CO_2 Pipeline Systems: Assessment of the Risks and Health & Safety Regulations

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Delivering sustainable solutions in a more competitive world

Introduction

- **A project undertaken for the CO_2 Capture Project**
  - a partnership of eight of the world's leading energy companies and three government organisations
  - undertaking research and developing technologies to help make CO_2 capture and geological storage (CCS) a practical reality for reducing global CO_2 emissions and tackling climate change.
  - www.co2captureproject.org

bp
Chevron
ConocoPhillips
eni
BR PETROBRAS
Shell
StatoilHydro
SUNCOR ENERGY

US Department of Energy

Research Council of Norway

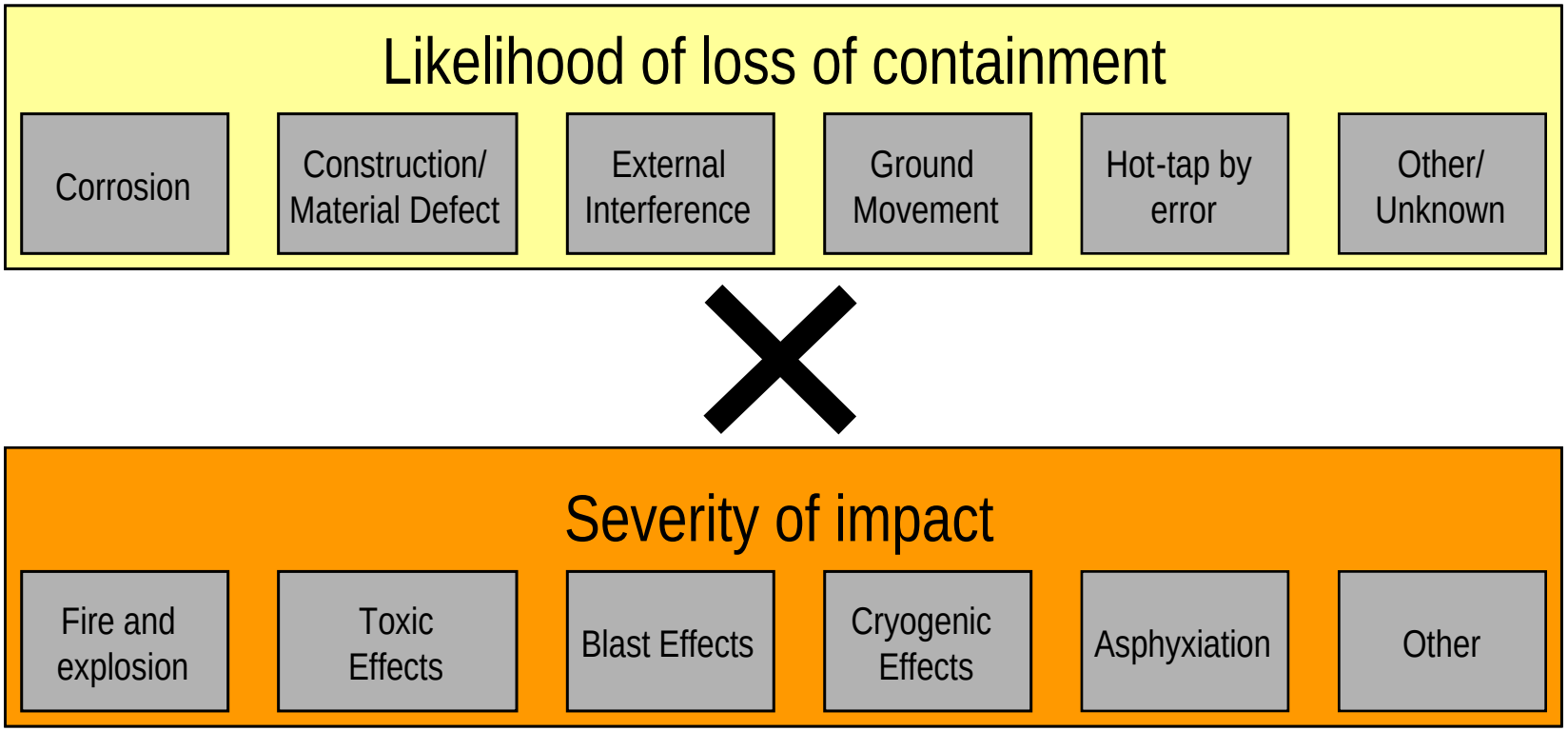
European Union

ERM

Project scope

- **To aid the understanding of the level of risk posed by CO_2 pipelines and how the risk is perceived and addressed by stakeholders:**
  - Comparative overview of the risks posed by natural gas, sour gas and CO_2 pipelines
  - Reviewing of safety regulatory requirements for pipelines in general, with a focus on CO_2 pipelines where these exist
  - Characterising the current state of acceptance of CO_2 pipelines from NGOs and other stakeholders
- **Canada, US and UK**

Pipeline risk assessment



CO_2 pipelines: similar approach to assessing risks as other pipeline systems, but with different impacts

CO_2 pipeline hazards associated with ….

Fire & explosion	Toxic effects	Blast effects & projectiles	Cryogenic effects	Asphyxiation

are….

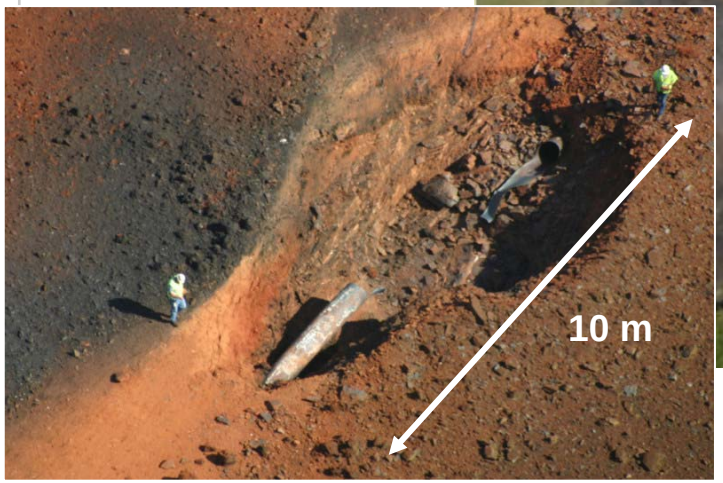
N/A	Comparable*	Lower	Higher	Higher

* May depend on composition of gas stream (i.e. presence of impurities/contaminants)

……. when compared to natural gas

Flammable materials

- **The impacts of ignited releases are all too obvious**



CO_2 poses an asphyxiation risk

- **Trees killed by carbon dioxide asphyxiation**

Pipeline comparative risk overview (1)

- **CO_2 pipelines should not pose higher risks than those already tolerated by wider society:**
  - provided that standards, controls and design factors for supercritical CO_2 transportation are taken into consideration.
  - based on the experience so far with CO_2 transport in the US (no deaths and limited damage over 20+ years)
  - as the frequency of incidents for CO_2 pipelines is similar to that of natural gas pipelines
- **However quality standards for CCS streams in order to transport CO_2 safely may be needed**
- **Potential environmental issues from CO_2 include asphyxiation of wildlife, changes to groundwater chemistry and soil acidification**

Pipeline comparative risk overview (2)

- **Overall level of risk posed by CO_2 pipelines difficult to assess with confidence (current limitations in modelling 3-phase releases)**
- **Key safety issues:**
  - Additional risks associated with higher population densities
  - Purity requirements and impurities in the transported stream
  - Higher operating pressures/masses in the dense/ supercritical phase

Safety regulatory gaps for onshore CO_2 pipeline transport by issue and jurisdiction

ISSUE

- Population density
- Impurities/purity requirements
- Supercritical/ dense phase issues
- Categorisation of CO_2

JURISDICTION

- UK
- US (Federal)
- US (Texas)
- US (Colorado)
- Canada (Federal)
- Canada (Alberta)
- Canada (Saskatchewan)

No issue / gap	Minor issue/gap	Major issue/gap

Population density

UK	US (Federal)	US (Texas)	US (Colorado)	Canada (Federal)	Canada (Alberta)	Canada (Saskatchewan)
Covered by existing gas transportation regulations. ALARP risk-based approach	Covered by existing gas transportation regulations. HCA risk- based approach	State level legislation follows federal and in Texas includes rural areas	State follows federal regulations	Covered by existing Federal and Provincial gas transportation regulations under pipeline design specifications (i.e. operating pressure) that are dependent upon population density	Covered by existing Provincial gas transportation regulations. Pipeline design specifications (i.e. operating pressure) are dependent upon population density	Covered by existing Provincial gas transportation regulations. Pipeline design specifications (i.e. operating pressure) are dependent upon population density

All jurisdictions take into account population density as a factor in risk assessment

Impurities & purity requirements

UK	US (Federal)	US (Texas)	US (Colorado)	Canada (Federal)	Canada (Alberta)	Canada (Saskatchewan)
European Commission not mandating purity requirements currently. Case by case basis at a member state level Risk assessment approach Risks are not yet fully understood More research would be required	Not covered by existing gas transportation regulations, but covered in tariff cases and contracts.	Not covered by existing gas transportation regulations, but covered in tariff cases and contracts.	Not covered by existing gas transportation regulations, but covered in tariff cases and contracts.	CO_2 is treated as a commodity and existing pipeline federal regulations do not apply.	Existing gas transportation regulations require that "high purity". CO_2 pipeline applications must indicate corrosion mitigation and monitoring issues due to water content and other impurities.	There are no specific requirements in the provincial regulations. There is reliance on CSA Standard Z662.

Purity requirements are expected to be destination-specific- i.e. CO_2 for EOR or to direct saline formation

Supercritical / dense phase issues

UK	US (Federal)	US (Texas)	US (Colorado)	Canada (Federal)	Canada (Alberta)	Canada (Saskatchewan)
No UK safety regulations or standards for pipelines transporting CO_2 in the supercritical phase. The UK HSE considers there may be technical benefit to applying the US Federal Code to proposals for conveying supercritical CO_2	Comprehensive safety regulations for transporting, design, and operation of these pipelines.	Covered by existing gas transportation regulations.	Enforces federal requirements, but no additional specific requirements.	CO_2 is treated as a commodity and existing pipeline federal regulations do not apply.	Existing gas transportation regulations require that CO_2 pipeline applications must indicate specific operating pressure ranges and pressure drops to avoid unnecessary phase change. Minimum pressure must be 7.4 Mpa which ensures CO_2 is in dense state.	There are no specific requirements in the provincial regulations. There is reliance on CSA Standard Z662.

Addressing supercritical/dense phase issues important because of energy and mass of potential releases

Categorisation of CO_2

UK	US (Federal)	US (Texas)	US (Colorado)	Canada (Federal)	Canada (Alberta)	Canada (Saskatchewan)
HSE intends to consult on an amendment to the Pipelines Safety Regulations which would deem pipelines carrying bulk quantities of CO_2 at high pressure as "Major Accident Hazard Pipelines".	DOT regulations list CO_2 as a Class 2.2 hazardous material (non-flammable)	Follows federal regulations	Follow federal regulations	Covered by existing Federal and Provincial gas transportation regulations and classified as Dangerous Goods (Class 2.2 Non Flammable, Non Toxic Gas)	Covered by existing Provincial regulations and classified as Non Flammable, Non Toxic Liquid	The province adopts the federal TDG regulations (with some exceptions). Same as federal categorization.

May be classified as 'dangerous fluid' under COMAH and PSR

US and Canada, with CO_2 transport experience, regulate CO_2 as a non-toxic, non flammable gas

Attitudes of affected communities by O&G pipeline projects

- **Consultation results for a major natural gas and a crude oil pipeline - concerns of the local community:**
  - Arise during construction and operation
  - Safety issues
  - Land take
  - Water pollution
  - Interruption of crossing (Rights of Way)
  - Habitat destruction (project or illegal loggers)

Lessons from existing pipeline projects

- If risk perceived as high, possible difficulties in securing private / agricultural land and RoW
- Positive aspects (e.g. economic growth, energy security) sometimes used to influence acceptance
- Engage early on to educate local communities on the wider societal benefits
- A well organised and interactive consultation and awareness programme can be important

Perception surveys for CCS & CO_2 pipelines

- Most respondents perceive the risks associated with CO_2 pipelines as similar to natural gas
- Many respondents did not have a clear opinion
- General public know very little about CCS (and thus about the associated risks)
- Variations between different countries / regions
- People would like more information about risks to human health and environment
- Canadian regulators feel more confident in understanding the risks posed CO_2 pipelines than UK

Summary

- CCS offers a means of reducing global CO_2 emissions and tackling climate change
- CO_2 pipelines should not pose higher risks than those already tolerated by society
- A lack of public acceptance could potentially be a “deal breaker” and impede policy development
- A lack of public acceptance may also hold up planning authorisation for capture, transport and especially storage (NUMBY “not under my backyard”)
- Need to demonstrate GHG (and other) benefits of CCS and that risks can be adequately managed

Thank you for listening

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