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## SDU-501 - Quality assurance plan for the safety assessment SR-PSU

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# 1 Introduction

## 1.1 General

In broad terms, a QA (Quality Assurance) plan for a long-term safety assessment have been appropriately included and handled in the safety assessment. While no QA system will rigorously prove that this is the case, a purpose designed QA plan and QA system will assist the implementer in carrying out the safety assessment in a structured and comprehensive manner and aid a reviewer in judging the quality and completeness of the assessment.

The methodology for the safety assessment SR-PSU will be similar to that used in the SR-Site assessment as described in detail in the SR-Site Main report /SKB 2011/. The final version of the methodology for the SR-PSU assessment will be given in the SR-PSU Main report.

A principal purpose of a safety assessment of a final repository is to investigate whether the repository can be considered radiologically safe over time. In principle, this is established by comparing estimated releases of radionuclides and associated radiation doses with regulatory criteria.

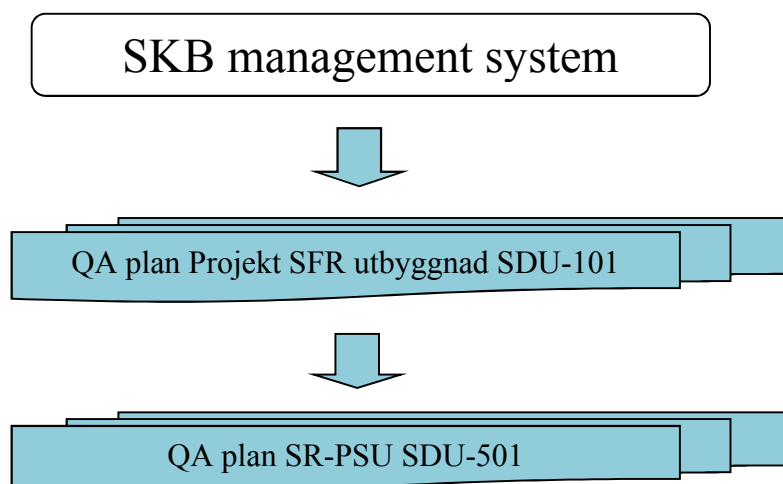
A large number of factors affecting long-term safety need to be handled in the assessment in a quality assured manner. These factors, or features, events and processes, FEPs, are collected in a FEP database that is also used as a tool for documentation of the outcome of the different steps in the FEP processing procedure as the work proceeds. Thus, the FEP database in itself is regarded as a QA instrument. The FEP database and underlying reports demonstrate how specific FEPs are included in the assessment or why they have been excluded.

The handling of many of the FEPs consists of modelling of the repository evolution. This requires a scientific evaluation of the understanding of the processes involved in the modelling, the formulation of mathematical models that simulate the process or system of coupled processes based on the understanding of the phenomena, the translation of the mathematical model into a computer code, derivation of input data and execution of the code. All these aspects need to be documented and quality assured.

Central parts of the QA plan thus relate to the FEP database and to the quantitative treatment of repository evolution.

The SR-PSU safety assessment will support the application to extend the SFR facility and is a sub-project of the SFR-extension project. In all general issues the SR-PSU project follows the QA plan for SDU-101 "Kvalitetsplan för Projekt SFR utbyggnad" SDU-101 is in agreement with general SKB routines described in SKB's management system, see Figure 1. The SKB management system fulfils the requirements of ISO 9001:2008.

This quality assurance (QA) plan is a complementary document applicable for the safety assessment SR-PSU and its staff, both SKB employees and consultants.



*Figure 1: Organisation for QA documents in SR-PSU.*

## 1.2 Objectives of this QA plan

The objective of this plan is to ensure that all relevant factors for long-term safety have been appropriately included and handled in the safety assessment SR-PSU. In particular it should aid in demonstrating:

- that all factors relevant for long-term safety occurring in earlier version of SKB databases and in the international NEA FEP database are considered in the assessment,
- that the exclusion of any of these factors is well motivated by an identifiable expert,
- that the handling of included factors are well motivated by identifiable experts,
- how quantitative aspects of the assessment are handled by mathematical models and how the models (computer codes) have been quality assured,
- how appropriate data for quantitative aspects of the assessment are derived and used in the assessment in a quality assured and traceable manner,
- how the safety assessment reports have been properly reviewed and approved for correct and complete content.

## 2 General issues

### 2.1 Organisation and responsibilities for QA work in SR-PSU

The organisation for the project is shown in the project plan.

The project manager has the overall responsibility for quality assurance in the project SR-PSU.

The quality coordinator is responsible for updating this Quality assurance plan.

### 2.2 QA audits

Internal QA audits are conducted according to the procedure SD-005 in SKB's management system and following a programme approved by the managing director of SKB. For each audit, an audit plan is established in advance, specifying the purpose and focus of the audit as well as the criteria of the audit. The audit is conducted by assigned auditors and the result of the audit is documented in an audit report. A plan for corrective actions of nonconformities identified in the audit is included in the audit

report by the audited part and when the plan is approved by the auditing team, the audit report is filed in SKB's internal documentation system SKBdoc.

## 2.3 Steering documents

Most of the steering and QA-related documents for the project SR-PSU are listed in table 1 to aid users of this document, including reviewers, in finding specific procedures, instructions and other documents related to the SR-PSU QA work.

Table 1. Steering and QA-related documents for PSU-05.

Object	Language	Id	Comments
Project decision	Swedish	SKBdoc: 1182230 ver. 2.0	
Project plan	Swedish	SKBdoc: 1173311 ver. 3.0	
Kvalitetsplan för Projekt SFR utbyggnad	Swedish	SDU-101	
Dokumenthanteringsplan Projekt SFR-utbyggnad.	Swedish	SDU-102	
Kravhantering SFR-utbyggnad	Swedish	SDU-103	
Instruction for qualification of "old" references	English	SDU-115	
Quality assurance plan SR-PSU	English	SDU-501	
Instructions for developing process descriptions in SR-PSU	English	SDU-502	
Instructions for development and handling of the SKB FEP database – Version SR-PSU	English	SDU-503	
SR-PSU model summary report instruction	English	SDU-504	
Supplying data for the SR-PSU Data report	English	SDU-505	
Instruction for use of preliminary data used in SR-PSU calculations/modelling	English	SDU-507	
Instruction for model and data quality assurance for the SR-PSU project	English	SDU-508	

Table 2. Other SR-PSU related documents

Project risk analysis	Swedish	SKBdoc: 1246114	Handling of risks is made according to SDU-114
Time schedule	English	SKBdoc: 1185479	
AMF for the safety assessment SR-PSU	English	SKBdoc: 1319657	

The project is defined by issuing, within SKB, a project decision, (SKBdoc: 1182230) describing the purpose of the project, its deliverables, its time frame, necessary prerequisites in terms of data deliveries from related projects, the actors involved in the project and their roles, a budget frame etc.

A project plan (SKBdoc: 1173311) is established, giving more detailed descriptions of how the purposes of the project are to be fulfilled. The project plan is updated as necessary throughout the project.

Associated with the project plan is a risk analysis document (SKBdoc: 1246114), identifying critical issues that could jeopardise the fulfilment of the project objectives. The risk analysis is updated several times per year.

Also this QA plan (SDU-501) is associated with the project plan. The QA plan builds on the general QA plan for the SFR extension project, (SDU-101).

A time schedule (SKBdoc: 1185479), covering project activities and their interdependencies is established and updated continuously.

Any planned departures from steering documents, such as SKB-routines and documents referred to in this QA-plan, will be documented in a decision, brought up in project meeting and entered in the minutes of the project meeting. Decisions are stored in the SKBdoc and, if relevant, in the requirement management system according to SDU-103.

## **2.4 Demonstrations of fulfilment of regulatory criteria**

The main purpose of the SR-PSU project is to have a long term safety assessment for present SFR and the extension. Applicable regulations are listed in the project decision. To ensure that regulations are followed, all relevant regulatory requirements will be duplicated in an Appendix of the SR-PSU Main report. References are inserted in the regulatory text to sections of the main report, or underlying reports, where fulfilments of the requirements are demonstrated.

### **2.4.1 Findings in regulator's review reports**

A related issue concerns review reports, issued by Swedish authorities, of SKB's past safety assessment reports.

The main review report /SKBdoc 1238588/ for the safety assessment SAR-08 is the most relevant document for SKB to consider since it expresses the authorities' view of all reviewed aspects of the SFR repository. There are also a number of supporting documents in the regulatory review (SKBdoc 1244276, SKBdoc 1244272, SKBdoc 1244270, SKBdoc 1244269, SKBdoc 1244268, SKBdoc 1244266, SKBdoc 1244265, SKBdoc 1244257).

## **2.5 Documentation of experts'**

Expert judgements permeate the safety assessment. In several of the central documents, (data report, process reports) relevant references will be made to these experts.

All experts contributing to the safety assessment are listed in a separate document (SKBdoc 1345416).

In general, experts are selected on the basis of their documented credentials. There are, however, no particular procedures for the selection of experts.

Regarding experts for the documentation of process understanding, for the selection of models or of input data etc for the quantitative aspects of the assessment, the ambition is to contract leading experts in the field.

## **2.6 QA procedures for reports**

### **2.6.1 Writing**

References produced within the project are listed in a document that is continuously updated (SKBdoc 1238432). All main references and many of the additional reports will be written in English to facilitate discussions and reviewing in international contexts.

All reports will be reviewed according to a review plan, see below.

## 2.6.2 Review process

### ***Factual review***

Peer reviewing with subsequent handling of review comments is an important method for broadening the basis on which expert opinions/judgements are formed in a safety assessment.

All reports produced in the SR-PSU project will therefore be subject to peer review within the project prior to being finalised. A review plan is established for each report and filed in the project archive. This review plan defines the document that should be provided to the reviewers, general criteria for acceptance of a report, requirements on reviewers' competence and how the review documents shall be handled.

A template, for review comments is used and the comments are filed to ensure traceability of the review process. The template also requires the author of the report to document how each comment is handled when the report is finalised.

### ***Quality review***

The quality review focuses on reviewing that correct workprocesses and instructions has been followed. Also a final check will be carried out to ensure that references are correct within and between reports, correct use of language in text by authors not writing in their mother tongue, etc.

### ***Simplified review of "old" references***

It is required that all documents that are produced for the license application shall undergo a factual and quality review as describe above. However, many of these new documents need to refer to older or SKB external documents that lack a documented factual and quality review. This procedure implies that qualification of references (SDU-115) is made in the report where the references are used, e.g. in the process descriptions in the process reports. The qualification is then reviewed by the experts selected for factual review of the report in question, e.g. the process report.

## 2.6.3 Approval

The project manager of SR-PSU approves all reports except the main report, which is approved by the project manager of the SFR extension project, of which SR-PSU is a sub-project.

## 2.7 Handling of documents

All steering documents for SR-PSU are filed in SKBdoc after review and approval by the project manager or by the project manager of the SFR extension project. These steering documents regulate the handling of QA-related documents produced in the project.

Deliverables from computational tasks shared by multiple sub-projects in SR-PSU are defined in planning documents.

No specific handling is defined for reports under production. However, review versions of the reports are registered in SKBdoc together with the review plan, the review document containing review comments and the handling of the comments and the final version of the report according to SD-037 Granskning.

Handling and documentation of data is described in the Instruction for model and data quality assurance for the SR-PSU project (SDU-508).

Notices and minutes of meetings are registered in SKBdoc.

## 3 FEP handling

### 3.1 Introduction

An important and formal tool for ensuring that all relevant factors have been considered in the safety assessment is provided by available databases of features, events and processes (FEPs) relevant to long-term safety of nuclear waste repositories.

A new version of SKB's database of FEPs relevant to the long-term safety of a KBS-3 repository was developed within the SR-Site project /SKB TR-10-45/. This database will now be extended to a SKB FEP database that also includes SR-PSU. The FEPs in the NEA international FEP database version 2.1 /NEA 2006/ and the interaction matrices for SFR /SKB 2001, SKB 2008/ will be included in the SR-PSU part of the database.

The handling of FEPs in SR-PSU is summarised below:

- FEPs are sorted into three main categories: i) initial state, ii) process and iii) external FEPs. FEPs are also categorised as irrelevant or as being related to methodology at a general level.
- Initial state FEPs are either i) included in the Initial state report, the site description or the site-specific layout of the repository or ii) categorised as initial state deviations to be further handled in scenario selection.
- Process FEPs will be documented in the Process reports.
- The handling of external FEPs related to long-term climate changes will be documented in the Climate report. The few external, large-scale geosphere FEPs will be addressed in the geosphere process report.
- The handling of external FEPs related to future human actions (FHA) will be developed in the FHA report.
- The reference initial state, all long-term processes and a reference external evolution is used to define a reference evolution for the repository system. This evolution is an important basis for a comprehensive main scenario.

### 3.2 FEP database, FEP catalogue

A database of all the relevant factors to be considered in the safety assessment is developed. In short, the database answers questions like:

- Is a factor included? How? Who made the decision?
- Is a factor neglected? Why? Who made the decision?

Quality assured handling of the FEP database is ensured by an instruction, SDU-503.

### 3.3 Initial state

The initial state of SR-PSU, i.e. the state at the repository closure will be documented in a dedicated report called Initial state report. A part of the report will be structured according to the set of variables used to describe the state of each of the barriers.

### 3.4 Process reports

The repository system will evolve as a consequence of a number of radiations related, thermal, hydraulic, mechanical, chemical and biological processes acting within the repository system over time. These processes are identified in the FEP handling and the current knowledge and the handling of the identified processes in SR-PSU (mathematical modelling, simple estimate, neglected) will be

documented in dedicated Process Reports. Each process and its handling are documented according to a template and an instruction, SDU-502.

### **3.5 External conditions**

The handling of FEPs related to external conditions will be documented in a dedicated report, the Climate report, with a structure similar to the process reports. The same instruction as for the process reports are utilised when describing the processes in the Climate report, SDU-502.

### **3.6 Selection of scenarios**

The method for selection of scenarios and the implementation of the method will be described in the SR-PSU Main report.

## **4 Modelling**

The overall handling of data and models is described by Instruction for model and data quality assurance for the SR-PSU project, SDU-508. In this instruction, references are made to more specific instructions.

Quantitative aspects of the repository evolution are primarily assessed by mathematical modelling of each scenario, using a set of computer codes. One so called assessment model flow charts, AMFs, are used to overview the models and their interdependencies.

### **4.1 Model summary report**

The purpose of the model summary report is to summarise all necessary documentation for quality assurance of models and the calculation procedures in the safety assessment. It thus covers, either explicitly or by references to supporting documents:

- A description of the mathematical model (the equations to be solved).
- A description of the methods by which the solution is obtained, usually a purpose designed computer code.
- User manuals
- Measures that have been taken to ensure that the code produces the correct solution to the mathematical problem, verification. This can e.g. be achieved by comparison to solutions obtained with other codes or to analytic solutions for special cases if available.
- Procedures for documenting input data and results of the assessment calculations.

Each model is treated in a dedicated section, where all the above issues are covered, following a specified instruction and template SDU-504.

### **4.2 Data report - Qualification of data**

Input data, with uncertainty estimates, to the mathematical modelling of repository evolution is quality assured through procedures that will be documented in a dedicated Data report. The procedures include

- Externally reviewed expert documents as basis for data selection (for essential data)
- Assessment team data selection based on expert documents
- Expert feedback on assessment team data selection

These procedures are described in an instruction, SDU-505.



If preliminary data are used it must be verified that the used data are in agreement with the final data being delivered later. These procedures should fulfil the requirements on documentation of the verification as specified in the instruction [SDU-507 Instruction for use of preliminary data used in SRPSU calculations/modelling](#).

### 4.3 Data report - Input data used in the safety assessment

The role of the Input data used in the safety assessment report, together with the SR-PSU Assessment Model Flow, is to be used as an easily readable compilation of all the data used in the SR-PSU Safety Assessment. This report provides data or references to where data can be found that are used in the assessment of the long-term radiation safety of the low-and intermediate level waste repository SFR..

### 4.4 Planning document

Information on how computational tasks in SR-PSU should be conducted is provided in planning documents. The format for and contents of these are described in instruction SDU- 508.

## 5 References

SKBdoc: 1182230	Project decision
SKBdoc: 117331	Project plan
SDU-101	Kvalitetsplan för Projekt SFR utbyggnad
SDU-102	Dokumenthanteringsplan Projekt SFR-utbyggnad.
SDU-103	Kravhantering SFR-utbyggnad
SDU-115	Instruction for qualification of “old” references
SDU-501	Quality assurance plan SR-PSU
SDU-502	Instructions for developing process descriptions in SR-PSU
SDU-503	Instructions for development and handling of the SKB FEP database – Version SR-PSU
SDU-504	SR-PSU Model Summary Report Instruction
SDU-505	Supplying data for the SR-PSU Data Report
SDU-508	Instruction for model and data quality assurance for the safety assessment SR-PSU
SKBdoc: 1246114	Project risk analysis
SKBdoc: 1185479	Time schedule
SKBdoc 1238432	Document list SR-PSU Extension Project
SKB 2011, “Long-term safety for the final repository for spent nuclear fuel at Forsmark Main report of the SR-Site project”, SKB Technical report TR-11-01	
SKB 2010, ” FEP report for the safety assessment SR-Site”, SKB Technical report TR-10-45	
/SKB 2001, SKB 2008/ Interaction matrices for SFR	
/NEA 2006/ NEA international FEP database version 2.1	
SKBdoc 1238588	Granskning av SFR-1 SAR-08
SKBdoc: 1244276	Review and Assessment of SFR Analyses
SKBdoc: 1244272	Review and Assessment of SFR 1 Long-term Safety Analyses
SKBdoc: 1244270	Assessment of SFR Analyses - Initial Simplified Assessment of Near Field Models
SKBdoc: 1244269	Review of Hydrogeological models supporting the SAFE SFR Final Safety Report
SKBdoc: 1244268	Review of biosphere modelling in SAR-08
SKBdoc: 1244266	"C-14 Long-Term Dose Assessment: Quantitative Model Comparison and Development 0 4"

SKBdoc: 1244265	Numerical modelling of SAR-08 biosphere features
SKBdoc: 1244257	Review of SKB Reports on Long-term Stability of SFR Barriers
SKBdoc 1345416	SR-PSU – List of expert
SD-037	Granskning

## 6 Revisions of QA-plan

VERSION	CONTENT OF THE REVISION	MADE BY	REVIEWED BY	APPROVED BY
1.0	New document	See first page	See first page	See first page
2.0	Minor editorial changes and adjustments to actual approach	See first page	See first page	See first page