The safety assessment SR-Can

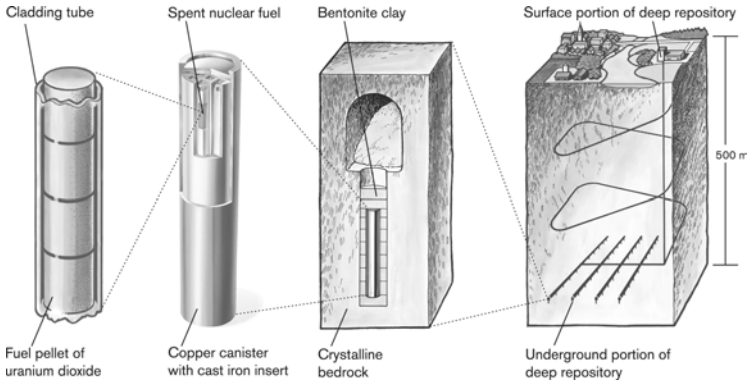
Allan Hedin, SKB

Outline

- Context
- Purposes, time plans etc
- Methodology

SR-Can planning IGSC topical session 15 October 2003

The KBS 3 repository

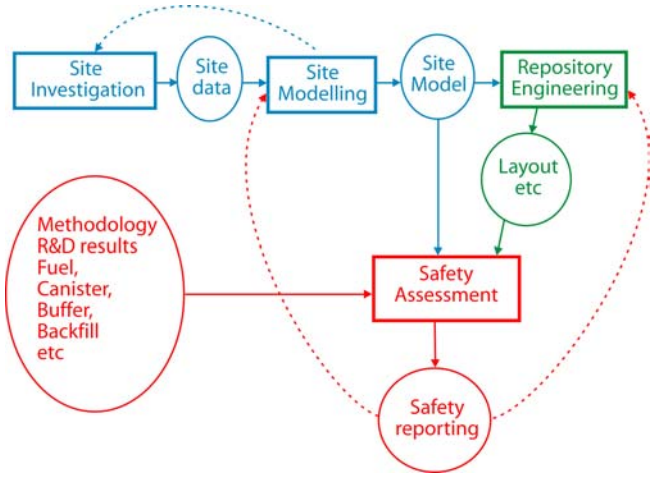


- Primary safety function: isolation
- Secondary safety function: retention

Context: Safety assessments during current program stage

- SKB is pursuing site investigations for SNF deep repository at Östhammar and Oskarshamn (2 sub-areas)
- Initial site investigations 2002 - 2005
  - Preliminary site evaluations to i) assess suitability and ii) give feedback
- If OK: Complete site investigations 2005 – 2008
- Aim: Application to build deep repository at one site to be handed in 2008, supported by safety assessment SR-Site
- Application to build encapsulation plant to be handed in 2006, supported by safety assessment SR-Can

Context: Site, engineering & safety



Context: Site description

- Site analysis group provides site description based on site investigation data. The site description consists of
  - A model of the geosphere and the biosphere at present
  - Site understanding, essentially a demonstration of how historic evolution has lead to the present situation
  - Hydrological simulation model to be used also in safety assessment to study future evolution

Purpose of the SR-Can project

- The purpose of the SR-Can project … to produce a safety report for the deep repository that will form part of the application to build an encapsulation plant
- The report shall be finished by the end of 2005.

Purpose of the SR-Can report

- SR-Can should assess the safety of a KBS 3 repository at Forsmark and Simpevarp with canisters according to the application to build the encapsulation plant
- SR-Can should provide feedback to further canister development, to repository design development, to further site investigations, to SKB's R&D programme, and to future safety assessment projects.

Miscellaneous

- Planning report TR-03-08
- Interim report, emphasis on methodology summer of 2004
- Final report SR-Can end of 2005,
  analyses of model version 1.2 of Forsmark and Simpevarp
- Assessment period: One million years after closure

The planning report TR-03-08

- Main chapters
  - Methodology
  - Climate issues
  - Biosphere issues
  - Geosphere issues
  - Near field issues
  - FHA (Intrusion issues)
  - Integrated modelling
- Appendix: SKI's and SSI's regulations
  - Inserted in text: references to sections in main chapters where plan for handling in SR-Can is given

SR-Can, methodology

- ”Main issue”: Does the evolution of the repository over time lead to doses/risks that exceeds given criteria? (SSI: Annual risk to individuals less than 10^{-6})
- Repository evolution determined by
  - Initial state
  - A system of coupled ”internal” processes in fuel, canister, buffer, backfill, geosphere and biosphere
  - External influences
- Need to handle uncertainties for all these aspects

Methodology in nine steps

1) Qualitative system description, FEP processing
2) Initial state descriptions
3) Description of internal processes and their handling in the safety assessment
4) Description of external conditions
5) Preliminary analyses
6) Scenario selection
7) Input data selection
8) Analysis of evolution for chosen scenarios
9) Integration of results and conclusions

SR-Can FEP database

- Audit of NEA's FEP database (which includes SKB's databases)
- FEPs sorted into categories
  - Initial state
  - Internal processes
  - External conditions
- Internal processes roughly same as those in SR 97

Initial state

- One or more initial states to be selected; both "reference state" and "deviating" states
  - Site according to model version 1.2 Forsmark and Simpevarp including alternative site interpretations
  - Reference design of KBS 3 in site specific tunnel layout (Repository engineering)
  - Conceivable deviations from reference design (e.g. mishaps during construction and operation). Note that e.g. initially damaged canisters to some extent are included in reference design.
  - Open design issues (buffer- and backfill materials, excavation technique etc)
  - Management of all "initial state FEPs"

Handling of internal processes

- Updating of SR 97 Process report
- Biosphere in separate report
- Documentations for each process
  - Overview/General description
  - Influencing/Influenced variables
  - Boundary conditions
  - Model studies/Experimental studies
  - Time perspectives
  - Natural analogues/observations in nature
  - Handling in safety assessment (“neglected or quantified”)
  - Handling of uncertainties
  - References
- Yields mapping of processes on models

Preliminary analyses

- Purpose: Gain insight into system evolution and into importance of specific issues, pave the way for selection of scenarios
- Examples of issues:
  - How does buffer and backfill evolve when exposed to ”reference water”, sea water, glacial melt water, oxygenated water?
  - Canister corrosion for the above waters, for initially entrapped oxygen and for buffer impurities
  - At what isostatic load does the canister collapse?
  - Consequences of maximum conceivable earthquakes with applicable respect distances
  - What uncertain input data dominate output distributions in radionuclide transport- and dose calculations?
  - Ditto for calculations of peak canister surface temperature, etc…

Choice of scenarios

- Overall aim of the safety assessment: Determine whether SSI's risk criterion is fulfilled
  - A number of alternative evolutions (scenarios) must be analysed
  - Together, the scenarios must give a reasonable coverage of conceivable evolutions with respect to radiological consequences
  - A risk contribution is calculated for each scenario = probability for the scenario times dose consequence
  - The risk contributions are added to yield a total risk
- Each scenario may have a number of variants

Choice of scenarios

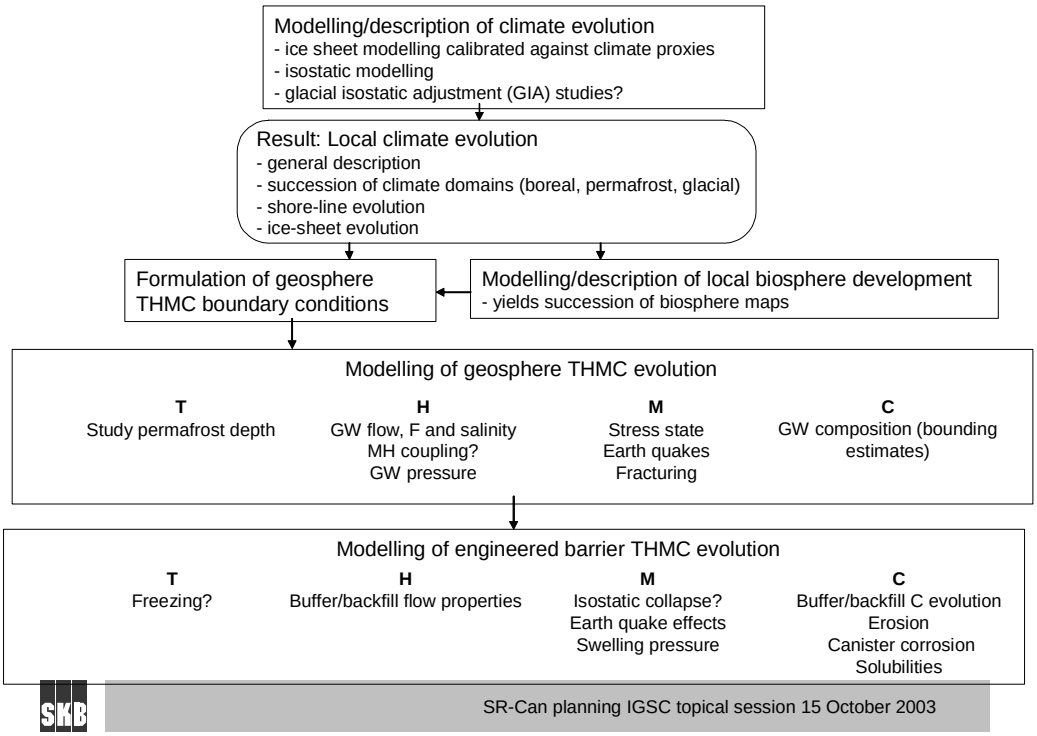
- Bases
  - Initial state report
  - Preliminary process report
  - Description of climatic evolution
  - Results of preliminary analyses
  - Descriptions of "safety functions"
  - A first analyses of repository "expected evolution"?
  - Etc
- Can be forecasted:
  - A "main scenario" with "probable" evolution of climate etc.
  - Several alternative climatic evolutions need to be included
  - A scenario where today's biosphere persists (required by SSI, zero probability?)
  - Earthquakes to be included in all scenarios (contrary to SR 97)
- A number of bounding cases will be analysed but probably not as formal scenarios (not included in risk calculation)

Analysis of chosen scenarios

- Analyse system evolution for each scenario
- If evolution implies canister ruptures (or initially damaged canisters):
  - Radionuclide transport and dose consequences for each scenario, typically for constant, pessimistic barrier properties derived from system evolution
  - Probabilistic calculations to manage data uncertainties within scenario
- Early in project: test analysis of entire glacial cycle
  - Assume repetition of last glacial cycle (Weichsel)
  - Specify sub-analyses and their interdependencies

Input data report

- Input data to radionuclide transport and other calculations
- Template for discussion of input data and data uncertainties is being developed and tested
- On what input data should we focus?
  - Sensitivity analyses on-going…



Handling of uncertainties

- Preliminary plan in Planning report; description of handling of uncertainties in the following steps:
  - Derivation of a comprehensive set of internal processes and variables
  - Compilation of Process Report
  - Derivation of a set of initial states that cover all relevant safety related features
  - Derivation of external conditions
  - Compilation of input database
  - Selection of scenarios
  - Model evolution for each scenario
  - Bounding calculation cases

SR-Can planning IGSC topical session 15 October 2003

Interim report Summer 2004

- Purpose: To consult with SKI and SSI on methodology for SR-Can
- Much of the methodology formulated in planning report
  - Dialogue has already started
- An Interim report will
  - not be a full safety report
  - not draw conclusions concerning safety for the analysed site
- Form of publication to be determined