INSIGHT

WHY ARE RISK ASSESSMENTS SO CRITICAL WHEN PLANNING TO TRANSPORT CO_2 BY PIPELINE?

Decarbonizing safely and sustainably will require a science-based approach to risk assessments for transporting CO_2 by pipeline – to meet regulatory requirements, streamline project approvals and ultimately increase the amount of carbon dioxide being removed from the atmosphere.

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Carbon dioxide (CO_2) has already been transported via pipelines for decades, but as the number of Carbon Capture Use and Storage (CCUS) facilities increases, the transportation capacity of pipelines must keep pace. With this growth, robust risk assessments will be required to promote and maintain safe CO_2 transport.

Energy companies and pipeline operators are under increasing pressure to establish and maintain their environmental, social and governance (ESG) credentials. Science-based risk assessments are a critical component of successful ESG strategies. When communicated well, they streamline project approvals while minimizing public concern.

The pipeline industry must implement comprehensive health, safety and environmental risk mitigation procedures for the transportation of CO_2 to secure their social license to build and operate this essential component of the energy transition.

What are the risks of transporting CO_2 by pipeline?

Transportation of any hazardous liquids and gases by pipeline has inherent risks. Risks from the release of hydrocarbons such as natural gas and crude oil have been well documented. They include damage from hazardous liquid plumes travelling over land or into water and releases of natural gas and other vapours can create fires, explosions or toxic vapour clouds. While CO_2 is not flammable and much less toxic than oil or gas, there are risks, and those risks must be understood, measured, and mitigated where possible.

Asphyxiation is the primary risk associated with an accidental release of carbon dioxide (vapour). CO_2 is found at >400 parts per million (ppm) naturally in our atmosphere, but when a large volume of CO_2 is released, it can displace oxygen in the air, causing difficulty breathing, headaches and dizziness. Asphyxiation can result if concentrations exceed 3% (30,000 ppm) or even less if exposure is maintained for longer. The risks can also increase under calm conditions or at lower elevations that could collect the heavy gas.

Past performance impacts policy

On February 22, 2020, a CO_2 pipeline failure in Satartia, Mississippi, resulted in local evacuations, caused almost 50 people to seek medical attention and proposed civil penalties that amount to $3,866,734. This incident prompted the Pipeline and Hazardous Materials Safety Administration (PHMSA) **to announce new safety measures**. Based on the requirements for new safety measures, California has passed a law (**SB 905**) prohibiting CO_2 from being transported by pipeline until the PHMSA has finalized the regulations. The PHMSA may take years to update the rules, and California's interim ban could become a significant barrier to CCUS deployment.

Leveraging risk assessment methodology from oil and gas

To inspire public and operator confidence, the ability to accurately assess risk from a CO_2 release – and develop appropriate mitigation measures using tools that have already been vetted, validated, and presented in regulatory formats – will be a crucial part of pipeline permitting and operation.

Scientists, regulators, and the energy industry have developed and implemented a range of modelling tools that have been used for decades to assess the risk of potential releases of hazardous liquids and gas. These tools are used to understand the movement, behaviour, and consequences following potential releases. Some of these same tools can also be applied to CO_2.

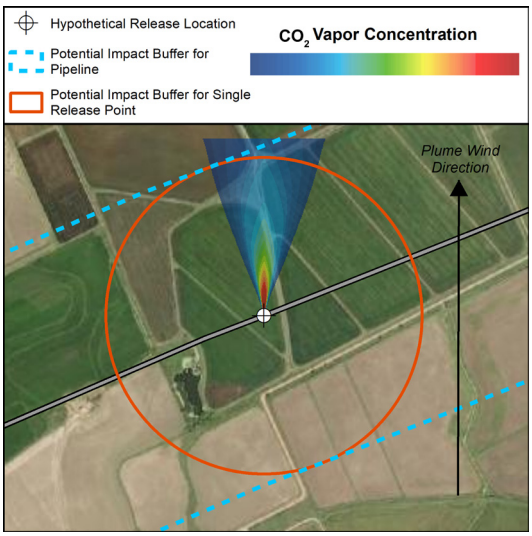
Atmospheric dispersion models can be used to simulate a release of CO_2 and to predict CO_2 vapour concentrations, and how large of an area could be impacted in the event of an accidental release from a pipeline. These model results can then be used to assess potential impacts to nearby receptors and to quantify risk along the entire pipeline route.

How is risk assessed through model simulations?

Model simulations are commonly used to assess the potential outcomes of a release of CO_2 along a pipeline. Simulations can be designed to account for the isolation of the pipeline from valves. A variety of hypothetical release scenarios are created using parameters like internal diameter, valves (operation type, location and the time to close), operating pressure, flow rate, and seasonal environmental conditions. Atmospheric dispersion modelling is used to simulate these scenarios to identify the range of possible impacts of release.

Many risk assessments will start with a set of baseline simulations that are performed to determine the consequences of the largest release possible. This ("worst-case" scenario) assumes a full-bore rupture of the pipeline. It uses maximum operating levels and maximum or no response (shutting down the pipeline and closing valves to isolate the release). While this is unlikely, it is often expected that an operator will assess a scenario like this in any risk assessment.

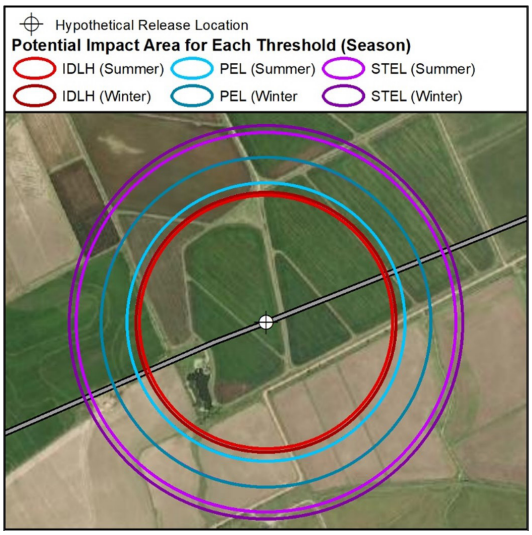
In addition to the baseline assessment, other scenarios can be performed to assess more likely release scenarios. These may account for more normal pipeline operation, expected isolation and response capabilities (as designed), or smaller (more likely) release scenarios. It can also be beneficial to perform sensitivity analysis to understand how the results under different operational conditions may impact a release. This can include changing parameters such as leak size, CO_2 temperature/pressure, and atmospheric conditions. This analysis can also aid in evaluating the impacts of more minor releases and helps determine the leak detection capabilities required to prevent adverse health and environmental effects.



Taking a conservative approach - Erring on the side of caution

When designing risk assessment model scenarios, it is best practice to be intentionally conservative and to estimate a reasonable maximum release to withstand scrutiny by the public, regulators and other stakeholders. All models require some level of assumption to simplify complex and dynamic

physical and chemical processes. In this modelling we assume constant wind speed and direction, and that the release occurs at ground level, not the buried pipeline. When assumptions are made, they should be designed to be conservative in order to estimate the maximum possible impacts.



A diagram of the distances of various threshold levels of a hypothetical release with concentration levels at multiple distances

According to a report released in 2022 from the US Department of Energy, between 70,000-96,000 miles (112K km – 154K km) of pipeline will be needed in the US alone for a target of 2.0 Gtpa CO_2 capture capacity by 2050. As of 2020, there are only approximately 5,000 miles of CO_2 pipelines in the US. That is a lot of new pipeline to approve quickly if the benefits of CCUS technology are to be realized swiftly.

Differentiating perceived and actual risk in transporting hazardous liquids or gases is a sensitive issue. At RPS, we're committed to a science-based approach to risk assessment that makes the complex project approval process easier while mitigating risk. We apply our decades of experience gained in the oil and gas industry to risk assessments and hazard management for decarbonization projects like CO_2 pipelines:

- integrating complex models and specialized engineering into risk assessments
- summarizing results for numerous model simulations and using Geographic Information Systems (GIS) to help visualize these results
- applying consequence modelling to help inform pipeline design, routing, and operation considerations to maximize safe operation

For more information regarding risk assessment for CO_2 transportation by pipeline, please get in touch with us using the form on this **page**.

Learn more about our services for CCS projects at rpsgroup.com/CCS