Safe CO_2 Operations – Key Considerations

(Major Accident Hazards)

SPE - CCUS Conference 2020

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Hamish Holt

Senior Principal Consultant

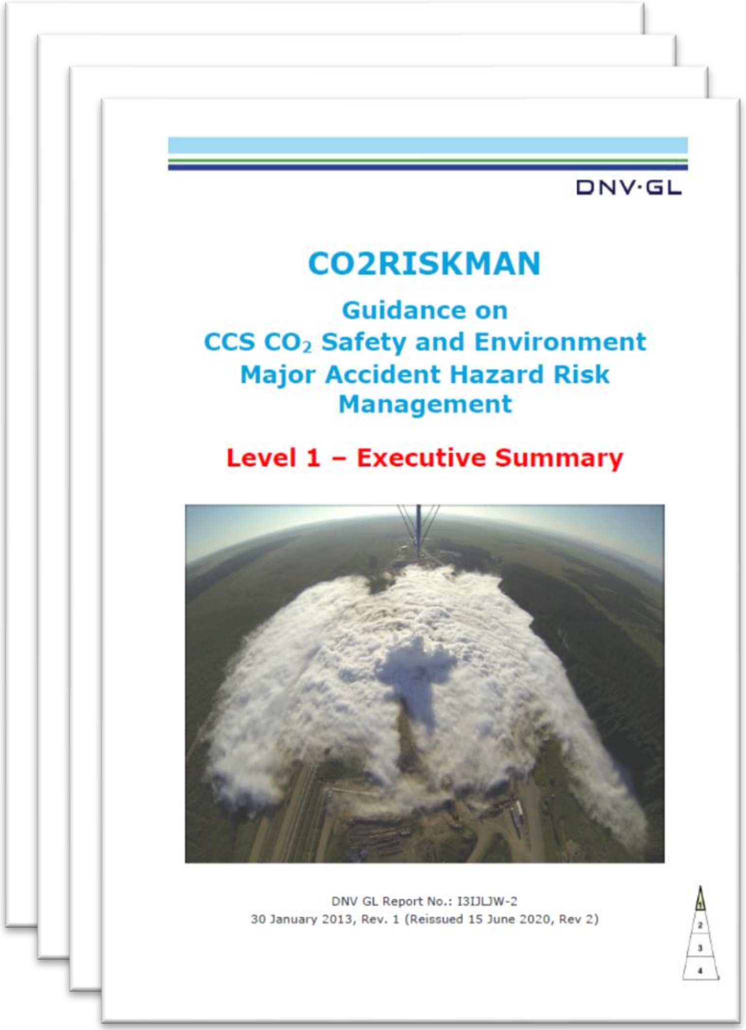
DNV GL

Key Message

"There is **no reason** why the **major accident risks** from a CO_2 handling system within a CCS operation **cannot** be low and well **within acceptable limits**.

To **achieve this** will require the **application** of **existing** rigorous **hazard management** processes combined with an **adequate understanding** of the properties and behaviours **of CO_2**."

Existing Industry Guidance


DNV·GL

CO2RISKMAN

Guidance on
CCS CO_2 Safety and Environment
Major Accident Hazard Risk
Management

Level 1 – Executive Summary

DNV GL Report No.: I3IJLJW-2
30 January 2013, Rev. 1 (Reissued 15 June 2020, Rev 2)

"Guidance on CCS CO_2 Major Accident Hazard Risk Management"

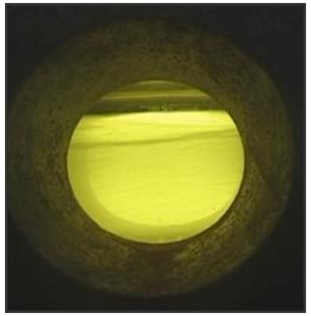
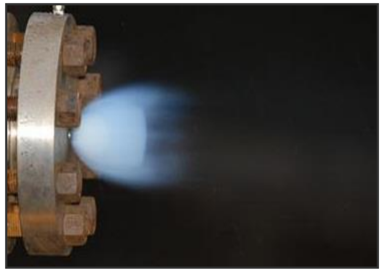
Developed by DNV GL and the following organisations:

- Air Liquide
- AMEC
- Chevron
- Environment Agency
- E.ON
- Gassco AS
- Gassnova SF
- Global CCS Institute
- Health & Safety Executive
- IEAGHG
- Institute for Studies and Power Engineering
- Maersk Oil
- National Grid
- Petroleum Safety Authority
- Scottish Environment Protection Agency
- Shell

Downloadable from: www.dnvgl.com/ccus

Knowledge Gain – Spadeadam Large Scale CO_2 Releases

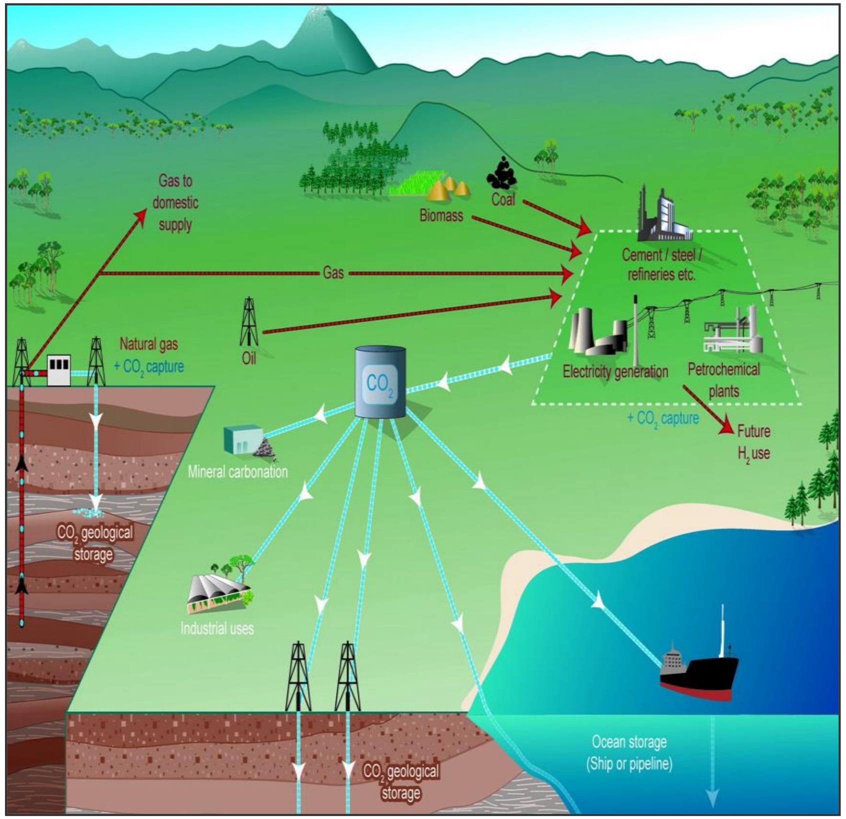



Photos courtesy of the DNV GL CO2PIPETRANS JIP

CCUS CO_2 Context

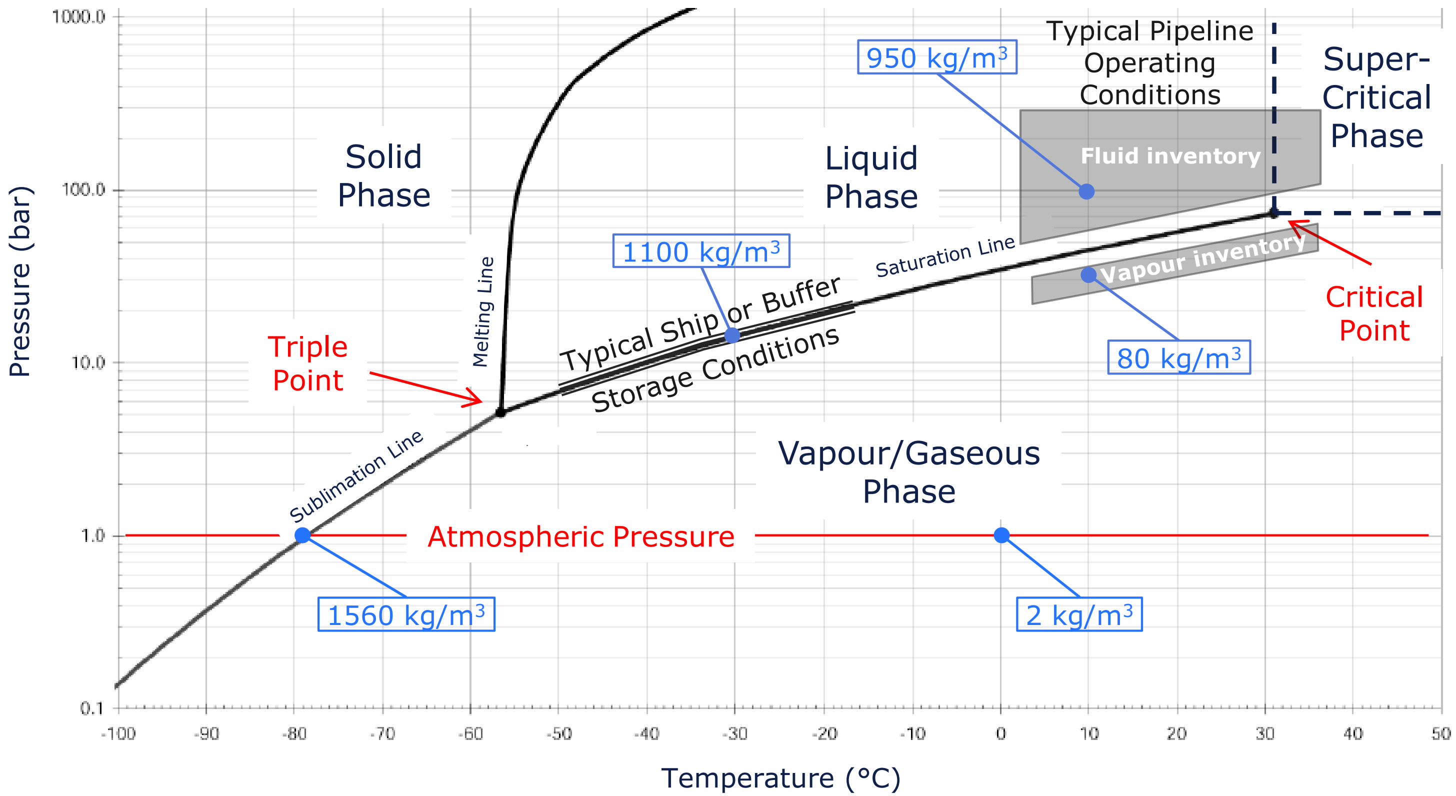
- Very large inventories of CO_2
- Transitions between gas, liquid and supercritical phase CO_2
- Geographical spread across land and subsea
- Point to point and integrated clusters
- Pipelines & ports located near populated areas
- Different stakeholders along the CCUS chain
- Dependency between links for hazard management
- New, untried or scaled up technologies
- Lack of experience and/or misplaced cross-industry learning
- Impurities vary considerably between sources
- Uncertain major accident regulatory oversight
- Many drivers for rapid, cost efficient and widescale deployment



Perception of some that CO_2 is not hazardous

Key Aspects of CCUS CO_2

- Pure CO_2:
  - Can only exist as a solid or vapour at atmospheric pressure
  - Depressurising liquid CO_2 will phase change to a mixture of low temperature gas and solids
  - Colourless, odourless & invisible vapour
  - Water vapour cloud only indicates chilled air
  - CO_2 vapour is heavier than air (x1.5)
  - Carbonic acid forms with water
  - Liquid & SC CO_2 are excellent solvents
  - Toxic (>5%) & asphyxiant (>50%)
- Impurities (e.g. SO_x, NO_x, H_2, N_2, etc.) change phase envelopes and the above



Example inventories:

100km 90cm dia pipeline – gas phase: ≈5,000 tonnes CO_2

100km 90cm dia pipeline – liquid phase: ≈60,000 tonnes CO_2

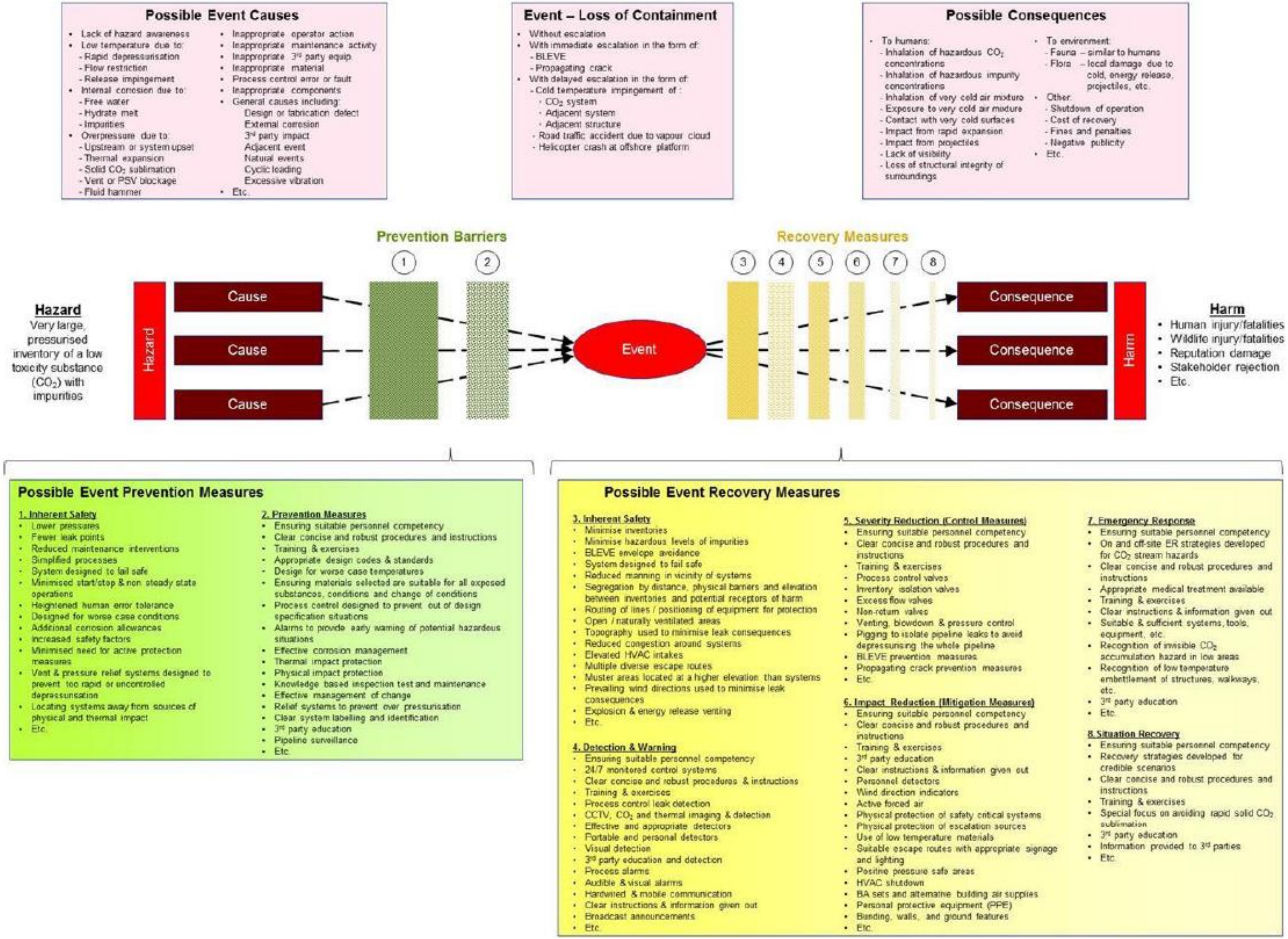
10m high 20m dia storage tank – gas/liquid phase: ≈3,500 tonnes CO_2

Major Accident Potential !

Generic Knowledge For Specific CCUS Developments

CO2RISKMAN Level 3 – Table of Contents

Generic Bow-Tie Diagram



Regulatory Oversight

- Where?
  - When the CO_2 mass inventory is above a defined threshold to cause a major accident

- Why?
  - To provide a clear, consistent, and risk-based requirements
  - To ensure the major accident hazard risks are effectively managed down to an acceptable level
  - To help gain and maintain public acceptance
  - To help avoid “knee jerk” regulations after the first significant major accident
  - To help ensure the long term success of CCUS

- How?
  - Existing major accident regulations are available for adaption (e.g. COMAH, PSR & SCR)
  - Competent Authorities are already providing oversight to other major accident industries

Concluding Remarks

- Some CCUS CO_2 systems will have the potential to cause a major accident
- Properties and behaviours of the CO_2 stream will cause or contribute to a major accident event
- Relevant knowledge, experience and hazard management processes exist to manage the risks
- Regulatory oversight of the major accident potential of CCUS is essential for effective risk control
- Long term success of CCUS depends on all operators delivering safe operations

" if you think safety is expensive, try an accident."

Dr Trevor Kletz – Process Safety Guru

Thank you

CO2RISKMAN Guidance downloadable from www.dnvgl.com/ccus

Hamish Holt
Hamish.holt@dnvgl.com
+44 (0)7775 820117

www.dnvgl.com

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