OIL & GAS

DNV GL Recommended Practices for CCS
- and a bit of CO$_2$ shipping

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Global reach – local competence

150 years
400 offices
100 countries
16,000 employees
Organized to maximise customer value

MARITIME

OIL & GAS

ENERGY

BUSINESS ASSURANCE

SOFTWARE

CYBERNETICS

RESEARCH & INNOVATION
Standardisation makes the industry more cost efficient

WE INNOVATE TOGETHER WITH THE INDUSTRY TO PRODUCE MARKET LEADING STANDARDS AND RECOMMENDED PRACTICES THAT ARE INTERNATIONALLY RECOGNISED
Committed to innovation

- Investing 5% of our revenue in research and innovation every year
- Collaborating with industry partners and external experts
- Sharing knowledge through standards and recommended practices
- Providing foresight and initiate competence building and innovation
Some challenges along the CCS value chain

Capture
- Fossil power plants
- Natural Gas CO$_2$ reduction
- Other industrial processes

Transport
- Pipelines
- Ships

Injection
- New wells
- Existing wells
- Abandoned wells

Storage
- Depleted oil or gas reservoirs
- Saline aquifers
- Enhanced Oil Recovery (EOR)

- Introduction of new technologies
- Up-scaling
- Accidental discharge and dispersion

- How to utilise Natural Gas experience
- Accidental and planned pressure release
- Flow assurance and operational issues

- Very long time scale
- Physical/chemical properties of CO$_2$: pH, supercritical behaviour, solubility in brine
- Well assurance

SCALE-UP, INTEGRATION, COMMUNICATION, ACCEPTANCE

Ungraded
Complimentary to other CCS Joint Industry Projects

CO2CAPTURE  Transport  INJECTION  Storage

CO2PIPETRANS  CO2WELLS  CO2QUALSTORE

CO2RISKMAN  www.dnvgl.com/ccus
DNV GL’s Recommended Practices and Guidelines

- DNV Recommended Practices
- DNV-RP-201 *Qualification Procedures for CO2 capture technology*
  - Based on the project specific guideline developed in the CO2CAPTRURE JIP
- DNV-RP-202 *Design and Operation of CO2 Pipelines*
  - Based on the project specific guideline developed in the CO2PIPETRANS Phase 1 JIP
- DNV-RP-J203 *Geological Storage of Carbon Dioxide*
  - Based on the project specific guidelines developed in CO2QUALSTORE and CO2WELLS
- CO2RISKMAN Guideline
a quick example
CO2PIPETRANS Phase 1

1. Kick off Phase 1 August 2008
2. State of the art
3. Gap-analysis offshore
4. Gap-analysis onshore
5. Key technical studies completed
   - Ductile fractures
   - Fatigue
   - Pipeline operation
   - Flow assurance
   - Corrosion
   - Material compatibility
   - Safety issues
6. Final project specific guideline was issued to the partnership 1st of September 2009
7. DNV Recommended Practice J-202 *Design and Operation of CO₂ pipelines* issued in April 2010
CO2PIPETRANS Phase 2

- **Objective**: Close significant knowledge gaps and update the Recommended Practice

- **Scope of Work:**
  
  WP 1 – Liquid & supercritical phase CO$_2$ release modelling validation data
  
  WP 2 – Full scale crack arrest testing
  
  WP 3 – Corrosion
  
  WP 4 – Material compatibility (elastomers/polymers)
  
  WP 5 – Examine effects of contaminants on the phase diagram
  
  WP 6 – Hydrate formation/ Water solubility
  
  WP 7 – Public Communication and Interaction
  
  WP 8 – Update of Recommended Practice

- Two batches of experimental results was made publically available in 2012, more to come in 2013.

- Updated Recommended Practice will be issued in **2014**
For those of you that thought this sounds a bit dry...
Short look at CO$_2$ shipping
In what state are CO$_2$ transported?

- **Ship transport**
- **Pipeline transport**
- Typical envelope for normal operation
CO₂ shipping – similar to other gas carriers

- Three out of four of today's CO₂ carriers are classified by DNV GL
  - They carry CO₂ for the food and nuclear market
- CO₂ carrier challenges do not differ from other carriers,
  - Pressure/temperature requirements for keeping CO₂ in liquid phase on both ship and terminal during loading and unloading
- Our rule book is updated with the special considerations for liquefied carbon dioxide (LCO₂)
Thank you for your attention!

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SAFER, SMARTER, GREENER

Ungraded