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The use of interaction matrices for identification, structuring and ranking of FEPs in a repository system

Application on the far-field of a deep geological repository for spent fuel

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November 1995

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APPLICATION ON THE FAR-FIELD OF A DEEP GEOLOGICAL REPOSITORY FOR SPENT FUEL

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Keywords: Scenario development, Performance assessment, Far-field, FEPs, Interaction matrix, Documentation, Deep repository, Spent fuel

ABSTRACT

The basic devise in the Rock Engineering Systems (RES) approach, the interaction matrix, has been used to identify, structure and rank Features, Events, and Processes (FEPs) describing barrier performance and radionuclide behaviour in the far-field of a deep geological repository for spent fuel. The result is a first version of the Process System, PS, for the far-field of a deep repository, structured in an interaction matrix with supporting documentation. The documentation is compiled in databases, one containing matrix specific information and one containing general FEP descriptions.

The study has shown that an interaction matrix is feasible to use both for the structuring of the PS and for visualisation of the PS. The developed documentation system increases the transparency of the system description and makes it possible to trace back the judgements made during the construction of the matrix. This will facilitate review work and future revisions as well as consistent treatment of different issues in the system.

This study is a first step in the application of a systematic method to establish a structured description of the PS for a deep repository for spent fuel. The work could be seen as a part of the preparation for the forthcoming performance and safety analyses. The next step would be to develop the PS for the remaining parts of the repository system to the same level as has been done for the far-field system. Before the PS is evaluated for different selected system premises, a scientific review of the contents of the PS for the whole repository system would be beneficial.

SAMMANFATTNING

En interaktionsmatris, av samma typ som den som används inom RES (Rock Engineering systems) metoden, har använts för att på ett systematiskt sätt identifiera, strukturera och värdera betydelsen av de FEPs (Features, Events, Processes) som beskriver barriärprestanda och radionuklidernas beteende i fjärrområdet runt ett djupförvar för använt kärnbränsle. Detta har resulterat i en första matrisversion av ett strukturerat och prioritiserat Process System, PS, för fjärrområdet, med tillhörande beskrivningar av FEPs och interaktioner samlade i databaser. Två olika databaser har byggts upp där en innehåller matrisspecifik information och den andra mer generella FEP beskrivningar.

Resultatet från studien har visat att det går att både strukturera och visualisera PS med hjälp av en interaktionsmatris. Det utvecklade dokumentationssystemet gör det möjligt att erhålla en mer utförlig beskrivning av systemet och att spåra alla beslut som fattats under framtagandet av interaktionsmatrisen. Detta underlättar både granskning och uppdatering av innehållet i matrisen samt ökar möjligheten för en konsekvent behandling av olika problemställningar.

Den här studien kan ses som ett första steg i att tillämpa en systematisk metod för att ta fram en strukturerad beskrivning av PS för ett djupförvar för utbränt kärnbränsle. Detta arbete kan ses som en del av förberedelserna inför kommande säkerhetsanalyser. För att komma vidare bör PS för de övriga delarna av förvarssystemet struktureras i interaktionsmatriser på samma sätt. Innan de framtagna matriserna används för att utvärdera hur systemet påverkas av andra systemförutsättningar, vore det värdefullt att göra en vetenskaplig granskning av innehållet i PS för hela förvarssystemet.

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Appendix B: FAR-FIELD1 database

Appendix C: SKB FEP database

1 INTRODUCTION

1.1 BACKGROUND

Safety assessments of radioactive waste repositories are based on predictive modelling of the performance of the engineered barriers and natural barriers for very long time scales. To evaluate the performance of a repository, assumptions must be made on the future evolution of engineered barriers and natural conditions considering all relevant Features, Events and Processes, FEPs. There is therefore a need for systematic scenario development methods to make sure that alternative future evolutions of the repository system relevant to a reliable assessment are considered.

Different systematic scenario development methods have been applied in safety assessment studies or are presently tested by organisations in Sweden and other countries. A summary of the different methodologies studied by SKB in the period 1981-1994 is given in /1-1/.

1.2 SCENARIO DEVELOPMENT METHODOLOGY

A systematic method for scenario development is an important part of a performance assessment. The scenario development should precede the quantitative analyses and predictions of the behaviour of the repository system. The purpose of the performance assessment is important for the scenario development work, and the results of the scenario development work are important input to the subsequent quantitative predictions of system behaviour. A transparent documentation of all the steps in the scenario development is an essential part of the methodology.

In the Joint SKI/SKB Scenario Development Project /1-2/, the concept of the Process System, PS, was introduced as:

> "the organised assembly of all phenomena (FEPs) required for the description of barrier performance and radionuclide behaviour in a repository and its environment, and that can be predicted with at least some degree of determinism from a given set of external conditions"

Adopting this definition of the PS, a systematic scenario development methodology to be used in performance or safety assessments can contain the following steps:
- definition of the purpose of the assessment,
- development and visualisation of a structured and ranked PS by applying a systematic approach to
  * define the system to be included in the PS

  * identify FEPs belonging to the PS and their interactions
  * rank interactions and FEPs,
- selection of scenario premises,
- qualitative analysis of the impact of the scenario premises on the PS.

Scenarios are generated by imposing scenario initiating FEPs to the structured and ranked PS. Scenario initiating FEPs could be external events or other factors acting outside the PS, or factors changing the initial states of the repository components. The impact of the scenario initiating FEPs on both the content of the PS and the ranking of FEPs in the PS are evaluated.

The output from the scenario development to the subsequent scenario analysis is a ranked PS with associated documentation. The ranked PS highlights FEPs judged to be of importance for the performance of the repository. The associated documentation describes how the ranked PS has been developed. This output forms the basis for the scenario description and the quantitative analyses of the scenario.

The main difference between different systematic scenario development methods concerns the means of structuring the PS. In the Rock Engineering Systems (RES) approach /1-1/, which was developed for approaching rock engineering problems, the structuring of the PS is achieved by the use of an interaction matrix. The main variables or parameters of the studied system are identified and listed along the leading diagonal of a square matrix. The interactions between the diagonal elements occur in the off-diagonal terms. This is illustrated in Figure 1-2 together with the clockwise convention for the influence direction. A more detailed description of the RES approach is given in /1-3/.

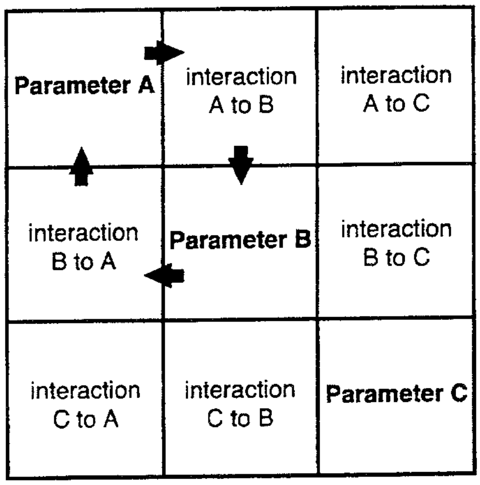


Figure 1-2. Principle of the interaction matrix

1.3 AIM OF THE STUDY

The aim of this study was to test the basic device in the RES approach, the interaction matrix, as a tool for identification, structuring and ranking of FEPs in a Process System for the far-field of a deep geological repository for spent fuel. The work should result in a comprehensive and well documented description of the PS for the far-field to support the forthcoming performance and safety analyses. In parallel, a documentation procedure for the application of interaction matrices should be developed.

1.4 STRUCTURE OF THE REPORT

The procedure for developing a structured PS for the far-field of a deep repository and the resulting interaction matrix (FAR-FIELD1) with associated documentation are described in Section 2. Some concluding remarks regarding the applied approach and the documentation procedure are given in Section 3.

The complete documentation of the FAR-FIELD1 matrix is compiled in a database. The FAR-FIELD1 matrix is found in Appendix A and a printout of the database is given in Appendix B. A general SKB FEP database is under construction to support the descriptions given in the interaction matrix documentation. A list of all FEPs presently documented and examples of FEP descriptions that can be found in the SKB FEP database are given in Appendix C.

2 CONSTRUCTION AND DOCUMENTATION OF THE FAR-FIELD INTERACTION MATRIX, FAR-FIELD1

2.1 PROCEDURE

The work with the construction of the interaction matrix for the far-field has resulted in a procedure for the development of a structured and ranked Process System. This procedure is schematically shown in Figure 2-1.

Once the purpose of the assessment has been defined the development of the PS is started by defining the part of the repository system to be covered by the PS. This involves a specification of the repository components to be included in the PS, the spatial extension of the PS and a definition of how the PS interacts with the system outside the PS.

The structuring of the PS is obtained by building an interaction matrix showing the interdependencies between FEPs belonging to the PS. The first step is to identify the main features of the PS and introduce them into the leading diagonal elements in a square matrix.

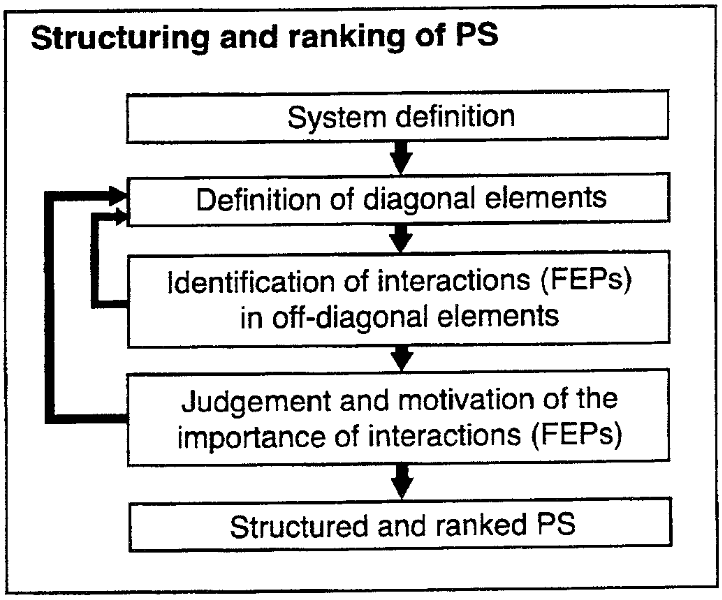


Figure 2-1. Procedure for the development of a structured and ranked Process System using an interaction matrix.

The PS will be affected by the system outside the boundary of the PS. This impact from the system outside is taken care of by defining the boundary conditions for the PS. These boundary conditions could be seen as FEPs which should belong to the PS if the spatial extension of the PS was increased. For example, if the near-field of a repository is defined as the system to be covered by the PS, then the hydrological, geochemical, thermal, and mechanical conditions in the far-field comprise the boundary conditions to the PS. To be able to describe relations between the PS and the system outside PS, the boundaries of the PS can be part of the leading diagonal elements in the matrix.

When the leading diagonal elements in the matrix are specified and documented, the interactions between the main features in the leading diagonal elements are identified and described by introducing FEPs into the appropriate off-diagonal elements (interaction boxes) in the matrix. This requires a definition of the initial conditions and states of the repository components covered by the PS as well as of the boundary conditions.

The next step is to set priorities to all the identified interactions (FEPs) in the interaction matrix. This requires a well defined priority scale. It should be noted that the priorities set are valid only for the previously defined initial states and boundary conditions. The output from this exercise is a ranked PS, in which the most important issues to be focussed on in subsequent parts of the performance assessment are highlighted.

Both the identification of interactions and the setting of priorities may reveal requirements on modifications of the definitions of the diagonal elements in the matrix. Building the interaction matrix is therefore an iterative process.

Another output from the work with structuring and ranking the PS concerns a specification of how the interactions in the matrix could be quantitatively treated in the performance assessment. This is not necessarily a part of the development of a systematic and ranked PS, but it is valuable input to the subsequent parts of the performance assessment.

The structuring of the PS and the ranking of FEPs and interactions require input from various information sources covering a broad range of disciplines. Therefore, these actions are preferable done by a group of people with both a general overview of the system and expertise in specific areas.

2.2 CONSTRUCTION OF THE FAR-FIELD INTERACTION MATRIX

The interaction matrix for the far-field has been developed during several working group meetings. The minutes from these meetings form the basis of the documentation describing the content of the matrix.

A first version of the matrix was created by a working group during two meetings held in the end of 1994. A first attempt to set priorities to the different interactions in the matrix was also made with the aim to identify the most important interactions in the far-field subsystem. The members of the working group were:

Torsten Eng, SKB
Lars O Ericsson, SKB
Olle Olsson, SKB
Anders Ström, SKB
Peter Wikberg, SKB.

Several contacts and discussions have taken place with members in the above working group, during the spring 1995. The definitions and the descriptions of the leading diagonal elements as well as of the interactions in the off-diagonal elements of the far-field matrix have been extended and clarified. This documentation work was carried out by:

Anders Ström, SKB
Kristina Skagius, Kemakta
Marie Wiborgh, Kemakta.

Revisiting the far-field matrix and extending the documentation resulted in modifications and changes of the original far-field matrix. It was therefore necessary to redo the assignment of priorities to the interactions in the matrix. To do this the working group was extended with experts from SKB. The ranking of the interactions was done in three meetings. Besides from assigning priorities, the documentation was checked and improved. The members of this working group were:

Torsten Eng, SKB
Lars O Ericsson, SKB
Lena Morén, SKB
Olle Olsson, SKB
Anders Ström, SKB
Peter Wikberg, SKB
Kristina Skagius, Kemakta
Marie Wiborgh, Kemakta.

In the following sub-sections the content of the far-field interaction matrix and the organisation of the documentation are described. Obviously, it is not possible to compile all the documentation in the matrix. Therefore, the matrix will contain headings and key words only. This means that the full documentation of the matrix must be associated with the matrix, either physically or in a computerised fashion or both. To facilitate this coupling both the matrix and the documentation are given the identification code FAR-FIELD1. The FAR-FIELD1 matrix is shown in Appendix A and the full documentation to the FAR-FIELD1 matrix is given in Appendix B.

2.3 DOCUMENTATION IN DATABASES

During the work with the documentation of the FAR-FIELD1 matrix the advantage of separating matrix specific information and more extensive descriptions of FEPs were identified. The reasons to this are that different aspects of a FEP may be involved in different interactions and that the same FEP may occur in different parts of the repository system. The matrix documentation will then focus on the actual aspect of a FEP that is involved in the specific interaction, while the FEP documentation will contain a more general description of the FEP. For example, a description of the FEP sorption contains several aspects which affect the sorption behaviour of radionuclides, such as water composition, surface area of the sorbent available to sorption and mineralogical composition of the sorbent. Several interactions in the interaction matrix will then be related to sorption. Instead of giving a general description of sorption for all these interactions in the matrix documentation, only the aspect of sorption which defines the actual interaction is described, while the general and more extensive description of the FEP sorption is kept in a separate documentation system.

To be able to easy search for specific aspects in the documentation and to cross-reference between the interaction matrix documentation and the more general FEPs descriptions it was decided to compile the information in a database format. The database program FileMaker PRO was selected as an appropriate tool for this task /2-1/.

The documentation containing the general descriptions of FEPs, the so called SKB FEP database, could then be utilised by several projects. By successively including information gained in future studies and assessments the number of FEPs in the database will increase and the FEP descriptions improve. Presently about 60 general FEP descriptions supporting the FAR-FIELD1 matrix are compiled in the SKB FEP database.

A schematic overview of the coupling between the SKB FEP database and the interaction matrix databases, so far containing only the FAR-FIELD1 database, is given in Figure 2-2.

SKB FEP database

In the SKB FEP database base, general FEP descriptions with reference to the literature and to other assessments or FEP-lists are compiled. For each FEP, references are given to the interaction matrices containing this FEP as well as to the specific interaction boxes where the FEP can be found. A list of all FEPs presently documented in the SKB FEP database is given in Appendix C together with some examples of FEPs descriptions that can be found in the database.

Interaction matrix databases

In the interaction matrix database the following topics are documented:

- Purpose of assessment
- Definition of the studied system
- Interaction matrix description, (characteristics covered by individual diagonal elements and descriptions of binary interactions)
- Assigned priorities to interactions with motivations
- Descriptions on how interactions will be treated in performance assessment, (in some cases).

In addition, for each binary interaction a reference is given to the appropriate FEP description in the general SKB FEP database. An overview of the FAR-FIELD1 documentation compiled in the database is given in the following sub-sections.

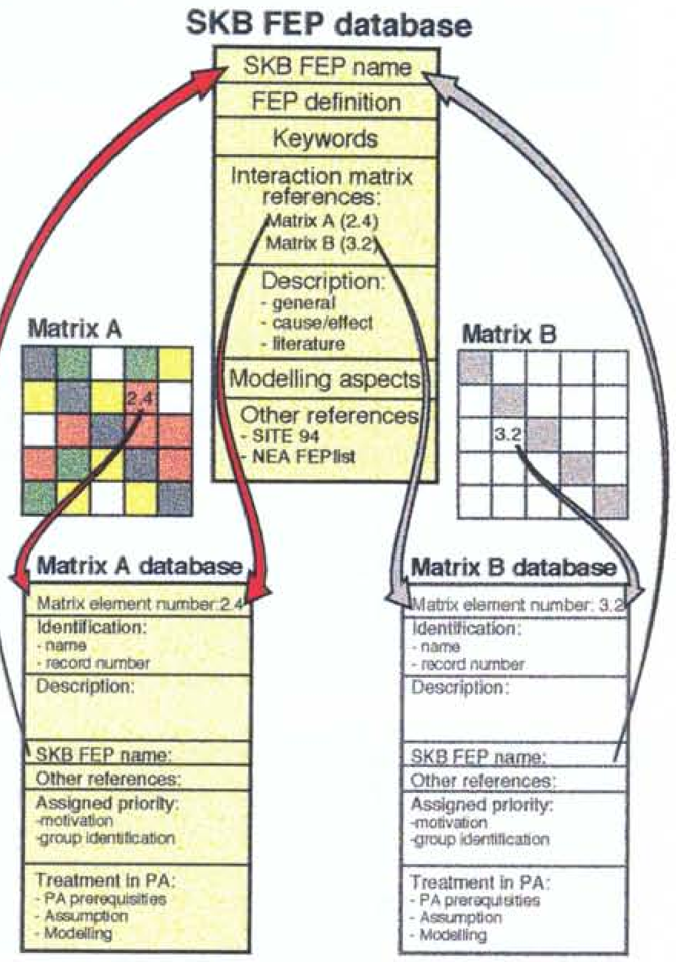


Figure 2-2. Coupling of interaction matrix databases and SKB FEP database.

2.3.1 Purpose of the assessment

The purpose of the assessment is to identify the important issues affecting the long-term behaviour of, and the radionuclide migration within the far-field rock of an underground repository for spent fuel. Another purpose is to test the interaction matrix as a tool for developing a systematic description of the Process System.

2.3.2 Definition of the system

The total repository system for spent nuclear fuel is often divided into several subsystems which are analysed in a safety assessment study. This report covers the far-field subsystem, i e the natural/geological barrier. Regarding the definition of the far-field, the following clarification could be made. The rock mass surrounding the repository will be affected, out to a certain distance, by the presence of the repository. This affected zone is, to the most extent, a part of the near field. The best location for the far-field/biosphere interface is a matter of debate and it is related to the modelling of radionuclides across this boundary.

The starting point for the construction of the interaction matrix and the assignment of priorities to the interactions in the matrix is a deep repository for spent nuclear fuel in crystalline rock according to the Swedish KBS-3 system. This means that the spent fuel elements will be encapsulated in copper canisters with inner steel containers and placed in a distributed repository at about 500 m depth in the crystalline bedrock. Bentonite clay will be used as buffer material and a mixture of sand and bentonite as backfill in the deposition tunnels. It is here furthermore assumed that radionuclides are available outside the canisters.

This far-field matrix is a description of the Process System where some events regarded as a part of the normal evolution of the system outside the PS are considered. For example, the biosphere element includes future climate changes. The ambition is to have the same set of diagonal elements for the far-field whatever scenario being analysed.

The interaction matrix is developed for a post-closure assessment, including the resaturation phase. The boundary conditions to the far-field are represented by the diagonal elements *2.2 Buffer/backfill/source* and *13.13 Biosphere*. Repository construction and operation will influence the post-closure conditions in the far-field and is therefore included as a diagonal element in the matrix *(1.1 Construction/layout)*.

2.3.3 Interaction matrix description

The initial version of the written description of the far-field matrix has been reviewed and improved. This was done by going through the matrix from the top row to the bottom row and by discussing and documenting all the binary interactions between diagonal elements. It was often found that the existing description of the interaction must be complemented/modified and even some times the interaction must be moved to another interaction box to be consistent with the definitions of the diagonal elements. In some cases the defined interaction was not a binary interaction between two diagonal elements, but a flow path involving several interactions and diagonal elements. In the documentation work of the interactions it was successively found that the content and description of different diagonal element must be improved. The characteristics of the diagonal elements have thus been defined in an iterative process.

The FAR-FIELD1 matrix comprises of 13 diagonal elements and 156 off diagonal elements, and is shown in Appendix A. The words in the different matrix elements are **key words** which should make it possible to associate to the interaction in question. In some cases it may be the reason for the interaction, in other the effect of the interaction. An example of an interaction description is given in Figure 2-3 and the full descriptions of all interactions are given in the database, see Appendix B.

Element number: 05.07 **Revision date:** 95-06-30
Interaction matrix: FAR-FIELD1 **Version:** A
Element name:
5.7b Connectivity

Element type: Interaction **Number of interactions:** 4

Recordnumber: 88 **Number of records:** 218

Description:
The interconnection between fractures and fracture zones is especially important for water movement in fractured rocks.

Priority: **Priority date:**
○ 0=White ○ 1=Green ○ 2=Yellow ● 3=Red 1995-06-12

Motivation:

Obvious

Group identification:
SKB: T Eng, LO Ericsson,
L Morén, O Olsson, A Ström,
P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:
● Experts
○ General Know how
○ Limited

SKB FEP reference:
Properties of far-field rock
Groundwater flow

Figure 2-3. Example of interaction description

Diagonal elements

According to the RES-approach, the leading diagonal elements in the matrix should contain the "main physical variables or parameters" of the system. In the construction of the far-field interaction matrix this definition has been extended to "the main features (concepts) or properties governing the system". This was done to be able to include a part of the system with all its characteristics in one diagonal element as well as to be able to include features which cannot directly be expressed as a physical variable or a parameter. The definition of the diagonal elements in the FAR-FIELD1 matrix is given below and is also found in the FAR-FIELD1 database.

1.1 CONSTRUCTION/LAYOUT:
This element is introduced to take care of the influence of the construction work, the operation of the deep repository and the layout of the repository on the definition of the initial conditions of the repository system. Construction includes drilling, blasting, ventilation, grouting etc. The layout is according to the KBS-3 concept, i.e. a distributed tunnel system with canisters in deposition holes with a certain spacing. The definition includes access shafts and the existence of a surface facility for the deep repository.

2.2 BUFFER/BACKFILL/SOURCE:
The properties of the backfill material in the tunnels of the repository and the source term for the radionuclide transport in the far-field is defined in this element. The source term is determined by the properties of the canisters with the spent fuel elements and the buffer around the canisters in the deposition holes. This element covers also the gas generated within the buffer. In addition, the heat generated by the waste and the temperature within the buffer and the backfill are included in the definition.
This element constitute boundary conditions for the far-field.

3.3 EDZ (Excavation Damaged Zone):
The Excavation Damaged Zone is defined as the zone extending around an underground opening which is affected by the excavation process and subsequent mechanical processes. EDZ is defined as the part of the surrounding rock around the deposition holes as well as around the tunnels wherein the material properties are changed compared to the undisturbed rock. The hydraulic, mechanical and thermal properties of the EDZ are included in the definition.

4.4 ROCK MATRIX/MINERALOGY:
This element represents the intact rock and includes mineralogy as well as thermal and mechanical properties related to the mineralogy of the intact rock.

5.5 NATURAL FRACTURE SYSTEM:
The natural fracture system includes fracture mineralogy as well as thermal and mechanical properties of the natural fractures. Fracture zones of different magnitude are part of this definition. The fractures in the disturbed zone are included in the definition of the EDZ.

6.6 GROUNDWATER CHEMISTRY:
This element represents the groundwater chemistry in the EDZ and in the far-field rock. It includes the natural composition of the groundwater, such as main constituents, redox sensitive elements, pH, Eh, fulvic and humic acids, bacteria, colloids and dissolved gases, which are affecting the performance of the barriers and radionuclide migration in the far-field.

7.7 GROUNDWATER MOVEMENT:
The fluid flow in the far-field rock, i e magnitude, direction and distribution of groundwater flow, is given by this element. Hydrogeological conditions in terms of intrinsic permeability and effects of viscosity and density are considered. The groundwater movement in the tunnels, in the EDZ around tunnels and deposition holes, and the mixing of different waters are also covered by this element.

8.8 GROUNDWATER PRESSURE:
The groundwater pressure here defined as the hydraulic head, $\phi = p_{tot}/\rho g + z$, is the driving force for groundwater movement. In addition to hydraulic head this element also refers to the absolute pressure.

9.9 TEMPERATURE/HEAT:
This element includes the temperature in the far-field as well as in the EDZ around tunnels and deposition holes.

10.10 ROCK STRESSES:
Rock stresses refer to the "total stresses" (effective stress+pore water pressure) which can be measured in-situ. In the definition the stresses in the far-field rock and in the EDZ around the tunnels and the deposition holes are included.

11.11 GAS GENERATION AND TRANSPORT:
Gas generation and gas transport in the rock matrix, in the natural fracture system, in the EDZ and in the backfilled tunnels are included in this element. Gas includes natural and waste generated gases of all kinds but not dissolved gases. Gas pressure is also included.

12.12 TRANSPORT OF RADIONUCLIDES:
The transport of radionuclides in the far-field rock, in the EDZ around tunnels and deposition holes, and in the backfilled tunnels are included in the definition of this element.

13.13 BIOSPHERE:
In this element all processes in the biosphere including vegetation, climate, wells, topography etc are included.
This element constitutes boundary condition for the far-field.

Off diagonal elements (interaction boxes)

The FAR-FIELD1 matrix comprises of 156 interaction boxes, (equal to 169 matrix elements minus 13 diagonal elements). About 150 interactions have been identified between the diagonal elements and allocated to about 100 interaction boxes. This means that about 1/3 of the boxes contain no interactions. On the other hand, several interaction boxes contain more than one interaction, but few boxes contain more than two interactions. The maximum number of interactions found in one box is four.

Descriptions of all identified interactions between the diagonal elements are documented in the FAR-FIELD1 database. Examples of identified interactions for the diagonal element *2.2 Buffer/backfill/source*, and how it interacts with other diagonal elements in the FAR-FIELD1 matrix are given below.

2.1 BUFFER/BACKFILL/SOURCE - CONSTRUCTION/LAYOUT:
- The properties (e.g. densities and swelling ability) of buffer and backfill will influence design constraints (dimensions, geometries).
- The heat generation from the spent fuel will influence design constraints (dimensions, geometries).

2.3 BUFFER/BACKFILL/SOURCE - EDZ:
- Swelling of buffer and backfill into the fissures in the EDZ and the cracks intersecting the deposition holes and the tunnels.

2.4 BUFFER/BACKFILL/SOURCE - ROCK MATRIX/MINERALOGY:
- No identified interactions

2.5 BUFFER/BACKFILL/SOURCE - NATURAL FRACTURE SYSTEM:
- When the buffer has been placed around the canisters in the deposition holes swelling occurs and the buffer will penetrate into natural fractures intersecting deposition holes.

2.6 BUFFER/BACKFILL/SOURCE - GROUNDWATER CHEMISTRY
- The buffer/backfill may act as a sulphate and carbonate source thereby influencing the concentration of these species in the groundwater. The Na/Ca ratio and pH of the groundwater are affected by the buffer/backfill.
- The buffer/backfill may act as a colloid source. Could also be formed by erosion.

2.7 BUFFER/BACKFILL/SOURCE - GROUNDWATER MOVEMENT
- Changed groundwater flow around deposition holes due to the existence of the buffer.
- Changed groundwater flow in tunnels due to the hydraulic conductivity of the tunnels.

2.8 BUFFER/BACKFILL/SOURCE - GROUNDWATER PRESSURE

- The successive emplacement of buffer in the deposition holes and the successive backfilling of used tunnels during the operation of the repository will lead to resaturation during operation of the repository, removes initial drawdown effects (transient phenomena).

2.9 BUFFER/BACKFILL/SOURCE - TEMPERATURE/HEAT

- The heat generated by the waste will be transferred to the surrounding far field rock. The thermal conductivity of the buffer and the backfill will have an influence on the temperature evolution in the far field rock.

2.10 BUFFER/BACKFILL/SOURCE - ROCK STRESSES

- As a consequence of water uptake the buffer and the backfill will swell. The extent of swelling will influence the swelling pressure.
  Effect: stress changes in surrounding rock, especially in the EDZ.

2.11 BUFFER/BACKFILL/SOURCE - GAS GENERATION AND TRANSPORT

- Gas source: hydrogen evolving corrosion of steel vessel, microbial degradation of organics in buffer(H_2 + CO_2), radiolytic decomposition of water, He-production, radioactive gases etc.

2.12 BUFFER/BACKFILL/SOURCE - TRANSPORT OF RADIONUCLIDES

- Release of radionuclides from the buffer is the source term for the transport in the backfill, the EDZ and the far field.

2.13 BUFFER/BACKFILL/SOURCE - BIOSPHERE

- No identified interactions

2.3.4 Assignment of priorities to interactions

In working group meetings priorities have been assigned to the interactions described in the revised version of the FAR-FIELD1 interaction matrix. The work with the setting of priorities was shown to be a good review of the FAR-FIELD1 matrix and resulted in modifications of diagonal elements and interactions. The definition of the priorities used in the evaluation of the far-field matrix is given in Table 2-1.

Table 2-1. Definition of priorities used in the FAR-FIELD1 matrix

Priority		Description
Nr	Colour	
3	Red	**Important interaction - part of the Performance Assessment.** Could also influence other parts of the Process System, (defined in this RES-matrix), or other parts of the repository system. The interaction can be either a prerequisite for the PA or handled by assumptions or modelling efforts in the PA.
2	Yellow	**Interaction present - probably part of the Performance Assessment.** Limited or uncertain influence directly or via this interaction on other parts of the Process System, (defined in this RES-matrix), or other parts of the repository system. However, this interaction can be in main focus in other RES-matrices.
1	Green	**Interaction present - do not have to be considered in the Performance Assessment.** Negligible influence on other parts of the Process System, (defined in this RES-matrix), or other parts of the repository system.
0	White	**No identified interactions.**

A colour coding was used to display the priorities in the interaction matrix. In cases where one interaction box contains more than one interaction, the interaction with the highest priority determines the colour of the interaction box.

In the FAR-FIELD1 documentation the priority set on each individual interaction can be found together with the motivation for assigning this priority, an identification of the group making the prioritisation and the level of expertise of the group. For the about 50 empty interaction boxes, the reasoning behind no identified interactions is given.

In total about 150 interactions are identified and assigned priorities, giving the following distribution of priorities; 3=Red $\approx$ 40%, 2=Yellow $\approx$ 40% and 1=Green $\approx$20%. Some examples of motivations for assigned priorities to interactions and empty interaction boxes are given in Table 2-2 and the full documentation is given in Appendix B.

Table 2-2. Examples of motivations for judged relative importance of a few interactions.

Element number:	Element name:	Priority:	Motivation:
02.01	2.1a Swelling ability	3=Red	Obvious, included in design.
02.01	2.1b Heat	3=Red	Obvious, important design parameter.
02.03	2.3 Buffer/backfill penetration into EDZ	2=Yellow	Affects mainly the near-field but also the groundwater flow via 3.7. Should be taken care of in the near-field analysis.
02.04	2.4	0=White	Obvious, all impacts by definition in the diagonal element EDZ.
02.05	2.5 Buffer into intersecting fractures	2=Yellow	Affects mainly the near-field but also the groundwater flow via 5.7. Should be taken care of in the near-field analysis.
02.06	2.6a Colloid source	3=Red	Colloids must be considered in the analysis. Low salinity water may generate colloids. Main colloid source is low salinity water.
02.06	2.6b Groundwater composition	3=Red	Obvious. The stability of groundwater chemistry is of utmost importance for the long-term safety and therefore anything that change this must be considered.
02.07	2.7a Changed flow around holes	2=Yellow	To be taken care of in the near-field analysis.
02.07	2.7b Changed flow in tunnels	3=Red	Obvious

2.3.5 Treatment of interaction in Performance Assessment

The assigned priorities to interactions in a matrix can be used as an indication to what level of detail different interactions should be considered in the performance assessment. However, the descriptions of the interactions are not sufficient to describe how they should be treated in the assessment. Therefore, descriptions of the treatment of interactions (FEPs) in the assessment is valuable.

The treatment of interactions (FEPs) in the assessment should be made in a consistent way. FEPs and interactions can be treated by models, assumptions or simple calculations in PA studies. In addition, different assumptions and models will be used to study different parts and aspects of the Process System.

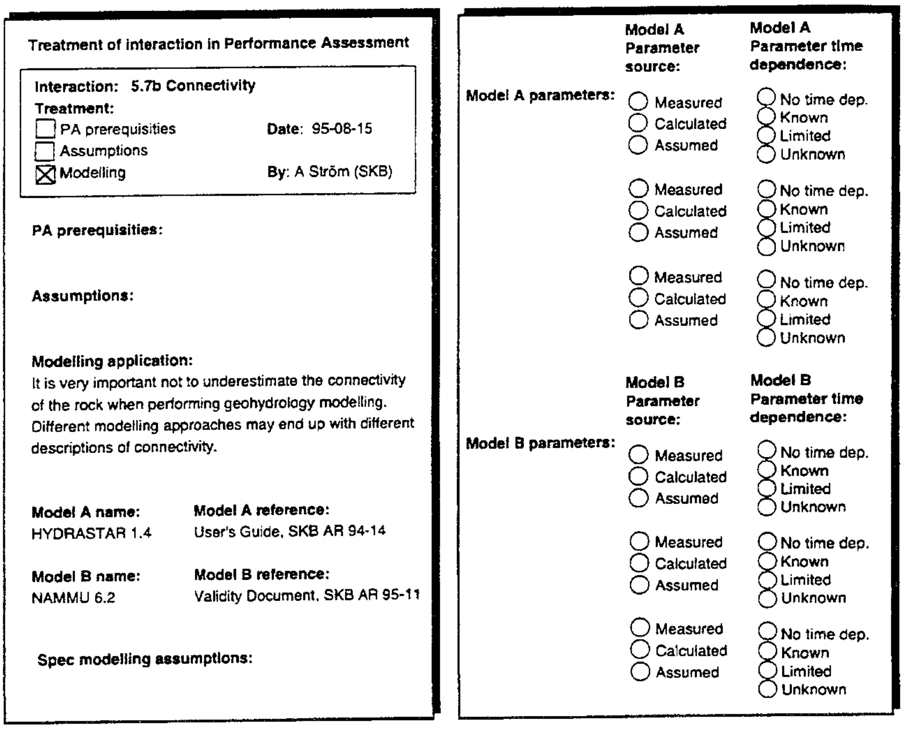
To try out what kind of information that could be useful to compile, a test was made for the FAR-FIELD1 matrix. At this stage, it was decided to only consider the treatment of interactions with the highest priority, 3=Red, defined as "Important interactions which should be part of the Performance Assessment". In a later stage, the treatment of less important interactions can be made in a similar way.

In Table 2-3 all interactions assessed to be important are given. For each of these interactions a protocol with the possible treatment of the interaction in a PA study has been filled in. An example of a protocol is given in Figure 2-4. In the database all existing preliminary protocols can be found together with descriptions and assigned priorities for the individual interactions, see Appendix B.

To describe the possible treatment of an interaction in PA it was decided to distinguish if the interaction is a prerequisite for the assessment, is handled by assumptions or is taken care of by models. Some comments should be given under the appropriate heading(s). If the interaction is treated by modelling efforts references should be given to relevant models. Initially, the intention was to also specify how values of the parameters in the models are obtained and how sensitive they are to different time aspects. However, this task was found to be rather time consuming and has only been carried through for a few interactions.

Table 2-3. All interactions in the FAR-FIELD1 matrix assessed to be an "Important interaction which should be part of the Performance Assessment"

Record number	Element number	Element name	Record number	Element number	Element name
14	01.02	1.2 Excavation method	99	06.01	6.1a Depth affected by redox potential
15	01.03	1.3a Excavation method	101	06.02	6.2 TDS - ion exchange - illitisation
20	01.06	1.6a Construction materials	102	06.03	6.3a Precipitation/bacterial growth operating phase
21	01.06	1.6b Stray materials	106	06.07	6.7 Density and viscosity
24	01.09	1.9a Repository depth	107	06.08	6.8 Density affects groundwater head
26	01.10	1.10 Tunnel dimensions	111	06.11	6.11b Microbially generated gas
33	02.01	2.1a Swelling ability	113	06.12	6.12a Sorption and solubility
34	02.01	2.1b Heat	114	06.12	6.12b Colloids and bacteria
38	02.06	2.6a Colloid source	117	07.01	7.1a Canister positioning
39	02.06	2.6b Groundwater composition	124	07.06	7.6 Mixing
41	02.07	2.7b Changed flow in tunnels	125	07.08	7.8 Equalisation of pressures
43	02.09	2.9 Heat generation	130	07.12	7.12b Direction, distribution and magnitude
45	02.11	2.11 Gas source	131	07.12	7.12c Hydrodynamic dispersion
46	02.12	2.12 Source term	132	07.13	7.13 Recharge and discharge
56	03.07	3.7 Changed permeability	139	08.07	8.7 Driving force due to pressure gradient
59	03.10	3.10 Fractures affected	142	08.11	8.11a Gas solubility
62	03.12	3.12a Changed porosity and surface area	143	08.11	8.11b Gas law
69	04.06	4.6 Rock-water interaction	153	09.07	9.7 Viscosity
73	04.09	4.9 Thermal properties	154	09.08	9.8 Density
76	04.12	4.12a Sorption	156	09.11	9.11a Gas solubility
77	04.12	4.12b Matrix diffusion	165	10.03	10.3b Fracture aperture
80	05.01	5.1a Avoid major fracture zones	168	10.05	10.5b Fracture aperture
86	05.06	5.6b Colloid generation	184	11.06	11.6b Eh affected
87	05.07	5.7a Flow paths	185	11.07	11.7 Creation of two-phase flow conditions
88	05.07	5.7b Connectivity	191	12.01	12.1 Design/layout
89	05.07	5.7c Fracture aperture	196	12.06	12.6a Redox front
94	05.11	5.11 Transport path for gas	203	12.13	12.13 Contamination
95	05.12	5.12a Molecular diffusion	204	13.01	13.1 Siting - Design/Layout
96	05.12	5.12b Surface area	210	13.07	13.7 Surface water recharge and percolation
97	05.12	5.12c Sorption	214	13.08	13.8d Hydraulic gradients
98	05.13	5.13 Wells			


Treatment of interaction in Performance Assessment

Interaction: 5.7b Connectivity
Treatment:
☐ PA prerequisities Date: 95-08-15
☐ Assumptions
☒ Modelling By: A Ström (SKB)

PA prerequisities:

Assumptions:

Modelling application:
It is very important not to underestimate the connectivity of the rock when performing geohydrology modelling. Different modelling approaches may end up with different descriptions of connectivity.

Model A name: HYDRASTAR 1.4
Model A reference: User's Guide, SKB AR 94-14

Model B name: NAMMU 6.2
Model B reference: Validity Document, SKB AR 95-11

Spec modelling assumptions:

	Model A Parameter source:	Model A Parameter time dependence:
Model A parameters:	○ Measured ○ Calculated ○ Assumed	○ No time dep. ○ Known ○ Limited ○ Unknown
	○ Measured ○ Calculated ○ Assumed	○ No time dep. ○ Known ○ Limited ○ Unknown
	○ Measured ○ Calculated ○ Assumed	○ No time dep. ○ Known ○ Limited ○ Unknown

	Model B Parameter source:	Model B Parameter time dependence:
Model B parameters:	○ Measured ○ Calculated ○ Assumed	○ No time dep. ○ Known ○ Limited ○ Unknown
	○ Measured ○ Calculated ○ Assumed	○ No time dep. ○ Known ○ Limited ○ Unknown
	○ Measured ○ Calculated ○ Assumed	○ No time dep. ○ Known ○ Limited ○ Unknown

Figure 2-4. Example of a preliminary protocol of the treatment of an interaction in Performance Assessment.

2.3.6 Check against the SITE-94 Influence Diagram

The content of the FAR-FIELD1 interaction matrix has been checked against the content of the far-field part of the Process Influence Diagram, PID, constructed within the SITE-94 project /2-2/. In the SKB FEP database references are given to FEPs and influences in the SITE-94 PID.

The comparison with the SITE-94 PID showed that there are interactions and FEPs in the FAR-FIELD1 matrix which are not included in the SITE-94 PID and vice versa. This could to some extent be explained by differences in system definitions and in resolution of the descriptions of the Process System. For example, construction and operation of the repository is not included in the SITE-94 PID, whereas the resolution in the PID description is higher than in the FAR-FIELD1 matrix description.

The results from the check against the SITE-94 Process Influence Diagram has been compiled and will be considered in forthcoming revisions and improvements of the interaction matrix for the far-field.

3 CONCLUDING REMARKS

This study is a first step in the application of a systematic scenario development method in preparation for the forthcoming performance and safety analyses of a deep repository for spent fuel. The result is a first version of the Process System, PS, for the far-field of a deep repository, structured in an interaction matrix with supporting documentation. The next steps would be to develop the PS for the remaining parts of the repository system to the same level as has been done for the far-field system. After that, a scientific review of the contents of the PS for the whole repository system would be beneficial before the PS is evaluated for different selected scenarios.

This study has shown that the basic devise in the RES approach, the interaction matrix, is feasible to use both for the structuring of the Process System, PS, and for visualisation of the PS. The developed documentation system increases the transparency of the system description and makes it possible to trace back the judgements made during the construction of the matrix. This will facilitate review work and future revisions as well as consistent treatment of different issues in the system.

One important experience from the work with the construction and documentation of the FAR-FIELD1 matrix is that it would be beneficial to set up some guidelines or instructions for the building and documentation of interaction matrices. Items identified to be of importance in this context and therefore should be included in the instructions are given below.

1. The purpose of the assessment should be defined and documented since this has implications on the selection of the diagonal elements in the matrix.

2. The system to be studied must be specified and documented in terms of system components, initial conditions and boundary conditions, since this also has implications on the selection of diagonal elements in the matrix.

3. The diagonal elements are selected and the features introduced in each diagonal element are defined and documented. In this process it is important to be as logic and physically correct as possible. Otherwise problems will occur in the identification of interactions between diagonal elements.

4. If the system to be studied and the corresponding matrix is large it may be practical to divide the matrix into sub-matrices. In such cases, the overlap between the sub matrices as well as the way the sub-matrices communicate with each other should be clearly defined. If different

groups are working with the different sub-matrices no changes in diagonal elements which overlap or communicate with other sub-matrices should be done without consulting the other groups working with the overlapping or communicating sub-matrices.

5. Binary interactions between diagonal elements are identified. Each interaction should be documented by defining the interacting phenomenon as well as the characteristics in the two interacting diagonal elements which are involved in the interaction, i.e. the cause and the effect. This will help in maintaining consistency in the matrix as well as increase the transparency of the contents of the matrix. It will hopefully also show whether the identified interaction really is a binary interaction and not a path via another diagonal element.

6. Each identified binary interaction should be used to check the definition and content of the interacting diagonal elements to ensure consistency between the identified interaction and the interacting diagonal elements. Any changes in the definition or the content of a diagonal element should be followed by a revisit of already identified interactions to identify and make any modifications necessary to maintain consistency between all the components of the matrix. Thus, the definition of the diagonal elements and the identification of interactions between the diagonal elements is an iterative process.

7. Dependent on the number of interactions in a row or a column of interaction boxes, it may be feasible to change the number of diagonal elements in the matrix. If a row or column of interaction boxes contains several interactions in each box, the diagonal element in that row or column could be split into two diagonal elements, thereby increasing the level of detail in the matrix. Vice versa, if a row or a column of interaction boxes contains very few interactions, the diagonal element in that row or column may be combined with another diagonal element, thereby decreasing the level of detail in the matrix. However, combining or splitting diagonal elements should be avoided if the diagonal element is a boundary element to another sub-matrix.

8. The importance of identified interactions should be judged using a well defined and documented priority scale. In addition, a motivation for assigning the priority should be given and documented as well as the competence of the group making the judgement in order to facilitate later review and re-evaluations.

9. Specification and documentation of how identified interactions (FEPs) in the PS could be treated quantitatively is valuable input to the subsequent quantitative analysis of a scenario. It will help in identifying lack of modelling tools and other quantitative information as well as increase the possibility of a consistent treatment of the different interactions.

References

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1-3 **Hudson J A, 1992**
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2-1 Filemaker Pro 2.0 Bv1, October 1992
1988-1992, Claris Corporation.

2-2 **Chapman N, Andersson J, Robinson P, Skagius K, Wene C O, Wiborgh M and Wingefors S ,1995**
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Appendix A:

Graphical Presentation of the FAR-FIELD1 Matrix

FAR FIELD

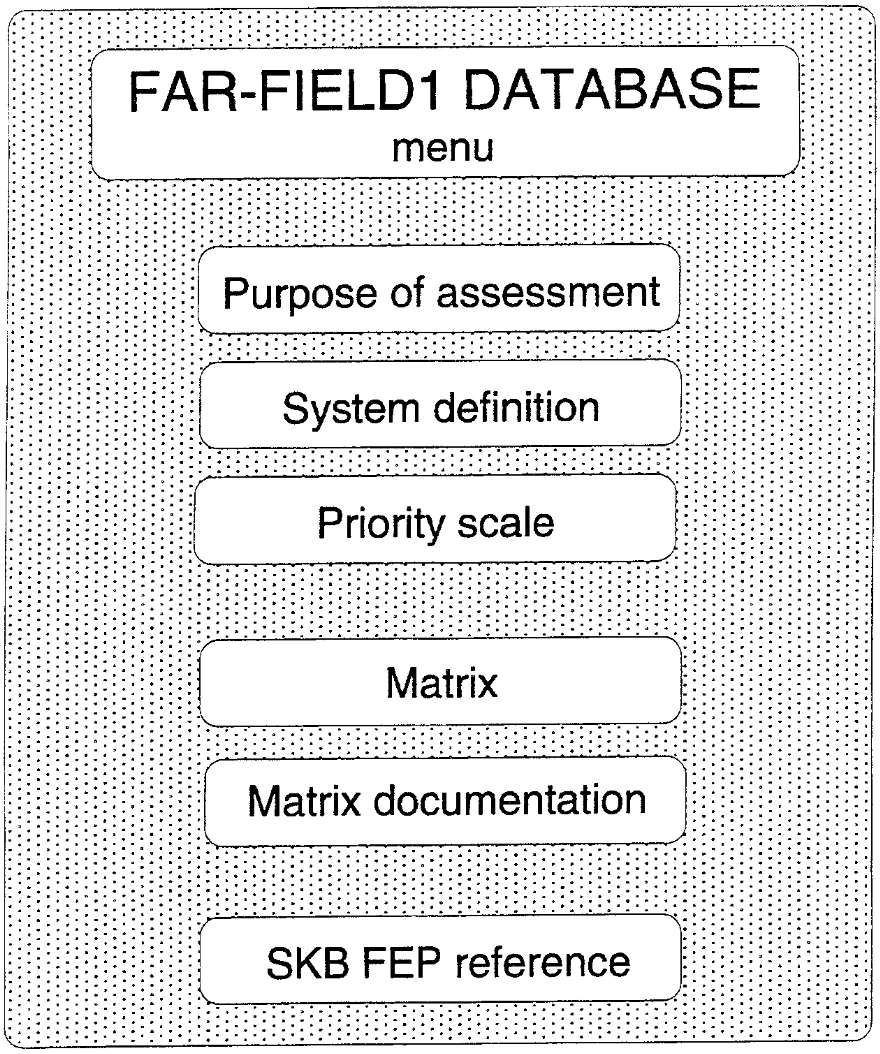
November 9, 1995

process system - far field 1

- Red: Interaction which should be part of the performance assessment
- Yellow: Interaction present - influences on other parts of the process system in a limited or uncertain way and/or under special circumstances
- Green: Interaction present - influences on other parts of the process system can be neglected

CONSTRUCTION/ LAYOUT	1.2 Excavation method	1.3 Excavation method Grouting Reinforcement	1.4	1.5 Displacement effects	1.6 Construction materials Stray materials	1.7	1.8 Drawdown effects	1.9 Repository depth Ventilation	1.10 Tunnel dimension	1.11 Ventilation Blasting gas Gas source	1.12	1.13 Industrial facility Dumps
2.1 Swelling ability Heat	**BUFFER/ BACKFILL/ SOURCE**	2.3 Buffer/backfill penetration into EDZ	2.4	2.5 Buffer into intersecting fractures	2.6 Colloid source Groundwater composition	2.7 Changed [illegible] Changed [illegible]	2.8 Resaturation	2.9 Heat generation	2.10 Swelling pressure	2.11 Gas source	2.12 Source term	2.13
3.1 Excavation method Amount of reinforcement	3.2 Volume for buffer/backfill swelling Rock fallout	**EDZ**	3.4	3.5	3.6 Changed ϵ_i and a_r Colloid and particulate generation	3.7 Changed permeability	3.8	3.9 Modified thermal diffusivity	3.10 Fractures affected	3.11 Indiffusion of air Transport path for gas	3.12 Changed ϵ_i and a_r Sorption capacity	3.13
4.1 Layout/ construction method	4.2	4.3 Magnitude and geometrical extent	**ROCK MATRIX/ MINERALOGY**	4.5 Fracture characteristics and infilling mineralisation	4.6 Rock-water interaction	4.7 Matrix K Rock compressibility	4.8	4.9 Thermal properties	4.10 Genesis, tectonic history and rock type	4.11 Radon generation	4.12 Sorption Matrix diffusion	4.13 Land-use Potential human intrusion
5.1 Avoid major zones Constructability	5.2	5.3 Mechanical properties and fracture frequency	5.4	**NATURAL FRACTURE SYSTEM**	5.6 Dissolution of fracture minerals Colloid generation	5.7 Flow paths Connectivity Fracture aperture Storage capa.	5.8	5.9 Thermal properties	5.10 Stress magnitude and orientation	5.11 Transport path for gas	5.12 Molecular diffusion Surface area Sorption	5.13 Wells
6.1 Depth affected by redoxpot Construction materials	6.2 TDS, ion exchange, infiltration	6.3 Precipitation/ bacterial growth	6.4 Groundwater rock interaction	6.5 Precipitation and dissolution of fracture minerals	**GROUNDWATER CHEMISTRY**	6.7 Density and viscosity	6.8 Density affects groundwater head	6.9 Heat conductivity	6.10	6.11 Chemically generated gas Microbially generated gas Clathrates	6.12 Sorptivity and solubility Colloids and bacteria	6.13 Water-use Biotopes
7.1 Canister positioning Construction methods	7.2 Saturation Bentonite erosion	7.3 Erosion	7.4	7.5 Erosion and sedimentation	7.6 Mixing	**GROUNDWATER MOVEMENT**	7.8 Equalisation of pressures	7.9 Forced heat convection	7.10	7.11 Two-phase flow	7.12 Transport of dissolved gas [illegible]	7.13 Recharge and discharge
8.1 Construction methods	8.2	8.3	8.4	8.5	8.6 Solubility	8.7 Driving force due to pressure gradient	**GROUNDWATER PRESSURE**	8.9	8.10 Effective stress	8.11 Gas solubility Gas law	8.12	8.13 Potential effect on vegetation
9.1	9.2 Temperature in buffer/ backfill	9.3	9.4 Thermal expansion Thermal conductivity	9.5 Permafrost	9.6 Dissolution and precipitation of minerals	9.7 Viscosity	9.8 Density	**TEMPERATURE/HEAT**	9.10 Thermal expansion	9.11 Gas solubility Gas law	9.12 Kinetic effects	9.13
10.1 Design/layout Construction methods	10.2 Reaction force on swelling pressure Rock fallout	10.3 Mechanical stability Fracture aperture	10.4 Mechanical stability	10.5 Mechanical stability Fracture aperture	10.6	10.7	10.8 Confined aquifers	10.9	**ROCK STRESSES**	10.11	10.12	10.13 Mechanical stability
11.1 Ventilation problems	11.2	11.3 Opening of fractures Heat conduction	11.4 Fracturing Thermal properties	11.5 Fracture aperture	11.6 pH, Eh affected	11.7 Creation of 2-phase flow conditions	11.8 Capillary forces	11.9 Gas law	11.10	**GAS GENERATION AND TRANSPORT**	11.12 Colloid sorption on gas bubbles	11.13 Gas release
12.1 Design/ layout	12.2	12.3	12.4	12.5	12.6 Radiolysis Redox front	12.7	12.8	12.9	12.10	12.11	**TRANSPORT OF RADIONUCLIDES**	12.13 Contamination
13.1 Siting, design/ layout	13.2	13.3	13.4	13.5	13.6 Infiltrating water	13.7 Surface water recharge & percolation	13.8 Land use Climate & [illegible]	13.9 Climatic driving forces	13.10 External load Erosion	13.11	13.12	**BIOSPHERE**

Appendix B: FAR-FIELD1 Database



Content:

List of records in the FAR-FIELD1 database B-1
Printout of database records B-9

List of records in the FAR-FIELD1 database

Record number:	Element number:	Element name:
1	01.01	1.1 CONSTRUCTION/LAYOUT
2	02.02	2.2 BUFFER/BACKFILL/SOURCE
3	03.03	3.3 EDZ - Excavation Damaged Zone
4	04.04	4.4 ROCK MATRIX/MINERALOGY
5	05.05	5.5 NATURAL FRACTURE SYSTEM
6	06.06	6.6 GROUNDWATER CHEMISTRY
7	07.07	7.7 GROUNDWATER MOVEMENT
8	08.08	8.8 GROUNDWATER PRESSURE
9	09.09	9.9 TEMPERATURE/HEAT
10	10.10	10.10 ROCK STRESSES
11	11.11	11.11 GAS GENERATION AND TRANSPORT
12	12.12	12.12 TRANSPORT OF RADIONUCLIDES
13	13.13	13.13 BIOSPHERE
14	01.02	1.2 Excavation method
15	01.03	1.3a Excavation method
16	01.03	1.3b Grouting
17	01.03	1.3c Reinforcement
18	01.04	1.4
19	01.05	1.5 Displacement effects
20	01.06	1.6a Construction materials
21	01.06	1.6b Stray materials
22	01.07	1.7
23	01.08	1.8 Drawdown effects
24	01.09	1.9a Repository depth
25	01.09	1.9b Ventilation
26	01.10	1.10 Tunnel dimensions
27	01.11	1.11a Ventilation
28	01.11	1.11b Blasting gas

List of records in the FAR-FIELD1 database

Record number:	Element number:	Element name:
29	01.11	1.11c Gas source
30	01.12	1.12
31	01.13	1.13a Industrial facility
32	01.13	1.13b Dumps
33	02.01	2.1a Swelling ability
34	02.01	2.1b Heat
35	02.03	2.3 Buffer/backfill penetration into EDZ
36	02.04	2.4
37	02.05	2.5 Buffer into intersecting fractures
38	02.06	2.6a Colloid source
39	02.06	2.6b Groundwater composition
40	02.07	2.7a Changed flow around holes
41	02.07	2.7b Changed flow in tunnels
42	02.08	2.8 Resaturation
43	02.09	2.9 Heat generation
44	02.10	2.10 Swelling pressure
45	02.11	2.11 Gas source
46	02.12	2.12 Source term
47	02.13	2.13
48	03.01	3.1a Excavation method
49	03.01	3.1b Amount of reinforcement
50	03.02	3.2a Volume for buffer/backfill swelling
51	03.02	3.2b Rock fallout
52	03.04	3.4
53	03.05	3.5
54	03.06	3.6a Changed porosity and surface area
55	03.06	3.6b Colloid and particulate generation
56	03.07	3.7 Changed permeability

List of records in the FAR-FIELD1 database

Record number:	Element number:	Element name:
57	03.08	3.8
58	03.09	3.9 Modified thermal diffusivity
59	03.10	3.10 Fractures affected
60	03.11	3.11a Indiffusion of air
61	03.11	3.11b Transport path for gas
62	03.12	3.12a Changed porosity and surface area
63	03.12	3.12b Sorption capacity
64	03.13	3.13
65	04.01	4.1 Layout/construction method
66	04.02	4.2
67	04.03	4.3 Magnitude and geometrical extent
68	04.05	4.5 Fracture characteristics and infilling mineralisation
69	04.06	4.6 Rock-water interaction
70	04.07	4.7a Matrix conductivity
71	04.07	4.7b Rock compressibility
72	04.08	4.8
73	04.09	4.9 Thermal properties
74	04.10	4.10 Genesis, tectonic history and rock type
75	04.11	4.11 Radon generation
76	04.12	4.12a Sorption
77	04.12	4.12b Matrix diffusion
78	04.13	4.13a Land use
79	04.13	4.13b Potential human intrusion
80	05.01	5.1a Avoid major fracture zones
81	05.01	5.1b Constructability
82	05.02	5.2
83	05.03	5.3 Mechanical properties and fracture frequency
84	05.04	5.4

List of records in the FAR-FIELD1 database

Record number:	Element number:	Element name:
85	05.06	5.6a Dissolution of fracture minerals
86	05.06	5.6b Colloid generation
87	05.07	5.7a Flow paths
88	05.07	5.7b Connectivity
89	05.07	5.7c Fracture aperture
90	05.07	5.7d Storage capacity
91	05.08	5.8
92	05.09	5.9 Thermal properties
93	05.10	5.10 Stress magnitude and orientation
94	05.11	5.11 Transport path for gas
95	05.12	5.12a Molecular diffusion
96	05.12	5.12b Surface area
97	05.12	5.12c Sorption
98	05.13	5.13 Wells
99	06.01	6.1a Depth affected by redox potential
100	06.01	6.1b Construction materials
101	06.02	6.2 TDS - ion exchange - illitisation
102	06.03	6.3a Precipitation/bacterial growth operating phase
103	06.03	6.3b Precipitation/bacterial growth in the long run
104	06.04	6.4 Groundwater rock interaction
105	06.05	6.5 Precipitation and dissolution of fracture minerals
106	06.07	6.7 Density and viscosity
107	06.08	6.8 Density affects groundwater head
108	06.09	6.9 Heat conductivity
109	06.10	6.10
110	06.11	6.11a Chemically generated gas
111	06.11	6.11b Microbially generated gas
112	06.11	6.11c Clathrates

List of records in the FAR-FIELD1 database

Record number:	Element number:	Element name:
113	06.12	6.12a Sorption and solubility
114	06.12	6.12b Colloids and bacteria
115	06.13	6.13a Water use
116	06.13	6.13b Biotopes
117	07.01	7.1a Canister positioning
118	07.01	7.1b Construction methods
119	07.02	7.2a Saturation
120	07.02	7.2b Bentonite erosion
121	07.03	7.3 Erosion
122	07.04	7.4
123	07.05	7.5 Erosion and sedimentation
124	07.06	7.6 Mixing
125	07.08	7.8 Equalisation of pressures
126	07.09	7.9 Forced heat convection
127	07.10	7.10
128	07.11	7.11 Two-phase flow
129	07.12	7.12a Transport of dissolved gas
130	07.12	7.12b Direction, distribution and magnitude
131	07.12	7.12c Hydrodynamic dispersion
132	07.13	7.13 Recharge and discharge
133	08.01	8.1 Construction methods
134	08.02	8.2
135	08.03	8.3
136	08.04	8.4
137	08.05	8.5
138	08.06	8.6 Solubility
139	08.07	8.7 Driving force due to pressure gradient
140	08.09	8.9

List of records in the FAR-FIELD1 database

Record number:	Element number:	Element name:
141	08.10	8.10 Effective stress
142	08.11	8.11a Gas solubility
143	08.11	8.11b Gas law
144	08.12	8.12
145	08.13	8.13 Potential effect on vegetation
146	09.01	9.1
147	09.02	9.2 Temperature in buffer/backfill
148	09.03	9.3
149	09.04	9.4a Thermal expansion
150	09.04	9.4b Thermal conductivity
151	09.05	9.5 Permafrost
152	09.06	9.6 Dissolution and precipitation of minerals
153	09.07	9.7 Viscosity
154	09.08	9.8 Density
155	09.10	9.10 Thermal expansion
156	09.11	9.11a Gas solubility
157	09.11	9.11b Gas law
158	09.12	9.12 Kinetic effects
159	09.13	9.13
160	10.01	10.1a Design/layout
161	10.01	10.1b Construction methods
162	10.02	10.2a Reaction force on swelling pressure
163	10.02	10.2b Rock fallout
164	10.03	10.3a Mechanical stability
165	10.03	10.3b Fracture aperture
166	10.04	10.4 Mechanical stability
167	10.05	10.5a Mechanical stability
168	10.05	10.5b Fracture aperture

List of records in the FAR-FIELD1 database

Record number:	Element number:	Element name:
169	10.06	10.6
170	10.07	10.7
171	10.08	10.8 Confined aquifers
172	10.09	10.9
173	10.11	10.11
174	10.12	10.12
175	10.13	10.13 Mechanical stability
176	11.01	11.1 Ventilation problems
177	11.02	11.2
178	11.03	11.3a Opening of fractures
179	11.03	11.3b Heat conduction
180	11.04	11.4a Fracturing
181	11.04	11.4b Thermal properties
182	11.05	11.5 Fracture aperture
183	11.06	11.6a pH and Eh affected
184	11.06	11.6b Eh affected
185	11.07	11.7 Creation of two-phase flow conditions
186	11.08	11.8 Capillary forces
187	11.09	11.9 Gas law
188	11.10	11.10
189	11.12	11.12 Colloid sorption on gas bubbles
190	11.13	11.13 Gas release
191	12.01	12.1 Design/layout
192	12.02	12.2
193	12.03	12.3
194	12.04	12.4
195	12.05	12.5
196	12.06	12.6a Radiolysis

List of records in the FAR-FIELD1 database

Record number:	Element number:	Element name:
197	12.06	12.6b Redox front
198	12.07	12.7
199	12.08	12.8
200	12.09	12.9
201	12.10	12.10
202	12.11	12.11
203	12.13	12.13 Contamination
204	13.01	13.1 Siting - Design/Layout
205	13.02	13.2
206	13.03	13.3
207	13.04	13.4
208	13.05	13.5
209	13.06	13.6 Infiltrating water
210	13.07	13.7 Surface water recharge and percolation
211	13.08	13.8a Land use
212	13.08	13.8b Tidal driving forces
213	13.08	13.8c Climatic driving forces
214	13.08	13.8d Hydraulic gradients
215	13.09	13.9 Climatic driving forces
216	13.10	13.10a External load
217	13.10	13.10b Erosion
218	13.11	13.11
219	13.12	13.12

Printout of database records

The database comprises of 219 records. The information on the diagonal elements are given in records 1-13 and interactions in records 14-219. The record number is the same as the page number.

1

Element number: 01.01

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

1.1 CONSTRUCTION/LAYOUT

Element type: Diagonal

Number of interactions: Not valid

Recordnumber: 1

Total number of records: 219

Description:

This element is introduced to take care of the influence of the construction work, the operation of the deep repository and the layout of the repository on the definition of the initial conditions of the repository system. Construction includes drilling, blasting, ventilation, grouting etc. The layout is according to the KBS-3 concept, i.e. a distributed tunnel system with canisters in deposition holes with a certain spacing. The definition includes access shafts and the existence of a surface facility for the deep repository.

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date:

Motivation:

Group identification:

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:

Alteration/degradation of rock reinforcement and grout
Repository excavation
Repository construction, layout and operation

Treatment of interaction in Performance Assessment

Interaction: 1.1

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 02.02

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

2.2 BUFFER/BACKFILL/SOURCE

Element type: Diagonal

Number of interactions: Not valid

Recordnumber: 2

Total number of records: 219

Description:

The properties of the backfill material in the tunnels of the repository and the source term for the radionuclide transport in the far-field is defined in this element. The source term is determined by the properties of the canisters with the spent fuel elements and the buffer around the canisters in the deposition holes. This element covers also the gas generated within the buffer. In addition, the heat generated by the waste and the temperatu re within the buffer and the backfill are included in the definition. **This element constitute boundary conditions for the far-field.**

2

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date:

Motivation:

Group identification:

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:

Temperature, buffer
Temperature, backfill
Gas flow and transport, buffer/backfill
Properties of buffer
Transport of nuclides, buffer
Properties of backfill
Water chemistry, backfill
Water chemistry, buffer
Chemical alteration of buffer/backfill
Dilution of buffer/backfill

Treatment of interaction in Performance Assessment

Interaction: 2.2 BUFFER/BACKFILL/SOURCE

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 03.03 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

3.3 EDZ - Excavation Damaged Zone

Element type: Diagonal **Number of interactions:** Not valid

Recordnumber: 3 **Total number of records:** 219

Description:

The Excavation Damaged Zone is defined as the zone extending around an underground opening which is affected by the excavation process and subsequent mechanical processes. EDZ is defined as the part of the surrounding rock around the deposition holes as well as around the tunnels wherein the material properties are changed compared to the undisturbed rock. The hydraulic, mechanical and thermal properties of the EDZ are included in the definition.

3

Priority: **Priority date:**

O 0=White O 1=Green O 2=Yellow O 3=Red

Motivation:

Group identification:

Expertise:

O Experts
O General Know how
O Limited

SKB FEP reference:
Properties of rock, EDZ

Treatment of interaction in Performance Assessment

Interaction: 3.3 EDZ

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name: **Model A reference:**

Model B name: **Model B reference:**

Spec modelling assumptions:

4

Element number: 04.04

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

4.4 ROCK MATRIX/MINERALOGY

Element type: Diagonal

Number of interactions: Not valid

Recordnumber: 4

Total number of records: 219

Description:

This element represents the intact rock and includes mineralogy as well as thermal and mechanical properties related to the mineralogy of the intact rock.
Comment: The starting point for endogenous scenarios are included, i e scenarios that deal with the forecast of movements driven by forces emanating from the earth's interior/crust.

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date:

Motivation:

Group identification:

Expertise:

O Experts
O General Know how
O Limited

SKB FEP reference:
Properties of far-field rock

Treatment of interaction in Performance Assessment

Interaction: 4.4

Treatment:

☐ PA prerequisites
☐ Assumptions
☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

5

Element number: 05.05

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

5.5 NATURAL FRACTURE SYSTEM

Element type: Diagonal

Number of interactions: Not valid

Recordnumber: 5

Total number of records: 219

Description:

The natural fracture system includes fracture mineralogy as well as thermal and mechanical properties of the natural fractures. Fracture zones of different magnitude are part of this definition. The fractures in the disturbed zone are included in the definition of the EDZ.

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date:

Motivation:

Group identification:

Expertise:

O Experts
O General Know how
O Limited

SKB FEP reference:
Properties of far-field rock

Treatment of interaction in Performance Assessment

Interaction: 5.5 NATURAL FRACTURE SYSTEM

Treatment:

☐ PA prerequisites
☐ Assumptions
☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

6

Element number: 06.06 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

6.6 GROUNDWATER CHEMISTRY

Element type: Diagonal **Number of interactions:** Not valid

Recordnumber: 6 **Total number of records:** 219

Description:

This element represents the groundwater chemistry in the EDZ and in the far-field rock. It includes the natural composition of:

- main constituents
- redox sensitive elements
- pH, Eh
- fulvic and humic acids
- bacteria
- colloids
- dissolved gases

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date:

Motivation:

Group identification:

Expertise:

O Experts
O General Know how
O Limited

SKB FEP reference:

Microbial activity
Groundwater chemistry, far-field
Groundwater chemistry in nearby rock
Colloid generation and transport

Treatment of interaction in Performance Assessment

Interaction: 6.6 GROUNDWATER CHEMISTRY

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name: **Model A reference:**

Model B name: **Model B reference:**

Spec modelling assumptions:

Element number: 07.07

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

7.7 GROUNDWATER MOVEMENT

Element type: Diagonal

Number of interactions: Not valid

Recordnumber: 7

Total number of records: 219

Description:

The fluid flow in the far-field rock, i e magnitude, direction and distribution of groundwater flow, is given by this element. Hydrogeological condition in terms of intrinsic permeability and effects of viscosity and density are considered. The groundwater movement in the tunnels, in the EDZ around tunnels and deposition holes, and the mixing of different waters are also covered by this element.

7

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date:

Motivation:

Group identification:

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:

Groundwater flow

Flow through buffer/backfill

Treatment of interaction in Performance Assessment

Interaction: 7.7 GROUNDWATER MOVEMENT

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

8

Element number: 08.08

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

8.8 GROUNDWATER PRESSURE

Element type: Diagonal

Number of interactions: Not valid

Recordnumber: 8

Total number of records: 219

Description:

The groundwater pressure here defined as the hydraulic head, $\phi=p_{tot}/\rho g+z$. is the driving force for groundwater movement. In addition to hydraulic head this element also refers to the absolute pressure.

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date:

Motivation:

Group identification:

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:
Groundwater flow

Treatment of interaction in Performance Assessment

Interaction: 8.8 GROUNDWATER PRESSURE

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

9

Element number: 09.09

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

9.9 TEMPERATURE/HEAT

Element type: Diagonal

Number of interactions: Not valid

Recordnumber: 9

Total number of records: 219

Description:

This element includes the temperature in the far-field as well as in the EDZ around tunnels and deposition holes.

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date:

Motivation:

Group identification:

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:

Temperature, EDZ
Temperature, far-field

Treatment of interaction in Performance Assessment

Interaction: 9.9 TEMPERATURE/HEAT

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

10

Element number: 10.10

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

10.10 ROCK STRESSES

Element type: Diagonal

Number of interactions: Not valid

Recordnumber: 10

Total number of records: 219

Description:

Rock stresses refer to the "total stresses" (effective stress+pore water pressure) which can be measured in-situ. In the definition the stresses in the far-field rock and in the EDZ around the tunnels and the deposition holes are included.

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date:

Motivation:

Group identification:

Expertise:

O Experts
O General Know how
O Limited

SKB FEP reference:
Rock stresses

Treatment of interaction in Performance Assessment

Interaction: 10.10 ROCK STRESSES

Treatment:

☐ PA prerequisites
☐ Assumptions
☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 11.11

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

11.11 GAS GENERATION AND TRANSPORT

Element type: Diagonal

Number of interactions: Not valid

Recordnumber: 11

Total number of records: 219

Description:

Gas generation and gas transport in the rock matrix, in the natural fracture system, in the EDZ and in the backfilled tunnels are included in this element. Gas includes natural and waste generated gases of all kinds but not dissolved gases. Gas pressure is also included.

11

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date:

Motivation:

Group identification:

Expertise:

O Experts
O General Know how
O Limited

SKB FEP reference:

Gas flow and transport, buffer/backfill
Gas flow and transport in rock
Gas generation/sources in rock

Treatment of interaction in Performance Assessment

Interaction: 11.11 GAS GENERATION AND TRANSPORT

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

12

Element number: 12.12 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

12.12 TRANSPORT OF RADIONUCLIDES

Element type: Diagonal **Number of interactions:** Not valid

Recordnumber: 12 **Total number of records:** 219

Description:

The transport of radionuclides in the far-field rock, in the EDZ around tunnels and deposition holes, and in the backfilled tunnels are included in the definition of this element.

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date:

Motivation:

Group identification:

Expertise:

O Experts
O General Know how
O Limited

SKB FEP reference:

Transport of nuclides, backfill
Transport of radionuclides in rock

Treatment of interaction in Performance Assessment

Interaction: 12.12 TRANSPORT OF RADIONUCLIDES

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name: **Model A reference:**

Model B name: **Model B reference:**

Spec modelling assumptions:

13

Element number: 13.13 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

13.13 BIOSPHERE

Element type: Diagonal **Number of interactions:** Not valid

Recordnumber: 13 **Total number of records:** 219

Description:

All processes in the biosphere including vegetation, climate, wells, topography etc. This element constitutes boundary condition for the far field.
Comment: The starting point for exogenous scenarios that focus on predicting events and processes at the earth's surface mainly caused by climatic conditions are included.

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date:

Motivation:

Group identification:

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:
Environment
Sea-level changes

Treatment of interaction in Performance Assessment

Interaction: 13.13 BIOSPHERE

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

14

Element number: 01.02

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

1.2 Excavation method

Element type: Interaction

Number of interactions: 1

Recordnumber: 14

Total number of records: 219

Description:

The excavation method, TBM or drilling/blasting technique, affects the tunnel wall smoothness etc and this puts requirements on the backfill in terms of geometry and material properties (swelling, density).

Priority:

O 0=White O 1=Green O 2=Yellow ⊙ 3=Red

Priority date: 95-05-19

Motivation:

Geometry and properties of buffer/backfill are important for the barrier function. Blasting puts higher requirements on the swelling ability of the backfill compared to drilling. Deposition holes always made by drilling.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Repository excavation
Properties of backfill

Treatment of interaction in Performance Assessment

Interaction: 1.2 Excavation method

Treatment:

- ■ PA prerequisites
- □ Assumptions
- □ Modelling

Date 95-05-22

By: A Ström (SKB)

PA prerequisites:

Buffer/backfill geometry as well as their material properties are near-field prerequisites. The treatment in PA far-field modelling depends on modelling strategy and resolution in far-field model description.

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

15

Element number: 01.03
Revision date: 95-11-30
Interaction matrix: FAR-FIELD1
Version: A

Element name:

1.3a Excavation method

Element type: Interaction
Number of interactions: 3
Recordnumber: 15
Total number of records: 219

Description:

The excavation method determines the magnitude and extent of the EDZ.

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

The extent and magnitude of EDZ are important for water flow and RN-transport.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

O Experts
O General Know how
O Limited

SKB FEP reference:

Properties of rock, EDZ
Repository excavation

Treatment of interaction in Performance Assessment

Interaction: 1.3a Excavation method

Treatment:

■ PA prerequisites
☐ Assumptions
☐ Modelling

Date 95-05-22

By: A Ström (SKB)

PA prerequisites:

The magnitude and extent of the EDZ affect the PA far-field analyses. The exact formation of the EDZ due to the excavation of the deep repository is part of the research programme. In a safety report this work will be reviewed. The outcome may be regarded as a PA prerequisite.

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

16

Element number: 01.03

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

1.3b Grouting

Element type: Interaction

Number of interactions: 3

Recordnumber: 16

Total number of records: 219

Description:

Grouting of rock will influence the hydraulic and mechanical properties of the EDZ.

Priority:

O 0=White ⊙ 1=Green O 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

May improve the properties of the EDZ, but main function during the operational phase.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg. Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Alteration/degradation of rock reinforcement and grout
Properties of rock, EDZ

Treatment of interaction in Performance Assessment

Interaction: 1.3

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 01.03

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

1.3c Reinforcement

Element type: Interaction

Number of interactions: 3

Recordnumber: 17

Total number of records: 219

Description:

Reinforcement of rock will influence the hydraulic and mechanical properties of the EDZ.

17

Priority:

O 0=White ⦿ 1=Green O 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

May improve the properties of the EDZ, but main function during the operational phase.

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⦿ Experts
O General Know how
O Limited

SKB FEP reference:

Alteration/degradation of rock reinforcement and grout
Properties of rock, EDZ

Treatment of interaction in Performance Assessment

Interaction: 1.3

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

18

Element number: 01.04 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

1.4

Element type: Interaction **Number of interactions:** 0

Recordnumber: 18 **Total number of records:** 219

Description:

Priority: **Priority date:** 95-05-19

O 0=White O 1=Green O 2=Yellow O 3=Red

Motivation:

Obvious, all impacts by definition in the diagonal element EDZ.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg. Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 1.4

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name: **Model A reference:**

Model B name: **Model B reference:**

Spec modelling assumptions:

19

Element number: 01.05

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

1.5 Displacement effects

Element type: Interaction

Number of interactions: 1

Recordnumber: 19

Total number of records: 219

Description:

There are displacement effects due to shock waves from blasting during the construction work. Small displacements are elastic and larger plastic (dynamic loading). These displacements will affect the fracture system not being part of the EDZ in terms of fracture aperture and connectivity etc.
Comment: It may be argued that the natural fracture system by definition should not be affected by the construction work of the repository. All these effects are part of the EDZ definition, see (3,3). However, this definition is hard to make and here we have a special case.

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

Influence the hydraulic properties of the fracture system. Remaining effects unknown.

Group Identification:
SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:
- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:
Repository excavation
Properties of far-field rock

Treatment of interaction in Performance Assessment

Interaction: 1.5

Treatment:
- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

20

Element number: 01.06

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

1.6a Construction materials

Element type: Interaction

Number of interactions: 2

Recordnumber: 20

Total number of records: 219

Description:

Construction materials like concrete, rock bolts etc change the groundwater chemistry.

Priority:

O 0=White O 1=Green O 2=Yellow ⊙ 3=Red

Priority date: 95-05-19

Motivation:

Obvious. The stability of groundwater chemistry is of utmost importance for the long-term safety and therefore anything that change this must be considered.

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Alteration/degradation of rock reinforcement and grout

Treatment of interaction in Performance Assessment

Interaction: 1.6a Construction materials

Treatment:

- ☐ PA prerequisites
- ■ Assumptions
- ■ Modelling

Date 95-05-22

By: A Ström (SKB)

PA prerequisites:

Assumptions:

Construction materials like concrete will affect the groundwater chemistry in the far-field. This has to be considered in PA. However, this interaction may be treated by separate analysis, in this case chemical transport modelling. Based on this analysis, we will be provided with a range in pH which can be used as a variation case in PA in order to evaluate the possible consequences. An assessment of this kind is given in e g M.Tyres et al, 1995 "Assessment of the geochemical impact of emplacing a separate service road in a granite tunnel"

Modelling application:

Only the chemical influence on the Kd-values, (Kd= f(pH)), is considered in the far-field model FARF 31 in PA/SA.

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

21

Element number: 01.06

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

1.6b Stray materials

Element type: Interaction

Number of interactions: 2

Recordnumber: 21

Total number of records: 219

Description:

Stray materials like oil spill and nitrous compounds change the groundwater chemistry and activate the bacterial processes.

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

Obvious. The stability of groundwater chemistry is of utmost importance for the long-term safety and therefore anything that change this must be considered.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:

Stray materials left

Treatment of interaction in Performance Assessment

Interaction: 1.6b Stray materials

Treatment:

- ■ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date 95-05-18

By: A Ström (SKB)

PA prerequisites:

There are reasons to consider this effect in PA/SA, even though the impact on safety has been evaluated to be without importance. The distribution coefficients for sorption, Kd-values, should be chosen in order to compensate for this fact in PA/SA. In a PA model, the Kd-values are affected by this phenomena. A discussion may be found in SKB TR 91-50.

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

22

Element number: 01.07

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

1.7

Element type: Interaction

Number of interactions: 0

Recordnumber: 22

Total number of records: 219

Description:

Priority:

Priority date: 95-05-19

O 0=White O 1=Green O 2=Yellow O 3=Red

Motivation:

Effects on groundwater movement via other paths (1.3 - 3.7, 1.8 - 8.7).

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 1.7

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 01.08

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

1.8 Drawdown effects

Element type: Interaction

Number of interactions: 1

Recordnumber: 23

Total number of records: 219

Description:

The location and the depth of the repository will determine the hydraulic head, drawdown effects (transient phenomena). During the operation of the repository atmospheric pressure will prevail.

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

Initial effect, short duration, but may affect other parts of the system e g groundwater chemistry via groundwater movement.

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Repository construction, layout and operation
Resaturation

Treatment of interaction in Performance Assessment

Interaction: 1.8

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

24

Element number: 01.09 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

1.9a Repository depth

Element type: Interaction **Number of interactions:** 2

Recordnumber: 24 **Total number of records:** 219

Description:

The location and the depth of the repository will determine the temperature in the surrounding rock.

Priority: O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

Obvious, temperature is depth dependence.

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Temperature, EDZ
Repository construction, layout and operation

Treatment of interaction in Performance Assessment

Interaction: 1.9a Repository depth

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ■ Modelling

Date 95-05-22

By: A Ström (SKB)

PA prerequisites:

Assumptions:

Modelling application:

The temperature analysis for a repository concept is an important part of a PA. The buffer temperature is one of the most important design parameters. The repository depth is one of the input parameters (background temperature) in the temperature calculations.

Model A name:
SOLVIA

Model A reference:
SOLVIA SYSTEM,Version 90.2
SKB AR 91-13

Model B name:

Model B reference:

Spec modelling assumptions:

25

Element number: 01.09

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

1.9b Ventilation

Element type: Interaction

Number of interactions: 2

Recordnumber: 25

Total number of records: 219

Description:

The ventilation of the repository will have an impact on the temperature.
Effect: Temperature change in nearby rock. Transient effect.

Priority:

O 0=White ⊙ 1=Green O 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

Transient effect, negligible in relation to the heating by decaying fuel.

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Repository construction, layout and operation
Temperature, EDZ

Treatment of interaction in Performance Assessment

Interaction: 1.9

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 01.10

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

1.10 Tunnel dimensions

Element type: Interaction

Number of interactions: 1

Recordnumber: 26

Total number of records: 219

Description:

The dimensions and size of the excavated tunnels determine the stress situation in the surrounding rock mass.
Effect: Changes the rock stress around the repository, especially in the EDZ.

26

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

Important for the stability of the tunnel and therefore important for rock stresses in the EDZ. Less important for rock stresses outside the EDZ.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- Experts
- General Know how
- Limited

SKB FEP reference:

Repository excavation
Rock stresses

Treatment of interaction in Performance Assessment

Interaction: 1.10 Tunnel dimensions

Treatment:

- ■ PA prerequisites
- □ Assumptions
- □ Modelling

Date 95-05-22

By: A Ström (SKB)

PA prerequisites:

The tunnel dimensions determine the stress situation. This will affect the overall impact of the EDZ including hydraulic properties. The EDZ description is an input to near-field and far-field analysis. The actual interaction is not a subject to investigate in the PA.

Assumptions:

Modelling application:

Model A name:
SOLVIA

Model A reference:
SOLVIA SYSTEM,Version 90.2
SKB AR 91-13

Model B name:

Model B reference:

Spec modelling assumptions:

27

Element number: 01.11
Revision date: 95-11-30
Interaction matrix: FAR-FIELD1
Version: A
Element name:

1.11a Ventilation

Element type: Interaction
Number of interactions: 3
Recordnumber: 27
Total number of records: 219

Description:

The ventilation of the repository may dry out the nearby rock and air can diffuse into the rock. This will affect the groundwater chemistry. Transient effect.

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

Entrapped air may act as an oxygen source which subsequently may affect groundwater chemistry.

Group identification:
SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:
⊙ Experts
O General Know how
O Limited

SKB FEP reference:
Gas generation/sources in rock
Repository construction, layout and operation

Treatment of interaction in Performance Assessment

Interaction: 1.11

Treatment:
- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 01.11

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

1.11b Blasting gas

Element type: Interaction

Number of interactions: 3

Recordnumber: 28

Total number of records: 219

Description:

Blasting of tunnels generates gas. This will affect the groundwater chemistry.
Effect: Content of gas in EDZ.

28

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date:

95-05-19

Motivation:

Nitrogen in blasting gas may affect water chemistry and canister corrosion.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Repository construction, layout and operation
Gas generation/sources in rock

Treatment of interaction in Performance Assessment

Interaction: 1.11

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

29

Element number: 01.11

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

1.11c Gas source

Element type: Interaction

Number of interactions: 3

Recordnumber: 29

Total number of records: 219

Description:

Gas source, hydrogen evolving gas corrosion of rock reinforcement.

Priority:

O 0=White ⊙ 1=Green O 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

Limited effects on other parts at early times. In long term perspective small amounts in comparison with potential amounts from canister corrosion.

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Alteration/degradation of rock reinforcement and grout

Treatment of interaction in Performance Assessment

Interaction: 1.11

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

30

Element number: 01.12

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

1.12

Element type: Interaction

Number of interactions: 0

Recordnumber: 30

Total number of records: 219

Description:

Priority:

⊙ 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

No direct interaction. Goes via groundwater movement etc.

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 1.12

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

31

Element number: 01.13 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

1.13a Industrial facility

Element type: Interaction **Number of interactions:** 2

Recordnumber: 31 **Total number of records:** 219

Description:

Physical environmental impact due to industrial facility on surface. Examples: excavations for access to repository, compaction of soil/surface layers, diversion of small streams with effect on surface hydrology.

Priority:

O 0=White ⊙ 1=Green O 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

Negligible effects on repository long-term performance. Part of the EIS.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Repository construction, layout and operation
Physical changes

Treatment of interaction in Performance Assessment

Interaction: 1.13

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name: **Model A reference:**

Model B name: **Model B reference:**

Spec modelling assumptions:

Element number: 01.13

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

1.13b Dumps

Element type: Interaction

Number of interactions: 2

Recordnumber: 32

Total number of records: 219

Description:

Impact of dumps for excavated rock.
Effect: Vegetation, topography, release from dumps. Impact on vegetation should be relatively short lived after repository closure.

32

Priority:

O 0=White ⊙ 1=Green O 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

Negligible effects on repository long-term performance. Part of the EIS.

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Repository construction, layout and operation
Physical changes
Chemical changes

Treatment of interaction in Performance Assessment

Interaction: 1.13

Treatment:

☐ PA prerequisites
☐ Assumptions
☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

33

Element number: 02.01 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

2.1a Swelling ability

Element type: Interaction **Number of interactions:** 2

Recordnumber: 33 **Total number of records:** 219

Description:

The properties (eg densities and swelling ability) of buffer and backfill will influence design constraints (dimensions, geometries).

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

Obvious, included in design.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg. Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:

Properties of buffer
Properties of backfill
Repository construction, layout and operation

Treatment of interaction in Performance Assessment

Interaction: 2.1a Swelling ability

Treatment:

- ■ PA prerequisites
- □ Assumptions
- □ Modelling

Date 95-05-22

By: A Ström (SKB)

PA prerequisites:

The buffer/backfill properties will influence the dimensions of the repository system. The dimensions are prerequisites for the far-field analyses.

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

34

Element number: 02.01

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

2.1b Heat

Element type: Interaction

Number of interactions: 2

Recordnumber: 34

Total number of records: 219

Description:

The heat generation from the spent fuel will influence design constraints (dimensions, geometries).

Priority:

O 0=White O 1=Green O 2=Yellow ⊙ 3=Red

Priority date: 95-05-19

Motivation:

Obvious, important design parameter.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Temperature, backfill
Temperature, buffer

Treatment of interaction in Performance Assessment

Interaction: 2.1b Heat

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ■ Modelling

Date 95-05-22

By: A Ström (SKB)

PA prerequisites:

Assumptions:

Modelling application:

This is part of the temperature analysis in a PA. Important design parameter. The design will be a PA prerequisite.

Model A name:

SOLVIA

Model A reference:

SOLVIA SYSTEM,Version 90.2
SKB AR 91-13

Model B name:

Model B reference:

Spec modelling assumptions:

35

Element number: 02.03

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

2.3 Buffer/backfill penetration into EDZ

Element type: Interaction

Number of interactions: 1

Recordnumber: 35

Total number of records: 219

Description:

Swelling of buffer and backfill into the fissures in EDZ and the cracks intersecting the deposition holes and the tunnels.
Effects: Affects the hydraulic and mechanical properties of the EDZ.

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

Affects mainly the near-field but also the groundwater flow via 3.7. Should be taken care of in the near-field analysis.

Group identification:
SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:
- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:
Bentonite swelling
Bentonite swelling, backfill
Bentonite swelling, buffer

Treatment of interaction in Performance Assessment

Interaction: 2.3

Treatment:
- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

36

Element number: 02.04

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

2.4

Element type: Interaction

Number of interactions: 0

Recordnumber: 36

Total number of records: 219

Description:

Priority:

⊙ 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

Obvious, all impacts by definition in the diagonal element EDZ.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg. Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 2.4

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

37

Element number: 02.05

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

2.5 Buffer into intersecting fractures

Element type: Interaction

Number of interactions: 1

Recordnumber: 37

Total number of records: 219

Description:

When the buffer has been placed around the canisters in the deposition holes swelling occurs and the buffer will penetrate into natural fractures intersecting deposition holes.
Comment: Just for the deposition holes and not around the tunnels since the EDZ is so small around these holes.

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

Affects mainly the near-field but also the groundwater flow via 5.7. Should be taken care of in the near-field analysis.

Group Identification:
SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:
⊙ Experts
O General Know how
O Limited

SKB FEP reference:
Bentonite swelling, buffer

Treatment of interaction in Performance Assessment

Interaction: 2.5

Treatment:
☐ PA prerequisites
☐ Assumptions
☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

38

Element number: 02.06

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

2.6a Colloid source

Element type: Interaction

Number of interactions: 2

Recordnumber: 38

Total number of records: 219

Description:

The buffer/backfill may act as a colloid source. Could also be formed by erosion.
Comment: The spent fuel source term is a part of the BUFFER/BACKFILL definition.

Priority:

O 0=White O 1=Green O 2=Yellow ⊙ 3=Red

Priority date: 95-05-19

Motivation:

Colloids must be considered in the analysis. Low salinity water may generate colloids. Main colloid source is low salinity water.

Group identification:
SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:
- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:
Colloid generation/source, buffer/backfill

Treatment of interaction in Performance Assessment

Interaction: 2.6b Colloid source

Treatment:
- ■ PA prerequisites
- □ Assumptions
- □ Modelling

Date 95-05-22

By: A Ström (SKB)

PA prerequisites:

The colloidal generation in the buffer/backfill will be the subject of a specific investigation as a background report to a safety report. The output of this study will be a PA prerequisite.

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

39

Element number: 02.06 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

2.6b Groundwater composition

Element type: Interaction **Number of interactions:** 2

Recordnumber: 39 **Total number of records:** 219

Description:

The buffer/backfill may act as a sulphate and carbonate source thereby influencing the concentration of these species in the groundwater. The Na/Ca ratio and pH of the groundwater are affected by the buffer/backfill.
Comment: The spent fuel source term is a part of the BUFFER/BACKFILL definition.

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

Obvious. The stability of groundwater chemistry is of utmost importance for the long-term safety and therefore anything that change this must be considered.

Group identification:
SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:
- O Experts
- O General Know how
- O Limited

SKB FEP reference:
Water chemistry, backfill
Water chemistry, buffer
Groundwater chemistry in nearby rock

Treatment of interaction in Performance Assessment

Interaction: 2.6a Groundwater speciation

Treatment:
- ■ PA prerequisites
- □ Assumptions
- □ Modelling

Date 95-05-22

By: A Ström (SKB)

PA prerequisites:

This is a subject of a specific study as background material to a PA. Will constitute a PA prerequisites for the PA models

Assumptions:

Modelling application:

Model A name: **Model A reference:**

Model B name: **Model B reference:**

Spec modelling assumptions:

40

Element number: 02.07

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

2.7a Changed flow around holes

Element type: Interaction

Number of interactions: 2

Recordnumber: 40

Total number of records: 219

Description:

Changed groundwater flow around deposition holes due to the existence of the buffer.

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

To be taken care of in the near-field analysis.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg. Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Properties of buffer
Groundwater flow

Treatment of interaction in Performance Assessment

Interaction: 2.7

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 02.07 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

2.7b Changed flow in tunnels

Element type: Interaction **Number of interactions:** 2

Recordnumber: 41 **Total number of records:** 219

Description:

Changed groundwater flow in tunnels due to the hydraulic conductivity of the tunnels.

Priority:

O 0=White O 1=Green O 2=Yellow ⊙ 3=Red

Priority date: 95-05-19

Motivation:

Obvious

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Properties of backfill
Flow through buffer/backfill

Treatment of interaction in Performance Assessment

Interaction: 2.7b Changed flow in tunnels

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ■ Modelling

Date 95-05-18

By: A Ström (SKB)

PA prerequisites:

Assumptions:

Modelling application:

Implemented in the PA model HYDRASTAR 1.4, described in SKB AR 91-18. Part of the SKB model chain.

Model A name:

HYDRASTAR 1.4

Model A reference:

User's Guide, SKB AR 94-14

Model B name:

Model B reference:

Spec modelling assumptions:

The assumptions for the implementation in the PA model is described in SKB AR 91-18.

Element number: 02.08

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

2.8 Resaturation

Element type: Interaction

Number of interactions: 1

Recordnumber: 42

Total number of records: 219

Description:

The successive emplacement of buffer in the deposition holes and the successive backfilling of used tunnels during the operation of the repository will lead to resaturation during operation of the repository, removes initial drawdown effects (transient phenomena).

42

Priority:

○ 0=White ○ 1=Green ⊙ 2=Yellow ○ 3=Red

Priority date: 95-05-19

Motivation:

Transient effect, not important for the far-field, but may be important in the near-field.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
○ General Know how
○ Limited

SKB FEP reference:
Resaturation

Treatment of interaction in Performance Assessment

Interaction: 2.8

Treatment:

☐ PA prerequisites
☐ Assumptions
☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 02.09

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

2.9 Heat generation

Element type: Interaction

Number of interactions: 1

Recordnumber: 43

Total number of records: 219

Description:

The heat generated by the waste will be transferred to the surrounding far field rock. The thermal conductivity of the buffer and the backfill will have an influence on the temperature evolution in the far field rock.

43

Priority:

O 0=White O 1=Green O 2=Yellow ʘ 3=Red

Priority date: 95-05-19

Motivation:

Obvious

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- ʘ Experts
- O General Know how
- O Limited

SKB FEP reference:

Temperature, backfill
Temperature, buffer
Temperature, EDZ
Temperature, far-field

Treatment of interaction in Performance Assessment

Interaction: 2.9 Heat generation

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ■ Modelling

Date 95-05-22

By: A Ström (SKB)

PA prerequisites:

Assumptions:

Modelling application:

This is part of temperature analysis in a PA. Important design parameter. The design will be a PA prerequisite. See for example SKB TR 91-57

Model A name:

SOLVIA

Model A reference:

SOLVIA SYSTEM,Version 90.2
SKB AR 91-13

Model B name:

Model B reference:

Spec modelling assumptions:

44

Element number: 02.10
Revision date: 95-11-30
Interaction matrix: FAR-FIELD1
Version: A

Element name:

2.10 Swelling pressure

Element type: Interaction
Number of interactions: 1
Recordnumber: 44
Total number of records: 219

Description:

As a consequence of water uptake the buffer and the backfill will swell. The extent of swelling will influence the swelling pressure.
Effect: stress changes in surrounding rock, especially in the EDZ.

Priority:
O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date:
95-05-19

Motivation:

Mostly a near-field effect on properties of buffer/backfill and EDZ.

Group identification:
SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:
⊙ Experts
O General Know how
O Limited

SKB FEP reference:
Bentonite swelling, backfill
Bentonite swelling, buffer

Treatment of interaction in Performance Assessment

Interaction: 2.1

Treatment:
☐ PA prerequisites
☐ Assumptions
☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 02.11 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

2.11 Gas source

Element type: Interaction **Number of interactions:** 1

Recordnumber: 45 **Total number of records:** 219

Description:

Gas source: hydrogen evolving corrosion of steel vessel, microbial degradation of organics in buffer (H2 + CO_2), radiolytic decomposition of water, He-production, radioactive gases etc.

Comment: Gas transport properties in buffer/backfill is by definition included in the diagonal element (2,2).

45

Priority:

O 0=White O 1=Green O 2=Yellow ⊙ 3=Red

Priority date: 95-05-19

Motivation:

Obvious

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Gas generation and gas sources in the rock, EDZ and far-field
Gas flow and transport, buffer/backfill
Gas generation/sources in rock

Treatment of interaction in Performance Assessment

Interaction: 2.11 Gas source

Treatment:

■ PA prerequisites
□ Assumptions
□ Modelling

Date 95-05-22

By: A Ström

PA prerequisites:

The output from separate analyses will provide us with PA prerequisite/input.

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 02.12

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

2.12 Source term

Element type: Interaction

Number of interactions: 1

Recordnumber: 46

Total number of records: 219

Description:

Release of radionuclides from the buffer is the source term for the transport in the backfill, the EDZ and the far field.

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

Obvious

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:

Transport of nuclides, buffer
Transport of nuclides, backfill
Transport of radionuclides in rock
Colloid generation/source, buffer/backfill

Treatment of interaction in Performance Assessment

Interaction: 2.12 Source term

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ■ Modelling

Date 95-05-18

By: A Ström (SKB)

PA prerequisites:

Assumptions:

Modelling application:

The migration rate from the near-field for each radionuclide is included in the far-field transport model. Part of the SKB PA model chain for radionuclide migration.

Model A name:

FARF 31

Model A reference:

SKB TR 90-01, Technical description

Model B name:

Model B reference:

Spec modelling assumptions:

This is the boundary conditions of the nuclide transport model and it naturally needs to be included in the far-field model, (FARF31 allows any input boundary conditions).

Element number: 02.13

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

2.13

Element type: Interaction

Number of interactions: 0

Recordnumber: 47

Total number of records: 219

Description:

47

Priority:

- ʘ 0=White
- O 1=Green
- O 2=Yellow
- O 3=Red

Priority date: 95-05-19

Motivation:

No effects on BIOSPHERE, physically isolated.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg. Kemakta: K Skagius & M Wiborgh.

Expertise:

- ʘ Experts
- O General Know how
- O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 2.13

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 03.01 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

3.1a Excavation method

Element type: Interaction **Number of Interactions:** 2

Recordnumber: 48 **Total number of records:** 219

Description:

The EDZ affects the choice of excavation method, e g TBM or drilling/blasting technique.

48

Priority:

O 0=White O 1=Green ⦿ 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

A design question which is not a part of the far-field analysis, but could affect the near-field.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⦿ Experts
O General Know how
O Limited

SKB FEP reference:

Repository excavation
Properties of rock, EDZ

Treatment of interaction in Performance Assessment

Interaction: 3.1

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name: **Model A reference:**

Model B name: **Model B reference:**

Spec modelling assumptions:

49

Element number: 03.01 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

3.1b Amount of reinforcement

Element type: Interaction **Number of interactions:** 2

Recordnumber: 49 **Total number of records:** 219

Description:

The properties of the EDZ affects the amount of reinforcement required.

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

A design question which is not a part of the far-field analysis, but could affect the near-field.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Alteration/degradation of rock reinforcement and grout
Properties of rock, EDZ

Treatment of interaction in Performance Assessment

Interaction: 3.1

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name: **Model A reference:**

Model B name: **Model B reference:**

Spec modelling assumptions:

Element number: 03.02

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

3.2a Volume for buffer/backfill swelling

Element type: Interaction

Number of Interactions: 2

Recordnumber: 50

Total number of records: 219

Description:

The EDZ constitute an additional volume for buffer/backfill swelling.
Effect: Reduced density of buffer and backfill.

50

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

Effects on the buffer should be handled in the near-field analysis. Effects on backfill probably small but should be verified.

Group identification:
SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:
- O Experts
- O General Know how
- O Limited

SKB FEP reference:
Bentonite swelling, backfill
Bentonite swelling, buffer

Treatment of interaction in Performance Assessment

Interaction: 3.2

Treatment:
- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

51

Element number: 03.02 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

3.2b Rock fallout

Element type: Interaction **Number of interactions:** 2

Recordnumber: 51 **Total number of records:** 219

Description:

Rock fallout in the EDZ which will affect the density and/or the geometry of the buffer/backfill.

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

Effects on the buffer should be handled in the near-field analysis. Effects on backfill uncertain.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg. Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Rock fallout

Treatment of interaction in Performance Assessment

Interaction: 3.2

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name: **Model A reference:**

Model B name: **Model B reference:**

Spec modelling assumptions:

52

Element number: 03.04

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

3.4

Element type: Interaction

Number of interactions: 0

Recordnumber: 52

Total number of records: 219

Description:

Priority:

⊙ 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

Obvious, all impacts by definition in the diagonal element EDZ.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 3.4

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

53

Element number: 03.05

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

3.5

Element type: Interaction

Number of interactions: 0

Recordnumber: 53

Total number of records: 219

Description:

Priority:

⊙ 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

Obvious, all impacts by definition in the diagonal element EDZ.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 3.5

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

54

Element number: 03.06

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

3.6a Changed porosity and surface area

Element type: Interaction

Number of interactions: 2

Recordnumber: 54

Total number of records: 219

Description:

Changed porosity and changed surface area (a_w) affect the groundwater chemistry through dissolution and precipitation of fracture minerals.
Comment: Some of these processes are partly reversible, others totally irreversible.

Priority:

O 0=White ⦿ 1=Green O 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

The increase in contact area between rock and water of minor importance for the groundwater chemistry

Group Identification:
SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:
⦿ Experts
O General Know how
O Limited

SKB FEP reference:
Alteration/weathering of rock and fracture minerals

Treatment of interaction in Performance Assessment

Interaction: 3.6

Treatment:
☐ PA prerequisites
☐ Assumptions
☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 03.06

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

3.6b Colloid and particulate generation

Element type: Interaction

Number of interactions: 2

Recordnumber: 55

Total number of records: 219

Description:

Precipitation of fracture minerals in EDZ may generate colloidal and particulate fractions of precipitated fracture minerals in the groundwater.
Comment: Some of these processes are partly reversible, others totally irreversible.

55

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

May be of importance, uncertain if source negligible in comparison with other colloidal sources, should be studied.

Group Identification:
SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:
⊙ Experts
O General Know how
O Limited

SKB FEP reference:
Colloid generation and transport

Treatment of interaction in Performance Assessment

Interaction: 3.6

Treatment:
- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

56

Element number: 03.07 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

3.7 Changed permeability

Element type: Interaction **Number of interactions:** 1

Recordnumber: 56 **Total number of records:** 219

Description:

Changed permeability affects water movement. Fluid flow in the EDZ as well as in the surrounding rock.

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

Obvious

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:

Groundwater flow
Properties of rock, EDZ

Treatment of interaction in Performance Assessment

Interaction: 3.7 Changed permeability

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ■ Modelling

Date 95-05-18

By: A Ström (SKB)

PA prerequisites:

Assumptions:

Modelling application:

Implemented in the PA model HYDRASTAR 1.4, described in SKB AR 91-18. Part of the SKB PA model chain

Model A name: HYDRASTAR 1.4

Model A reference: User's Guide, SKB AR 94-14

Model B name:

Model B reference:

Spec modelling assumptions:

The assumptions for the implementation in the PA model is described in SKB AR 91-18

57

Element number: 03.08

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

3.8

Element type: Interaction

Number of interactions: 0

Recordnumber: 57

Total number of records: 219

Description:

Priority:

⊙ 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

No interaction by definition (EDZ geometric definition).

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 3.8

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

58

Element number: 03.09 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

3.9 Modified thermal diffusivity

Element type: Interaction **Number of interactions:** 1

Recordnumber: 58 **Total number of records:** 219

Description:

The properties (eg porosities, fissure apertures, saturation degrees etc) and the extent of the EDZ will affect the thermal diffusivity.
Effect: influence the evolution of the temperature in the far field rock.

Priority:

O 0=White ⊙ 1=Green O 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

Changes in thermal properties in EDZ negligible.

Group identification:
SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:
⊙ Experts
O General Know how
O Limited

SKB FEP reference:
Properties of rock, EDZ
Temperature, EDZ
Temperature, far-field

Treatment of interaction in Performance Assessment

Interaction: 3.9

Treatment:
☐ PA prerequisites
☐ Assumptions
☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

59

Element number: 03.10 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

3.10 Fractures affected

Element type: Interaction **Number of Interactions:** 1

Recordnumber: 59 **Total number of records:** 219

Description:

Formation of new fractures and changed aperture of existing fractures in EDZ. The existence of the EDZ affects the rock stresses of the EDZ.
Effect: stress relaxation in surrounding rock.

Priority:

O 0=White O 1=Green O 2=Yellow ⊙ 3=Red

Priority date: 95-05-19

Motivation:

Major impact on rock stress in the EDZ. Decrease with distance into surrounding rock.

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Properties of rock, EDZ
Rock stresses

Treatment of interaction in Performance Assessment

Interaction: 3.10 Fractures affected

Treatment:

- ☐ PA prerequisites
- ■ Assumptions
- ☐ Modelling

Date 95-05-22

By: A Ström (SKB)

PA prerequisites:

Assumptions:

A study of the phenomena will help in order to build a conceptual model of the EDZ. This model is an input to PA.

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

60

Element number: 03.11 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

3.11a Indiffusion of air

Element type: Interaction **Number of interactions:** 2

Recordnumber: 60 **Total number of records:** 219

Description:

An increased porosity in EDZ will affect the amount of air that diffuse into the EDZ.

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

Entrapped air may act as an oxygen source which subsequently may affect groundwater chemistry.

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Properties of rock, EDZ
Gas generation/sources in rock

Treatment of interaction in Performance Assessment

Interaction: 3.11

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name: **Model A reference:**

Model B name: **Model B reference:**

Spec modelling assumptions:

61

Element number: 03.11

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

3.11b Transport path for gas

Element type: Interaction

Number of interactions: 2

Recordnumber: 61

Total number of records: 219

Description:

The EDZ with a higher permeability than the far field rock may constitute a preferential flow path for gas transport.

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

Uncertain whether the higher permeability in EDZ increases the gas transport capacity.

Group Identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Gas flow and transport in rock
Properties of rock, EDZ

Treatment of interaction in Performance Assessment

Interaction: 3.11

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

62

Element number: 03.12

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

3.12a Changed porosity and surface area

Element type: Interaction

Number of interactions: 2

Recordnumber: 62

Total number of records: 219

Description:

Changed porosity and surface areas in the EDZ influence the extent of matrix diffusion and sorption and thereby the solute transport in EDZ and the release to surrounding rock.
Comment: Naturally, the EDZ with a higher permeability than the far field rock may constitute a preferential path for solute transport. However, this interaction is obtained via 3.7 and 7.12.

Priority:

O 0=White O 1=Green O 2=Yellow ⊙ 3=Red

Priority date: 95-05-19

Motivation:

Obvious

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Matrix diffusion
Sorption

Treatment of interaction in Performance Assessment

Interaction: 3.12a Changed porosity and surface area

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ■ Modelling

Date 95-05-18

By: A Ström (SKB)

PA prerequisites:

Assumptions:

Modelling application:

These physical concepts are parameters of the FF PA model.

Model A name:

HYDRASTAR 1.4

Model A reference:

User's Guide, SKB AR 94-14

Model B name:

FARF 31

Model B reference:

SKB TR 90-01, Technical description

Spec modelling assumptions:

If their geometrical extent is known it may be included in a PA. However, presently FARF31 use a constant "a_w" in modelling, effective number. The groundwater flow model use a constant flow porosity. This may be changed if considered important.

63

Element number: 03.12 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

3.12b Sorption capacity

Element type: Interaction **Number of interactions:** 2

Recordnumber: 63 **Total number of records:** 219

Description:

Change in fracture mineralogy affects the sorption capacity, K_d, and thereby solute transport.

Comment: Naturally, the EDZ with a higher permeability than the far field rock may constitute a preferential path for solute transport. However, this interaction is obtained via 3.7 and 7.12.

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

Negligible compared to effects of change in surface area in EDZ and mineralogic changes in the undisturbed rock.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:
Sorption

Treatment of interaction in Performance Assessment

Interaction: 3.12

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

64

Element number: 03.13
Revision date: 95-11-30
Interaction matrix: FAR-FIELD1
Version: A

Element name:

3.13

Element type: Interaction
Number of interactions: 0
Recordnumber: 64
Total number of records: 219

Description:

Priority:
O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

Physically isolated by definition.

Group identification:
SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:
O Experts
O General Know how
O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 3.13

Treatment:
- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

65

Element number: 04.01

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

4.1 Layout/construction method

Element type: Interaction

Number of interactions: 1

Recordnumber: 65

Total number of records: 219

Description:

Mineralogy (rock type), the distribution of mineralogies and mechanical properties affect the repository siting, layout as well as the construction method.

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

Must be considered as a input to design but not part of the far-field analysis.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Properties of far-field rock
Repository construction, layout and operation

Treatment of interaction in Performance Assessment

Interaction: 4.1

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

66

Element number: 04.02

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

4.2

Element type: Interaction

Number of interactions: 0

Recordnumber: 66

Total number of records: 219

Description:

Priority:

0=White 1=Green 2=Yellow 3=Red

Priority date: 95-05-19

Motivation:

Physically isolated by definition.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg. Kemakta: K Skagius & M Wiborgh.

Expertise:

- Experts
- General Know how
- Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 4.2

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 04.03 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

4.3 Magnitude and geometrical extent

Element type: Interaction **Number of interactions:** 1

Recordnumber: 67 **Total number of records:** 219

Description:

The mechanical properties of each rock type will influence the damage during the excavation (induced fracturing).
Effect: extent of EDZ and degree of fracture formation.

67

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

Minor influence compared with effects from excavation method.

Group Identification:
SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:
- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:
Enhanced rock fracturing

Treatment of interaction in Performance Assessment

Interaction: 4.3

Treatment:
- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name: **Model A reference:**

Model B name: **Model B reference:**

Spec modelling assumptions:

68

Element number: 04.05 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

4.5 Fracture characteristics and infilling mineralisation

Element type: Interaction **Number of interactions:** 1

Recordnumber: 68 **Total number of records:** 219

Description:

The interaction is here, by our definition of the diagonal elements, that the rock type determines the fracture characteristics and infilling mineralisations.

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

The basic host rock type determines the fracture characteristics and frequency. Will not be specifically analysed, but will have consequences for other interactions.

Group Identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:
Properties of far-field rock

Treatment of interaction in Performance Assessment

Interaction: 4.5

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name: **Model A reference:**

Model B name: **Model B reference:**

Spec modelling assumptions:

69

Element number: 04.06
Revision date: 95-11-30
Interaction matrix: FAR-FIELD1
Version: A

Element name:

4.6 Rock-water interaction

Element type: Interaction
Number of interactions: 1
Recordnumber: 69
Total number of records: 219

Description:

pH, Eh, TDS (salinity), trace elements are affected by mineralogy as a result of reactions between the rock minerals and the groundwater. If there are naturally occurring colloids they have been formed through the rock-water interaction.

Priority:

O 0=White O 1=Green O 2=Yellow ⊙ 3=Red

Priority date: 95-05-19

Motivation:

One of the main reasons for the stable groundwater.

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Properties of far-field rock
Groundwater chemistry, far-field
Alteration/weathering of rock and fracture minerals
Colloid generation and transport

Treatment of interaction in Performance Assessment

Interaction: 4.6 Rock-water interaction

Treatment:

■ PA prerequisites
□ Assumptions
□ Modelling

Date 95-05-22

By: A Ström (SKB)

PA prerequisites:

Studied separately. Will influence the Kd-values of the far-field model.

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

70

Element number: 04.07

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

4.7a Matrix conductivity

Element type: Interaction

Number of interactions: 2

Recordnumber: 70

Total number of records: 219

Description:

The matrix hydraulic conductivity of the rock mass is determined by the rock type.
Effect: The groundwater movement in the far field rock is affected.

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

By definition no fractures in the rock matrix. Consequently rock matrix conductivity negligible compared to natural fracture transmissivity.

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:

Properties of far-field rock
Groundwater flow

Treatment of interaction in Performance Assessment

Interaction: 4.7

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

71

Element number: 04.07

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

4.7b Rock compressibility

Element type: Interaction

Number of interactions: 2

Recordnumber: 71

Total number of records: 219

Description:

The rock compressibility is affected which also affects the transient groundwater flow.

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date:

95-05-19

Motivation:

During normal climate conditions negligible effects. Long-term climate changes (e g glaciation) may make this interaction important.

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:

Properties of far-field rock
Groundwater flow

Treatment of interaction in Performance Assessment

Interaction: 4.7

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 04.08 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

4.8

Element type: Interaction **Number of interactions:** 0

Recordnumber: 72 **Total number of records:** 219

Description:

72

Priority: **Priority date:**

◉ 0=White ○ 1=Green ○ 2=Yellow ○ 3=Red 95-05-19

Motivation:

Material properties do not directly affect the groundwater pressure.

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

◉ Experts
○ General Know how
○ Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 4.8

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 04.09 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

4.9 Thermal properties

Element type: Interaction **Number of interactions:** 1

Recordnumber: 73 **Total number of records:** 219

Description:

The rock type determines the thermal properties and thus the geothermal gradient.
Effect: The heat transport by conduction and thereby the temperature evolution in the surrounding rock.

73

Priority:

O 0=White O 1=Green O 2=Yellow ⊙ 3=Red

Priority date: 95-05-19

Motivation:

Thermal properties of large importance for the heat conduction from the repository and thus the design.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Properties of far-field rock
Temperature, far-field

Treatment of interaction in Performance Assessment

Interaction: 4.9 Thermal properties

Treatment:

- ☐ PA prerequisites
- ■ Assumptions
- ☐ Modelling

Date 95-05-18

By: A Ström (SKB)

PA prerequisites:

Assumptions:

The rock type determines the thermal properties for the temperature analysis. These are assumptions to the PA.

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 04.10 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

4.10 Genesis, tectonic history and rock type

Element type: Interaction **Number of interactions:** 1

Recordnumber: 74 **Total number of records:** 219

Description:

Genesis, tectonic history and rock type determine the rock stresses.

74

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

Limited influence, but could have an influence on construction/layout

Group Identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg. Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:

Properties of far-field rock
Rock stresses

Treatment of interaction in Performance Assessment

Interaction: 4.1

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

75

Element number: 04.11 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

4.11 Radon generation

Element type: Interaction **Number of interactions:** 1

Recordnumber: 75 **Total number of records:** 219

Description:

The rock type determines the potential for radon generation.
Effect: Gas source.
Comment: May be important during the operational phase of the repository.

Priority: O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

Negligible for the post closure phase, but could be important during the operational phase of the repository.

Group identification:
SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:
- O Experts
- O General Know how
- O Limited

SKB FEP reference:
Properties of far-field rock
Gas generation/sources in rock

Treatment of interaction in Performance Assessment

Interaction: 4.11

Treatment:
- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

76

Element number: 04.12

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

4.12a Sorption

Element type: Interaction

Number of interactions: 2

Recordnumber: 76

Total number of records: 219

Description:

The mineralogy of the rock matrix will have an impact on the sorption capacity.

Priority:

O 0=White O 1=Green O 2=Yellow ⊙ 3=Red

Priority date: 95-05-19

Motivation:

Obvious

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg. Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Sorption

Treatment of interaction in Performance Assessment

Interaction: 4.12a Sorption

Treatment:

■ PA prerequisites
□ Assumptions
□ Modelling

Date 95-05-22

By: A Ström (SKB)

PA prerequisites:

Will be the subject of a background study in the PA. The Kd-values are affected in the end and will be the input to the PA.

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

77

Element number: 04.12

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

4.12b Matrix diffusion

Element type: Interaction

Number of interactions: 2

Recordnumber: 77

Total number of records: 219

Description:

The rock type determines the available porosity for diffusion in the rock matrix, open and closed porosity. Effect: Extent of matrix diffusion.

Priority:

O 0=White O 1=Green O 2=Yellow ⊙ 3=Red

Priority date: 95-05-19

Motivation:

Obvious

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Matrix diffusion

Treatment of interaction in Performance Assessment

Interaction: 4.12b Matrix diffusion

Treatment:

- ■ PA prerequisites
- □ Assumptions
- □ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

The correlation between rock type and the available porosity is a part of the general research programme. In the PA it will affect the prerequisites of the PA.

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 04.13

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

4.13a Land use

Element type: Interaction

Number of interactions: 2

Recordnumber: 78

Total number of records: 219

Description:

Rock type influences land use. The rock type has an effect on topography and hydrography which affects the land use.

78

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

This interaction not itself of importance, but the effects of land use on biosphere and then back to the far-field is interesting.

Group Identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Properties of far-field rock
Physical changes

Treatment of interaction in Performance Assessment

Interaction: 4.13

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

79

Element number: 04.13

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

4.13b Potential human intrusion

Element type: Interaction

Number of interactions: 2

Recordnumber: 79

Total number of records: 219

Description:

Potential human intrusion. The rock type affects the mining potential which may lead to human intrusion.

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-05-19

Motivation:

This interaction not itself of importance, but may influence the potential for future human intrusion.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:

Properties of far-field rock
Physical changes

Treatment of interaction in Performance Assessment

Interaction: 4.13

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

80

Element number: 05.01

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

5.1a Avoid major fracture zones

Element type: Interaction

Number of interactions: 2

Recordnumber: 80

Total number of records: 219

Description:

The natural fracture system will affect the layout of the repository is made in order to avoid major fracture zones which could act as potential pathways for radionuclides escaping from the repository.

Priority:

O 0=White O 1=Green O 2=Yellow ⊙ 3=Red

Priority date:

95-06-12

Motivation:

The lay-out of the repository is strongly correlated to the properties of the rock, safety aspects. The repository lay-out is optimised from safety point of view.

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Properties of far-field rock
Repository construction, layout and operation

Treatment of interaction in Performance Assessment

Interaction: 5.1a Avoid major fracture zones

Treatment:

■ PA prerequisites
□ Assumptions
□ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

The occurrence of the fracture system affects the design of the repository. The design is a prerequisite in PA.

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

81

Element number: 05.01 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

5.1b Constructability

Element type: Interaction **Number of interactions:** 2

Recordnumber: 81 **Total number of records:** 219

Description:

The parts of the bedrock where shafts, access tunnels, deposition tunnels etc are planned shall possess such properties that the construction work can be carried out in a safe manner using known technology. One of the factors affecting the constructability is the location and character of fracture zones.

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

Not important in the long-term safety but will be important for the operational safety.

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Properties of far-field rock
Repository construction, layout and operation

Treatment of interaction in Performance Assessment

Interaction: 5.1

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 05.02

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

5.2

Element type: Interaction

Number of interactions: 0

Recordnumber: 82

Total number of records: 219

Description:

82

Priority:

⊙ 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

No direct interactions identified.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 5.2

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

83

Element number: 05.03 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

5.3 Mechanical properties and fracture frequency

Element type: Interaction **Number of interactions:** 1

Recordnumber: 83 **Total number of records:** 219

Description:

The inherent properties of the natural fracture system in terms of mechanical properties and fracture frequency affects the extent and the characteristics of the EDZ.

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

Limited importance compared to disturbances caused by different excavation methods.

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Properties of far-field rock
Properties of rock, EDZ

Treatment of interaction in Performance Assessment

Interaction: 5.3

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

84

Element number: 05.04 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

5.4

Element type: Interaction **Number of interactions:** 0

Recordnumber: 84 **Total number of records:** 219

Description:

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

No interaction by definition of diagonal elements.

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

O Experts
O General Know how
O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 5.4

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name: **Model A reference:**

Model B name: **Model B reference:**

Spec modelling assumptions:

85

Element number: 05.06 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

5.6a Dissolution of fracture minerals

Element type: Interaction **Number of interactions:** 2

Recordnumber: 85 **Total number of records:** 219

Description:

Dissolution and precipitation of secondary fracture minerals affects groundwater chemistry (concentration of solutes).

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

Limited importance compared to dissolution of primary minerals (host rock minerals) and other processes.

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Alteration/weathering of rock and fracture minerals

Treatment of interaction in Performance Assessment

Interaction: 5.6

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

86

Element number: 05.06

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

5.6b Colloid generation

Element type: Interaction

Number of interactions: 2

Recordnumber: 86

Total number of records: 219

Description:

Precipitation of fracture minerals may generate colloid and particulate fractions of precipitated fracture minerals in the groundwater.

Priority:

O 0=White O 1=Green O 2=Yellow ⊙ 3=Red

Priority date: 95-06-12

Motivation:

Colloids are important in PA. This is one way to generate natural colloids. Must therefore be analysed.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg. Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Colloid generation and transport

Treatment of interaction in Performance Assessment

Interaction: **5.6b Colloid generation**

Treatment:

- ■ PA prerequisites
- □ Assumptions
- □ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

The colloid content in groundwater is an important research area in the SKB research programme. The outcome will affect the PA prerequisites.

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

87

Element number: 05.07 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

5.7a Flow paths

Element type: Interaction **Number of interactions:** 4

Recordnumber: 87 **Total number of records:** 219

Description:

The natural fracture system forms the pathways in fractured rocks where fluid flow may take place.

Priority: **Priority date:**

O 0=White O 1=Green O 2=Yellow O 3=Red 95-06-12

Motivation:

Obvious

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:

Properties of far-field rock
Groundwater flow

Treatment of interaction in Performance Assessment

Interaction: 5.7a Flow paths

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ■ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

Assumptions:

Modelling application:

The hydraulically important fracture zones are included in the far-field assessment models. The may be included explicitly or implicitly in the models describing groundwater flow. When using a stochastic approach, trends will emphasis flow paths along observed fracture zones.

Model A name:

HYDRASTAR 1.4

Model A reference:

User's Guide, SKB AR 94-14

Model B name:

NAMMU 6.2

Model B reference:

Validity Document, SKB AR 95-11

Spec modelling assumptions:

88

Element number: 05.07

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

5.7b Connectivity

Element type: Interaction

Number of interactions: 4

Recordnumber: 88

Total number of records: 219

Description:

The interconnection between fractures and fracture zones is especially important for water movement in fractured rocks.

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

Obvious

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg. Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Properties of far-field rock
Groundwater flow

Treatment of interaction in Performance Assessment

Interaction: 5.7b Connectivity

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ■ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

Assumptions:

Modelling application:

It is very important not to underestimate the connectivity of the rock when performing geohydrology modelling. Different modelling approaches may end up with different descriptions of connectivity.

Model A name:

HYDRASTAR 1.4

Model A reference:

User's Guide, SKB AR 94-14

Model B name:

NAMMU 6.2

Model B reference:

Validity Document, SKB AR 95-11

Spec modelling assumptions:

89

Element number: 05.07

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

5.7c Fracture aperture

Element type: Interaction

Number of interactions: 4

Recordnumber: 89

Total number of records: 219

Description:

The aperture of individual fractures also affects water movement. The aperture distribution as well as the connectivity among fractures will determine the degree of channelling in fluid flow (flow porosity).

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

Obvious

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:

Properties of far-field rock
Groundwater flow

Treatment of interaction in Performance Assessment

Interaction: 5.7c Fracture aperture

Treatment:

- ■ PA prerequisites
- □ Assumptions
- □ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

The treatment in PA very much depends on the chosen modelling approach. The aperture distribution is often the subject of special research. It will provide knowledge for decisions regarding other model parameters.

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 05.07

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

5.7d Storage capacity

Element type: Interaction

Number of interactions: 4

Recordnumber: 90

Total number of records: 219

Description:

Storativity is the parameter that describes the capacity of an aquifer to transfer groundwater to and from storage. The storage capacity is related to the fractures of the rock and, obviously, there is an interaction between the fracture system and water movement.

90

Priority:

O 0=White O 1=Green ⦿ 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

Important only during transient conditions. (see 4.7)

Group Identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg. Kemakta: K Skagius & M Wiborgh.

Expertise:

⦿ Experts
O General Know how
O Limited

SKB FEP reference:

Properties of far-field rock
Groundwater flow

Treatment of interaction in Performance Assessment

Interaction: 5.7

Treatment:

☐ PA prerequisites
☐ Assumptions
☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 05.08

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

5.8

Element type: Interaction

Number of interactions: 0

Recordnumber: 91

Total number of records: 219

Description:

91

Priority:

Priority date: 95-06-12

⊙ 0=White O 1=Green O 2=Yellow O 3=Red

Motivation:

The driving forces of fluid flow are differences in groundwater pressure, the hydraulic gradients. These are influenced by the topography and the natural fracture system. The flow at repository depth may be much influenced by regional groundwater system and to a less extent influenced by the local topography. This is due to extending fracture zones affecting the prevailing hydraulic gradients. Note that this interaction is not

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg. Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 5.8

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

92

Element number: 05.09

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

5.9 Thermal properties

Element type: Interaction

Number of interactions: 1

Recordnumber: 92

Total number of records: 219

Description:

The natural fractures determine the thermal properties. The properties may be different as compared to the rock mass.
Comment: See also 4.9.

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

The amount of fracture minerals small compared to volume of rock. In addition differences in thermal properties of fracture minerals small compared to rock properties.

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:

Properties of far-field rock
Temperature, far-field

Treatment of interaction in Performance Assessment

Interaction: 5.9

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

93

Element number: 05.10 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

5.10 Stress magnitude and orientation

Element type: Interaction **Number of interactions:** 1

Recordnumber: 93 **Total number of records:** 219

Description:

The local variation in rock stress in terms of magnitude and orientation will depend on the prevailing natural fracture system.

Priority: **Priority date:** 95-06-12

O 0=White ⊙ 1=Green O 2=Yellow O 3=Red

Motivation:

Negligible in undisturbed rock but important for EDZ.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg. Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Properties of far-field rock
Rock stresses

Treatment of interaction in Performance Assessment

Interaction: 5.1

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name: **Model A reference:**

Model B name: **Model B reference:**

Spec modelling assumptions:

94

Element number: 05.11

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

5.11 Transport path for gas

Element type: Interaction

Number of interactions: 1

Recordnumber: 94

Total number of records: 219

Description:

The natural fracture system may constitute a transport path for gas.

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date:

95-06-12

Motivation:

Obvious, in analogy with water.

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:

Properties of far-field rock
Gas flow and transport in rock

Treatment of interaction in Performance Assessment

Interaction: 5.11 Transport path for gas

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ■ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

Assumptions:

Modelling application:

As for transport of solutes the fracture system will provide paths for gas. If appropriate it has to be included in PA modelling. This is presently not the case with the available PA models of today. The effect of transport of gas may also be treated by assumptions (like short circuiting of the far-field).

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

95

Element number: 05.12

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

5.12a Molecular diffusion

Element type: Interaction

Number of interactions: 3

Recordnumber: 95

Total number of records: 219

Description:

Molecular diffusion of radionuclides in the natural fracture system.

Priority:

O 0=White O 1=Green O 2=Yellow ⊙ 3=Red

Priority date: 95-06-12

Motivation:

Important process at low water flows.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Diffusion

Treatment of interaction in Performance Assessment

Interaction: 5.12a Molecular diffusion

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ■ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

Assumptions:

Modelling application:

Molecular diffusion of radionuclides is described by the far-field PA models and therefore part of the SKB PA model chain.

Model A name:

FARF 31

Model A reference:

SKB TR 90-01, Technical description

Model B name:

Model B reference:

Spec modelling assumptions:

The maximum diffusive penetration depth is constant along the stream tube.

Element number: 05.12 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

5.12b Surface area

Element type: Interaction **Number of interactions:** 3

Recordnumber: 96 **Total number of records:** 219

Description:

It will affect important transport parameters such as the surface area available for sorption and matrix diffusion.

96

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date:

95-06-12

Motivation:

Obvious

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:

Sorption
Matrix diffusion

Treatment of interaction in Performance Assessment

Interaction: 5.12b Surface area

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ■ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

Assumptions:

Modelling application:

The fracture system will affect the surface area available for sorption. This parameter is important in radionuclide migration modelling. Part of the SKB PA model chain.

Model A name:

FARF 31

Model A reference:

SKB TR 90-01, Technical description

Model B name:

Model B reference:

Spec modelling assumptions:

Using the stream tube approach, the surface area may not vary along the tube. It is seen as an average value.

Element number: 05.12

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

5.12c Sorption

Element type: Interaction

Number of interactions: 3

Recordnumber: 97

Total number of records: 219

Description:

The sorption capacity of the rock is affected by the fracture minerals.

97

Priority:

O 0=White O 1=Green O 2=Yellow ⊙ 3=Red

Priority date: 95-06-12

Motivation:

The primary sorption capacity. Fracture minerals may have substantially different capacities. Some of the fracture minerals have extremely high sorption capacities.

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Sorption

Treatment of interaction in Performance Assessment

Interaction: 5.12c Sorption

Treatment:

- ■ PA prerequisites
- □ Assumptions
- □ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

The fracture minerals affects the sorption capacity which will affect the choice of suitable Kd-values for assessment modelling. This relationship will be treated in separate analyses.

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 05.13 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

5.13 Wells

Element type: Interaction **Number of interactions:** 1

Recordnumber: 98 **Total number of records:** 219

Description:

The fractures and the fracture zones are the water bearing features of the rock and will therefore influence the well locations.
Comment: See also 5.7 and 7.13

98

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

Well scenarios are important in PA.

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- ʘ Experts
- O General Know how
- O Limited

SKB FEP reference:

Well supply
Groundwater recharge and discharge

Treatment of interaction in Performance Assessment

Interaction: 5.13 Wells

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ■ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

Assumptions:

Modelling application:

The treatment of fracture zones and wells are often treated in special modelling studies in a PA.

Model A name:
NAMMU 6.2

Model A reference:
Validity Document, SKB AR 95-11

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 06.01 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

6.1a Depth affected by redox potential

Element type: Interaction **Number of interactions:** 2

Recordnumber: 99 **Total number of records:** 219

Description:

Reducing conditions and favourable chemistry for the entire lifetime of the repository are factors of importance for deciding the depth of the repository. The chemical stability is increasing with depth.

99

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

The groundwater chemistry one of the major reasons for selection of depth. Basic premises, could be discriminating.

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:

Groundwater chemistry, far-field
Repository construction, layout and operation

Treatment of interaction in Performance Assessment

Interaction: 6.1a Depth affected by redox potential

Treatment:

- ■ PA prerequisites
- □ Assumptions
- □ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

Important research subject. Affects the repository design.

Assumptions:

Modelling application:

Model A name: **Model A reference:**

Model B name: **Model B reference:**

Spec modelling assumptions:

Element number: 06.01

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

6.1b Construction materials

Element type: Interaction

Number of interactions: 2

Recordnumber: 100

Total number of records: 219

Description:

Deep stagnant groundwater is often saline, sometimes even strongly saline. Extremely saline water has a negative effect on the buffer and canister material.

100

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date:

95-06-12

Motivation:

The system is not so sensitive to salinity.

Group Identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Groundwater chemistry, far-field
Repository construction, layout and operation

Treatment of interaction in Performance Assessment

Interaction: 6.1

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

101

Element number: 06.02

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

6.2 TDS - ion exchange - illitisation

Element type: Interaction

Number of interactions: 1

Recordnumber: 101

Total number of records: 219

Description:

A low TDS value of the water gives a dissolution of the buffer, a high calcium rich groundwater gives an ion exchange of calcium of the water in exchange of sodium from the bentonite, high contents of potassium can contribute to an illitisation which destroys the swelling ability of the buffer/backfill materials.

Priority:

O 0=White O 1=Green O 2=Yellow ⊙ 3=Red

Priority date: 95-06-12

Motivation:

Obvious

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Chemical alteration of buffer/backfill

Treatment of interaction in Performance Assessment

Interaction: 6.2 TDS - ion exchange - illitisation

Treatment:

- ☐ PA prerequisites
- ■ Assumptions
- ☐ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

Assumptions:

This issue is important to address in a PA study. However, it will not be the subject of PA modelling.

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

102

Element number: 06.03

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

6.3a Precipitation/bacterial growth operating phase

Element type: Interaction

Number of interactions: 2

Recordnumber: 102

Total number of records: 219

Description:

During the operating phase, calcite precipitation, iron and manganese precipitation takes place in the vicinity of the tunnel wall due to the pressure drawdown and the air in the tunnel. Bacterial growth on the tunnel walls is expected. Creates new minerals which may affect the long term performance.
Comment: See also the pathway 1.11-->11.6-->6.3.

Priority:

O 0=White O 1=Green O 2=Yellow ⊙ 3=Red

Priority date: 95-06-12

Motivation:

Very different conditions which may generate new minerals which affects long-term performance.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Alteration/weathering of rock and fracture minerals

Treatment of interaction in Performance Assessment

Interaction: 6.3a Precipitation/bacterial growth operating

Treatment:

■ PA prerequisites
□ Assumptions
□ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

This issue is the subject of research. It will provide PA with prerequisites.

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

103

Element number: 06.03

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

6.3b Precipitation/bacterial growth in the long run

Element type: Interaction

Number of interactions: 2

Recordnumber: 103

Total number of records: 219

Description:

In the long run, calcite precipitation, iron and manganese precipitation takes place in the vicinity of the tunnel wall due to the pressure drawdown and the air in the tunnel. Bacterial growth on the tunnel walls is expected.

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

During the long-term performance changes in water chemistry may affect the properties of EDZ.

Group identification:
SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:
- O Experts
- O General Know how
- O Limited

SKB FEP reference:
Alteration/weathering of rock and fracture minerals

Treatment of interaction in Performance Assessment

Interaction: 6.3

Treatment:
- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

104

Element number: 06.04

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

6.4 Groundwater rock interaction

Element type: Interaction

Number of interactions: 1

Recordnumber: 104

Total number of records: 219

Description:

Dissolution and alteration of minerals in the rock matrix.
Effects: Change in matrix porosity and mineralogy.

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

Uncertain. Studies in progress

Group Identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- ⊙ General Know how
- O Limited

SKB FEP reference:

Alteration/weathering of rock and fracture minerals

Treatment of interaction in Performance Assessment

Interaction: 6.4

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

105

Element number: 06.05

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

6.5 Precipitation and dissolution of fracture minerals

Element type: Interaction

Number of interactions: 1

Recordnumber: 105

Total number of records: 219

Description:

The groundwater flowing in the fracture system reacts with the fracture minerals and by dissolution of minerals and precipitation of secondary minerals the fracture apertures and the fracture minerals are changed. Old fractures are sealed and others are opened.

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

May be important locally (micro-scale), but opening and closure of fractures evens out for the total system. Effects on mineralogy very slow process

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

O Experts
⊙ General Know how
O Limited

SKB FEP reference:
Alteration/weathering of rock and fracture minerals

Treatment of interaction in Performance Assessment

Interaction: 6.5

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 06.07

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

6.7 Density and viscosity

Element type: Interaction

Number of interactions: 1

Recordnumber: 106

Total number of records: 219

Description:

Variations in salinity affects the density and viscosity of water.

106

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

Viscosity and density are parameters in the basic equation for estimating hydraulic conductivity from intrinsic permeability.

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

O Experts
O General Know how
O Limited

SKB FEP reference:

Groundwater chemistry, far-field
Groundwater flow
Saline water intrusion

Treatment of interaction in Performance Assessment

Interaction: **6.7 Density and viscosity**

Treatment:

- ☐ PA prerequisites
- ■ Assumptions
- ■ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

Assumptions:

The influence of groundwater chemistry on groundwater movement may be included in PA models or neglected (conservative assumption).

Modelling application:

The influence of groundwater chemistry on groundwater movement may be included in PA models or neglected (assumption).

Model A name:

NAMMU 6.2

Model A reference:

Validity Document, SKB AR 95-11

Model B name:

PHOENICS

Model B reference:

SKB AR 94-57

Spec modelling assumptions:

Element number: 06.08

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

6.8 Density affects groundwater head

Element type: Interaction

Number of interactions: 1

Recordnumber: 107

Total number of records: 219

Description:

The density affects groundwater head (gradient). It therefore affects the modelling of the groundwater flow.

107

Priority:

O 0=White O 1=Green O 2=Yellow ʘ 3=Red

Priority date:

95-06-12

Motivation:

Density is a parameter in the basic equation, (Hydraulic head, $\phi = p_{tot}/\rho g + z$.). Density differences = driving forces.

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

ʘ Experts
O General Know how
O Limited

SKB FEP reference:

Groundwater chemistry, far-field
Groundwater flow

Treatment of interaction in Performance Assessment

Interaction: 6.8 Density affects groundwater head

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ■ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

Assumptions:

Modelling application:

Density affects the groundwater head and is included in the description of groundwater flow. Part of the SKB PA model chain for radionuclide migration.

Model A name:

HYDRASTAR 1.4

Model A reference:

User's Guide, SKB AR 94-14

Model B name:

NAMMU 6.2

Model B reference:

Validity Document, SKB AR 95-11

Spec modelling assumptions:

108

Element number: 06.09 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

6.9 Heat conductivity

Element type: Interaction **Number of interactions:** 1

Recordnumber: 108 **Total number of records:** 219

Description:

The salinity affects the heat conductivity of groundwater.

Priority:

O 0=White ⊙ 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

Negligible effects.

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Groundwater chemistry, far-field
Groundwater chemistry in nearby rock
Temperature, far-field
Temperature, EDZ

Treatment of interaction in Performance Assessment

Interaction: 6.9

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name: **Model A reference:**

Model B name: **Model B reference:**

Spec modelling assumptions:

109

Element number: 06.10

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

6.10

Element type: Interaction

Number of interactions: 0

Recordnumber: 109

Total number of records: 219

Description:

Priority:

⊙ 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

No direct interactions identified

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 6.1

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

110

Element number: 06.11

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

6.11a Chemically generated gas

Element type: Interaction

Number of interactions: 3

Recordnumber: 110

Total number of records: 219

Description:

Chemical processes, e g pH-change in a calcite-saturated system may generate CO2, in the groundwater may generate gas.

Priority:

O 0=White ⊙ 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

Negligible gas source

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg. Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- ⊙ General Know how
- O Limited

SKB FEP reference:

Gas generation/sources in rock

Treatment of interaction in Performance Assessment

Interaction: 6.11

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

111

Element number: 06.11

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

6.11b Microbially generated gas

Element type: Interaction

Number of interactions: 3

Recordnumber: 111

Total number of records: 219

Description:

Microbial processes in the groundwater may generate gas.

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date:

95-06-12

Motivation:

Major gas source

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

O Experts
O General Know how
O Limited

SKB FEP reference:

Gas generation/sources in rock
Microbial activity

Treatment of interaction in Performance Assessment

Interaction: 6.11b Microbially generated gas

Treatment:

- ☐ PA prerequisites
- ■ Assumptions
- ☐ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

Assumptions:

The exact generation process of gas is not a part of PA modelling. The outcome of special studies will influence the assumptions in PA.

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 06.11

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

6.11c Clathrates

Element type: Interaction

Number of interactions: 3

Recordnumber: 112

Total number of records: 219

Description:

Clathrates, methan hydrates that occur as solids, are a potential gas source when going from permafrost to warmer conditions.

112

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date:

95-06-12

Motivation:

Uncertain

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

O Experts
O General Know how
O Limited

SKB FEP reference:

Gas generation/sources in rock

Treatment of interaction in Performance Assessment

Interaction: 6.11

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

113

Element number: 06.12

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

6.12a Sorption and solubility

Element type: Interaction

Number of interactions: 2

Recordnumber: 113

Total number of records: 219

Description:

The speciation of radionuclides and other elements are related to the water chemistry, and thereby also their solubility and sorptivity.

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

Obvious

Group Identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

O Experts
O General Know how
O Limited

SKB FEP reference:

Sorption
Precipitation/dissolution of radionuclides

Treatment of interaction in Performance Assessment

Interaction: 6.12a Sorption and solubility

Treatment:

■ PA prerequisites
□ Assumptions
□ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

A very important PA prerequisite.

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

114

Element number: 06.12

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

6.12b Colloids and bacteria

Element type: Interaction

Number of interactions: 2

Recordnumber: 114

Total number of records: 219

Description:

Colloids and bacteria in the groundwater may act as carriers for radionuclides and other trace elements thereby affecting their transport.

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

If colloids and microbes are present, this is a potential important transport mechanism.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:

Colloid generation and transport
Microbial activity

Treatment of interaction in Performance Assessment

Interaction: 6.12b Colloids and bacteria

Treatment:

- ☐ PA prerequisites
- ■ Assumptions
- ■ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

Assumptions:

This may be treated by separate modelling as in SKB TR 91-50. A study like this may also give the bases for assumptions.

Modelling application:

This may be treated by separate modelling as in SKB TR 91-50. A study like this may also give the bases for assumptions.

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

115

Element number: 06.13 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

6.13a Water use

Element type: Interaction **Number of interactions:** 2

Recordnumber: 115 **Total number of records:** 219

Description:

The quality of the water is depending on the groundwater chemistry. Saline groundwater is unlikely to be used for domestic purposes.

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

This interaction not itself of importance, but may influence the potential for future wells.

Group identification:
SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:
- O Experts
- ⊙ General Know how
- O Limited

SKB FEP reference:
Groundwater chemistry, far-field
Well supply

Treatment of interaction in Performance Assessment

Interaction: 6.13

Treatment:
- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name: **Model A reference:**

Model B name: **Model B reference:**

Spec modelling assumptions:

116

Element number: 06.13

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

6.13b Biotopes

Element type: Interaction

Number of interactions: 2

Recordnumber: 116

Total number of records: 219

Description:

Groundwater chemistry, e g salinity, alkalinity/acidity, content of toxic cations, can affect plants and animals, particularly if the groundwater chemistry varies over extreme ranges. However, the degree of dilution of groundwater by surface water will determine the extent of the effect.

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

This interaction not itself of importance, but the effects of biotopes on biosphere and then back to the far-field is interesting.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kémakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- ⊙ General Know how
- O Limited

SKB FEP reference:

Groundwater chemistry, far-field
Surface water chemistry

Treatment of interaction in Performance Assessment

Interaction: 6.13

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

117

Element number: 07.01

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

7.1a Canister positioning

Element type: Interaction

Number of interactions: 2

Recordnumber: 117

Total number of records: 219

Description:

The groundwater movement in the far field, flow directions and distribution, will have an influence on repository layout and canister positioning.

Priority:

O 0=White O 1=Green O 2=Yellow ⊙ 3=Red

Priority date: 95-06-12

Motivation:

The layout of the repository is strongly correlated to the properties of the rock, safety aspects. The repository layout is optimised from safety point of view.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Groundwater flow
Repository construction, layout and operation

Treatment of interaction in Performance Assessment

Interaction: 7.1a Canister positioning

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ■ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

Assumptions:

Modelling application:

This may actually be a part of the PA far-field modelling, depending on the purpose of the PA. See for example SKB 91, SKB TR 92-20.

Model A name:
HYDRASTAR 1.4

Model A reference:
User's Guide, SKB AR 94-14

Model B name:

Model B reference:

Spec modelling assumptions:

118

Element number: 07.01 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

7.1b Construction methods

Element type: Interaction **Number of interactions:** 2

Recordnumber: 118 **Total number of records:** 219

Description:

Large groundwater movements will cause construction problems (grouting etc) and this will affect the layout..

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

From operational safety point of view avoid local high water flows. Input to design and a prerequisite for the far-field analysis.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg. Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:

Groundwater flow

Alteration/degradation of rock reinforcement and grout

Treatment of interaction in Performance Assessment

Interaction: 7.1

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name: **Model A reference:**

Model B name: **Model B reference:**

Spec modelling assumptions:

Element number: 07.02

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

7.2a Saturation

Element type: Interaction

Number of interactions: 2

Recordnumber: 119

Total number of records: 219

Description:

The supply of groundwater in the surrounding rock affects the saturation process. Swelling pressure and thermal properties are affected.

119

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

To be taken care of in the near-filed analysis. The importance from far-field point of view of this interaction is limited.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- ⊙ General Know how
- O Limited

SKB FEP reference:

Resaturation of bentonite buffer
Resaturation of tunnel backfill

Treatment of interaction in Performance Assessment

Interaction: 7.2

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

120

Element number: 07.02 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

7.2b Bentonite erosion

Element type: Interaction **Number of interactions:** 2

Recordnumber: 120 **Total number of records:** 219

Description:

The groundwater flow may erode the buffer and the backfill. Density affected.

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

Uncertain effects on the backfill. The effects on the buffer should be considered in the near-field analysis.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg. Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Erosion of buffer/backfill

Treatment of interaction in Performance Assessment

Interaction: 7.2

Treatment:

☐ PA prerequisites
☐ Assumptions
☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

121

Element number: 07.03
Revision date: 95-11-30
Interaction matrix: FAR-FIELD1
Version: A

Element name:

7.3 Erosion

Element type: Interaction
Number of interactions: 1
Recordnumber: 121
Total number of records: 219

Description:

The groundwater flow in the surrounding rock and/or in EDZ. Potential erosion of the EDZ.
Effect: Affects the aperture distribution, the connectivity etc.

Priority:

O 0=White ⊙ 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

Negligible effects compared to changes due to chemical processes.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Erosion of rock

Treatment of interaction in Performance Assessment

Interaction: 7.3

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

122

Element number: 07.04
Revision date: 95-11-30
Interaction matrix: FAR-FIELD1
Version: A
Element name:
7.4

Element type: Interaction
Number of interactions: 0
Recordnumber: 122
Total number of records: 219

Description:

Priority:
⊙ 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:
No direct interactions identified.

Group identification:
SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:
⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 7.4

Treatment:
- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

123

Element number: 07.05

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

7.5 Erosion and sedimentation

Element type: Interaction

Number of interactions: 1

Recordnumber: 123

Total number of records: 219

Description:

Erosion and sedimentation are physical processes taking place when groundwater moves through the natural fracture system.
Effect: Affects the aperture distribution, the connectivity etc.

Priority:

O 0=White ⊙ 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

Negligible effects compared to changes due to chemical processes.

Group identification:
SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:
- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:
Erosion of rock

Treatment of interaction in Performance Assessment

Interaction: 7.5

Treatment:
- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

124

Element number: 07.06

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

7.6 Mixing

Element type: Interaction

Number of interactions: 1

Recordnumber: 124

Total number of records: 219

Description:

The movement of the groundwater results in a mixing (and dilution) of water portions of different character. This results in precipitation of minerals and a changed composition.

Priority:

O 0=White O 1=Green O 2=Yellow ⊙ 3=Red

Priority date: 95-06-12

Motivation:

Determines the overall water chemistry.

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Groundwater chemistry, far-field
Groundwater chemistry in nearby rock
Groundwater flow
Saline water intrusion

Treatment of interaction in Performance Assessment

Interaction: 7.6 Mixing

Treatment:

☐ PA prerequisites
■ Assumptions
☐ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

Assumptions:

This is not a part of PA modelling. Separate analyses will provide basis for assumptions in PA.

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 07.08

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

7.8 Equalisation of pressures

Element type: Interaction

Number of interactions: 1

Recordnumber: 125

Total number of records: 219

Description:

The groundwater movements will equalise the pressure gradients. The laminar flow in fractures is governed by the Darcy law.

125

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

Obvious. The laminar flow in fractures is governed by Darcy´s law.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:

Groundwater flow

Treatment of interaction in Performance Assessment

Interaction: 7.8 Equalisation of pressures

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ■ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

Assumptions:

Modelling application:

The water movement e g the groundwater pressure. Naturally incorporated in any hydrology model and part of the SKB PA model chain..

Model A name:
HYDRASTAR 1.4

Model A reference:
User's Guide, SKB AR 94-14

Model B name:
NAMMU 6.2

Model B reference:
Validity Document, SKB AR 95-11

Spec modelling assumptions:

126

Element number: 07.09

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

7.9 Forced heat convection

Element type: Interaction

Number of interactions: 1

Recordnumber: 126

Total number of records: 219

Description:

Heat generated in the repository can be transported with the flow of groundwater, forced heat convection.
Effect: The evolution of the temperature around the repository in the far field rock.

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

In a limited way compared to heat conduction.

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Groundwater flow
Temperature, EDZ
Temperature, far-field

Treatment of interaction in Performance Assessment

Interaction: 7.9

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

127

Element number: 07.10

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

7.10

Element type: Interaction

Number of interactions: 0

Recordnumber: 127

Total number of records: 219

Description:

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date:

95-06-12

Motivation:

By definition in the interaction between groundwater pressure and rock stresses (8.10).

Group Identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg. Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 7.1

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

128

Element number: 07.11

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

7.11 Two-phase flow

Element type: Interaction

Number of interactions: 1

Recordnumber: 128

Total number of records: 219

Description:

Influence of groundwater movement on gas flow, two-phase flow.

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

There is a coupling of water flow and gas flow. Importance of interaction uncertain.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- O General Know how
- ⊙ Limited

SKB FEP reference:

Groundwater flow
Flow through buffer/backfill
Gas flow and transport, buffer/backfill
Gas flow and transport in rock

Treatment of interaction in Performance Assessment

Interaction: 7.11

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

129

Element number: 07.12

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

7.12a Transport of dissolved gas

Element type: Interaction

Number of interactions: 3

Recordnumber: 129

Total number of records: 219

Description:

Transport of dissolved gas by moving groundwater.

Priority:

O 0=White ⊙ 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

Negligible transport mechanism for dissolved gases, radioactive and others.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- ⊙ General Know how
- O Limited

SKB FEP reference:

Groundwater flow
Transport of radionuclides in rock
Transport of nuclides, backfill

Treatment of interaction in Performance Assessment

Interaction: 07.12

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

130

Element number: 07.12 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

7.12b Direction, distribution and magnitude

Element type: Interaction **Number of interactions:** 3

Recordnumber: 130 **Total number of records:** 219

Description:

The direction, distribution and magnitude of groundwater movement in the far field rock.
Effect: Influence the transport of dissolved species and colloids.

Priority: O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

One of the most important transport paths for radionuclide release.

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:

Transport of nuclides, backfill
Colloid generation and transport
Transport of radionuclides in rock
Groundwater flow

Treatment of interaction in Performance Assessment

Interaction: 7.12b Direction, distribution and magnitude

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ■ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

Assumptions:

Modelling application:

This is the actual coupling between groundwater movement and transport of radionuclides. The treatment in PA varies. By using HYDRASTAR-FARF 31 and a stream tube approach, a distribution of groundwater travel times is obtained. This is the actual coupling. Part of the SKB PA model chain..

Model A name:
HYDRASTAR 1.4

Model A reference:
User's Guide, SKB AR 94-14

Model B name:
FARF 31

Model B reference:
SKB TR 90-01, Technical description

Spec modelling assumptions:

131

Element number: 07.12 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

7.12c Hydrodynamic dispersion

Element type: Interaction **Number of Interactions:** 3

Recordnumber: 131 **Total number of records:** 219

Description:

The groundwater flow in the far field rock affects the hydrodynamic dispersion.
Effect: Distribution in solute travel times in the rock.

Priority:

O 0=White O 1=Green O 2=Yellow ⊙ 3=Red

Priority date: 95-06-12

Motivation:

Obvious. Strong influence on travel times and distribution of radionuclides.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:
Dispersion

Treatment of interaction in Performance Assessment

Interaction: 7.12c Hydrodynamic dispersion

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ■ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

Assumptions:

Modelling application:

The effect of hydrodynamic dispersion is modelled by the assessment models used. HYDRASTAR mimics large scale dispersion by the use of a stochastic continuum approach, whereas FARF 31 includes small scale dispersion, Peclet number. Part of the SKB PA model chain..

Model A name:
HYDRASTAR 1.4

Model A reference:
User's Guide, SKB AR 94-14

Model B name:
FARF 31

Model B reference:
SKB TR 90-01, Technical description

Spec modelling assumptions:

132

Element number: 07.13

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

7.13 Recharge and discharge

Element type: Interaction

Number of interactions: 1

Recordnumber: 132

Total number of records: 219

Description:

The groundwater flow system determines the recharge to and discharge from the repository area.
Effect: Supply of water, dilution, location of recipients and wells etc.

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

Determines the recharge and discharge areas.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

SKB FEP reference:

Groundwater recharge and discharge

Expertise:

- O Experts
- O General Know how
- O Limited

Treatment of interaction in Performance Assessment

Interaction: 7.13 Recharge and discharge

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ■ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

Assumptions:

Modelling application:

A groundwater model also includes a description of recharge to and discharge from a repository area.

Model A name:

HYDRASTAR 1.4

Model A reference:

User's Guide, SKB AR 94-14

Model B name:

NAMMU 6.2

Model B reference:

Validity Document, SKB AR 95-11

Spec modelling assumptions:

133

Element number: 08.01 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

8.1 Construction methods

Element type: Interaction **Number of interactions:** 1

Recordnumber: 133 **Total number of records:** 219

Description:

The groundwater pressure may cause construction problems (necessitates grouting, problems with drilling, problems during operation of the repository).

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

Of concern for the operational safety. Input to design and a prerequisite for the far-field analysis.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Alteration/degradation of rock reinforcement and grout
Groundwater flow
Repository construction, layout and operation

Treatment of interaction in Performance Assessment

Interaction: 8.1

Treatment:

☐ PA prerequisites
☐ Assumptions
☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name: **Model A reference:**

Model B name: **Model B reference:**

Spec modelling assumptions:

134

Element number: 08.02

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

8.2

Element type: Interaction

Number of interactions: 0

Recordnumber: 134

Total number of records: 219

Description:

Priority:

⊙ 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

The groundwater pressure affects the mechanical properties of the buffer/backfill. However, this interaction is obtained as pathway via rock stresses, (8.10-->10.2).

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 8.2

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

135

Element number: 08.03

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

8.3

Element type: Interaction

Number of interactions: 0

Recordnumber: 135

Total number of records: 219

Description:

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

The influence of groundwater pressure on EDZ is obtained as pathway via rock stresses, (8.10-->10.3).

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

O Experts
O General Know how
O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 8.3

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

136

Element number: 08.04

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

8.4

Element type: Interaction

Number of interactions: 0

Recordnumber: 136

Total number of records: 219

Description:

Priority:

⊙ 0=White O 1=Green O 2=Yellow O 3=Red

Priority date:

95-06-12

Motivation:

No direct interactions identified.

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 8.4

Treatment:

☐ PA prerequisites
☐ Assumptions
☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 08.05

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

8.5

Element type: Interaction

Number of interactions: 0

Recordnumber: 137

Total number of records: 219

Description:

137

Priority:

⊙ 0=White O 1=Green O 2=Yellow O 3=Red

Priority date:

95-06-12

Motivation:

The influence of groundwater pressure on the natural fracture system is obtained as pathway via rock stresses, (8.10-->10.5).

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 8.5

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 08.06

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

8.6 Solubility

Element type: Interaction

Number of interactions: 1

Recordnumber: 138

Total number of records: 219

Description:

Solubility is in general affected by the groundwater pressure.

138

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

Negligible effect on solubilities of small pressure changes.
Comment: Pressure changes affect the dissolution and outguessing of carbon dioxide which in turn affects the pH of the water. A change in pH gives a potential for reactions such as precipitation and/or dissolution. This interaction is obtained indirectly through 8.11 and 11.6

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:

Alteration/weathering of rock and fracture minerals

Treatment of interaction in Performance Assessment

Interaction: 8.6

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

139

Element number: 08.07

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

8.7 Driving force due to pressure gradient

Element type: Interaction

Number of interactions: 1

Recordnumber: 139

Total number of records: 219

Description:

The groundwater pressure here defined as the hydraulic head is the driving force for groundwater movement.

Priority:

O 0=White O 1=Green O 2=Yellow ⊙ 3=Red

Priority date: 95-06-12

Motivation:

Obvious

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg. Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Groundwater flow

Treatment of interaction in Performance Assessment

Interaction: 8.7 Driving force due to pressure gradient

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ■ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

Assumptions:

Modelling application:

Interaction included in the equations describing groundwater flow. Naturally, part of the SKB PA model chain..

Model A name:

HYDRASTAR 1.4

Model A reference:

User's Guide, SKB AR 94-14

Model B name:

NAMMU 6.2

Model B reference:

Validity Document, SKB AR 95-11

Spec modelling assumptions:

140

Element number: 08.09

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

8.9

Element type: Interaction

Number of interactions: 0

Recordnumber: 140

Total number of records: 219

Description:

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

No direct interactions identified.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 8.9

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

141

Element number: 08.10

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

8.10 Effective stress

Element type: Interaction

Number of Interactions: 1

Recordnumber: 141

Total number of records: 219

Description:

The effective stresses will change according to the pore water pressure.
Effective stresses=Total stresses(=ROCK STRESSES)-Groundwater pressure.

Priority:

O 0=White ⊙ 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

The resulting variations in stress are relatively small under undisturbed conditions.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Groundwater flow
Rock stresses

Treatment of interaction in Performance Assessment

Interaction: 8.1

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

142

Element number: 08.11 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

8.11a Gas solubility

Element type: Interaction **Number of interactions:** 2

Recordnumber: 142 **Total number of records:** 219

Description:

Gas solubility is affected by groundwater pressure. This affects the amount of gas in gas-phase.

Priority:

O 0=White O 1=Green O 2=Yellow ⊙ 3=Red

Priority date: 95-06-12

Motivation:

Must be considered in evaluations of gas transport.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Groundwater flow
Gas generation/sources in rock
Gas flow and transport in rock

Treatment of interaction in Performance Assessment

Interaction: 8.11a Gas solubility

Treatment:

- ■ PA prerequisites
- □ Assumptions
- □ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

Not part of the assessment modelling. Separate studies need to reviewed in PA.

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 08.11

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

8.11b Gas law

Element type: Interaction

Number of interactions: 2

Recordnumber: 143

Total number of records: 219

Description:

Gas law (pV=nRT). The groundwater pressure will have an impact on the gas volume.

143

Priority:

O 0=White O 1=Green O 2=Yellow ⊙ 3=Red

Priority date: 95-06-12

Motivation:

Relatively large changes in pressure along the transport path.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Groundwater flow
Gas generation/sources in rock
Gas flow and transport in rock

Treatment of interaction in Performance Assessment

Interaction: 8.11b Gas law

Treatment:

■ PA prerequisites
□ Assumptions
□ Modelling

Date 95-09-21

By: A Ström

PA prerequisites:

Known relationship. Included when modelling is performed. Studied separately.

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

144

Element number: 08.12

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

8.12

Element type: Interaction

Number of interactions: 0

Recordnumber: 144

Total number of records: 219

Description:

Priority:

☉ 0=White ○ 1=Green ○ 2=Yellow ○ 3=Red

Priority date: 95-06-12

Motivation:

No direct interactions identified.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

○ Experts
☉ General Know how
○ Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 8.12

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 08.13 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

8.13 Potential effect on vegetation

Element type: Interaction **Number of interactions:** 1

Recordnumber: 145 **Total number of records:** 219

Description:

Some changes in the groundwater pressure may have effects on vegetation.
Comment: The vegetation mainly rely on the soil water in the unsaturated vadose zone which is above the phreatic water, groundwater. This zone is subject to large moisture fluctuations in response to transpiration and evaporation. Some vegetation is however found in moist environments with deeply penetrating roots reaching the water table.

145

Priority:

O 0=White ⊙ 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

Negligible effect.

Group identification:
SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:
- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:
Groundwater flow

Treatment of interaction in Performance Assessment

Interaction: 8.13

Treatment:
- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name: **Model A reference:**

Model B name: **Model B reference:**

Spec modelling assumptions:

146

Element number: 09.01

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

9.1

Element type: Interaction

Number of interactions: 0

Recordnumber: 146

Total number of records: 219

Description:

Priority:

⊙ 0=White O 1=Green O 2=Yellow O 3=Red

Priority date:

95-06-12

Motivation:

Background temperature influences the allowable temperature increase and thereby repository depth and canister separation. The influence of temperature on construction/layout is obtained as pathway via buffer/backfill, (9.2-->2.1).

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 9.1

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

147

Element number: 09.02

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

9.2 Temperature in buffer/backfill

Element type: Interaction

Number of interactions: 1

Recordnumber: 147

Total number of records: 219

Description:

Background temperature affects the temperature in the buffer/backfill.
Comment: Temperature effects due to heat generation from the waste, such as thermal expansion, permeability, saturation affected by thermal gradient, diffusion affected by thermal gradient are included in the diagonal element (2.2) by definition.

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

Small effects from outside compared to the inside. However, important design parameter.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Temperature, backfill
Temperature, buffer
Temperature, EDZ
Temperature, far-field

Treatment of interaction in Performance Assessment

Interaction: 9.2

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 09.03

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

9.3

Element type: Interaction

Number of interactions: 0

Recordnumber: 148

Total number of records: 219

Description:

148

Priority:

⊙ 0=White O 1=Green O 2=Yellow O 3=Red

Priority date:

95-06-12

Motivation:

No interaction by definition of diagonal elements.

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 9.3

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

149

Element number: 09.04 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

9.4a Thermal expansion

Element type: Interaction **Number of interactions:** 2

Recordnumber: 149 **Total number of records:** 219

Description:

Thermal expansion is given by known physical laws.

Priority:

O 0=White ⊙ 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

Negligible effect, weak dependence.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Temperature, far-field
Properties of far-field rock

Treatment of interaction in Performance Assessment

Interaction: 9.4

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name: **Model A reference:**

Model B name: **Model B reference:**

Spec modelling assumptions:

150

Element number: 09.04 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

9.4b Thermal conductivity

Element type: Interaction **Number of interactions:** 2

Recordnumber: 150 **Total number of records:** 219

Description:

The thermal conductivity in the rock matrix is weakly dependent on temperature, $\lambda = \lambda(T)$, and decreases with increased temperature. The thermal capacity increases approximately by 10 % at a temperature increase of 100 degrees C.

Priority:

O 0=White ⊙ 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

Weak dependence.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Temperature, far-field
Properties of far-field rock

Treatment of interaction in Performance Assessment

Interaction: 9.4

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

151

Element number: 09.05 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

9.5 Permafrost

Element type: Interaction **Number of interactions:** 1

Recordnumber: 151 **Total number of records:** 1

Description:

Permafrost conditions will prevail in the rock at certain temperatures.
Permafrost implies a nonpermeable layer in the rock preventing all interaction between surface water and groundwater during thousands of years. The direct interaction on the fracture system is that the frozen water in the fractures will affect the fracture characteristics in terms of aperture and connectivity etc. Note the other interaction via 9.10 and 10.5.

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

Uncertain

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:

Temperature, far-field
Properties of far-field rock

Treatment of interaction in Performance Assessment

Interaction: 9.5

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

152

Element number: 09.06 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

9.6 Dissolution and precipitation of minerals

Element type: Interaction **Number of interactions:** 1

Recordnumber: 152 **Total number of records:** 219

Description:

Temperature affects the groundwater chemistry in terms of chemical equilibria and the kinetics of reactions, $\Delta H = T * \Delta S$. For example dissolution and precipitation of fracture minerals.

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

Limited effects for small temperature variations, (5 - 10 °C). Larger variations more important.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg. Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Temperature, EDZ
Temperature, far-field
Alteration/weathering of rock and fracture minerals
Groundwater chemistry in nearby rock
Groundwater chemistry, far-field

Treatment of interaction in Performance Assessment

Interaction: 9.6

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name: **Model A reference:**

Model B name: **Model B reference:**

Spec modelling assumptions:

153

Element number: 09.07 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

9.7 Viscosity

Element type: Interaction **Number of interactions:** 1

Recordnumber: 153 **Total number of records:** 219

Description:

Temperature affects viscosity of water and thereby groundwater flow. Heat convection.

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

Important for the conductivity and thereby for the flow field.

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

O Experts
O General Know how
O Limited

SKB FEP reference:

Temperature, EDZ
Temperature, far-field
Groundwater flow

Treatment of interaction in Performance Assessment

Interaction: 9.7 Viscosity

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ■ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

Assumptions:

Modelling application:

Included in groundwater flow simulation models.

Model A name:
HYDRASTAR 1.4

Model A reference:
User's Guide, SKB AR 94-14

Model B name:
NAMMU 6.2

Model B reference:
Validity Document, SKB AR 95-11

Spec modelling assumptions:

Element number: 09.08

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

9.8 Density

Element type: Interaction

Number of interactions: 1

Recordnumber: 154

Total number of records: 219

Description:

Temperature affects the density which affects the groundwater pressure, buoyancy effects.

154

Priority:

O 0=White O 1=Green O 2=Yellow ⊙ 3=Red

Priority date: 95-06-12

Motivation:

Important for the pressure field and thereby the flow field. Freezing of water is an extreme change in density.

Group identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Temperature, EDZ
Temperature, far-field
Groundwater flow

Treatment of interaction in Performance Assessment

Interaction: 9.8 Density

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ■ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

Assumptions:

Modelling application:

Included in the basic equations describing groundwater flow.

Model A name:
HYDRASTAR 1.4

Model A reference:
User's Guide, SKB AR 94-14

Model B name:
NAMMU 6.2

Model B reference:
Validity Document, SKB AR 95-11

Spec modelling assumptions:

155

Element number: 09.10
Revision date: 95-11-30
Interaction matrix: FAR-FIELD1
Version: A

Element name:

9.10 Thermal expansion

Element type: Interaction
Number of interactions: 1
Recordnumber: 155
Total number of records: 219

Description:

Variations in temperature may increase/decrease the rock volume, thermal expansion.
Effect: Stress changes in the rock mass.

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

May interact through rock matrix/mineralogy and/or EDZ, (9.4-->4.10 and/or 9.3-->3.10)

Group Identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Temperature, EDZ
Temperature, far-field
Rock stresses

Treatment of interaction in Performance Assessment

Interaction: 9.1

Treatment:

☐ PA prerequisites
☐ Assumptions
☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

156

Element number: 09.11

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

9.11a Gas solubility

Element type: Interaction

Number of interactions: 2

Recordnumber: 156

Total number of records: 219

Description:

Temperature and temperature changes influence the solubility of gases in the groundwater.
Effect: Increase/decrease in gas amounts and dissolved gas.

Priority:

O 0=White O 1=Green O 2=Yellow ⊙ 3=Red

Priority date: 95-06-12

Motivation:

Relatively strong dependence between temperature and gas solubility.

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Temperature, EDZ
Temperature, far-field
Gas generation/sources in rock
Gas flow and transport in rock

Treatment of interaction in Performance Assessment

Interaction: 9.11a Gas solubility

Treatment:

■ PA prerequisites
☐ Assumptions
☐ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

Not part of the assessment modelling. Separate studies need to reviewed in PA.

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

157

Element number: 09.11
Revision date: 95-11-30
Interaction matrix: FAR-FIELD1
Version: A

Element name:

9.11b Gas law

Element type: Interaction
Number of interactions: 2
Recordnumber: 157
Total number of records: 219

Description:
Gas law (pV=nRT). The temperature affects the gas volume.

Priority:
O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:
Small variations in temperature.

Group identification:
SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:
- O Experts
- O General Know how
- O Limited

SKB FEP reference:
Temperature, EDZ
Temperature, far-field
Gas generation/sources in rock
Gas flow and transport in rock

Treatment of interaction in Performance Assessment

Interaction: 09.11

Treatment:
- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

158

Element number: 09.12

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

9.12 Kinetic effects

Element type: Interaction

Number of interactions: 1

Recordnumber: 158

Total number of records: 219

Description:

Temperature and temperature changes influence the kinetics of solute transport and retardation processes.
Effect: Increase/decrease in diffusivities and sorption reaction rates.

Priority:

O 0=White ⊙ 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

Effect of temperature small compared to uncertainties in diffusivity values and sorption reaction rates.

Group identification:

SKB: T Eng, LO Ericsson, L Morén,
O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Sorption
Matrix diffusion
Diffusion

Treatment of interaction in Performance Assessment

Interaction: 9.12

Treatment:

☐ PA prerequisites
☐ Assumptions
☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

159

Element number: 09.13

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

9.13

Element type: Interaction

Number of interactions: 0

Recordnumber: 159

Total number of records: 219

Description:

Priority:

⦿ 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-12

Motivation:

No direct interactions identified.

Group Identification:

SKB: T Eng, LO Ericsson, L Morén, O Olsson, A Ström, P Wikberg.
Kemakta: K Skagius & M Wiborgh.

Expertise:

⦿ Experts
O General Know how
O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 9.13

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

160

Element number: 10.01 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

10.1a Design/layout

Element type: Interaction **Number of interactions:** 2

Recordnumber: 160 **Total number of records:** 219

Description:

The rock stresses will have implications on the design and layout of the repository, e g the orientation of the tunnels.

Priority:

- O 0=White
- O 1=Green
- ⊙ 2=Yellow
- O 3=Red

Priority date: 95-06-29

Motivation:

Must be considered as a input to design but not part of the far-field analysis.

Group identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Rock stresses
Repository construction, layout and operation

Treatment of interaction in Performance Assessment

Interaction: 10.1

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name: **Model A reference:**

Model B name: **Model B reference:**

Spec modelling assumptions:

161

Element number: 10.01

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

10.1b Construction methods

Element type: Interaction

Number of interactions: 2

Recordnumber: 161

Total number of records: 219

Description:

The rock stresses will have implications on the choice of construction method, e g reinforcement.

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

Must be considered as a input to design but not part of the far-field analysis.

Group Identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Alteration/degradation of rock reinforcement and grout
Repository construction, layout and operation
Rock stresses

Treatment of interaction in Performance Assessment

Interaction: 10.1

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

162

Element number: 10.02

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

10.2a Reaction force on swelling pressure

Element type: Interaction

Number of interactions: 2

Recordnumber: 162

Total number of records: 219

Description:

The stress in the rock close to the buffer/backfill will counteract the swelling pressure in the buffer/backfill. Thus, the stress affects the volume available to buffer/backfill expansion and consequently the swelling pressure.
Effect: Influence on swelling pressure.

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date:

95-06-29

Motivation:

To be taken care of in the near-field analysis. The importance from far-field point of view of this interaction is limited.

Group identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Bentonite swelling, backfill
Bentonite swelling, buffer

Treatment of interaction in Performance Assessment

Interaction: 10.2

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 10.02

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

10.2b Rock fallout

Element type: Interaction

Number of interactions: 2

Recordnumber: 163

Total number of records: 219

Description:

Rock fallout into deposition holes may occur due to unfortunate location of natural fractures. Will affect the density and/or the geometry of the buffer/backfill.

163

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

To be taken care of in the near-field analysis. The importance from far-field point of view of this interaction is limited.

Group Identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- ⊙ General Know how
- O Limited

SKB FEP reference:

Rock fallout

Mechanical impact/failure, buffer/backfill

Treatment of interaction in Performance Assessment

Interaction: 10.2

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

164

Element number: 10.03

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

10.3a Mechanical stability

Element type: Interaction

Number of interactions: 2

Recordnumber: 164

Total number of records: 219

Description:

The changes in stress may be slow (rock creep) or instantaneous.
Effects: The stress in the rock close to the buffer/backfill will affect the mechanical stability of EDZ. Loss of mechanical stability may cause fracturing of the rock in EDZ and thereby change the fracture density in EDZ.

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

Under normal conditions at 500 m this interaction less important for properties of EDZ than effects from excavation. Should, however, be investigated when site specific data are available. Can be important under high stresses.

Group identification:
SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:
- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:
Rock creep
Enhanced rock fracturing

Treatment of interaction in Performance Assessment

Interaction: 10.3

Treatment:
- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

165

Element number: 10.03

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

10.3b Fracture aperture

Element type: Interaction

Number of interactions: 2

Recordnumber: 165

Total number of records: 219

Description:

The changes in stress may be slow (rock creep) or instantaneous.
Effects: The stress in the rock close to the buffer/backfill will affect the properties of existing fractures in EDZ. Effect: Changes in fracture apertures.

Priority:

O 0=White O 1=Green O 2=Yellow ⊙ 3=Red

Priority date: 95-06-29

Motivation:

Important since changes in fracture apertures caused by stress significant.

Group identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Rock stresses
Rock creep
Properties of rock, EDZ

Treatment of interaction in Performance Assessment

Interaction: 10.3b Fracture aperture

Treatment:

- ■ PA prerequisites
- □ Assumptions
- □ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

Not an actual part of the assessment modelling. Important to discuss/review in PA for the prerequisites for modelling.

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 10.04

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

10.4 Mechanical stability

Element type: Interaction

Number of interactions: 1

Recordnumber: 166

Total number of records: 219

Description:

Rock stresses may affect the mechanical stability of the rock matrix.
Effect: Fracturing of the rock matrix at high stresses (e g glaciation).
Comment: The EDZ is more affected.

166

Priority:

O 0=White ⊙ 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

High stresses occur only in EDZ. Rock stresses will normally not affect the stability of the rock matrix. For fracturing extreme stresses are required.

Group identification:
SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:
⊙ Experts
O General Know how
O Limited

SKB FEP reference:
Enhanced rock fracturing

Treatment of interaction in Performance Assessment

Interaction: 10.4

Treatment:
☐ PA prerequisites
☐ Assumptions
☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 10.05

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

10.5a Mechanical stability

Element type: Interaction

Number of interactions: 2

Recordnumber: 167

Total number of records: 219

Description:

The direction and magnitude of rock stresses, principal stresses, will affect the mechanical stability of the fracture system. (Faulting)
Comment: See 8.5 and 8.10: In fractured rocks total stresses are measured in-situ. In order to evaluate the effective stresses influencing fractures we need to know the groundwater pressure.

167

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

Under normal conditions at 500 m this interaction less important. Should, however, be investigated when site specific data are available. Can be important under high stresses.

Group identification:
SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:
- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:
Faulting

Treatment of interaction in Performance Assessment

Interaction: 10.5

Treatment:
- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 10.05

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

10.5b Fracture aperture

Element type: Interaction

Number of interactions: 2

Recordnumber: 168

Total number of records: 219

Description:

The apertures of fractures will also be affected by the rock stresses.
Comment: See 8.5 and 8.10: In fractured rocks total stresses are measured in-situ. In order to evaluate the effective stresses influencing fractures we need to know the groundwater pressure.

168

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

The influence of stress on fracture aperture must be considered.

Group identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Rock stresses
Properties of far-field rock

Treatment of interaction in Performance Assessment

Interaction: 10.5b Fracture aperture

Treatment:

- ■ PA prerequisites
- □ Assumptions
- □ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

Not an actual part of the assessment modelling. Important to discuss/review in PA for the prerequisites for modelling.

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

169

Element number: 10.06

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

10.6

Element type: Interaction

Number of interactions: 0

Recordnumber: 169

Total number of records: 219

Description:

Priority:

⊙ 0=White ○ 1=Green ○ 2=Yellow ○ 3=Red

Priority date: 95-06-29

Motivation:

No direct interactions identified.

Group Identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

○ Experts
⊙ General Know how
○ Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 10.6

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

170

Element number: 10.07

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

10.7

Element type: Interaction

Number of interactions: 0

Recordnumber: 170

Total number of records: 219

Description:

Priority:

- 0=White
- 1=Green
- 2=Yellow
- 3=Red

Priority date: 95-06-29

Motivation:

No direct interactions identified. The influence of rock stress on groundwater movement is obtained via the natural fracture system, (10.5-->5.7).

Group identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

- Experts
- General Know how
- Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 10.7

Treatment:

- PA prerequisites
- Assumptions
- Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

171

Element number: 10.08

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

10.8 Confined aquifers

Element type: Interaction

Number of interactions: 0

Recordnumber: 171

Total number of records: 219

Description:

Confined aquifers in the rock will have a groundwater pressure determined by the prevailing rock stresses since there is no connection between this isolated system and the rest of the groundwater system.

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

Confined aquifers have not been found in crystalline rocks.

Group Identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:

Rock stresses
Groundwater flow

Treatment of interaction in Performance Assessment

Interaction: 10.8

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

172

Element number: 10.09

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

10.9

Element type: Interaction

Number of interactions: 0

Recordnumber: 172

Total number of records: 219

Description:

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

No direct interactions identified.

Group identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 10.9

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

173

Element number: 10.11

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

10.11

Element type: Interaction

Number of interactions: 0

Recordnumber: 173

Total number of records: 219

Description:

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

No direct interactions identified.

Group identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 10.11

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

174

Element number: 10.12

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

10.12

Element type: Interaction

Number of interactions: 0

Recordnumber: 174

Total number of records: 219

Description:

Priority:

⊙ 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

No direct interactions identified.

Group identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

O Experts
⊙ General Know how
O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 10.12

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

175

Element number: 10.13
Revision date: 95-11-30
Interaction matrix: FAR-FIELD1
Version: A
Element name:

10.13 Mechanical stability

Element type: Interaction
Number of interactions: 1
Recordnumber: 175
Total number of records: 219

Description:
Major changes in mechanical stability might have an impact on the biosphere. (Earthquakes)

Priority:
O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date:
95-06-29

Motivation:
Probably extreme changes in mechanical stability required to significantly change the biosphere, recipients etc.

Group identification:
SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:
- O Experts
- O General Know how
- O Limited

SKB FEP reference:
Earthquakes

Treatment of interaction in Performance Assessment

Interaction: 10.13

Treatment:
- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

176

Element number: 11.01

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

11.1 Ventilation problems

Element type: Interaction

Number of interactions: 1

Recordnumber: 176

Total number of records: 219

Description:

Radon gas gives ventilation problems which in turn may affect the tunnel dimensions etc.

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

Related to occupational safety. Must be considered as a input to design but not part of the far-field analysis.

Group identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Gas generation/sources in rock
Repository construction, layout and operation

Treatment of interaction in Performance Assessment

Interaction: 11.1

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

177

Element number: 11.02

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

11.2

Element type: Interaction

Number of interactions: 0

Recordnumber: 177

Total number of records: 219

Description:

Priority:

⦿ 0=White ○ 1=Green ○ 2=Yellow ○ 3=Red

Priority date: 95-06-29

Motivation:

Interactions such as chemical effects (oxygen), homogenisation (water saturation, heat conductivity) is included by definition in the diagonal element (2,2). See also (2,11).

Group Identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

⦿ Experts
○ General Know how
○ Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 11.2

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

178

Element number: 11.03

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

11.3a Opening of fractures

Element type: Interaction

Number of interactions: 2

Recordnumber: 178

Total number of records: 219

Description:

High gas pressures in EDZ (around deposition holes) may open fractures if gas cannot escape through the fracture system. (Waste generated gas)

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

If high pressures build-up this may be important. Uncertain whether the rock has enough capacity to let gas escape, which affects pressure.

Group identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- ⊙ General Know how
- O Limited

SKB FEP reference:

Properties of rock, EDZ
Gas flow and transport in rock
Gas generation/sources in rock

Treatment of interaction in Performance Assessment

Interaction: 11.3

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 11.03

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

11.3b Heat conduction

Element type: Interaction

Number of interactions: 2

Recordnumber: 179

Total number of records: 219

Description:

Gas in EDZ will decrease the heat conduction in EDZ.

179

Priority:

O 0=White ⊙ 1=Green O 2=Yellow O 3=Red

Priority date:

95-06-29

Motivation:

The porosity (amount of water) is so small that effects on thermal properties will be negligible by exchanging the water with gas.

Group identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Properties of rock, EDZ
Gas flow and transport in rock
Gas generation/sources in rock

Treatment of interaction in Performance Assessment

Interaction: 11.3

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

180

Element number: 11.04 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

11.4a Fracturing

Element type: Interaction **Number of interactions:** 2

Recordnumber: 180 **Total number of records:** 219

Description:

High gas pressures in the rock matrix may cause fracturing of the rock matrix.
Effect: Increased permeability of the rock matrix.

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

If high pressures build-up this may be important. Uncertain whether the rock has enough capacity to let gas escape, which affects pressure.

Group identification:
SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:
- O Experts
- ⊙ General Know how
- O Limited

SKB FEP reference:
Properties of far-field rock
Enhanced rock fracturing
Gas generation/sources in rock

Treatment of interaction in Performance Assessment

Interaction: 11.4

Treatment:
- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

181

Element number: 11.04

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

11.4b Thermal properties

Element type: Interaction

Number of interactions: 2

Recordnumber: 181

Total number of records: 219

Description:

Gas in pores in the rock matrix may to an inconsiderable extent change thermal properties of the rock matrix.

Priority:

O 0=White ⊙ 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

The porosity (amount of water) is so small that effects on thermal properties will be negligible by exchanging the water with gas.

Group identification:
SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:
- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:
Properties of far-field rock
Gas generation/sources in rock

Treatment of interaction in Performance Assessment

Interaction: 11.4

Treatment:
- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

182

Element number: 11.05

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

11.5 Fracture aperture

Element type: Interaction

Number of interactions: 1

Recordnumber: 182

Total number of records: 219

Description:

At high gas pressures, included in the GAS element definition, opening of fractures may occur. This means changed fracture apertures.

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date:

95-06-29

Motivation:

If high pressures build-up this may be important. Uncertain whether the rock has enough capacity to let gas escape, which affects pressure.

Group identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- ⊙ General Know how
- O Limited

SKB FEP reference:

Gas flow and transport in rock
Gas generation/sources in rock
Properties of far-field rock

Treatment of interaction in Performance Assessment

Interaction: 11.5

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 11.06

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

11.6a pH and Eh affected

Element type: Interaction

Number of interactions: 2

Recordnumber: 183

Total number of records: 219

Description:

pH and Eh are affected by reactions with CO_2/CH_4/H_2/H_2S etc.

183

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-09-29

Motivation:

May be important under certain circumstances, i.e. biological activity.

Group identification:

SKB: L Morén, A Ström, P Wikberg.
Kemakta: K Skagius, M Wiborgh

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Groundwater chemistry, far-field
Groundwater chemistry in nearby rock
Gas flow and transport in rock
Gas generation/sources in rock

Treatment of interaction in Performance Assessment

Interaction: 11.6

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

184

Element number: 11.06

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

11.6b Eh affected

Element type: Interaction

Number of interactions: 2

Recordnumber: 184

Total number of records: 219

Description:

Redox sensitive elements and Eh are affected by reactions with O_2.

Priority:

O 0=White O 1=Green O 2=Yellow ⊙ 3=Red

Priority date: 95-09-29

Motivation:

Oxygen from the operation of the repository may be captured in the repository for long-time periods, (several hundred years). The available amount of oxygen has a strong influence on Eh conditions.

Group identification:

SKB: L Morén, A Ström, P Wikberg.
Kemakta: K Skagius, M Wiborgh

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Groundwater chemistry, far-field
Groundwater chemistry in nearby rock
Gas flow and transport in rock
Gas generation/sources in rock

Treatment of interaction in Performance Assessment

Interaction: 11.6b Eh affected

Treatment:

- ■ PA prerequisites
- □ Assumptions
- □ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

Prerequisite for PA modelling. Good description needed in PA. Separate analysis possible.

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

185

Element number: 11.07

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

11.7 Creation of two-phase flow conditions

Element type: Interaction

Number of interactions: 1

Recordnumber: 185

Total number of records: 219

Description:

Gas prevailing in the rock will create two-phase flow conditions.
Effect: May influence magnitude, direction and distribution of groundwater flow.

Priority:

O 0=White O 1=Green O 2=Yellow ⊙ 3=Red

Priority date: 95-06-29

Motivation:

Must be considered with present canister, (composite steel and copper).

Group Identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- ⊙ General Know how
- O Limited

SKB FEP reference:

Gas generation/sources in rock
Gas flow and transport in rock
Groundwater flow

Treatment of interaction in Performance Assessment

Interaction: 11.7 Creation of two-phase flow conditions

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ■ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

Assumptions:

Modelling application:

Two phase flow conditions may prevail in the rock with present canister. These effects are not included in our assessment models but should be preferably.

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

186

Element number: 11.08

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

11.8 Capillary forces

Element type: Interaction

Number of interactions: 1

Recordnumber: 186

Total number of records: 219

Description:

Gas-water interface will create capillary forces in the pores of the rock which affect the groundwater pressure. Note that most of all this affects groundwater movement, see 11.7.

Priority:

O 0=White ⊙ 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

The major influence from gas is on groundwater movement. The interactions 11.7 and 11.8 are both related to two-phase flow.

Group Identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- ⊙ General Know how
- O Limited

SKB FEP reference:

Gas generation/sources in rock
Gas flow and transport in rock
Groundwater flow

Treatment of interaction in Performance Assessment

Interaction: 11.8

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

187

Element number: 11.09 | Revision date: 95-11-30

Interaction matrix: FAR-FIELD1 | Version: A

Element name:

11.9 Gas law

Element type: Interaction | Number of interactions: 1

Recordnumber: 187 | Total number of records: 219

Description:

Gas law (pV=nRT). The existence of the gas will affect the temperature.

Priority: O 0=White ⊙ 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

Negligible effect on temperature from changes in gas volume under normal conditions.

Group Identification:
SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:
- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:
Gas generation/sources in rock
Gas flow and transport in rock
Temperature, EDZ
Temperature, far-field

Treatment of interaction in Performance Assessment

Interaction: 11.9

Treatment:
- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 11.10

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

11.10

Element type: Interaction

Number of interactions: 0

Recordnumber: 188

Total number of records: 219

Description:

188

Priority:

⦿ 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

No direct interactions identified.

Group identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- ⦿ General Know how
- O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 11.1

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 11.12

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

11.12 Colloid sorption on gas bubbles

Element type: Interaction

Number of interactions: 1

Recordnumber: 189

Total number of records: 219

Description:

Gas bubbles in the groundwater may sorb colloids from the water and thereby act as carriers of the colloids.
Effect: May increase the transport of colloids compared to colloid transport by moving groundwater.

189

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

The effect is observed, importance uncertain.

Group identification:
SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:
- O Experts
- O General Know how
- ⊙ Limited

SKB FEP reference:
Colloid generation and transport

Treatment of interaction in Performance Assessment

Interaction: 11.12

Treatment:
- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

190

Element number: 11.13

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

11.13 Gas release

Element type: Interaction

Number of interactions: 0

Recordnumber: 190

Total number of records: 219

Description:

Direct gas release (radioactive gases) may have an impact on contamination in the biosphere.

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

Could be important and will be investigated.

Group identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

O Experts
O General Know how
O Limited

SKB FEP reference:

Gas flow and transport in rock
Gaseous release

Treatment of interaction in Performance Assessment

Interaction: 11.13

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

191

Element number: 12.01

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

12.1 Design/layout

Element type: Interaction

Number of interactions: 1

Recordnumber: 191

Total number of records: 219

Description:

The retention in the far field and the release of radionuclides from the far field puts requirements on repository layout and on repository barriers.

Priority:

O 0=White O 1=Green O 2=Yellow ⊙ 3=Red

Priority date:

95-06-29

Motivation:

Input to design and a prerequisite for the far-field analysis.

Group identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Transport of radionuclides in rock
Repository construction, layout and operation

Treatment of interaction in Performance Assessment

Interaction: 12.1 Design/layout

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ■ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

Assumptions:

Modelling application:

This may actually be a part of the PA far-field modelling, depending on the purpose of the PA.

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

192

Element number: 12.02 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

12.2

Element type: Interaction **Number of interactions:** 0

Recordnumber: 192 **Total number of records:** 219

Description:

Priority: ⊙ 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

No direct interactions identified. Impacts go via the groundwater chemistry, (12.6-->).

Group identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- ⊙ General Know how
- O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 12.2

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

193

Element number: 12.03

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

12.3

Element type: Interaction

Number of interactions: 0

Recordnumber: 193

Total number of records: 219

Description:

Priority:

⊙ 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

No direct interactions identified. Impacts go via the groundwater chemistry, (12.6-->).

Group identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- ⊙ General Know how
- O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 12.3

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

194

Element number: 12.04 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

12.4

Element type: Interaction **Number of interactions:** 0

Recordnumber: 194 **Total number of records:** 219

Description:

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

No direct interactions identified. Impacts go via the groundwater chemistry, (12.6-->).

Group identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 12.4

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 12.05

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

12.5

Element type: Interaction

Number of interactions: 0

Recordnumber: 195

Total number of records: 219

Description:

195

Priority:

⊙ 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

No direct interactions identified. Impacts go via the groundwater chemistry, (12.6-->).

Group identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

O Experts
⊙ General Know how
O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 12.5

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

196

Element number: 12.06

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

12.6a Radiolysis

Element type: Interaction

Number of interactions: 1

Recordnumber: 196

Total number of records: 219

Description:

Radiolytic decomposition of water caused by radiation from dissolved radionuclides.

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-09-29

Motivation:

Negligible effect, due to the low concentration of radionuclides in the water.

Group Identification:

SKB: L Morén, A Ström, P Wikberg.
Kemakta: K Skagius, M Wiborgh

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:
Radiolysis

Treatment of interaction in Performance Assessment

Interaction: 12.6a Radiolysis

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

197

Element number: 12.06 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

12.6b Redox front

Element type: Interaction **Number of interactions:** 2

Recordnumber: 197 **Total number of records:** 219

Description:

The oxidation of species in the fuel-matrix and the transport of these species in the groundwater, especially U, will have an impact on the redox conditions.

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-09-29

Motivation:

The propagation of the redox front in the far-field must be evaluated.

Group Identification:

SKB: L Morén, A Ström, P Wikberg.
Kemakta: K Skagius, M Wiborgh

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:
Redox front

Treatment of interaction in Performance Assessment

Interaction: 12.6b Redox front

Treatment:

- ■ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date 95-10-13

By: Peter Wikberg

PA prerequisites:

Separate analysis is needed in order to show that the redox front is not expanded to the far-field. This is important to review in PA. However, for the far-field PA modelling it is a prerequisite.

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 12.07

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

12.7

Element type: Interaction

Number of interactions: 0

Recordnumber: 198

Total number of records: 219

Description:

198

Priority:

⦿ 0=White ○ 1=Green ○ 2=Yellow ○ 3=Red

Priority date: 95-06-29

Motivation:

No direct interactions identified.

Group identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

○ Experts
⦿ General Know how
○ Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 12.7

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

199

Element number: 12.08

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

12.8

Element type: Interaction

Number of interactions: 0

Recordnumber: 199

Total number of records: 219

Description:

Priority:

⊙ 0=White ○ 1=Green ○ 2=Yellow ○ 3=Red

Priority date: 95-06-29

Motivation:

No direct interactions identified.

Group identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

○ Experts
⊙ General Know how
○ Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 12.8

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

200

Element number: 12.09

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

12.9

Element type: Interaction

Number of interactions: 0

Recordnumber: 200

Total number of records: 219

Description:

Priority:

0=White 1=Green 2=Yellow 3=Red

Priority date: 95-06-29

Motivation:

No direct interactions identified.

Group identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

- Experts
- General Know how
- Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 12.9

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 12.10

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

12.10

Element type: Interaction

Number of interactions: 0

Recordnumber: 201

Total number of records: 219

Description:

201

Priority:

⊙ 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

No direct interactions identified.

Group Identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

O Experts
⊙ General Know how
O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 12.1

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

202

Element number: 12.11 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

12.11

Element type: Interaction **Number of interactions:** 0

Recordnumber: 202 **Total number of records:** 219

Description:

Priority:

⊙ 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

No direct interactions identified.

Group identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

O Experts
⊙ General Know how
O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 12.11

Treatment:

☐ PA prerequisites
☐ Assumptions
☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 12.13

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

12.13 Contamination

Element type: Interaction

Number of interactions: 1

Recordnumber: 203

Total number of records: 219

Description:

Contamination of the biosphere as a result of transport of radionuclides by the groundwater. Dose and exposure are biosphere processes and radiation dose is often reported as dose commitment to individuals in a critical group. Dose contributions originates from different exposure pathways in the biosphere.

203

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

Source term for the biosphere transport.

Group identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:

Groundwater release
Transport of radionuclides in rock

Treatment of interaction in Performance Assessment

Interaction: 12.13 Contamination

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ■ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

Assumptions:

Modelling application:

Far-field release term calculated by FARF 31. Part of the SKB PA model chain..

Model A name:

FARF 31

Model A reference:

SKB TR 90-01, Technical description

Model B name:

Model B reference:

Spec modelling assumptions:

204

Element number: 13.01

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

13.1 Siting - Design/Layout

Element type: Interaction

Number of interactions: 1

Recordnumber: 204

Total number of records: 219

Description:

Since our BIOSPHERE definition includes e g vegetation and topography the siting as well as the design/layout of the repository will be affected by the biosphere. Easy-to-interpret bedrock is a favourable siting factor. Pronounced discharge areas for groundwater is another important factor.

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

Input to design and a prerequisite for the far-field analysis.

Group identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:

Groundwater recharge and discharge

Treatment of interaction in Performance Assessment

Interaction: 13.1 Siting - Design/Layout

Treatment:

- ■ PA prerequisites
- □ Assumptions
- □ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

Design prerequisite of PA modelling.

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

205

Element number: 13.02

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

13.2

Element type: Interaction

Number of interactions: 0

Recordnumber: 205

Total number of records: 219

Description:

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

No direct interactions identified. Impacts go via the groundwater chemistry, (13.6-->).

Group identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 13.2

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

206

Element number: 13.03 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

13.3

Element type: Interaction **Number of interactions:** 0

Recordnumber: 206 **Total number of records:** 219

Description:

Priority:

⦿ 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

No direct interactions identified. Impacts go via the groundwater chemistry, (13.6-->).

Group identification:
SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:
- O Experts
- ⦿ General Know how
- O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 13.3

Treatment:
- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

207

Element number: 13.04

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

13.4

Element type: Interaction

Number of interactions: 0

Recordnumber: 207

Total number of records: 219

Description:

Priority:

⊙ 0=White ○ 1=Green ○ 2=Yellow ○ 3=Red

Priority date: 95-06-29

Motivation:

No direct interactions identified. Impacts go via the groundwater chemistry, (13.6-->).

Group identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

○ Experts
⊙ General Know how
○ Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 13.4

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 13.05

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

13.5

Element type: Interaction

Number of interactions: 0

Recordnumber: 208

Total number of records: 219

Description:

208

Priority:

⊙ 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

No direct interactions identified. Impacts go via the groundwater chemistry, (13.6-->).

Group identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- ⊙ General Know how
- O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 13.5

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

209

Element number: 13.06

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

13.6 Infiltrating water

Element type: Interaction

Number of interactions: 1

Recordnumber: 209

Total number of records: 219

Description:

The character (pH, Eh, TOC (total organic content), HCO_3, NO_2, NO_3, corrodants etc.) of the infiltrating groundwater is strongly depending on the soil cover where it infiltrates. A flat topography by the sea gives saline groundwater.

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

May be important during special circumstances.

Group identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- ⊙ General Know how
- O Limited

SKB FEP reference:

Surface water chemistry
Sea-level changes
Saline water intrusion

Treatment of interaction in Performance Assessment

Interaction: 13.6

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

210

Element number: 13.07 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

13.7 Surface water recharge and percolation

Element type: Interaction **Number of interactions:** 1

Recordnumber: 210 **Total number of records:** 219

Description:

Surface water recharge and percolation are processes affecting the groundwater movement in the geosphere.

Priority:

O 0=White O 1=Green O 2=Yellow ⊙ 3=Red

Priority date: 95-06-29

Motivation:

Must be considered, part of the groundwater system.

Group identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:
Groundwater recharge and discharge

Treatment of interaction in Performance Assessment

Interaction: 13.7 Surface water recharge and percolation

Treatment:

☐ PA prerequisites
☐ Assumptions
■ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

Assumptions:

Modelling application:

Part of the groundwater flow simulation models.

Model A name:
HYDRASTAR 1.4

Model A reference:
User's Guide, SKB AR 94-14

Model B name:
NAMMU 6.2

Model B reference:
Validity Document, SKB AR 95-11

Spec modelling assumptions:

211

Element number: 13.08

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

13.8a Land use

Element type: Interaction

Number of interactions: 4

Recordnumber: 211

Total number of records: 219

Description:

Land use can also affect groundwater pressure, e g drainage of wetlands, well-pumping, infilling of lakes, digging of gravel/sand etc.

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

May be important under special circumstances.

Group Identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Groundwater recharge and discharge

Treatment of interaction in Performance Assessment

Interaction: 13.8

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

212

Element number: 13.08

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

13.8b Tidal driving forces

Element type: Interaction

Number of interactions: 4

Recordnumber: 212

Total number of records: 219

Description:

Earth tides will give rise to small driving forces. Changes in groundwater storage due to pumping and recharge are reflected by corresponding changes in the groundwater table and the piezometric surface elevations. Also factors like barometric pressure changes and ocean tides influence groundwater levels.

Priority:

O 0=White ⊙ 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

Small effects compared to other processes affecting groundwater pressure.

Group identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Groundwater recharge and discharge
Earth tides
Sea-level changes

Treatment of interaction in Performance Assessment

Interaction: 13.8

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

213

Element number: 13.08
Revision date: 95-11-30
Interaction matrix: FAR-FIELD1
Version: A
Element name:
13.8c Climatic driving forces

Element type: Interaction
Number of interactions: 4
Recordnumber: 213
Total number of records: 219

Description:

By our definition of the BIOSPHERE climatically driven forces for groundwater flow need to be included. This may be important in the case of an ice load.

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

May be important under special circumstances.

Group identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Groundwater recharge and discharge

Treatment of interaction in Performance Assessment

Interaction: 13.8

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 13.08 **Revision date:** 95-11-30

Interaction matrix: FAR-FIELD1 **Version:** A

Element name:

13.8d Hydraulic gradients

Element type: Interaction **Number of interactions:** 4

Recordnumber: 214 **Total number of records:** 219

Description:

Topography and changes in topography (e g land uplift) affects the hydraulic gradients.

214

Priority:

O 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

Obvious.

Group identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

- O Experts
- O General Know how
- O Limited

SKB FEP reference:

Groundwater recharge and discharge

Treatment of interaction in Performance Assessment

Interaction: 13.8d Hydraulic gradients

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ■ Modelling

Date 95-08-15

By: A Ström (SKB)

PA prerequisites:

Assumptions:

Modelling application:

The topography affects the boundary condition of any groundwater flow simulation model. Part of the SKB PA model chain..

Model A name: HYDRASTAR 1.4

Model A reference: User's Guide, SKB AR 94-14

Model B name:

Model B reference:

Spec modelling assumptions:

Element number: 13.09

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

13.9 Climatic driving forces

Element type: Interaction

Number of interactions: 1

Recordnumber: 215

Total number of records: 219

Description:

Future climate changes will affect the temperature in the far field rock, e g periods of glaciation and deglaciation.
Effect: Decrease in temperature to permafrost conditions and then increase in temperature when area becomes covered by ice.

215

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

May be important under special circumstances.

Group Identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Permafrost
Glaciation

Treatment of interaction in Performance Assessment

Interaction: 13.9

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

216

Element number: 13.10

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

13.10a External load

Element type: Interaction

Number of interactions: 2

Recordnumber: 216

Total number of records: 219

Description:

During glaciation, the repository area may be covered by ice.
Effect: Changes in rock stresses due to the ice-load.

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

May be important under special circumstances.

Group identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:
Glaciation

Treatment of interaction in Performance Assessment

Interaction: 13.1

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

217

Element number: 13.10

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

13.10b Erosion

Element type: Interaction

Number of interactions: 2

Recordnumber: 217

Total number of records: 219

Description:

Erosion of the surface rock may remove some of the load on the far field rock. This may be important during melting of ice when surface flow will cause the erosion.

Priority:

O 0=White O 1=Green ⊙ 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

May be important under special circumstances.

Group Identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⊙ Experts
- O General Know how
- O Limited

SKB FEP reference:

Surface sediment erosion

Treatment of interaction in Performance Assessment

Interaction: 13.1

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

218

Element number: 13.11

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

13.11

Element type: Interaction

Number of interactions: 0

Recordnumber: 218

Total number of records: 219

Description:

Priority:

- ⦿ 0=White
- O 1=Green
- O 2=Yellow
- O 3=Red

Priority date: 95-06-29

Motivation:

No direct interactions identified. Infiltrating surface waters contain dissolved gas. This interaction goes via groundwater chemistry, pathway: 13.6-->6.7-->7.8-->8.11.

Group identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

- ⦿ Experts
- O General Know how
- O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 13.11

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

219

Element number: 13.12

Revision date: 95-11-30

Interaction matrix: FAR-FIELD1

Version: A

Element name:

13.12

Element type: Interaction

Number of interactions: 0

Recordnumber: 219

Total number of records: 219

Description:

Priority:

⊙ 0=White O 1=Green O 2=Yellow O 3=Red

Priority date: 95-06-29

Motivation:

No direct interactions identified. Impacts go via groundwater movement and pressure, (13.7-->,13.8-->).

Group identification:

SKB: T Eng, L Morén, O Olsson, A Ström. Kemakta: K Skagius & M Wiborgh.

Expertise:

⊙ Experts
O General Know how
O Limited

SKB FEP reference:

Treatment of interaction in Performance Assessment

Interaction: 13.12

Treatment:

- ☐ PA prerequisites
- ☐ Assumptions
- ☐ Modelling

Date

By:

PA prerequisites:

Assumptions:

Modelling application:

Model A name:

Model A reference:

Model B name:

Model B reference:

Spec modelling assumptions:

Appendix C: SKB FEP Database

Content:

List of FEPs in SKB FEP database C-1
Example of general FEP descriptions C-3

List of FEPs in the SKB FEP database

Alteration/degradation of rock reinforcement and grout
Alteration/weathering of rock and fracture minerals
Bentonite swelling, backfill
Bentonite swelling, buffer
Chemical alteration of buffer/backfill
Chemical changes
Colloid generation and transport
Colloid generation/source, buffer/backfill
Diffusion
Dilution of buffer/backfill
Dispersion
Earth tides
Earthquakes
Enhanced rock fracturing
Environment
Erosion of buffer/backfill
Erosion of rock
Faulting
Flow through buffer/backfill
Gas flow and transport, buffer/backfill
Gas flow and transport in rock
Gas generation/sources in rock
Gaseous release
Glaciation
Groundwater chemistry, far-field
Groundwater chemistry in nearby rock
Groundwater flow
Groundwater recharge and discharge
Groundwater release
Matrix diffusion
Mechanical impact/failure, buffer/backfill
Microbial activity
Permafrost
Physical changes
Precipitation/dissolution of radionuclides
Properties of backfill
Properties of buffer
Properties of far-field rock
Properties of rock, EDZ
Radiolysis
Redox front
Repository construction, layout and operation
Repository excavation
Resaturation
Resaturation of bentonite buffer
Resaturation of tunnel backfill
Rock creep

List of FEPs in the SKB FEP database (cont.)

Rock fallout
Rock stresses
Saline water intrusion
Sea-level changes
Sorption
Stray materials left
Surface sediment erosion
Surface water chemistry
Temperature, backfill
Temperature, buffer
Temperature, EDZ
Temperature, far-field
Transport of nuclides, backfill
Transport of nuclides, buffer
Transport of radionuclides in rock
Water chemistry, backfill
Water chemistry, buffer
Well supply

General FEP description (Example 1)

IDnumber:	1	**Revision date:**	95-11-20
Number of records	1	**Project:**	SR-95
		Version:	I

FEPname:

Bentonite swelling, buffer

FEPinfo:

Expansion of bentonite buffer due to water uptake.

Keywords:

Buffer, expansion, swelling pressure

Interaction matrix:

Far-field1(02.03), Far-field1(02.05), Far-field1(02.10), Far-field1(03.02), Far-field1(10.02)

Description:

As a consequence of water uptake the bentonite buffer will swell to fill up the void between the canister and the rock in the deposition hole. Swelling into cracks intersecting the deposition holes and into the tunnels, which are backfilled with bentonite/sand with a lower swelling pressure, is also possible.

The extent of swelling will influence the hydraulic properties of the bentonite buffer and the swelling pressure. Consequently, an additional swelling into cracks intersecting the deposition holes and into the tunnels will result in higher hydraulic conductivity and lower swelling pressure compared to swelling restricted to the deposition holes.

The swelling pressure will impact the canister and surrounding rock. The canister should be designed to withstand the bentonite swelling pressure. However, the build-up of corrosion products which are more voluminous than the canister material will result in a compression of the bentonite buffer and an increase in swelling pressure.

Swelling of bentonite into a failed canister may have to be considered. This could lead to a reduction in hydraulic and transport resistance in the buffer.

Uneven swelling can occur, but probably represents a transient state (resaturation phase). Deficiencies in material structure, cementing etc could cause steady-state imperfections. Uneven swelling could cause preferential pathways or even flow instead of diffusion. The probability is judged low, provided quality control is good.

Cause/influenced by:

-Resaturation of bentonite buffer
-Buffer properties, e.g. buffer materials and buffer density
-Amount and size of fractures intersecting the deposition holes
-Rock stresses affect the volume available to buffer expansion and consequently the swelling pressure

Effect:

-Swelling of bentonite into fractures intersecting deposition holes
-Changes in stress in rock surrounding deposition holes
-Volume available for expansion influences buffer properties, e.g. hydraulic, transport, mechanical

Literature:

FEP 3.2.1.1 in SKI/SKB Scenario Development Project,
SKB Technical Report 89-35.

Modelling aspects:

SITE94 reference:

Bentonite swelling, buffer, BE5, BE51, BE128, BE129, NE80, BE62

Other reference:

General FEP description (Example 2)

IDnumber:	20	**Revision date:**	95-11-20
Number of records	1	**Project:**	SR-95
		Version:	I

FEPname:

Groundwater flow

FEPinfo:

Magnitude, distribution and direction of groundwater flow and groundwater pressure in the rock

Keywords:

EDZ, excavation damage zone, near-field rock, natural fracture system, far-field rock, thermal boyancy, channeling

Interaction matrix:

Far-field 1(07.07), Far-field1(08.08), Far-field1(02.07), Far-field1(03.07), Far-field1(04.07), Far-field1(05.07), Far-field1(06.07), Far-field1(06.08), Far-field1(07.01), Far-field1(07.06), Far-field1(07.08), Far-field1(07.09), Far-field1(07.11), Far-field1(07.12), Far-field1(08.01),

Description:

Refers to the magnitude, distribution and direction of the groundwater flow as well as to the groundwater pressure. The magnitude, distribution and direction of groundwater flow may be altered locally around the repository due to changes in the barriers or the nearby rock, in the far-field due to changes in the rock, and globally due to changes in the groundwater recharge. The groundwater flow may also be affected by gas generation and flow and by gradients in water salinity and vice versa.

The water flow will also be affected by variations in temperature, thermal buoyancy, since both the water density and the viscosity depends on the temperature. In reverse, the groundwater flow affects the temperature field as the flowing water will transport the heat through advection. However, heat is also transported through conduction in both the water and the solid phase. In very low permeable media heat conduction is the dominant heat transport mechanism. In general, the temperature effects on groundwater flow are relatively well understood. However, special attention to the problem may be required in relation to coupled thermo-hydro-mechanical effects.

The water does not flow over the whole fracture plane. This fact is often noted "channelling". However, within this term vastly different concepts on how flow occurs are possible.

One concept of channelling is that each fracture plane consists of open and closed parts - for this there is also experimental evidence. This concept might only be viewed as an extension of the discrete fracture approach, at least if the closed part portion is not too large. There is little knowledge on how the fracture transmissivity is distributed on the fracture plane. It is clear that the flow distribution among the different fractures will depend very much on the shape of the open parts. To complicate matters further this shape depends upon the rock stress field, the strength of the rock, and the asperity distribution and strength of the fractures. There exist a need to establish the geometry and statistics of such channels, which existence is already confirmed by the shape of breakthrough curves of certain tracer experiments. Statistical analysis of fracture and hydraulic conductivity data, resin imprints of natural fractures are possible tools to increase the understanding of the channelling effect. Detailed mapping of inflows on tunnel and shaft walls have also been suggested. However, it is questionable whether these observations are relevant for the bedrock beyond the disturbed rock zone, but simply show the perturbation of flow by the disturbed zone.

Another concept of "channels" is "extreme channelling" where there are only a few paths where most of the water flows in the rock mass. These paths may be considered and modelled as real physical conduits, "worm holes", in the rock mass. Other means of obtaining extreme channelling are through a poorly percolating fracture network model or a poorly percolating stochastic continuum model and a given set of boundary conditions. Geostatistically, channelling will emerge in a model when the correlation scale of the material property is equal to the flow domain and its variance is high. A poorly percolating fracture network could be the result of a large fracture size and a relatively low fracture density.

The difference between "worm holes" and a poorly percolating network or stochastic continuum is that in the latter two cases the position and amounts of the important paths may change totally if the hydraulic boundary conditions are changed, whereas in the former case the flow is always confined to the "worm holes". The situation with a poorly percolating network would make it extremely difficult to characterise the flow and transport properties of the rock. Experiments performed on one scale then cannot be extrapolated to a larger scale.

Channelling will increase groundwater velocities, but this is not the most important effect. More important is that the fracture surface per volume flowing water available for sorption and matrix diffusion decreases. In addition, it may enhance the flow of oxidants towards a canister deposition hole. The specific fracture surface available for sorption/matrix diffusion is included in the "standard" migration models, but a well understood treatment of channelling is still lacking.

General FEP description (Example 2 cont.)

In the near-field, channelling will make the flow over some canister deposition holes much larger than the average flow (and v.v. much smaller at some holes). Channelling needs to be considered when evaluating the time distribution for canister failure and when evaluating the source term (i.e. only a percentage of the canister holes will see the large flows).

Cause/influenced by:

-Permeability in EDZ (near-field rock)
-Hydraulic properties of buffer in deposition holes
-Rock matrix conductivity and rock compressibility
-The characteristics of the natural fracture system , such as fracture frequencies, orientations, connectivity, apertures etc
-Salinity gradients (gradients in density and viscosity) affects groundwater flow
-Temperature affects the density and viscosity of water and thereby the groundwater flow, heat convection and buoyancy effects
-Gas will affect the magnitude, distribution and direction of groundwater flow and the groundwater pressure, two phase flow conditions
-Groundwater recharge
-Earth tides causing cyclic variations in groundwater pressure
-Rock stresses affect groundwater pressure in confined aquifers

Effect:

-Magnitude of groundwater flow and groundwater pressure will affect repository construction, e.g. extent of grouting, and operation
-Flow directions and distribution will affect repository layout and canister positioning
-The groundwater flow will affect the resaturation of the buffer in the deposition holes and the backfill in the tunnels
-Groundwater flow in EDZ surrounding deposition holes and tunnels may cause erosion of buffer/backfill
-Groundwater movement which affects the exchange of dissolved species in the groundwater and causes mixing of different waters
-Groundwater flow will transport heat and thereby affect the temperature in the rock
-Groundwater flow will affect gas flow, two-phase flow
-Groundwater flow will affect the transport and dispersion of dissolved species, colloids and

Literature:

FEPs 4.2.5, 4.2.4 and 4.2.3 in SKI/SKB Scenario Development Project, SKB Technical Report 89-35, and in Complementary memo-text for FEPs defined in SKB TR 89-35, SKB AR 94-11.

Modelling aspects:

SITE94 reference:

Groundwater flow, NE50, NE112, GE46, GE60, NE71, GE69, NE115, GE72, NE116, NT14, GT15, NE119, GE74, NE69, NE110, GE54, GE55, NE48, GE59, GE58, NE49, NE53, GE57, GE65, NE84, BE131, GE73

Other reference:

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The KBS Annual Report 1979
KBS Technical Reports 79-01 – 79-27
Summaries
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Summaries
Stockholm, March 1981

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Stockholm, April 1982

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Stockholm, July 1983

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Summaries
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TR 85-01
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Stockholm, June 1985

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Stockholm, May 1986

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Including Summaries of Technical Reports Issued during 1991
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TR 94-33
SKB Annual Report 1994
Including Summaries of Technical Reports Issued during 1994.
Stockholm, May 1995

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TR 95-01
Biotite and chlorite weathering at 25°C. The dependence of pH and (bi) carbonate on weathering kinetics, dissolution stoichiometry, and solubility; and the relation to redox conditions in granitic aquifers
Maria Malmström[1], Steven Banwart[1], Lara Duro[2], Paul Wersin[3], Jordi Bruno[3]
[1] Royal Institute of Technology, Department of Inorganic Chemistry, Stockholm, Sweden
[2] Universidad Politécnica de Cataluña, Departmento de Inginería Química, Barcelona, Spain
[3] MBT Tecnología Ambiental, Cerdanyola, Spain
January 1995

TR 95-02
Copper canister with cast inner component. Amendment to project on Alternative Systems Study (PASS), SKB TR 93-04
Lars Werme, Joachim Eriksson
Swedish Nuclear Fuel and Waste Management Co, Stockholm, Sweden
March 1995

TR 95-03
Prestudy of final disposal of long-lived low and intermediate level waste
Marie Wiborgh (ed.)
Kemakta Konsult AB, Stockholm, Sweden
January 1995

TR 95-04
Spent nuclear fuel corrosion: The application of ICP-MS to direct actinide analysis
R S Forsyth[1], U-B Eklund[2]
[1] Caledon-Consult AB, Nyköping, Sweden
[2] Studsvik Nuclear AB, Nyköping, Sweden
March 1995

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Palaeohydrological implications in the Baltic area and its relation to the groundwater at Äspö, south-eastern Sweden – A literature study
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Geokema AB, Lidingö, Sweden
March, 1995

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SKB
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Swedish Nuclear Fuel and Waste Management Co., Stockholm
January 1995

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Ignasi Puigdomènech[1], Jordi Bruno[2]
[1] Studsvik AB, Nyköping, Sweden
[2] Intera Information Technologies SL, Cerdanyola, Spain
April 1995

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Karsten Pedersen[1], Fred Karlsson[2]
[1] Göteborg University, General and Marine Microbiology, The Lundberg Institute, Göteborg, Sweden
[2] Swedish Nuclear Fuel and Waste Management Co., Stockholm, Sweden
June 1995

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Luis Moreno, Björn Gylling, Ivars Neretnieks
Department of Chemical Engineering and Technology, Royal Institute of Technology, Stockholm, Sweden
June 1995

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Yvonne Ohlsson, Ivars Neretnieks
Department of Chemical Engineering and Technology, Royal Institute of Technology, Stockholm, Sweden
August 1995

TR 95-13
Interactions of trace elements with fracture filling minerals from the Äspö Hard Rock Laboratory
Ove Landström[1], Eva-Lena Tullborg[2]
[1] Studsvik Eco & Safety AB
[2] Terralogica AB
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Roland Pusch
Clay Technology AB
February 1995

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Estimation of effective block conductivities based on discrete network analyses using data from the Äspö site
Paul R La Pointe[1], Peter Wallmann[1], Sven Follin[2]
[1] Golder Associates Inc., Seattle, WA, USA
[2] Golder Associates AB, Lund, Sweden
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Temperature conditions in the SKB study sites
Kaj Ahlbom[1], Olle Olsson[1], Stefan Sehlstedt[2]
[1] Conterra AB
[2] MRM Konsult AB
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Measurements of colloid concentrations in the fracture zone, Äspö Hard Rock Laboratory, Sweden
Anna Ledin, Anders Düker, Stefan Karlsson, Bert Allard
Department of Water and Environmental Studies,Linköping University, Linköping, Sweden
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TR 95-18
Thermal evidence of caledonide foreland, molasse sedimentation in Fennoscandia
Eva-Lena Tullborg[1], Sven Åke Larsson[1], Lennart Björklund[1], Lennart Samuelsson[2], Jimmy Stigh[1]
[1] Department of Geology, Earth Sciences Centre, Göteborg University, Göteborg, Sweden
[2] Geological Survey of Sweden, Earth Sciences Centre, Göteborg, Sweden
November 1995

TR 95-19
Compaction of bentonite blocks. Development of technique for industrial production of blocks which are manageable by man
Lars-Erik Johannesson, Lennart Börgesson, Torbjörn Sandén
Clay Technology AB, Lund, Sweden
April 1995

TR 95-20
Modelling of the physical behaviour of water saturated clay barriers. Laboratory tests, material models and finite element application
Lennart Börgesson[1], Lars-Erik Johannesson[1], Torbjörn Sandén[1], Jan Hernelind[2]
[1] Clay Technology AB, Lund, Sweden
[2] FEM-Tech AB, Västerås, Sweden
September 1995

TR 95-21
Conceptual model for concrete long time degradation in a deep nuclear waste repository
Björn Lagerblad, Jan Trägårdh
Swedish Cement and Concrete Research Institute
February 1994