Health and Safety
Executive

Controlling Health and Safety risks in Carbon Transportation and Storage

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Key Messages

- Need to consider of the hazards and risks of CCS in order to enable its safe introduction.
- An appropriate safety regulatory regime will underpin public confidence in CCS technologies.
- We need to recognise the limitations of current knowledge and address the specific challenges associated with CCS.

Changes to CO_2 hazards

- Very familiar substance
- Few hundred ppm in atmosphere
- Handled industrially for many years in drinks industry, solvent extraction etc

But …

- ➢ Scale proposed is very different
- ➢ Properties of supercritical/dense phase
- ➢ Regulations did not envisage CCS

Pipelines Safety Regulations 1996

- General duties apply to all pipelines
- Additional duties apply to major accident hazard pipelines conveying dangerous fluids
- Land use planning controls in the vicinity of major accident hazard pipelines
- Interim guidance at http://www.hse.gov.uk/pipelines/co2conveying.htm

Striking the balance

- Should CO_2 be defined as a dangerous fluid?
- How can we do this without introducing unnecessary regulatory controls on existing CO_2 industries?

Major Accident Hazard Potential of CO_2

- Exposure to high concentrations of CO_2 is known to be fatal
- A major pressure loss of dense phase CO_2 could result in:
  - Cryogenic burns/embrittlement of neighbouring plant
  - Toxic contamination
  - Dry ice ‘grit blasting’ effects

Risks can be controlled

- 20 000 km of high pressure natural gas pipelines in the UK
- Milford Haven pipeline – 300km, 48”, 94bar

Modelling the risk

Work completed

- Toxicity quantified in form of DTL values
  www.hse.gov.uk/hid/haztox.htm

- Comparative study of hazard ranges from CO_2 and natural gas
  (publication pending)

SLOT and SLOD conditions

Exposure period (min)	CO_2 concentration (%) producing the	
	SLOT	SLOD
0.5	11.5	15.3
1	10.5	14.0
10	7.9	10.5
30	6.8	9.2
60	6.3	8.4
120	5.5	7.7

Specified Level of Toxicity (SLOT)

Significant Likelihood of Death (SLOD)

Modelling the risk

Work ongoing

- Defining the characteristics of a large-scale high pressure CO_2 release.
- Estimating the consequences of a loss of containment event.
- Determining failure rates.

Is there a risk based argument to define CO_2 as a dangerous fluid?

Source terms

Standard gas dispersion models do not consider phase change

Experimental validation coupled with theoretical understanding needed

Cooling effect

- High Joule-Thomson cooling effect
- How significant in:
  - Pressure let-down in piping
  - Blowdown
  - Incident scenarios
- Effect on plant or structures
- Brittle fracture?

Areas of uncertainty

- Limited experience: 10,000 years UK North Sea experience in hydrocarbon major accident hazards but <100years in handling large scale CO_2 flows

- Best practice for modelling CO_2 releases from dense/high pressure.
- Best practice for containment, integrity and operation.

Looking forward

- Industry are looking for certainty or at least a clear direction of travel.
- UK demonstration project – bidders advised to assume major hazard legislation will apply.
- A common regulatory approach to CCS - North Sea Offshore Authorities Forum working group.
- How should we regulate health and safety at capture/injection sites?

Conclusions

- HSE is working with other Government departments, international partners and industry to enable the safe introduction of CCS technologies.
- An appropriate regulatory regime will support societal acceptance of CCS technologies.
- Ongoing research is required to fill knowledge gaps.

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