SKI Report 01:3
SSI-report 2001:02

SKI's and SSI's Joint Review of SKB's Safety Assessment Report, SR 97

Summary

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1 Summary

The Swedish Nuclear Fuel and Waste Management Co (SKB) has a programme for the siting of a repository for spent nuclear fuel in Swedish bedrock. In 1996, the Swedish Government decided that SKB must perform an assessment of the repository's long-term safety before undertaking the next step of the programme which entails drilling in a minimum of two municipalities (site investigations). SKB has presented such a safety assessment in SR 97 – Post-closure Safety (henceforth referred to as SR 97). SR 97 is one of the documents in the comprehensive reporting that SKB must provide when it proposes sites for investigation.

The Swedish Nuclear Power Inspectorate (SKI) and the Swedish Radiation Protection Institute (SSI) have evaluated SR 97 in terms of its purposes which are to demonstrate a methodology for safety assessment, to show that Swedish bedrock can provide a safe repository using SKB's method, to provide a basis for specifying the factors that are important for site selection and to derive preliminary requirements on the function of the engineered barriers. The authorities have reached the following conclusions:

- SR 97 does not indicate any conditions that would mean that geological final disposal in accordance with SKB's method would have significant deficiencies in relation to the safety and radiation protection requirements of the authorities.

- SR 97 contains the elements required for a comprehensive assessment of safety and radiation protection.

- SKB's safety assessment methodology has improved within several important areas, such as the documentation of processes and properties that can affect repository performance and the development of models for safety assessment calculations.

- The methodology used in SR 97 has some deficiencies, for example, the specification of future events to be described in the safety assessment. SR 97 has not, to an adequate extent, dealt with unfavourable conditions that can affect the future safety of a repository.

- SKB states that the results of SR 97 have been applied to formulate requirements and preferences regarding the host rock for a repository. In the authorities' opinion, SR 97 does not include a description of how this has been done. The coupling between safety assessment and site investigation, should be improved.

- A safety assessment of a repository for spent nuclear fuel will always contain uncertainties and deficiencies in the underlying data. Access to experts who can provide expert judgement is therefore vital. SKB should improve its procedures for obtaining expert judgement.

To summarize, the authorities find that parts of the methodology in SR 97 must be further developed and detailed prior to the forthcoming stages of the site selection process. SKB's development of methods for safety assessment

is a continuous process that should be conducted throughout all of the stages of the final disposal process.

On the basis of the review of SR 97 and previous reviews of SKB's RD&D programmes (Research, Development and Demonstration), the authorities find that the KBS-3 method is an adequate basis for SKB's forthcoming site investigations and for the further development of the engineered barriers.

In connection with future reviews of SKB's RD&D programmes, the authorities intend to present additional views on the reporting that is necessary prior to the different stages of SKB's final disposal programme.

Background to SR 97

According to the Act on Nuclear Activities, the reactor owners in Sweden must, in a safe manner, handle and dispose of the spent nuclear fuel and nuclear waste generated during the operation of the nuclear power plants. The owners have allocated this task to their jointly-owned company, the Swedish Nuclear Fuel and Waste Management Co (SKB). SKB must also conduct the research that is necessary to develop a method and to identify a suitable site for a repository.

The radioactive inventory of the spent nuclear fuel requires that the fuel be isolated from man and the environment for a very long time. In Sweden, as in most other countries with nuclear power plants, the main principle for the final disposal of the waste is some form of geological disposal.

The competent regulatory authorities, the Swedish Nuclear Power Inspectorate (SKI) and the Swedish Radiation Protection Institute (SSI), have established basic requirements for possible geological final disposal methods. The purpose of the requirements is to ensure that the hazard to human health and the environment is very low.

An assessment of the long-term safety of the repository, namely a safety assessment, must be submitted for evaluation by the authorities (regulatory review). The regulatory review of such a preliminary safety assessment (SR 97) is presented here.

SKB must also prepare an Environmental Impact Statement (EIS) which describes the assumed impact on human health and the environment.

2 Why Perform a Safety Assessment Now?

As part of the ongoing siting process, which currently involves six municipalities, SKB intends to present in December of this year (2000) a compilation of feasibility studies conducted in these six municipalities and then select a minimum of two sites for further investigation (site investigations).

On December 19, 1996, the Government decided that SKB should perform an assessment of the repository's long-term safety before starting site investigations and before submitting an application to construct an encapsulation plant.

SKB's site investigations require commitment from the municipalities in the site selection process. The authorities are required to assist municipalities and other concerned parties with an in-depth evaluation of the status of SKB's safety-related work. The safety assessment also provides the authorities with a basis to evaluate the extent to which SKB's site investigation programme is linked to the safety-related work and to the development of the system's barriers.

SR 97 is SKB's safety assessment report, based on a KBS-3 type repository. The method involves placing the spent nuclear fuel in a cast iron insert surrounded by a copper canister which isolates the fuel from its surroundings. The canisters are placed in individual deposition holes, at a depth of 500 meters in granitic bedrock and surrounded by bentonite clay.

2.1 What is a Safety Assessment?

The SR 97 safety assessment is a method for identifying and evaluating risks and uncertainties in the repository for spent nuclear fuel. SKB's safety assessment must also show the conditions for ensuring that the regulatory requirements regarding safety and radiation protection can be met.

The safety assessment is based on geological and mathematical models that describe the bedrock and scenarios where various event sequences can be combined and assessments of the future development of safety in the repository can be made.

Risks to man and the environment must be described based on different conditions for the present day and the future. By analyzing how

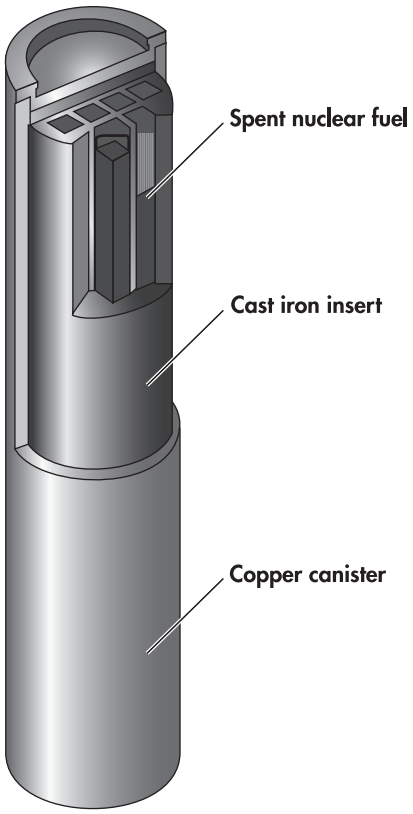

Figure 1.
In a KBS-3 type repository, the spent nuclear fuel is placed in copper canisters with cast iron inserts.

a final disposal system is expected to perform under different conditions (such as earthquakes, climatic changes, human intrusion etc.) the long-term impact on the repository and the consequences of different events can be assessed.

The term "final disposal system" refers to all of the components and barrier functions that are necessary to achieve a well-functioning repository (nuclear fuel, canisters, bentonite clay buffer, backfill and bedrock). A safety assessment must also describe uncertainties in calculation models and data as well as how these uncertainties affect the conclusions. The results from the safety assessment are also important to improve the safety of a final disposal system.

A safety assessment is not only performed prior to the final decision for the construction of a repository, it can be repeated at different stages in the development of the nuclear waste management system. Since the early eighties, the nuclear industry has performed three safety assessments (1983, 1991 and the subject of this review – SR 97 – presented in 1999). These safety assessments have all been reviewed by the authorities.

New safety assessments are performed as new knowledge and data emerge. At the early stages of a development programme, the safety assessment does not have to provide a detailed investigation of all of the issues relating to the barriers and their performance.On the other hand, it is important that the safety assessment method should meet the overall regulatory requirements and that it should be possible to develop the method to comply with the requirements in connection with future license applications.

New safety assessments can be required in connection with future decision-making, primarily when applications are to be submitted for permission to construct an encapsulation plant, to conduct a detailed characterization (the excavation of a shaft down to repository depth) and to operate a repository at various stages.

A basic requirement of a safety assessment is that the knowledge that is gained should result in the probable conclusion that no unresolved issue is so serious as to make it impossible to construct a repository that complies with the overall safety and radiation protection requirements. At the very least, by the time an application is submitted to construct a repository, the safety assessment should be both comprehensive and show that no such unresolved issue exists.

The safety assessment thereby plays a central role, as a means of successively supervising and following up SKB's research as well as a basis for deciding whether to grant permission for the construction, ownership or operation of nuclear facilities.

3 SR 97 – SKB's Report

3.1 Purpose, Delimitations and Method

In November 1999, SKB submitted the safety assessment that was requested by the government and regulatory authorities. The safety assessment comprised the following reports (available in English):

– SR 97 – Post-closure Safety (Main Report, Volumes I and II), TR-99-06
– SR 97 – Waste, Repository Design and Sites (Background Report), TR-99-08
– SR 97 – Processes in the Repository Evolution (Background Report), TR-99-07
– SR 97 – Data and Data Uncertainties (Background Report), TR-99-09

In the Main Report, SKB specifies four concrete purposes for SR 97, namely to:

- demonstrate safety assessment methodology
- demonstrate the feasibility of finding a site in the Swedish bedrock where the KBS-3 method meets the requirements on long-term safety and radiation protection that are defined in SKI's and SSI's regulations.
- serve as a basis for deriving preliminary function requirements with respect to the canister and the other barriers
- provide a basis for specifying the factors upon which the selection of sites for investigation will be based and for deriving the parameters that must be determined as well as for determining the other requirements to be made on a site investigation.

Furthermore, SKB states that SR 97 is a complete safety assessment of the KBS-3 method for the final disposal of spent nuclear

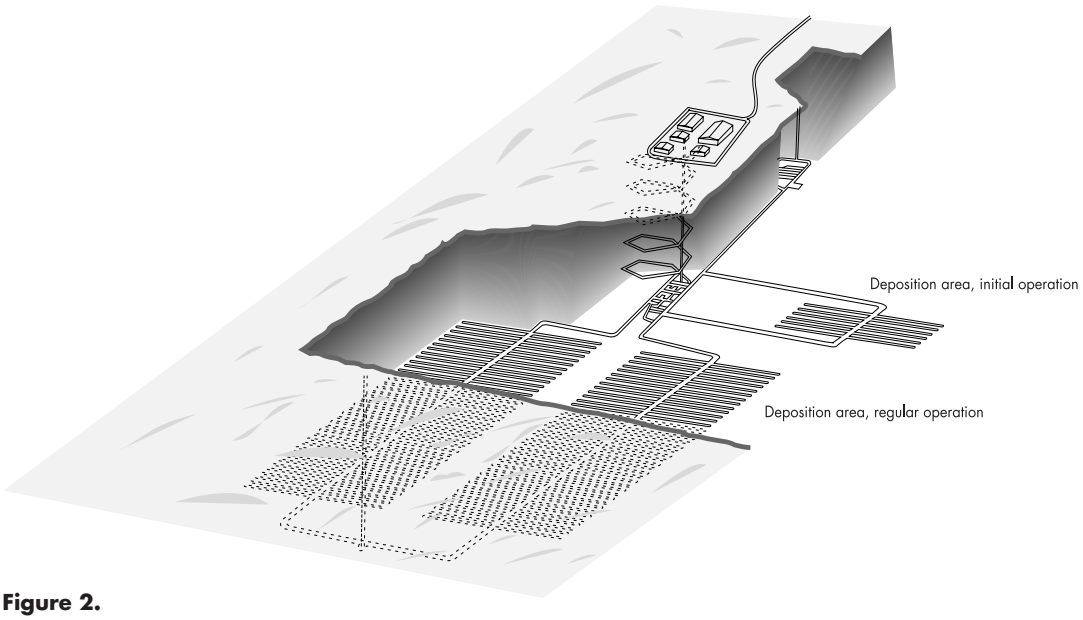

Figure 2.
Repository layout.

fuel based on geosphere data from three actual sites in Sweden. The report assesses the long-term safety of the repository after closure.

Long-lived waste other than spent nuclear fuel, such as core components from nuclear power plant dismantling which is intended to be disposed of in a separate repository, is not included in SR 97.

The method used in the assessment is based on an initial description of repository properties immediately after closure, followed by an analysis of the change in the system over time, as a result of internal processes and external events (*system description*). The evolution of the final disposal system is analyzed as five *scenarios*.

3.2 System Description

SKB describes the system of barriers that comprises the KBS-3 repository (fuel, copper canisters with cast iron inserts, bentonite clay and the bedrock at a depth of 500 meters).

According to SKB, a systematic analysis requires the description of all known internal processes of any possible importance, the relationships between them and the properties of the repository affected by each process.

The repository is divided into four subsystems: fuel, canister, buffer/backfill and geosphere. For each subsystem, all known Thermal, Hydraulic, Mechanical and Chemical (THMC) processes of importance to repository evolution and their interactions are described.

Three hypothetical repository sites are analyzed in SR 97 in order to illustrate actual conditions in Swedish crystalline bedrock (Aberg, Beberg and Ceberg). The sites represent three areas in a stable geological environment and are located relatively near to the coast (Äspö, located in Småland, Finnsjön in Uppland and Gideå in Ångermanland).

3.3 Scenarios

The consequences of changes in the climate, biosphere and society in the future are analyzed in SR 97.

SKB evaluates five scenarios:

- a base scenario where no canisters have initial defects and where present-day conditions are assumed to exist in the environment

- a canister defect scenario with a few initially defective canisters

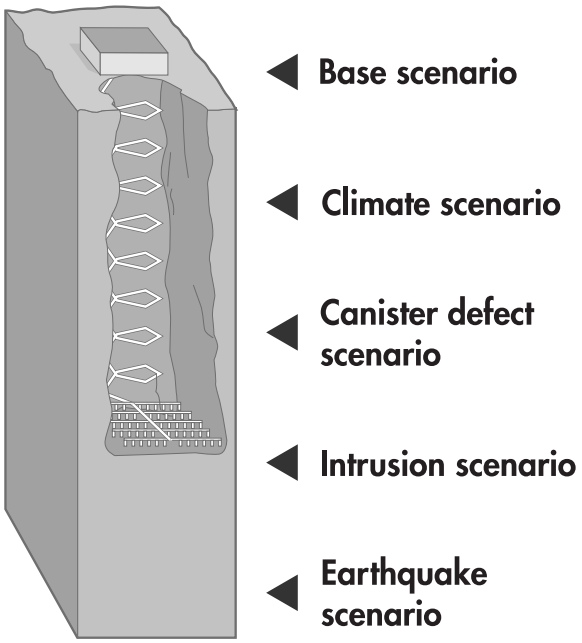

Figure 3.
The base scenario involves present-day environmental conditions and canisters with no initial defects. In SR 97, the base scenario is the baseline used to compare all other scenarios.

- a climate scenario with future climate-induced changes
- an earthquake scenario
- a scenario that deals with future human actions that could conceivably affect the deep repository (human intrusion).

3.4 SKB's Conclusions from SR 97

In SKB's opinion, the repository layout (KBS-3) analyzed in SR 97 has been adequately developed, the understanding of the long-term performance of the repository is adequate and there are adequate safety margins to achieve a satisfactory basis for performing site investigations.

According to SKB, the conditions at Aberg, Beberg and Ceberg provide substantial safety margins for repository safety. In the climate scenario, the evolution is assessed to lead to safety being maintained at all of the analyzed sites. SKB considers the differences between the three sites to be so small that they do not have any decisive importance to the overall consideration of all of the factors affecting repository siting (for example, technological, economic, land use-related, environmental and societal factors).

In SKB's opinion, SR 97 shows that a safe repository for spent nuclear fuel, based on the KBS-method, can be built. This can be done at a site where the conditions are similar to those at Aberg, Beberg and Ceberg.

4 Regulatory Review

4.1 Implementation

The regulatory review of SR 97 took the form of a joint project conducted by SKI and SSI. The evaluation of the authorities is presented in Chapter 5.

A central component of SKI's and SSI's review was the evaluation of SKB's method for the structure, implementation and reporting of a safety assessment and the evaluation of how this method was applied in SR 97. This involves examining issues such as the identification and selection of scenarios, risk analysis, SKB's selection of data and models and the analysis of uncertainties in data, models and scenarios.

To contribute to the breadth and depth of the review of SR 97, OECD's Nuclear Energy Agency (NEA) appointed an International Review Team (IRT) on behalf of SKI, to conduct an international peer review of SR 97. The findings of the IRT were taken into account in SKI's and SSI's joint evaluation. The conclusions of the IRT are presented under a separate heading below.

The National Council for Nuclear Waste (KASAM) has reviewed and submitted a statement of opinion on SR 97. In addition, about fifteen consultants were commissioned by SKI to review various parts of SR 97.

All of the organizations that participate in the review of SKB's regular RD&D programme (including municipalities involved in feasibility studies, county administrative boards and environmental organizations) have been given the opportunity to submit statements of opinion on SR 97. A total of twelve statements were submitted.

4.2 Comments of the Reviewing Bodies

The comments of the reviewing bodies on SR 97 mainly concern issues relating to the scenarios selected and the following barriers: canister, buffer and geosphere.

National Council for Nuclear Waste

In KASAM's opinion, SR 97 is a good basis for further work on the KBS-3 method and site investigations. However, KASAM also provides a number of comments on the work presented in SKB's report.

KASAM raises the question of the stated purpose of SR 97 – to specify site selection criteria, namely, the characteristics of the rock that SKB considers are necessary for a safe repository. With SKB's safety assessment, it is difficult to determine which site selection criteria, relating to the bedrock, are of decisive importance. SKB places too much importance on the engineered barriers (the canister and bentonite clay).

KASAM also questions whether SKB, in its choice of scenarios, has managed to include all of the relevant areas that should be analyzed. Even if the prime purpose of SR 97 is to assess repository safety after closure, circumstances that result in the non-closure of the repository should also be included in the safety assessment.

KASAM would also like to see analyses of the impact of land elevation on the bedrock and whether this can cause creep movements in the repository which would have an impact on the canisters. In KASAM's opinion, the investi-

gation of the impact of the future climate on the buffer must be improved.

KASAM appreciates the fact that SKB has developed the models to describe transport and concentration processes in the biosphere. However, according to KASAM, the account presented in SR 97 is not sufficiently clear since the reader cannot trace the entire chain of calculations which result in a dose contribution to man.

Other reviewing bodies include:

- **The Royal Institute of Technology, Stockholm (KTH)** which stated that it would like to see a detailed justification of SKB's scenario selection.

- **The Swedish Geological Survey (SGU)** emphasizes that there seems to be a causal relationship between deglaciation and displacement movements which should warrant further research. SGU lacks a compilation and analysis of available geological and hydrogeological data that could provide important information on the rock type or tectonic environment that can generally be considered to be the most favorable for a repository. A final safety assessment can only be performed when data have been obtained from the site or sites that are considered to have favourable conditions for repository siting.

- **Stockholm University: the Department of Paleogeophysics & Geodynamics** is highly critical of the fact that SKB has not taken into account existing knowledge about major earthquakes in connection with deglaciation.

In the opinion of **the Department of Physics**, SKB's risk analysis for radionuclide transport is brief. Nevertheless, the Department states that SKB has the necessary tools to perform its safety assessments. However, the risk analysis should have been more complete than in SR 97.

4.3 Evaluation by the NEA-appointed International Review Team (IRT)

General Conclusions

The IRT concludes that SR 97 illustrates the potential safety of the KBS-3 method, considering the conditions of the Swedish bedrock. The IRT's view is that the document is generally well written and that the reasoning is well presented.

SKB's desire to move on to the site selection stage is considered to be well-founded. However, data from possible repository sites are needed in order to develop and test the assessment methodology. During the course of its review, the IRT has not identified any issues that must be resolved before SKB proceeds to the next stage – the investigation of potential repository sites.

At the same time, the IRT is of the opinion that the safety assessment methodology should be further developed.

Observations and Recommendations

The terms of reference for the review comprised a number of specific questions. The main

observations and the recommendations of the IRT, related to these questions, are reported here. The IRT group finds that:

- With the KBS-3 final disposal method, SKB has developed a robust multiple-barrier concept to isolate the waste. The IRT notes that that SKB has conducted rigorous engineering and scientific investigations to evaluate and reduce the uncertainties and to demonstrate safety. Furthermore, the IRT finds that SKB's strategy is sufficiently flexible to incorporate improvements in the concept resulting from advances in science and engineering as the programme proceeds.

- SR 97 is SKB's first comprehensive safety assessment in over a decade. The IRT states that more frequent, iterative safety assessments would facilitate the timely evaluation of the significance of new developments in science and technology.

- SKB's work is based on a solid scientific basis and no issue has been identified that would undermine the overall conclusions of the safety assessment report. The IRT also finds that future improvements within some identified areas would enhance the robustness of the safety assessment.

- SR 97 contains a number of scenarios that illuminate essential aspects of long-term safety. However, the IRT finds that a formal justification is lacking for the choice of the scenarios. Furthermore, no explanation is given of the purpose and representativeness of the different scenarios.

- SKB has an appropriate selection of models and computational tools that can be used and developed flexibly. However, the incorporation of the process information into the analysis is not documented.

- SKB calculates a bounding estimate of risk, which is based on its own interpretation of regulations. The result is of uncertain meaning both statistically and from the point of view of regulatory compliance. SKB must, therefore, develop practical methods to calculate risk while preserving statistical veracity.

- SKB would benefit from further guidance from the authorities with respect to the definition of risks and how regulatory requirements can be met.

- The focus of SR 97 is on demonstrating safety rather than on investigating detailed aspects of barrier performance. Therefore, in the opinion of the IRT, SKB should place greater emphasis on incorporating more realistic descriptions of repository performance into future safety assessments. SKB should also conduct more comprehensive sensitivity and uncertainty analyses that would contribute to supporting the analysis of significant site-specific data which can be obtained in connection with site investigations.

During the course of its review, the IRT has not identified any issues that it believes could prevent the technical implementation of the KBS-3 method. However, in the opinion of the IRT, a discernable link between the results of the safety assessment and the development of site investigations and siting criteria is lacking.

5 SKI's and SSI's Overall Evaluation

5.1 Introduction

An overall purpose of the analysis presented by SKB in SR 97 is to demonstrate that KBS-3 as a final disposal method has good prospects of meeting the long-term safety and radiation protection requirements. Furthermore, the analysis must show that it is possible to find a site in Sweden that meets the requirements.

In SR 97, SKB states that "a safe deep repository for spent nuclear fuel, based on the KBS-3 method, can be constructed at a site with conditions similar to those exemplified in the three examples – Aberg, Beberg and Ceberg".

SKI's and SSI's evaluation of SR 97 is based on the assumption that the repository must meet the safety and radiation protection requirements of the authorities' regulations. In addition to this, the authorities also evaluate other goals that have been specified for the report, namely:

- To present a method for safety assessment.
- To show the factors that are important for site selection.
- The show the requirements that must be made with respect to barrier function.

In their evaluation of SR 97, SKI and SSI have not found any obstacles to prevent final disposal in accordance with the KBS-3 method from meeting the required safety and radiation protection requirements.

At the current stage of SKB's work on developing the KBS-3 method, certain parts of a safety assessment must be based on assumptions that result from present-day knowledge concerning the design and operation of the repository. For example, data from site investigations and canister fabrication are still lacking.

Extensive development work on the engineered barriers is currently being conducted by SKB. An evaluation of this development work is beyond the scope of the regulatory review of SR 97 and will be conducted in another context.

The regulatory review of SR 97 and evaluation of other forthcoming reports from SKB will be submitted to the Government and can lead to government requirements on SKB, under the Act on Nuclear Activities.

5.2 Basis and Technical Premises of the Safety Assessment

A fundamental component of SR 97 is the analysis of five scenarios. The base scenario is based on the performance of the repository as intended, no initial canister defects at the time of repository closure and present-day climate conditions.

Four different types of deviations from the base scenario are analyzed: the canister defect scenario, the earthquake scenario, the climate scenario and the intrusion scenario.

The assumptions used regarding the engineered barriers (canister and bentonite clay) and the rock, which is a natural barrier, are important premises for the analyses presented in SR 97.

SKB's canister defect scenario is based on an example where one of the canisters has an initial defect when it is deposited in the reposi-

tory while the other canisters are assumed to be intact.

Throughout SR 97, it is assumed that the bentonite buffer has no initial defects and that its evolution is similar around all of the canisters in the repository.

Taking into account that research on the engineered barriers is still in progress and that there is a need for feedback to the barrier development work, it is the opinion of the authorities that several types of canister defects in the repository should have been evaluated in SR 97. Similarly, the authorities consider that, in future analyses, SKB should account for the importance of possible defects in the bentonite buffer and in the backfill in tunnels and boreholes.

In SR 97, SKB has used data from three previously investigated sites which each represent geological environments that are common in Sweden: Aberg (Äspö), Beberg (Finnsjön) and Ceberg (Gideå).

Although the availability of data from these three sites varies, it is the opinion of the authorities that the data are sufficient for the purposes of the safety assessment.

5.3 Safety Assessment Methodology

In the authorities' opinion, in SR 97 SKB has shown that it has access to both the necessary knowledge and methods to evaluate the long-term safety of a repository for spent nuclear fuel. In the view of the authorities, the method used in SR 97 is good for SKB's further development work on safety assessment.

SR 97 contains those components that, in SKI's proposed regulations for the final disposal of nuclear waste, must be included in a safety assessment. Nevertheless, the methodology used in SR 97 must be further developed prior to forthcoming licence applications.

Focus of the Safety Assessment

In SR 97, SKB has placed considerable emphasis on the assumption that the engineered barriers will perform as intended.

In the opinion of the authorities, this should also have been the subject of a more in-depth analysis of the uncertainties associated with the engineered barriers and their evolution in the repository, particularly with regard to possible defects in and malfunctions of the canister and buffer as well as the importance of long-term chemical changes in the buffer.

In the authorities' view, it is necessary to evaluate factors that are uncertain and difficult to predict, in order to determine the significance of the rock as a barrier as well as to develop requirements on the design of the engineered barriers.

System Description

SR 97 contains a detailed and thorough examination of the processes that can affect repository performance. The documentation demonstrates that considerable progress has been made. However, SKB should clarify its justification for selecting important data and models and for not dealing with certain unfavourable conditions in the risk analysis.

Scenarios

According to SKI and SSI, the scenarios evaluated in SR 97 include the essential events that can affect the repository's protective capability. However, an adequate analysis of how the impaired function of different barriers can interact with each other is lacking.

SKB has not adequately described the impact that future climate changes can have on the engineered barriers, on the transport of radioactive substances in the rock and ground and the importance of earthquakes on the protective capability of the repository.

A more comprehensive analysis of uncertainties, such as climate evolution alternatives and the possibility of additional defects in the engineered barriers should be conducted in future analyses.

Data and Models

In the opinion of the regulatory authorities, prior to conducting SR 97, SKB developed a comprehensive set of models and data for the needs of the safety assessment. This work can and should be further developed after the review of SR 97 has been completed.

The authorities are favourable to the fact that SKB is attempting to gain knowledge of the complex processes that affect defect canisters in the repository. The models used in SR 97 must now be evaluated and better supported by underlying data prior to future safety assessments. The corrosion analysis for defect-free canisters must be further tested through experiments and other corrosion models. Furthermore, SKB should take the canister weld joints into account in the corrosion analysis.

SKB evaluates a number of examples of human exposure to radioactive substances in various ecosystems. In the opinion of the authorities, SKB should improve its knowledge of how radioactive substances are transported in the groundwater from the rock to the environment close the ground surface. SKB should also take into account the possibility that man can simultaneously receive radiation doses from drinking water wells and other parts of the environment, such as through the consumption of agricultural products.

Measurement of the Protective Capability of the Repository

In the opinion of the authorities, SKB has correctly interpreted the health protection requirements stipulated by SSI in the SSI FS 1998:1 regulations.

However, the assessment of environmental protection (impact on animals and nature) is deficient in SR 97. The authorities are aware that SKB is actively working on this issue. The authorities are expecting SKB to take further initiatives in this area.

SKB states that it did not take into account the dilution of radioactive substances and migration in the biosphere as a safety function, with the explanation that it is difficult to predict the evolution of the biosphere. At the same time, dilution in the biosphere is a deciding factor in the assessment of the consequences of the climate scenario.

In the view of the authorities, SKB should, in consultation with the authorities, define the role of the biosphere prior to future safety assessments.

Risk Analysis and Calculations

In the opinion of the authorities, in its defect canister scenario, SKB has developed a set of calculation cases that describe the interactions of the various barrier functions and illustrate the possible consequences of leakage from a defect canister. At the same time, the uncertainties in the analysis can be handled further.

The analysis of possible risks (the probability and the consequences of certain events occurring) is good but the methodology must be further developed so as to comply with the regulatory requirements.

In the view of the authorities, a specific account of the protective capability of the repository in the short term (0 – 1,000 years after closure), as stipulated in SSI's regulations on the final management of nuclear waste, is lacking.

Expert Judgement

A safety assessment of a repository for spent nuclear fuel will always be associated with uncertainties and deficiencies in knowledge. In the authorities' opinion, SR 97 provides a good review and description of the processes that can affect repository performance. However, at the same time, the authorities recommend that SKB should, to a greater extent and in a documented manner, allow various experts to evaluate the most important data and assumptions before the safety assessment is completed.

5.4 Compliance with Safety and Radiation Protection Requirements

Following their review of SR 97, the authorities have not identified any obstacles that would prevent geological final disposal in accordance with the KBS-3 method from complying with the necessary safety and radiation protection requirements.

Based on their review of SR 97 and previous reviews of SKB's RD&D (Research, Development and Demonstration) programme, it is the opinion of the authorities that the KBS-3 method is a good basis for SKB's forthcoming site investigations and for the further development of the engineered barriers.

However, a detailed body of data from site investigations and more extensive practical experience from the manufacturing and testing of the engineered barriers is necessary before a more detailed evaluation of the KBS-3 method can be conducted.

Furthermore, it is necessary that SKB should supplement and further develop its safety assessment methodology. The recommendations of the authorities from their review of SR 97 should be taken into account in this work.

5.5 SR 97 as a Basis for Site Investigations and Function Requirements

SKI and SSI are of the opinion that SR 97 has provided SKB with a basis for further work on the site investigation and function requirements. However, the authorities find that SR 97 does not contain any in-depth discussion of what the

results of the safety assessment would mean for the site investigation programme and function requirements for the engineered barriers.

Instead, SKB states that the results from SR 97 will be dealt with in separate projects, including the project to develop the site investigation programme, the formulation of requirements and preferences with respect to the rock and the review of functional requirements and design basis requirements for the canister and the other barriers.

Therefore, the authorities intend to return to these issues in connection with the regulatory review of SKB's supplement to RD&D Programme 98 and, at a later stage, in connection with the review of SKB's RD&D Programme 01.

This regulatory review was performed by a project team comprising representatives from the office of nuclear waste management safety and the office of waste and environment at SKI and SSI, respectively. The following individuals were responsible for writing the report (area of responsibility and main area of expertise specified in brackets):

SKI:	
Björn Dverstorp	(Project Manager and Editor; hydrology, safety assessment methodology)
Fritz Kautsky	(climate, earthquakes and tectonics)
Christina Lilja	(canister, corrosion and heat generation)
Bo Strömberg	(spent fuel, geochemistry and radionuclide transport)
Öivind Toverud	(geology and buffer)
Magnus Westerlind	(regulations and the decision-making process)
Stig Wingefors	(regulations and system description)
SSI:	
Mikael Jensen	(SSI's Project Manager; risk criteria, human impact)
Leif Moberg	(biosphere processes and environmental protection)
Anders Wiebert	(scenario and risk analysis)

In addition to the above, several experts at each regulatory authority were consulted by the project team, including Carl-Magnus Larsson, Rodolfo Avila, Synnöve Sundell-Bergman and Åsa Wiklund from SSI and Benny Sundström from SKI.