Evolution of Risk Management from project inception to commissioning, operation and post-injection

Simon O'Brien provided a view of the Quest CCS project's risk management process. Shell's Quest project in Alberta, Canada, has now been successfully injecting CO_2 since 2015 and through November 2020 has injected over 5.6 million tonnes. The original risk management plan has subsequently been adapted as the project has progressed. This insight can make a valuable contribution to the planning and risk assessment of future projects, not only for operators but also for regulators and other key stakeholders.

The measurement, monitoring and verification (MMV) plan in 2015 was a first of a kind for Shell and Alberta so a conservative approach was initially adopted. It was risk-based, site-specific, independently reviewed and used a combination of both new and conventional technologies. One of the conditions of the regulator was to update the plan every three years, which has been the main impetus for Shell's evolution of the risk management plan since project start up. In 2017 the MMV plan was updated to focus on addressing key risks and driving towards ALARP (as low as reasonably

practicable), whilst reducing usage of technologies that didn't drive solutions with more emphasis on downhole technologies and the introduction of a tiered approach to addressing risk. The original bow-tie was revisited and it's interesting to note that many of the issues predicted upfront were addressed by site selection and site design, meaning the bow-tie became more refined. The 2020 MMV plan was recently approved with a focus on an updated risk profile, clarification of the tiered approach, plus incorporation of operational and integrity processes. The 2020 MMV plan also continues to drive down costs and optimise monitoring frequency.

Quest was a FOAK (first of a kind) facility and the initial focus was to demonstrate that CCS works with an opportunity to evaluate and test technological limits. Lessons learned showed that the risks were approached very conservatively. Experience revealed that the biggest issues are with operational processes and what can be learnt and adapted from them. 'Understanding and perception of risk changes as you learn more'.

Panel Discussion

Do current risk management approaches need to be adapted to larger scale; does bigger storage mean riskier projects?

The bow-tie approach is commonly used at other active and potential storage projects (e.g. Northern Lights) and is likely to be used at multiple sites in the future. With the scaling up of projects, i.e. a project of 1 MT compared to a 50 MT site, there will be more wells and therefore larger databases of information on well performance that gives a better ability to understand and model the potential risks associated with well leakage. More wells also provide additional geological data on storage complexes. This comprehensive understanding and large number of wells allows adjustments to mechanical integrity plans, therefore allowing greater flexibility and risk reduction. With more injection, learning increases and uncertainties are reduced, however, as the plume migrates the probability of reaching legacy wells increases which can introduce new risks.

There was consensus between the panellists that with bigger projects there is a reduction in risk because more technical information can be assessed, but as more wells are likely to be encountered there is also an increased exposure to risk.

Are the biggest risks before, during or after a CO_2 injection project?

There is the potential for risks and challenges to arise at any point during the operational process, but the learning experience means that risks can be diminished as the project evolves. There needs to be some operational experience to be able to properly model well performance. A large amount of well data allows operators to compile and model the data for many different operations and situations. The mechanical integrity testing programme of a project is critical to allow proper understanding of uncertainty in a storage complex. Risk profiles are very site-specific and they depend on the amount of detail, i.e. geological data, well data etc., available at the beginning of a project and as it progresses.

Do public stakeholders have realistic or exaggerated perceptions about storage risks, and how should these be addressed?

As Shell has recognised, perceived risk by the public equals a risk for the project. It was noted that a lot of CO_2 storage projects have progressed in countries that are used to oil and gas operations, but a country with little experience of that industry could be wary. The location has an impact as does the familiarity with projects. As society evolves, and technological understanding grows, it is possible to build confidence in risk assessment. Perception problems arise where people do not understand the technology or lack familiarity or belief in the complexity of risk management.

It is critical that projects are transparent with their public stakeholders and that the information is readily available. Shell used a lot of methods for local engagement, including town hall meetings, coffee mornings and expert input directly to the community as well as having an open door policy for

community representatives to express any concerns or questions. Along with public communication, Shell were also very collaborative with NGOs, who were involved to help develop the stakeholder engagement plan. Not only should the local public be educated, but the wider population too with demonstrations to show how CCS actually works. Quest is a good example showing when it's done properly, there is little to no risk, which has and continues to be communicated to stakeholders including regulators and the environmental community.

How do you communicate to stakeholders how you quantify risk?

In an offshore environment, research work has been done in projects to actively collaborate with experts on how to detect and assess the impacts of leaks, for example at the STEMM-CCS project. Peer reviewed papers are then published, providing independent, scientifically sound assessments.

The bow-tie approach is an effective tool for people working on risk assessment, but it's also valuable for the general public as it's an understandable concept. Showing and explaining the bow-tie analysis of a project is a powerful way to explain the types of risks that have been considered and how measures can be applied to bring the risks to ALARP (as low as reasonably practicable) level.

On this point, it can be useful to apply a bow-tie approach to a day to day experience, like cycling or driving, to provide an analogy. If there is an appreciation of safety that relates to everyday life, and if this perception can be applied to the safety of well management, for example, it would be more understandable to the general public. CO_2 storage should be compared with some everyday activity that most people can relate to. It can be hard for people to conceptualise risk in technologies they lack familiarity with but it's important that this concept is understood.

What about the level of expertise and / or understanding of CO_2 storage operations in government regulatory bodies – are governments ready for CCS?

At the Quest project, the Alberta Energy Regulator (AER) approved the technical details around the MMV plan and the injection scheme. The AER is a semi-autonomous board that has been granted authority by the provincial Government of Alberta to ensure that companies develop its energy resources in a safe and environmentally responsible fashion. Effectively the AER is an oil and gas regulator so they have an abundance of understanding on well integrity. The operator educated the regulator on other aspects of the CCS project. There is positive collaboration and communication between Quest and the regulator which is an important concept that should be extended to other projects. The regulator should educate and assist with the project, and vice versa.

Discussion between different regulators is important too, to share experiences and learning, especially in emerging technologies like CCS. In many cases, there are several different jurisdictions involved in a single project so it's essential that they work together.

What level of monitoring is required to satisfy a project?

In the case of EOR projects, there are multiple (hundreds, if not thousands) of wells, and data acquisition systems provide real time data on how wells are operating. There is also control on the balance of pressure in the reservoir via injection and extraction operations. In the case of EOR and CO_2 storage onshore, there is a production aspect so real time monitoring is relied upon. Non-essential or 'luxury' technologies aren't used for financial reasons.

MMV programmes are adapted as each project progresses particularly in onshore settings. Offshore monitoring is slightly different as there is less opportunity for well monitoring and well interventions, but MMV is still adapted over time. The big takeaway for both onshore and offshore MMV is that operators should not stick to a rigid plan. It's crucial to adapt and change with time as each project progresses. There may be some regulatory requirements but many of the technologies and processes are decided upon as part of a discussion between operators and regulators. There is also flexibility with the monitoring plan designs.

In view of the evolution of risk management, what is the most significant improvement (tool or methodology) in the risk management process?

A monitoring tool alone is not sufficient for risk management – it's simply a means to provide data. This data helps to understand what is happening and how to react with the correct processes if required. A reaction plan is always needed based on the corrective measures developed in the bow-tie analysis. MMV and the associated tools not only provide monitoring data but the means to implement a risk based action plan.

With decades of operational experience particularly in the oil and gas industry and EOR operations the ability to detect and respond has improved tremendously. Consequently a much greater level of certainty can be provided. With continuous streaming there is almost too much data so smarter methods are required to analyse data. Monitoring equipment needs to be calibrated to ensure robust data is recorded and that operators can react immediately to events and avoid unnecessary issues.

With risk management at CCS projects, it must be emphasised that well integrity management is crucial; most of the potential issues are going to be well-related.

Conclusions & Key Messages

The ninety minute webinar and virtual panel discussion covered a wide range of ideas and conversation points regarding risk management of CCS projects, particularly looking at the evolution of risk during CCS projects' lifecycle. The following conclusions and key messages were drawn from IEAGHG's review of the panellists' discussion:

- The bow-tie risk assessment framework is a trusted approach for containment management of CO_2 storage projects.
- As injection progresses, accumulated experience increases and uncertainties are reduced. Risk management is a process for evaluating uncertainties and developing mitigation plans. This approach reduces exposure to risk as a project evolves.
- The geomechanical integrity testing programme is critical to allow proper understanding of uncertainty in a storage complex.
- As projects increase in size and number, there is also an increase in exposure to risk, but with more data risk assessment can be improved and uncertainties reduced.
- Perceived risk can be equated with adverse events. Perception problems can arise where people do not understand specific technologies or understand the complexity of risk management practices.
- Experience from live projects shows that it is critical that project developers are transparent with their public stakeholders and information is readily available.
- It's important to educate not only the local and wider public, but the regulatory and environmental communities.
- The bow-tie approach is also a powerful communication tool.
- Collaboration and communication between the project and the regulator is an important concept that should be followed by all projects, from planning to implementation, operation and eventual closure.
- Discussion between different regulators is important to share experiences and learning. The Alberta regulators communicate with other regulatory authorities.
- MMV programmes can be adapted and evolve as projects progress.
- Better methods are needed for analysing the significant quantities of data generated from MMV programmes.
- Well integrity management is crucial.

Previous Risk Management Network Meetings

The impetus behind this webinar, and discussion panel, was prompted by current travel restrictions and built upon key areas of growing importance identified by members of the IEAGHG Risk Management Network Steering Committee, particularly the anticipated scale-up of CCS projects worldwide. The original intention was to hold a Risk Management Network Meeting hosted by Total in Pau, southern France. Unfortunately the COVID-19 pandemic curtailed any prospect of holding this network meeting although it is hoped that another network meeting will be convened during 2021 depending on future international travel restrictions. The previous in-person Risk Management Network meeting was held in combination with the Modelling Network in 2018; for a copy of the report from this meeting, please contact tom.billcliff@ieaghg.org quoting report number 2018-07. For more information on the IEAGHG Risk Management Network, please visit our website at https://ieaghg.org/networks/risk-management-network.

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