Review of SKB's Radionuclide Transport Methodology

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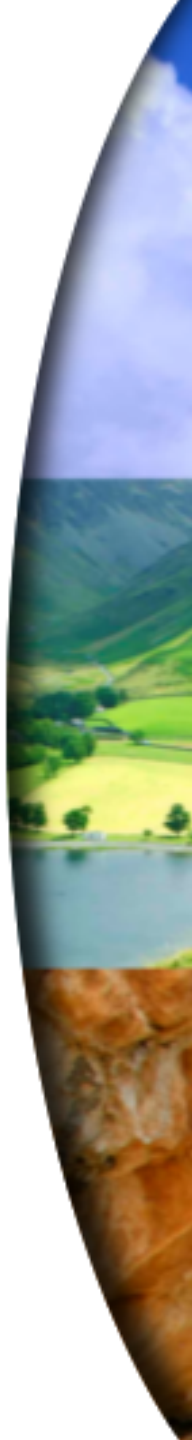
Quintessa



Introduction

Scope

- To consider whether SKB's methodology to abstract FEPs, as well as site information and other data, into assessment models for radionuclide transport is appropriate and sufficient for its purpose

Reports Reviewed

Reviewed report	Reviewed sections	Comments
TR-11-01 (Main report)	Sections 13.4–13.8, 14.5	
TR-10-50 (Radionuclide transport report)	Entire report including appendices	
TR-10-51 (Model summary report)	Sections 3.9, 3.12 and 3.20	These sections cover FARF31, COMP23 and solubility model
TR-10-45 (FEPs report)	Entire report including appendices	Focussed on radionuclide transport FEPs
SKB FEP database	SR-Site FEPs	Focussed on radionuclide transport FEPs
TR-10-48 (Geosphere process report)	Chapter 1, Section 5.9, and Chapter 6	Colloidal processes and radionuclides transport processes
TR-10-52 (Data report)	Sections 5.3, 6.7 and 6.8	Migration properties in buffer, backfill and geosphere.
R-06-81 (SR-Can ecosystem models report)	Chapter 7	Gas release calculations
R-06-82 (SR-Can biosphere report)	Section 8.2.4	Gas release calculations

Main Review Findings

Documentation of Methodology

- No clear, concise documentation of methodology
  - relevant information is dispersed around various reports
  - not synthesised in an easily reviewed/audited form
- Individual reports generally adequate although there is scope for improvement, e.g. provision of a table summarising calculation cases and the codes used
- Process of taking the FEPs and site information to develop the conceptual models is not clearly explained or documented

Justification for Inclusion/Exclusion of FEPs

- Limited justification/explanation for the inclusion/exclusion of FEPs
- The justification/explanation that is provided is distributed around a number of reports rather than in a single report (cf. POVISA 2007-12)

  => hinders review and auditing
- Electronic FEP database does not provide a central repository of the reasons for the inclusion/exclusion of FEPs

Representation of Certain FEPs: Gas Releases

- Extremely limited consideration (e.g. 2 pages in Main Report)
- No explanation for the exclusion of Cl-36, Se-79 and I-129
- Various errors and non-conservative assumptions identified in calculations

Representation of Certain FEPs: Solubility Limitation

- No quantitative consideration to variation with temperature
- No explanation of the reasons for variation in values between SR-Can and SR-Site
- COMP23 does not allow changes in solubility limits with time

  => not possible to investigate how near-field fluxes change with glacial cycling (potentially important for Ra)

Representation of Certain FEPs: Colloids

- The assumption of rapid reversible sorption/desorption is adopted but not justified
- No calculations are presented for the assumption of irreversible sorption that might result in higher impacts

Representation of Certain FEPs: Transport under Periglacial and Glacial Conditions

- The impact of permafrost on radionuclide transport is not taken into account
- Are pathlines obtained using groundwater flow simulations for temperate conditions are appropriate to use under periglacial/glacial conditions?

Radionuclide Transport Data

- Were the DFN variants intended to cover uncertainty for both flow and transport behaviour? Is it possible to specify alternative (more conservative) conceptual models consistent with the available data that would give higher radiological consequences?
- Are there any site data which could be used to validate transport properties?
- Kd range are often large and could give rise to non-conservative results when applied in transport calculations

Radionuclide Transport Calculations

- Good to see use of analytical calculations and regression models
- Preponderance of probabilistic calculations:
  - limits reader's ability to gain a good understanding of key issues
  - hinders reproduction of SKB's calculations by a third party
- Calculations terminate at 1 Ma. Extending some beyond 1 Ma would be useful, especially for those cases which show risks still steeply rising at 1 Ma
- Checks on various calculations have uncovered some quality assurance issues

Editorial

- Reports can be:
  - turgid (excessive and unnecessary detail)
  - repetitive (both between and within reports)
  - poorly cross-referenced (section numbers in cited SR-Site reports are rarely given)
- These factors restrict their readability, auditability and transparency

Summary

Issue	Findings
Completeness	**Generally good**, but limited documentation provided for inclusion/exclusion of FEPs and process of developing conceptual models using FEPs and site data
Scientific soundness & quality	**Generally good**, but quality assurance issues have been identified with certain calculations. Lack of clarity in documentation can sometimes hinder evaluation of scientific soundness.
Adequacy of models, data & safety functions	**Generally good**, but issues over adequacy of gas calculations and poorly-justified assumptions for certain data sets and some relatively minor updates to codes could have been made (e.g. time-dependence in COMP23 solubility) to avoid some forced approximations
Handling of uncertainties	**Generally good**, wide range of calculations, but would be useful to summarise the approach taken to manage uncertainties in SR-Site.
Safety significance	**Limited**, safety of repository is primarily dependent on factors beyond the scope of this review
Quality in terms of transparency and traceability of information	**Poor**, information relevant to radionuclide transport methodology is dispersed around various reports. Data report does not contain all data required for transport calculations and data that are included are described and justified at variable levels of detail

Recommendations to SSM

Recommendations

- Undertake audit to ensure SR-Can review comments have been appropriately addressed in SR-Site reports
- Assess need for further review work in light of SKB's responses to questions raised by current review
- Suggested review issues:
  - if not already reviewed, review the documentation for SKB's codes, especially Simple Functions
  - check the quality assurance of the process of passing data between SKB's flow and transport codes
  - request and review results from modelling of fully transient flow conditions in MARFA
  - investigate whether is it possible to specify alternative (more conservative) discrete fracture network models consistent with available data that would give higher radiological consequences

Recommendations

- Suggested review issues (cont):
  - investigate whether pathlines obtained using groundwater flow simulations for temperate conditions are appropriate for use under periglacial and glacial conditions
  - investigate approach taken to represent solubilities of Th and Ra, e.g.:
    - choice of thermodynamic data
    - representation of Ba-Ra co-precipitation
    - time variation of solubilities on releases from near field
  - review Kd values especially whether the large upper limits given for many elements lead to risk dilution