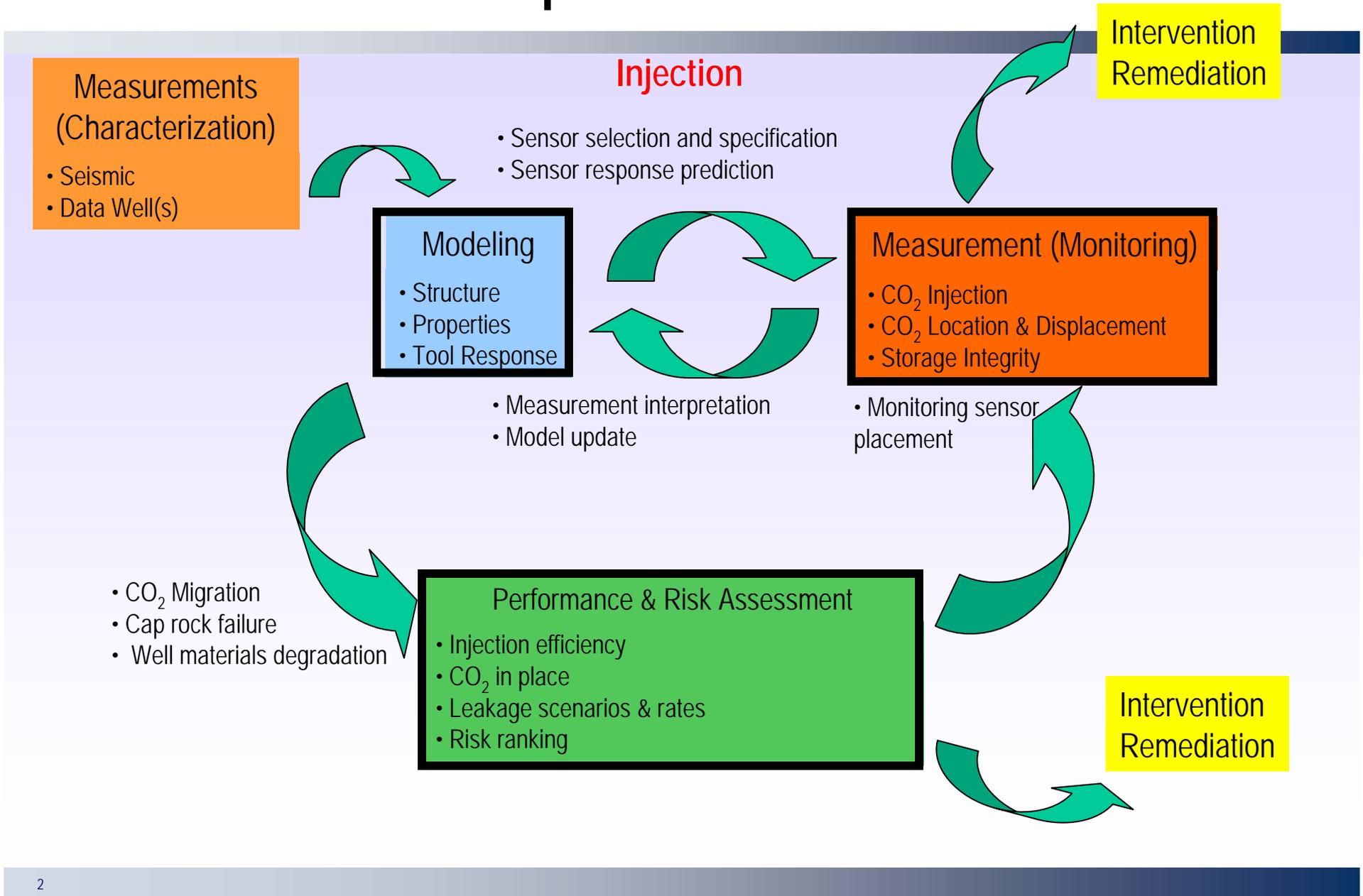


Risk Assessment

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Schlumberger Carbon Services
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Thanks to Ken Hnottavange-Telleen for lending many slides

MVA is a iterative process



FEPs

- A **Feature** is a static attribute of a system.
Example: Reservoir porosity.
- An **Event** is a sudden change in the system or its environment.
Example: Lightning strikes the dehydration equipment.
- A **PROCESS** is a way in which system attributes or conditions change in a relatively slow and progressive way.
Examples:
Injected CO₂ ...
... displaces formation brine near the injection well,
... migrates updip away from the injection well,
... partially dissolves into formation brine.
Manufactured components ...
... decay and degrade over time, in various ways.

FEP concepts

- Any scenario involves multiple F's – E's – P's; one FEP may have multiple risks. There IS "redundancy" that minimizes the chance of overlooking an important risk.
- The Basic Questions
 - 1) "If something went wrong related to this FEP ...
 - **How Severe** would the impact be?
 - **How Likely** is it that project values would be negatively impacted?"
 - 2) "What are the specific risk targets, and how do we reduce risk to those targets?"
- Risk is defined as the product of the severity and the likelihood $R=L*S$

Features, Events, and Processes

The screenshot shows a web browser window with the URL <http://www.quintessa-online.com/co2/PHP/frames.html>. The page features the Quintessa logo and the title 'CO₂ FEP Database'. The main content area is titled 'Risk Assessment' and includes navigation links for 'Home', 'Generic Database Front Page', 'Go Back', and 'Print'. A user login status is shown as 'Ken Hnottavange-Telleen' with a 'Change your password' link. The database entry is for '2.1.3 CO2 composition', with a 'Suggest FEP improvement' link. The entry details include a description of CO₂ composition and physical state, its relevance to performance and safety, and a list of references. The page is copyrighted by Quintessa Ltd. in 2004.

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43/178 Full list / [CO₂ Storage](#) / [Pre-closure](#) / [CO₂ composition](#) [Suggest FEP improvement](#)

Name 2.1.3 CO₂ composition **F E P**

Description
The composition and physical state (liquid, supercritical fluid etc.) of injected CO₂, with contents of impurities etc. Temperature and pressure of injected fluid are also relevant.
During CO₂ storage operations, the principal injected gas is CO₂ captured and concentrated from human activity sources. However, the gas that is injected into a reservoir may not be 100 % CO₂, especially if there is some recycling of gas (in the case of enhanced oil recovery). Impurities can include: H₂S, CH₄, N₂, NO_x, SO₂ and mercaptans. These may be present either intentionally or because it could be particularly difficult or superfluous to separate them from CO₂.

Relevance to performance and safety
The presence of even small amounts of other gases has a strong effect on the phase behaviour of CO₂-dominated gases. High-pressure equations of state for CO₂-dominated gas mixtures are required to take into account changes in critical pressures and temperatures caused by the presence of other gases. Impurities will reduce the critical temperature which, in turn, has effects on interfacial tension.
Amongst the possible companion gases, NO_x and SO₂ are particularly relevant because:
- NO_x and SO₂ are polluting gases that are generated by the same power plants that generate massive amounts of CO₂ and attract emission taxes in certain countries (e.g. Italy). Their injection, in smaller amounts, with CO₂ could therefore help the economics of sequestration.
Impurities may affect pore water chemistry (pH and redox conditions, for example) depending on the impurities involved. Special care is needed when considering corrosive gases, such as H₂S.

References
1. [Islam R, Malik O, Huang S and Dong M. \(1999\). Potential of Greenhouse Gas Storage and Utilisation through Enhanced Oil Recovery. Saskatchewan Research Council](#)
2. [Holloway et al. \(1996\). The Underground Disposal of Carbon Dioxide. British Geological Survey](#)

Links
There are no links.

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FEP concepts

- Any part of a project includes multiple Features and Processes; might include an Event, too.
- Same with risks: they usually involve multiple FEPs.
- And one FEP may entail multiple risks. Therefore:
- FEP concepts DO create overlap.
- Conceptual overlap minimizes the chance of overlooking an important risk.

Key FEPs are used to construct scenarios

Quantitative risk/hazard assessment workflow of scenario approach

