Nacka District Court
Environmental court
Box 1104
131 26 NACKA

APPLICATION FOR PERMIT UNDER THE ENVIRONMENTAL CODE

Applicant:	The Swedish Nuclear Fuel and Waste Management Company (Svensk Kärnbränslehantering AB), corp. ID no. 556175-2014 Box 250, SE-101 24 Stockholm, Sweden
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Matter:	Application for permit under the Environmental Code (1998:808) for facilities in an integral system for final disposal of spent nuclear fuel and nuclear waste (code 90.460)

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CONTENTS

Contents

PETITIONS

Svensk Kärnbränslehantering AB (SKB) applies for a permit under the Environmental Code for the **existing** and **planned** activity at facilities included in an integrated system for final disposal of spent nuclear fuel and nuclear waste as follows:

A. Central interim storage facility and facility for encapsulation of spent nuclear fuel (Clab/Clink), on the premises of Oskarshamn Simpevarp 1:9 and part of Simpevarp 1:8

A.1 to store nuclear material, consisting mainly of spent nuclear fuel, and used core components, in the existing facility Clab in Oskarshamn.[1]The quantity of spent nuclear fuel present at any one time may not exceed 8,000 tonnes,

A.2 to build at Clab, and operate integrated with Clab, a facility (Clink) for storage of nuclear material and core components according to A.1 and for encapsulation of nuclear material, consisting primarily of spent nuclear fuel, and nuclear waste[2] from the Swedish nuclear power programme. The facility will have a design capacity of about 200 canisters per year,

A.3 and for drainage of Clab/Clink to divert the requisite quantity of groundwater to the Baltic Sea and build the structures needed for this diversion,

all in conformity with what is stated in this application with appendices.

B. Final repository facility/final repository on the premises of Östhammar Forsmark 3:32, 6:5 and 6:20

B.1 to build and operate a facility for final disposal of nuclear material, consisting primarily of spent nuclear fuel, and in addition nuclear waste from the Swedish nuclear power programme, within the defined area in Forsmark in Östhammar Municipality. The nuclear material and the waste are specified in section 1.3 below,

B.2 to infill small water areas for the above-ground parts of the final repository,

B.3 to build a road bridge across the cooling water channel,

B.4 to divert the requisite quantity of water to the Baltic Sea for drainage of the final repository facility and build the structures needed for this diversion,

B.5 as a protective measure for the consequences of drainage according to B.4 above, to re-infiltrate water into the soil and build the structures required for this infiltration,

B.6 to regulate the water level in Tjärnpussen Lake between +3.15 m and +1.80 m, and for this purpose to build a dam in the lake's outlet; and

B.7 to store rock material next to the above-ground parts of the final repository facility pending utilisation of the material,

all in conformity with what is stated in this application with appendices.

[1] In the case of spent nuclear fuel the figure refers to the quantity of uranium, and in the case of MOX fuel also plutonium, in the unirradiated fuel

[2] Construction material in the fuel assemblies

C. <u>Other requests</u>

SKB requests that the environmental court ordain

C.1 that the hazardous activities in additional facilities shall have been commenced not later than ten years after the permit judgement gains legal force,

C.2 for each water activity, that the permitted measures shall be implemented not later than ten years after the permit judgement gains legal force,

C.3 that conditions, procedures for deferred conditions, and authorisations be issued in accordance with SKB's proposals in point 8.3 below, and

C.4 that the environmental impact statement (EIS) prepared for the activity be approved.

COMPETENCE OF THE ENVIRONMENTAL COURT

This application covers the facilities that form part of the integrated system for management and final disposal of spent nuclear fuel from the Swedish nuclear power programme. The facilities in the system consist of the existing Clab facility and a planned encapsulation facility adjacent to Clab, which will be built to form a single integrated facility – Clink, at Oskarshamn Municipality, and a planned final repository facility at Östhammar Municipality.

Under Chap. 20, Sec. 8 of the Environmental Code: "*Cases concerning the conduct of activities at facilities included in an integrated system for management, processing, storage and final disposal of spent nuclear fuel or nuclear waste shall be examined by an environmental court, within whose district one or more of the facilities are situated or are intended to be situated.*"

Since the final repository is planned to be sited at Forsmark, the environmental court in Nacka is competent to examine this application.

PRESENTATION OF SKB'S PERMIT APPLICATION

1. BACKGROUND AND ORIENTATION REGARDING THE MATTER AT HAND

1.1 SKB and the nuclear fuel programme

SKB is owned by the companies that own nuclear power plants in Sweden. SKB's owners are Vattenfall AB, E.ON Kärnkraft Sverige AB, Forsmarks Kraftgrupp AB and OKG Aktiebolag. On their behalf, SKB is responsible for the management and final disposal of the radioactive waste and the spent nuclear fuel from the Swedish reactors in the safe manner required by society.

The energy industry in Sweden has been producing electricity in nuclear power plants for nearly 40 years. Since Barsebäck was shut down, there are three nuclear power plants in operation in Sweden: Forsmark, Oskarshamn and Ringhals. They have altogether ten reactors that produce some 60 TWh per year, which is equivalent to nearly half of Sweden's total electricity production.

The operation of the nuclear power plants produces not only high-level spent nuclear fuel, but also other types of radioactive waste. SKB's task includes taking care of all radioactive waste so that human health and the environment are protected, both now and in the future. This task is vital in achieving the national environmental objective of a safe radiation environment. Today, SKB has a functioning system for taking care of spent nuclear fuel and nuclear waste. Since the mid-1980s there are both a final repository for short-lived radioactive waste (SFR at Forsmark) and a central interim storage facility for spent nuclear fuel (Clab at Simpevarp). Safe transport of the radioactive waste from the nuclear power plants to the storage facilities is included in SKB's system for radioactive waste management. Over long distances, the waste is transported between the facilities by sea.

In the early days of nuclear power in the 1950s, the focus was on developing and building nuclear power reactors, and it was not until the 1970s that the question of management of the radioactive waste came to the fore in the political debate. The result of this political involvement was a statutory requirement passed in 1977 – the Stipulations Act, which stated that the spent fuel should either be reprocessed or emplaced in an "absolutely safe" final repository. In 1984 the Stipulations Act was superseded by the Nuclear Activities Act.

In response to the Stipulations Act, the nuclear power producers assigned their company SKBF (now SKB) the task of working out a general proposal for how to take care of the spent fuel. The first proposals were presented in two reports: KBS-1 in 1977 and KBS-2 in 1978, where KBS stands for Kärnbränslesäkerhet (*translator's remark:* Nuclear Fuel Safety). The proposals in the reports were based on the two alternatives offered by the Stipulations Act: final disposal after reprocessing, and final disposal without reprocessing. The report "*Final storage of spent nuclear fuel – KBS-3"* was presented in May 1983. The concept presented in that report, the present KBS-3 method, has since then been further developed and now has the design described in this application.

1.2 About nuclear fuel

The nuclear power reactors are powered by fuel made from uranium ore, which must be enriched to the right grade for energy extraction. After enrichment, the uranium concentrate is converted to uranium dioxide, which is pressed into cylinders, pellets, and sintered to ceramic form at high temperature. The pellets are then placed in metal tubes and assembled in bundles to form fuel assemblies, which are delivered to the nuclear power plants.

Before the fuel assemblies are used as fuel in a nuclear reactor, they can be handled without extensive radiation protection measures. During operation in a reactor, nuclei of the isotope uranium-235 are split in a fission process with the evolution of large quantities of energy. The energy is used to generate electricity in a steam turbine. After about five years of energy extraction, the fuel is removed from the reactor and is then highly radioactive and very hazardous to man and the environment.

The risks associated with spent nuclear fuel are often described in terms of *radiotoxicity* and *accessibility*. Radiotoxicity describes the harm which the radiation from the radionuclides can cause if people are exposed to it. Accessibility expresses the degree to which a person can be exposed to the fuel in different situations, for example during transport, interim storage or final disposal.

Radiation from radioactive materials is dangerous to living organisms, since it can damage and kill biological cells. In man, short-duration exposure to high radiation doses can lead to death, and if the doses are very high death can be instantaneous. Lower doses can cause cancer or chromosomal damage.

Spent nuclear fuel is being handled in several steps. Whenever the spent nuclear fuel is handled, its accessibility is limited by containment, to prevent the radioactive substances from escaping, and by radiation shielding. Special transport casks are used for shipment, and during interim storage the fuel is stored in water pools in rock caverns 30 metres below the ground surface. The transport casks, as well as the water in the pools, shield off the fuel's ionising radiation.

The radioactivity of the spent nuclear fuel declines with time. After about 30 years the radiation level is about five percent of what it was when the fuel was removed from the reactor. After about 100,000 years the radiotoxicity of the spent nuclear fuel has declined to roughly the same level as that of the natural uranium mineral from which it was made.

1.3 Fuel quantities and types

This application regards the nuclear material, consisting primarily of spent nuclear fuel, which is stored today at Clab. The application also regards the additional spent nuclear fuel and nuclear material from activities in Studsvik and from the operation of the ten nuclear power reactors that have operating licences today. The nuclear waste covered by the application for the final repository mainly consist of the construction material in the fuel assemblies that the nuclear material form part of.

Almost all spent nuclear fuel to be finally disposed of comes from the reactors in Forsmark, Oskarshamn and Ringhals that are in operation and from Barsebäck, which is closed down. The estimate of the quantity of spent nuclear fuel on which the safety report is based assumes that the reactors at Forsmark and Ringhals are operated for 50 years and the reactors in Oskarshamn for 60 years. The total quantity[3] of spent nuclear fuel from the reactors at Barsebäck, Forsmark, Ringhals and Oskarshamn is today estimated to be about 12,000 tonnes.

A small quantity of spent nuclear fuel from Oskarshamn has been reprocessed, and the plutonium resulting from the reprocessing will be used to fabricate MOX fuel (Mixed Oxide Fuel), which will be used in one of the reactors in Oskarshamn. The spent MOX fuel is included in the estimated quantity of spent nuclear fuel. The spent nuclear fuel from the R1 research reactor that was operated at KTH (*translator's remark:* Swedish Royal Institute of Technology) between 1954 and 1970 has been sent for reprocessing, and the plutonium from the reprocessing is included in the MOX fuel to be used in Oskarshamn. A small fraction of the R1 fuel is not suitable for reprocessing but will be finally disposed of together with nuclear material (mainly fuel residues) from activities in Studsvik. The total quantity of nuclear material from Studsvik is about three tonnes.

At an early stage of the Swedish nuclear power programme, some spent nuclear fuel from Barsebäck and Ringhals was reprocessed. In 1986, this fuel was exchanged for spent MOX fuel of German origin, often called "swap MOX". It is being stored in Clab, and the quantity is just over 20 tonnes. This fuel will be finally disposed of.

Between 1963 and 1974, a nuclear reactor was operated in Ågesta south of Stockholm, and there are about 20 tonnes of spent fuel from there to be finally disposed of.

Altogether, SKB is applying for a licence to emplace approximately 12,000 tonnes of spent nuclear fuel in the final repository. To this must be added nuclear waste, mainly in the form of construction material in the fuel assemblies. This nuclear waste is hereinafter referred to collectively as "spent nuclear fuel".

1.4 The purpose of the applied for activity

The purpose of the applied for activity is to finally dispose of the spent nuclear fuel in order to protect human health and the environment from the harmful effects of ionising radiation from the spent nuclear fuel, both now and in the future.

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[3] The weights refer to the quantity of uranium, and for MOX fuel plutonium as well, in the unirradiated nuclear fuel.

The central interim storage facility for the spent nuclear fuel is an important part of the system for management and final disposal. Here the spent nuclear fuel is interim-stored in a safe manner. Radioactivity and heat output decline, facilitating encapsulation and final disposal of the fuel.

The fundamental conditions for the final repository system are that the nuclear fuel from the Swedish reactors shall be finally disposed of within Sweden's borders with the consent of the concerned municipalities. The encapsulation facility and the final repository facility shall be built and operated with a focus on safety, radiation protection and environmental consideration. The final repository system shall be designed so that illicit handling of nuclear fuel is prevented. The post-closure safety of the final repository shall be based on a system of passive barriers and be designed so that the final repository remains safe even without future maintenance or monitoring after closure. The final repository shall be established by the generations that have derived benefit from Swedish nuclear power.

1.5 Statutory requirements

The requirement on final disposal of the nuclear waste from Swedish nuclear power plants is found in the **Nuclear Activities Act** (SFS 1984:3), which also contains provisions regarding all handling of nuclear materials or nuclear waste. Clab, the encapsulation facility and the final repository are nuclear facilities whose construction, operation and ownership require a licence under the Nuclear Activities Act. Licensing is done by the Government, but the matters are prepared by the Swedish Radiation Safety Authority (SSM). As part of the licensing under the Nuclear Activities Act, a determination of conditions is also conducted under the Radiation Protection Act.

Provisions regarding precautions and protective measures for preventing damage or detriment to human health or the environment are found in **The Environmental Code** (SFS 1998:808). Construction and operation of nuclear facilities also require a permit under the Environmental Code. The environmental court examines the permit application, but, as a part of the permit process, the Government decides on permissibility.

Requirements on radiation protection are found in **the Radiation Protection Act** (SFS 1988:220) and in SSM's regulations. They can be regarded as clarifications of the environmental requirements as regards the harmful effects of radiation.

1.6 Reports on SKB's activities to the Government

The KBS-3 method served as a basis for applications in 1983 for permits under the Stipulations Act to put the nuclear power reactors Oskarshamn 3 and Forsmark 3 into operation. In a decision in June 1984 – based on the provisions of the then-new Nuclear Activities Act – the Government observed that the KBS-3 method *"in its entirety has been found essentially acceptable with regard to safety and radiation protection*". The Government therefore decided to grant fuelling permits for the two reactors.

Under Section 12 of the Nuclear Activities Act, the reactor owners shall prepare a programme for the comprehensive research and development work that is needed "*for ensuring the safe management and final disposal of nuclear waste arising in the activities or nuclear material arising therein that is not reused*". The programme shall be prepared every three years, cover a period of six years and be submitted to SSM (previously SKI, the Swedish Nuclear Power Inspectorate). The reactor owners have assigned SKB the task of preparing this programme, called an RD&D programme, where RD&D stands for research, development and demonstration.

As a result of the RD&D process, the Government decided in 1995 that feasibility studies should be conducted on five to ten sites and site investigations on at least two sites.

In all the RD&D programmes presented (1986–2010), SKB has regarded the KBS-3 method as the reference method. The Government has stipulated requirements on that accounts should be provided of alternative methods. In response to the evaluation of alternative methods made by SKB in a supplement to RD&D-Programme 98 (known as RD&D-K), the Government declared in 2001 that SKB should use the KBS-3 method as a planning premise for the site investigations which SKB was then planning, and that SKB should keep track of the technology development regarding alternative methods.

The RD&D programmes presented so far have been reviewed by SSM and circulated to a number of organizations for comment. In parallel with SSM's review, the Swedish National Council for Nuclear Waste has also reviewed SKB's programmes. Based on statements of comment from these reviews, the Government has then decided that the programmes meet the requirements of the Nuclear Activities Act.

1.7 The scope of the licence review

The facilities included in the integrated system for management and disposal of spent nuclear fuel consist of the interim storage facility for spent nuclear fuel (Clab) in Oskarshamn Municipality, built together with a planned facility for encapsulation of the fuel to form an integrated facility (Clink), and a planned facility (*translator's remark:* repository) for final disposal of the encapsulated nuclear fuel. SKB has decided to carry out encapsulation immediately adjacent to Clab and to site the final repository facility at Forsmark in Östhammar Municipality.

This application covers the activities at Clab, Clink and the final repository facility and thereby permits an integrated licence review of the entire activity within the integrated system for final disposal of spent nuclear fuel. SKB has also applied for a licence under the Nuclear Activities Act for construction, operation and ownership of facilities for encapsulation and final disposal of spent nuclear fuel and nuclear waste, which means that the final repository system will be examined simultaneously under both the Environmental Code and the Nuclear Activities Act. The licence review processes are overlapping to some extent; for example, the Environmental Code's general rules of consideration will be applied in licensing under the Nuclear Activities Act. Furthermore, the EIS must be approved in both examination processes.

The application describes the consequential activity, consisting of transporting filled canisters from Clink to the final repository facility. The industrial ports in Simpevarp and Forsmark are not included in the applied for activity. The fabrication of copper canisters precedes the encapsulation process, but the canister factory, where inspection and attachment of the canister bottom is done, is not a nuclear facility and is not described in detail in this application. Mining of copper and iron for canister fabrication or extraction of bentonite clay is not so closely related to the applied for activity as to constitute a consequential activity under Chap. 16, Sec. 7 of the Environmental Code.

A joint EIS has been prepared for the applications under the Environmental Code and the Nuclear Activities Act. It covers the entire final repository system.

1.8 The contents of the application

In addition to this document, the application consists of appendices intended to support the examination of whether the activity is compatible with the general rules of consideration[4] and the other permissibility rules in the Environmental Code. The examination concerns nuclear facilities. The basis for the assessment of the environmental consequences is that the facilities and the activity must satisfy the safety requirements stipulated in the Nuclear Activities Act and the Radiation Protection Act.

[4] The environmental impact statement with sub-appendices and the appendices AH, PV, MV, TB and KP.

Relevant portions of the safety reports for Clink and the final repository facility/final repository are therefore also appended.[5] A safety report shall "*show, as a whole, how the safety of the facility is arranged in order to protect human health and the environment from nuclear accidents*"[6].

The appendices to the application are (abbreviation in parentheses):

- Environmental Impact Statement (EIS)
- Operations and the general rules of consideration (AH)
- Technical description (TB)
- Proposal for inspection programme (KP)
- Right of disposition and list of concerned parties (RS)
- Site selection – siting of the final repository for spent nuclear fuel (PV)
- Choice of method – evaluation of strategies and systems to manage spent nuclear fuel (MV)
- Preliminary Safety Report – Clink (Appendix F)
- Safety report for final disposal of spent nuclear fuel (SR)
- Safety report for operation of the final repository facility for spent nuclear fuel (SR-Operation)
- Long-term safety for the final repository for spent nuclear fuel at Forsmark (SR-Site)

Appendices EIS, AH, TB, KP and RS cover facilities and activities on two sites: Forsmark in Östhammar Municipality and Simpevarp in Oskarshamn Municipality. Appendix F only deals with Clink in Oskarshamn Municipality. Appendices SR, SR-Operation and SR-Site only deal with the final repository facility in Östhammar Municipality. The two appendices PV and MV are broader accounts of the site selection process and the choice of method.

A list of terms is appended to the application. Some documents have also been supplemented with specific lists of terms or glossaries.

2. SAFETY – THE SUPERORDINATE GOAL

2.1 Safety principles

Since the work with the Swedish final repository project commenced in the late 1970s, SKB has established a number of principles for the design of a final repository for spent nuclear fuel. These principles constitute the safety strategy behind the KBS-3 method.

- The final repository will be located deep down in a long-term stable geological environment to isolate the waste from man and the environment. This reduces the risk that the repository will be impacted by possible societal changes or long-term climatic changes.

- The final repository will be located at a site where the host rock can be assumed to be of little economic interest for future generations, reducing the risk of human intrusion.

- The spent nuclear fuel will be surrounded by multiple safety barriers – engineered and natural.

- The primary safety function of the barriers will be to contain the fuel in the canister.

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[5] The appendices SR-Operation, SR-Site and F (for Clink)
[6] SSMFS 2008:1, Chap. 4, Sec. 2

- If the containment should be breached, the secondary safety function of the barriers will be to retard any release from the repository.

- Engineered barriers will consist of naturally occurring materials that are stable in the long-term in the repository environment.

- The repository will be designed so that the radiation from the spent fuel does not have significant detrimental effects on the properties of the engineered barriers or rock.

- The repository will be designed so that high temperatures, which could ultimately have significant dertrimental effects on the properties of the barriers, are avoided.

- The barriers will be passive, i.e. function without human intervention and without active input of materials or energy.

Together with other aspects – such as the premises defined by Sweden's geological environment and the requirement that the final repository's facilities must be technically feasible to build and operate safely – these principles have led to the choice of the KBS-3 method for final disposal of spent nuclear fuel.

2.2 The KBS-3 method

The KBS-3 method can be summarized as follows:

- The spent nuclear fuel is placed in copper canisters with high resistance to corrosion in the repository environment. The approximately five metre long canisters have an insert of nodular iron that increases their stability.

- The canisters are surrounded by a buffer of bentonite clay – a naturally occurring material that swells in water, protects the canister in the event of minor rock movements and shields it from groundwater movements. This limits the amount of corrodants in the groundwater that can reach the canister. The clay also absorbs radioactive substances that can be released if the canisters should be damaged.

- The canisters with surrounding bentonite clay are placed at a depth of about 500 metres in crystalline bedrock with long-term stable conditions.

- If any canister should be damaged, the nuclear fuel and the chemical properties of the radioactive materials, for example their low solubility in water, severely limit the transport of radionuclides from the repository to the ground surface.

Based on these principles, the extensive development work and several safety assessments, a reference design for the final repository facility and the activity has been worked out. The analysis on which the application is based shows that the design and production as it is planned for Forsmark will provide a final repository that meets the requirements on safety and radiation protection.

The KBS-3 method allows for some variation in its implementation. This applies to both the choice of material quality of the barriers and the dimensions and placement of canisters and openings in the rock. The application regards vertical deposition (KBS-3V), which is available technology and satisfies the safety requirements. By vertical deposition, the canisters are emplaced one by one, upright in deposition holes in the floors of rock tunnels. A variant of the KBS-3 method is KBS-3H, where the canisters are placed lying down in a row in horizontal tunnels. The two variants could be possible to combine within the final repository. The development work on horizontal deposition shows that the method is interesting and promising, but not yet sufficiently developed to be available. More research and development is required to determine whether it can be used. Only when and if a safety assessment shows that KBS-3H offers equivalent or improved safety will a switch to horizontal deposition be considered. Work is continuing on development of the technology for horizontal deposition.

3. THE KBS-3 SYSTEM

The KBS-3 system consists of the facilities which SKB plans to build and operate for final disposal of the spent nuclear fuel according to the KBS-3 method. The whole system will consist of the existing interim storage facility for the spent fuel **Clab**, which will be built together with an encapsulation facility to form an integrated facility called **Clink**, **a transportation system** for transportation of the encapsulated fuel and a **final repository facility**.

The facilities that will be built currently have the reference design that is specified in the application documents. The work of developing details regarding the different barriers and the variations in the deposition method will continue at least until deposition can start, which is planned to be in just over a decade. Changes in technology or material quality will, after notification by SKB, be examined in accordance with the rules for approval of the safety report (SSMFS 2008:1 Chap. 4, Sec. 2) and, if necessary, under the Environmental Code.

3.1 Clab – central interim storage facility for spent nuclear fuel

Clab is a nuclear facility that was put into operation in 1985. The facility has been subject to examination under relevant establishment and environmental legislation.

In a decision in October 1978, the Government granted Svensk Kärnbränsleförsörjning AB (now SKB) permission under the Building Act to build a new central storage facility for no more than 3,000 tonnes of spent nuclear fuel etc. in Simpevarp in Oskarshamn Municipality. In July 1979, the National Licensing Board for Environment Protection granted SKB a permit[7] under the Environment Protection Act to build and operate a central storage facility for interim storage of no more than 3,000 tonnes of spent nuclear fuel plus used core components from the nuclear power plants at Forsmark, Simpevarp, Barsebäck and Ringhals.

In August 1998, the Government granted SKB a licence under the Natural Resources Act to increase the storage capacity in Clab to 8,000 tonnes of spent nuclear fuel etc. In October 1998, the National Licensing Board for Environment Protection decided to grant SKB a permit[8] under the Environment Protection Act to extend Clab and to operate the existing and extended storage facility with a combined capacity of 8,000 tonnes of spent nuclear fuel and core components.

In 1998, the Water court in Växjö granted SKB a permit under the Water Act to divert 600 litres of sea water per second for cooling purposes in Clab, and to divert seeping groundwater from Clab's rock caverns to the Baltic Sea.

The aforementioned licences and permits under the Natural Resources Act, the Environment Protection Act and the Water Act are regarded as issued under the Environmental Code. Clab has furthermore been subject to an extensive process of licensing and determination of conditions under the Atomic Energy Act and now the Nuclear Activities Act.

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[7] Decision No. 135/79, 10 July 1979
[8] Decision No. 128/98, 6 October 1998

The industrial port of Simpevarp is located adjacent to the Oskarshamn Nuclear Power Plant. The port is mainly used for reception and shipping of spent nuclear fuel and nuclear waste and is currently operated by SKB. The port activity, and the power increase at the Oskarshamn Nuclear Power Plant (*translator's abbreviation: "***NPP**"), are covered by a permit issued by the environmental court in Växjö and are not included in the licencing review.

3.1.1 Site description

Clab is situated in Oskarshamn Municipality on the Simpevarp Peninsula, about 700 metres west of the Oskarshamn Nuclear Power Plant.

The distance to Oskarshamn is about 30 kilometres. The Simpevarp industrial port, which is designed to handle SKB's and the Oskarshamn Nuclear Power Plant's shipments of heavy goods, is situated south of the Oskarshamn NPP. The ship m/s Sigyn calls at the port regularly with cargoes of spent nuclear fuel and nuclear waste. A road specially built for heavy vehicular traffic leads from the harbour to the the Oskarshamn Nuclear Power Plant and Clab.

The nearby area is sparsely populated. The nearest residential development is about 500 metres southwest of Clab. A more detailed description of the conditions on the site and in the environs is provided in the EIS.

3.1.2 National interests

The Simpevarp Peninsula, most of Ävrö and part of Hålö with the associated water area is an area of national interest for both energy production and final disposal of nuclear waste. The navigation channel outside Simpevarp harbour is of national interest for shipping. The Västervik and Oskarshamn archipelagos are of national interest for nature conservation, and all of the Småland archipelago is of national interest for outdoor activities. Two areas out at sea southeast of Ävrö are of national interest for wind power. The entire coastal and archipelago area is of national interest under the special management provisions for highly developed stretches of coast in Chap. 4, Secs. 2-3, para. 4 of the Environmental Code. The Natura 2000 site of Figeholm is located along county road 743.

3.1.3 The activity in Clab

The spent nuclear fuel is first kept for about one year in water pools at the nuclear power plants. The fuel and spent core components are then shipped from the NPPs to Clab in transport casks that are designed to withstand even severe accidents without consequences for the environment. The shipments go by sea to the Simpevarp industrial port.

In Clab, the spent nuclear fuel is received and stored in pools in rock caverns approximately 30 metres underground. Fuel from nearly 40 years of operation of the Swedish nuclear power plants is stored there. Clab was expanded in the early 2000s with a new facility section that was put into operation in 2008.

The water in the pools is a good radiation shield and also cools the fuel. This makes the fuel visible for inspection, and the radionuclides that are emitted to the pool water can be measured and removed. The water in the pools is cooled by sea water.

There are currently about 5,000 tonnes of spent nuclear fuel from the NPPs in Clab. The future storage quantity will not exceed the licensed quantity. During the period of about 30 years for which the spent nuclear fuel is stored, its radioactivity and heat output decline, which facilitates further handling.

3.2 Clab and encapsulation facility – Clink

After interim storage in Clab, the spent nuclear fuel, in the form of fuel assemblies, will be encapsulated in copper canisters. An encapsulation facility is planned for this purpose, to be built adjacent to Clab. The two facilities will be operated as a single integrated facility, called Clink. Existing functions and systems in Clab will be co-utilised wherever possible. SKB has chosen Simpevarp as the site for the encapsulation facility, since this makes it possible to exploit the personnel's experience of fuel handling at the same time as many of the existing systems and facility parts in Clab can be utilised for the encapsulation facility as well.

3.2.1 Design of the facility

The encapsulation facility will be built on rock and consist of a storage pool blasted out of the rock and two above-ground buildings: a building for the encapsulation process and a terminal building for storage of transport casks. The storage pool is designed to shield off radiation and to withstand a mishap, so that the safety requirements can be satisfied.

The encapsulation facility will contain a transport corridor, work stations, water pools and a handling cell. The facility will be designed for a capacity to fill and seal about 200 canisters per year.

3.2.2 The activity in Clink

Future interim storage will take place in the same way as previously. The spent nuclear fuel is taken up out of the storage pools in the interim storage facility and transferred to the encapsulation facility in storage canisters via water-filled pools that provide continued protection, radiation shielding and cooling of the fuel. The fuel assemblies to be placed in a canister are selected so that their heat output is limited. The selected assemblies are moved to a transfer canister and dried. They are then lifted over to the canister's insert. The empty canisters come to the encapsulation facility already fabricated. Before the canister lid is welded on, the air in the insert is replaced with argon gas to protect the canister from internal corrosion. Finally, the canister's sealing weld is tested by radiographic and/or ultrasonic inspection.

The filled copper canister is transferred mechanically and under radiation shielding between the work stations for welding, testing and machining.

Canister handling is designed so that the outside of the canister is not contaminated with radioactive particles during the process. Before the canister is placed in the transport cask for transport to the industrial port, it is checked in the work station for measurement and cleaning. The transport cask holds one canister.

After quality inspection, the filled canisters are placed in transport casks and transported to the final repository facility.

For a more detailed account of the activities in Clink, see Appendix TB.

3.3 The final repository facility

3.3.1 Siting

In assessing which site fulfils the purpose with minimum damage and detriment to human health and the environment, the focus is on post-closure safety. The properties of the bedrock at the site for the final repository are of crucial importance for the prospects of achieving the repository's objective: long-term safe final disposal of spent nuclear fuel.

SKB’s decision on a site for the final repository is the result of an evaluation process that began in the early 1990s. Gathering the necessary knowledge of the properties of the rock requires comprehensive investigations, including boreholes drilled to repository depth. Test drilling has been done on a large scale at Forsmark in Östhammar Municipality and at Laxemar in Oskarshamn Municipality.

The choice of site was made when the analyses of data from the site investigations had come to the point where it was clear that Forsmark offers better prospects for post-closure safety than Laxemar. The analysis work that remained could not alter this conclusion, which was later confirmed when the analyses were concluded.

The EIS shows that the activity in the final repository facility will not give rise to unacceptable damage and detriment for human health and the environment. This means that the siting at Forsmark satisfies the requirements in Chap. 2, Sec. 6 of the Environmental Code.

A more detailed account of SKB’s efforts to find a suitable site and its reasons for choosing Forsmark is given in Appendix PV.

3.3.2 Site description

The surface parts of the final repository facility will be located in an area of approximately ten hectares on industrial land near the Forsmark Nuclear Power Plant in Östhammar Municipality. The nearby area is sparsely populated, and no one lives within a kilometre of the planned repository’s operations area. There are approximately 700 households within a radius of ten kilometres of the planned final repository, 400 of which are part-time residents.

The nuclear power plant with three reactors owned by Forsmarks Kraftgrupp AB (FKA) is located within the industrial area in Forsmark covered by a detailed development plan. Peripheral activities required for the operation of the NPP are also located here, including a water supply and sewage treatment works, power lines and a surface repository for low-level waste. SKB’s final repository for short-lived radioactive waste, SFR, is also located within the plan area.

There is also an industrial port designed to handle SKB’s and the Forsmark NPP’s shipments of heavy goods. The industrial port is operated by FKA.

The Forsmark area has an unusual wilderness character for Uppland, although parts have been affected by large-scale forestry.

A more detailed description of the conditions on the site and in the environs is provided in the EIS.

3.3.3 National interests

In 2004, with the support of Chap. 3, Sec. 8 of the Environmental Code, SKI decided that the area at Forsmark being considered for all parts of the final repository facility is of national interest for the final disposal of spent nuclear fuel and nuclear waste. A large part of the area is also of national interest for energy production, and part of the area is of national interest for nature conservation. The whole area is of national interest under the special management provisions for highly developed stretches of coast in Chap. 4, Secs. 1 and 4 of the Environmental Code.

3.3.4 The phases of the final repository facility

The time required for construction, operation and closure of the facility is estimated at about 70 years, based on the currently planned operating times of the nuclear power plants. According to the current timetable, the facility will be ready to receive the first canister by the mid-2020s and the last canister about 50 years later. After that the repository will be backfilled and closed, which could take another ten to twenty years.

During this time the final repository facility will undergo three phases:

Construction: No radioactive material is handled during construction. The phase commences when the licences, permit and conditions required to begin construction have been issued. Ground works and construction of certain buildings are done first, then shafts and ramp are excavated to repository level. The central area in the facility and parts of the first deposition area are then excavated at repository level. Systems and equipment for deposition are installed, and the remaining buildings are erected on the ground surface. The rock heap for the excavated rock spoil begins to take shape.

Operation: This phase is divided into two stages: trial operation and routine operation. The deposition rate is progressively increased during trial operation to approach the rate that will prevail during routine operation.

The routine operation phase commences when SSM has approved the updated safety report and granted a licence for routine operation under the Nuclear Activities Act. The activity is the same as during trial operation, but may proceed at a faster pace. The phase is concluded when the last deposition tunnel has been backfilled and plugged.

Deposition of canisters in the repository and build-out of new repository areas will proceed in parallel, both during trial operation and during routine operation. During the gradual build-out of the final repository facility, experience from investigations, analysis and modelling will be utilised to optimise the design and adapt the repository to existing rock conditions.

Closure and decommissioning: This phase commences when all spent nuclear fuel has been deposited and the last deposition tunnel has been backfilled and plugged. Then the other tunnels are sealed, along with shafts and ramp. The handling of buildings and equipment on the ground surface depends on the premises and preferences that exist at that time. This phase is concluded when the facility has been closed and becomes a passive final repository.

3.3.5 The design of the final repository

The facility will be divided into an outer and an inner operations area. The buildings that do not have any contact with the spent nuclear fuel will be located in the *outer* area.[9] Spent nuclear fuel will be handled in the *inner* operations area. This area is a nuclear facility and is therefore subject to the Nuclear Activities Act and the Radiation Protection Act. The area will contain a number of above-ground buildings, as well as the underground part of the facility. Means of access to the repository's underground part are only located in the inner operations area. It is therefore a guarded area subject to special requirements on area protection and entry and exit procedures. In addition to the inner and outer operations area, the surface part includes a rock heap and ventilation stations.

The facility's *underground part* consists of a central area and a repository area with connections to the surface part in the form of shafts for elevators and ventilation and a ramp for vehicle transport. The central area consists of a series of parallel halls with different functions. The halls are interconnected by tunnels that serve as transport pathways in the central area. Transport tunnels lead from the central area to the repository area, where final deposition of the canisters with spent nuclear fuel will take place. Fully built, the repository will occupy a "footprint" area of approximately four square kilometre areas.

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[9] The production plant for buffer plus a number of buildings for operating functions, service, maintenance and personnel.

All areas in the final repository where canisters of spent nuclear fuel are handled are controlled and classified with regard to predicted radiation levels.

In licence petition B.1, SKB has defined the site of the final repository facility as “within the designated area in Forsmark”. This refers to the areas that have been set aside in detailed development plans for the final repository’s facilities. The exact location of the facilities should be determined progressively as they are built out and within the framework of the SSM-approved safety report. The relative flexibility allowed by the petition is not judged to have any influence on the impact area that has been specified for the drainage of the final repository facility.

3.3.6 The activity in the final repository facility

Deposition of canisters

A deposition sequence is initiated when a special vehicle with a canister filled with spent fuel in a transport cask arrives from the industrial port at the final repository facility’s terminal building. Here the load is checked and parked until the time comes to transfer it to the transloading hall.

The canister transport cask is transported from the terminal building down to the transloading hall by a specially built vehicle. There the cask is unloaded and the canister is moved to a deposition machine. In the repository area, the deposition hole is prepared by placing parts of the buffer in position. A radiation shielding hatch is fitted over the hole to shield off radiation from the canister during deposition. The radiation-shielded canister is then transported by the deposition machine from the transloading hall to its deposition tunnel.

The deposition machine is positioned above the deposition hole, the radiation shielding hatch is opened and the canister is lowered into the hole. When the canister has reached the right position, the last bentonite blocks are put in place on top of the canister. The sequence is concluded by covering the hole pending backfilling of the deposition tunnel. The deposition machine is driven back to the transloading hall to prepare for the next deposition sequence. All transport takes place at low speed and is monitored from a control room.

Backfilling of deposition tunnels

The backfill replaces the excavated rock in the deposition tunnels. The upper part of the deposition hole is filled up and the floor is levelled off. Then blocks of bentonite are put in place in the tunnel and the space between the bentonite blocks and the rock is filled with pellets. Temporary installations used during deposition are removed as backfilling progresses. When the deposition tunnel is completely backfilled, it is sealed by casting a concrete plug in its mouth.

Closure and decommissioning

When all spent nuclear fuel has been deposited and SSM granted a licence, closure of the whole underground part is commenced. Installations and building elements are removed and transported up to the ground surface. Closure includes backfilling and plugging of all other underground openings.

How closure is to be done has not been determined in detail, since it lies so far off in the future, but technology is already available for executing closure in a safe and environmentally sound manner.

Possibility of retrieving canisters

If future generations should wish to retrieve the fuel, this would be resource-consuming but not impossible. In Sweden there is no formal requirement that it should be possible to retrieve deposited canisters after closure of the final repository facility. Nor is it the intention of final disposal that deposited canisters should be retrieved.

During the operating phase it may be necessary to retrieve an individual canister from its deposition hole if something unforeseen should occur during deposition, since the deposition process itself is reversible. After a deposition tunnel or the whole repository has been closed and sealed, the work required for retrieval increases considerably.

The post-closure period

The final repository facility is designed so that its safety is not dependent on post-closure monitoring and maintenance. Once the repository has been closed, SKB will have satisfied the requirements of the Nuclear Activities Act on safe final disposal of the spent nuclear fuel. The question of long-term responsibility for the closed repository is being examined in the study (M2008:05) concerning coordinated regulation of nuclear activities and radiation protection.

Preservation of knowledge for the future

Information on the repository must be preserved for the future so that future generations can make well founded decisions and avoid inadvertent intrusion in the final repository. SKB will, in international cooperation, prepare an action plan for long-term preservation of information on the final repository for radioactive waste. The issue of long-term knowledge preservation should be solved no later than by the time of closure of the repository in about 70 years. Then society can decide which type of information it wants to preserve and how. It is SKB's ambition to preserve and administer information in such a manner that society has the option of choosing the alternatives for the future that are then considered suitable.

3.4 Transportation between the facilities in the final repository system

Shipments of spent nuclear fuel from the nuclear power plants in Forsmark and Ringhals to the port of Simpevarp go by sea today. From the industrial port at Simpevarp and from the Oskarshamn Nuclear Power Plant, the fuel is transported by a specially built terminal vehicle to Clab in dry, air-cooled transport casks that provide radiation protection and protection against external damage.

After encapsulation, the copper canisters completely shield off the alpha and beta radiation, but the gamma and neutron radiation is high even outside the canister. This requires the use of transport casks that are approved for transport of encapsulated spent nuclear fuel. Such casks will be available prior to the commissioning of the encapsulation facility and the final repository facility.

The encapsulated fuel will be shipped by sea between the industrial ports at Simpevarp and Forsmark. A specially built terminal vehicle will be used for transporting canisters from Clink to the industrial port in Simpevarp, and from the industrial port in Forsmark to the final repository facility. It will be similar to the vehicle that is used today for the shipments of spent nuclear fuel from the industrial port in Simpevarp to Clab.

4. NUCLEAR SAFETY AND RADIATION PROTECTION

4.1 Clab

Clab is a nuclear facility that has been in operation since 1985. The facility has an approved safety report. Safety at the facility is evaluated continuously and systematically analysed and assessed. Safety-enhancing measures, both technical and organisational, are documented and the results are presented in Clab's annual report. There will be a joint safety programme for the integrated facility, Clink.

4.2 Clink

Clink is a nuclear facility resulting from the integration of the encapsulation facility with Clab. When SKB applied for a licence under the Nuclear Activities Act for construction, operation and ownership of the encapsulation facility in 2006, a preliminary safety report for encapsulation was appended. In October 2009 the application was supplemented with a preliminary safety report for Clink (Appendix F). The report describes how safety, radiation protection, physical protection and safeguards will be arranged for the integrated facility in order to protect human health and the environment from nuclear accidents and mishaps.

4.3 Final repository for spent nuclear fuel

4.3.1 Safety report and safety assessments

The safety report shows how the safety of the nuclear facility is arranged in order to protect human health and the environment from nuclear accidents. It must contain information on facility site, design rules, radioactive substances, radiation protection, facility operation and analysis of operating conditions. A description of the facility and functions must be included, along with references and drawings[10] . For the final repository, the report must also contain information on post-closure safety.[11]

The safety report that is being submitted with this application is a *preparatory* preliminary safety report (Appendix SR). It contains two safety assessments: one presents an assessment of safety during operation (SR-Operation, Chap. 8) while the other concerns the post-closure safety of the repository (SR-Site). Prior to construction of the facility, the safety report will be supplemented to become a preliminary safety report (PSAR), and prior to operation an updated safety report (SAR) will be submitted to the Swedish Radiation Safety Authority.

SR-Operation deals with the operating phase but not the decommissioning phase or the time thereafter. Chapter 8 of the safety assessment describes how events that could occur during operation could affect the safety of the facility. The purpose of the assessment is to verify that the facility satisfies all safety requirements and design premises for possible anticipated events (disturbances) and non-anticipated, improbable events (mishaps). SR-Operation also analyses events during operation which could affect the final repository's barriers if no measures are taken. Several preventive measures are therefore also described, and the reversible process that can be executed so that the requirements on post-closure safety can be met.

The purpose of the **SR-Site** safety assessment is to investigate whether the KBS-3 method can fulfil SSM's risk criterion (see section 4.3.3) at the selected site at Forsmark and to provide input data for further development of the repository's design. SR-Site should also deal with a number of other regulatory requirements. These include the design of a repository with multiple barriers and selection of a site with good characteristics for long-term safety. According to the requirements, the contents of the safety analysis report should include, for example, scenarios and handling of uncertainties. The analysis in SR-Site is based on the reference design of the repository and on the site descriptive model. It describes the rock's geology, rock mechanics, thermal properties, hydrogeology and geochemistry and the transport properties of the radionuclides. It also describes conditions on and near the ground surface.

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[10] Cf. SSMFS 2008:1, Chap. 4, Sec. 2
[11] Cf. 2008 SSMFS 21, Sec. 9

4.3.2 Post-closure safety and radiation protection

Safety is evaluated for a time period of a million years. The primary safety function of the final repository is the containment of the spent nuclear fuel in copper canisters. If a canister should be damaged, the secondary safety function is to retard any releases from the repository so that they do not cause unacceptable consequences.

SSM has issued regulations and general guidelines concerning Safety in connection with the Disposal of Nuclear Material and Nuclear Waste.[12] By “safety” is meant, under the general guidelines, the ability of a final repository to prevent the dispersion of radioactive substances. Under the regulations, this shall be done by a system of engineered and natural barriers which shall contain, prevent or at least retard the dispersion of radioactive substances. The geological formation at the repository site can, under the general guidelines for the regulations, constitute a natural barrier which can both isolate the nuclear waste from the environment on the ground surface and hinder human intrusion. The site and depth of the final repository should be chosen so that the geological formation provides sufficiently stable and favourable conditions to ensure that the final repository barriers perform as intended over a sufficiently long period of time.

The repository system – consisting of the deposited spent nuclear fuel, the barriers, the surrounding rock and the biosphere adjacent to the final repository – will evolve with time. The future state of the system will depend on:

- the initial state,
- internal processes acting in the repository system over time, and
- external processes acting on the system.

The initial state includes the state of the engineered barriers after deposition, for example the thickness of the copper of the deposited canisters, the quantity of buffer material in the deposition holes, or the geometry of the deposition holes. Conditions in the rock at the time of construction are also included in the initial state.

Internal processes include e.g. decay of radioactive material, which causes heating of the fuel, the barriers and the rock. Groundwater movements and chemical processes that affect the barriers and the composition of the groundwater are other examples.

External processes include e.g. the future climate, earthquakes and human actions that can affect the repository.

Calculations of how the repository system will evolve are presented in SR-Site.

4.3.3 The risk criterion

It follows from SSM’s regulations that nuclear accidents shall be prevented by a facility-specific design for each nuclear facility which shall incorporate multiple barriers, as well as a facility-specific defence-in-depth system.[13]

The purpose of safety is to protect human health and the environment against ionising radiation over time. In its regulation SSMFS 2008:37 on final disposal of spent nuclear fuel, SSM has specified a risk criterion stating that the annual risk of harmful effects may not exceed 10^{-6} (one in a million) for a representative individual in the group exposed to the greatest risk. By “harmful effects” is meant

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[12] SSMFS 2008:21
[13] SSMFS 2008:1, Chap. 2, Sec. 1

cancer and hereditary defects. According to SSM, the risk limit is equivalent to a dose limit of about one percent of the natural background radiation (1.4×10^{-2} millisievert per year). SKB has to show that the final repository will fulfil the risk criterion in the long term.

4.3.4 Scenarios

A main scenario that covers the entire analysis period of a million years is being studied for the repository in order to understand its evolution and provide further input for additional scenarios. The goal of the main scenario is to describe a reasonable evolution of the repository. Two different evolutions of the climate are being analysed. In the first case, it is assumed that the external conditions during a glacial cycle in 120,000 years are similar to those that prevailed during the last ice age. After that it is assumed that seven repetitions of the same glacial cycle cover the entire assessment period of a million years. In the second case, it is assumed that the future climate is greatly affected by emissions of greenhouse gases. A number of critical questions pertaining to the safety of the repository are analysed in a series of additional scenarios. Can the buffer freeze or disappear? Can it be transformed in an unfavourable way? Can the canister corrode so that containment is breached or be damaged by pressure from bentonite and groundwater? Can it be damaged by earthquakes?

4.3.5 Handling of uncertainties

Claims and assumptions in the safety assessments must be supported by scientific and technical arguments in order to lend confidence to the calculated results, but all the processes that might affect the final repository during a period of a million years can never be fully described and understood. Therefore, handling of uncertainties plays a central role in a safety assessment. This entails that uncertainties are classified, described and analysed in order to provide a possible picture of the evolution of the final repository.

The analyses in SR-Site lead to conclusions about the fulfilment of requirements in SSM’s regulations. The conclusions are based on the results of the thorough and systematic evaluation of the evolution of the barriers during the next million years that is done in the assessment. This evaluation is in turn based on the results of completed site investigations at Forsmark, a reference design with specified and practically feasible production and inspection methods and the scientific understanding of issues of importance for long-term safety.

Calculations of how the repository system will evolve are presented in SR-Site with appendices. SKB’s safety assessment applies to the reference design described in the application. Detailed solutions may be modified with time, due to new knowledge and improved technology during construction and operation.

4.3.6 Conclusions

The conclusion in the SR-Site safety assessment is that a KBS-3 repository that satisfies the requirements on long-term safety can be built on the selected site in Forsmark.

The scenario analyses show that a canister failure during the first 1,000 years can be ruled out, with the exception of a minimal probability of damage due to earthquakes. The probability of such a canister failure is calculated pessimistically to be one in 40,000. This means that only one canister failure due to earthquakes would occur in a thousand-year period in 40,000 final repositories, each with 6,000 canisters.

During the period up to a million years after closure, canister failure could occur due to either copper corrosion caused by sulphide in the groundwater, if the protective buffer has eroded, or earthquakes. With pessimistic assumptions concerning buffer erosion, copper corrosion and radionuclide transport, the radiological risk from erosion/corrosion is judged to be non-existent for tens of thousands of years after closure, at most a hundredth of the risk limit for a period of 100,000 years, and approximately one-tenth of the risk limit for a million years. The risk caused by canister failure due to earthquakes is less than one-hundredth of the risk limit for a hundred thousand years and less than one-tenth of the risk limit for a million years.

The total risk for a final repository in Forsmark with the described reference design and production and inspection methods is well below SSM's risk criterion, even over a period of a million years.

4.3.7 Safety and radiation protection during operation

As far as the final repository facility is concerned, under no circumstances will free radioactivity from the spent fuel be present in the facility, and therefore not outside the facility either. The reason is that the spent nuclear fuel is enclosed in copper canisters that are free of radioactivity on the surface and leakproof both in normal operation and in the event of incidents or mishaps. This means that there will not be any radiation dose to man or the environment outside the facility due to activities inside the facility.

The expected dose load to personnel, which also includes natural background radiation, is far below the limits prescribed by SSM, even when it is calculated with pessimistic assumptions.

By "physical protection" of nuclear facilities is meant measures to protect the facilities against intrusion, sabotage or other actions that could lead to a radiological accident, as well as to prevent illicit handling of nuclear material or nuclear waste. The design of such measures is regulated by SSM's regulations in SSMFS 2008:12. Information on the physical protection of the facilities is confidential and is only disclosed to SSM.

Spent nuclear fuel contains substances that can be used to manufacture nuclear weapons. Therefore, there are international agreements to prevent and provide safeguards against the diversion of nuclear material and nuclear waste. The Nuclear Activities Act requires that Sweden should fulfil its obligations under these agreements. The Act states that licensees of nuclear facilities are obligated to allow access to their facilities by the authority designated to exercise safeguards, in other words SSM, Euratom and the International Atomic Energy Agency, IAEA. The international control is exercised by Euratom, since the Euratom Treaty applies in Sweden due to the country's membership in the EU.

5. STRATEGIES FOR FINAL DISPOSAL OF SPENT NUCLEAR FUEL

5.1 General

There are two approaches to the management of spent nuclear fuel. One is to regard the nuclear fuel as a resource, the other to regard it as waste.

Utilising the spent nuclear fuel as a resource affects both waste management and nuclear fuel supply. Extracting fissionable materials from the fuel and reusing them in new fuel reduces the need for new uranium and thereby the need for uranium mining. Radioactive waste always remains anyway and must be disposed of. There are then two possible alternatives:

1. Conventional reprocessing and production of MOX, followed by final disposal of vitrified waste and spent MOX fuel

2. Transformation (transmutation) of the waste after reprocessing.

Alternative 1 entails that uranium and plutonium are separated from the spent nuclear fuel (*translator's remark:* partitioning), leaving the other radionuclides as high-level waste. As for Sweden, it is at present not considered economically defensible, or appropriate, to reprocess nuclear fuel in domestic facilities or send spent nuclear fuel abroad for reprocessing. Furthermore, the saving of uranium is moderate: 10–20%, depending on how many times the fuel is reprocessed.

Alternative 2 entails transforming (transmuting) the fuel after reprocessing so that most of the nuclides with half-lives of more than 1,000 years are converted to very short-lived or stable nuclides. This means that new types of reactors and facilities for partitioning need to be developed. Despite heavy research efforts internationally, partitioning and transmutation has not achieved a breakthrough that would permit consideration of the method in the foreseeable future. This alternative also requires final disposal of the waste that is left.

The following strategies have been considered internationally for final disposal of high-level nuclear waste:

1. Final disposal by launching into space.

2. Disposal in inaccessible areas, for example beneath the Antarctic ice sheet or in deep sea sediments.

3. Final disposal of the waste at great depth in the bedrock.

4. Long-term storage of the spent fuel in a monitored repository – possibly pending the further development of other strategic and technical alternatives.

The first two strategies have been dismissed for obvious reasons: they entail unacceptable safety risks and/or violate both the Nuclear Activities Act and international conventions. The fourth strategy entails leaving the disposal of the waste to future generations and is really a variant of the zero alternative described below.

5.2 Methods for final disposal in bedrock

The strategy for nuclear waste management in Sweden has been focused on the third alternative: final disposal at great depth in the bedrock. There is broad agreement among international experts that disposal at great depth in geological formations is the method that is best suited for spent nuclear fuel and other long-lived and high-level waste. This strategy is shared by most countries with a research and development programme for high-level waste or spent nuclear fuel. Over the course of the years, SKB has presented alternative methods for final disposal of spent nuclear fuel in the Swedish bedrock. Besides the chosen KBS-3 method presented above, the following alternatives have been studied but dismissed:

- Long tunnels (VLH) beneath the Baltic Sea: encapsulated fuel is emplaced in a few parallel, roughly five km long tunnels at a depth of 400–700 metres.

- WP-Cave[14]: encapsulated fuel is emplaced densely in a limited rock volume surrounded by a buffer at a depth of 300–500 metres.

- Deep Boreholes: encapsulated fuel is emplaced in very deep boreholes in rock.

[14] After the name of the company that originated the idea

Of these alternatives, Deep Boreholes has been examined in the review of SKB’s RD&D programme. The method entails that the waste is emplaced in holes drilled in the rock at a depth of two to five kilometres. The safety of the Deep Boreholes concept is based on the rock as a barrier and a number of assumptions concerning conditions and groundwater movements at great depths which are very difficult, if at all possible, to verify. These conditions must also be shown to persist during the time spans the final repository has to continue to function. The biggest technical problem is otherwise considered to be the difficulty of getting the canisters into the right position in a controlled manner. The canisters would be subjected to great stresses during deposition, with the risk of getting stuck and breaking apart during their transport down through the rock. It would also be difficult to correct any problems encountered. Any retrieval of the canister would also be very difficult, if at all possible, from deep boreholes. Another difficulty is the fact that the technology for achieving such deep boreholes with the dimensions in question is undeveloped, and that knowledge of the conditions at such great depths is limited. Nor does the Deep Boreholes method meet the requirements of multiple barriers and being based on available, proven or evaluated technology.

Long Tunnels (*translator’s remark:* or Very Long Holes, VLH) was initially considered to be equivalent to a KBS-3 repository in many respects, but is judged to have poorer prospects of meeting the safety requirements in the construction and operating phases, including with regard to occupational safety.

With the WP-Cave method, the fuel will be emplaced densely, which leads to high temperatures. This means that cooling will be required in an initial phase of about 100 years. The concept is also technically complicated.

In the case of both Deep Boreholes and WP-Cave, extensive technology and knowledge development is required to demonstrate that the fundamental requirements on radiation protection and safety can be met.

SKB has chosen the KBS-3 method. Appendix MV provides a more detailed description and evaluation of the strategies and methods studied by SKB and the reasons for SKB’s choice.

5.3 The zero alternative

If final disposal of the spent nuclear fuel does not come about, the remaining option is to continue storing it like today, under monitored forms. This can be done either in Clab, where the fuel is stored today, or in the fuel pools at the nuclear power plants, where it is stored awaiting interim storage in Clab. The zero alternative would require an expansion of Clab, and/or of the fuel pools at the nuclear power plants, with a considerably increased storage period. Another possibility would be dry storage, which entails that the fuel is encapsulated in large steel cylinders and cooled by air instead of water, as in Clab. Prolonged monitored storage is not final disposal and therefore does not satisfy the requirements laid down the legislation on the nuclear power producers.

The zero alternative is described in greater detail in Appendix EIS.

6. THE WATER OPERATIONS IN PARTICULAR

The activities at Clink and the final repository facility involve measures in water. This is described in greater detail in the EIS. Information on right of disposition is provided in Appendix RS.

6.1 Water operations at Clink

As stated in section 3.1 above, a permit has been granted under the Environmental Code to utilise 600 litres per second for cooling purposes of Clab's pools, and to divert seeping groundwater from Clab's rock caverns to the Baltic Sea. The cooling water system will be modified to include the additional pool in the encapsulation facility. The current rate of withdrawal of sea water averages about 200 litres per second. The marginal increase in withdrawal rate due to the encapsulation facility is covered by the existing permit.

The groundwater that seeps into excavation pits and rock caverns during construction and operation of the encapsulation facility will have to be diverted and discharged into the Baltic Sea. This water operation is covered by this licence review. Water operations will be conducted on SKB's own property Oskarshamn Simpevarp 1:9 and on a part of Simpevarp 1:8, which SKB has acquired. The impact area will be very limited. No damage can be foreseen as a result of the water operations.

6.2 Water operations at the final repository facility

Establishment of the final repository's operations area and operation of the final repository facility involve a number of water operations.

During establishment of the operations area, a few small water areas will be infilled. There is plant and animal life worthy of protection in some of these, for example the pool frog. As a protective measure, SKB plans to move the pool frog to newly created water areas with a surface area equivalent to the surface area that will be lost due to infilling. SKB has applied to the County Administrative Board in Uppsala County for an exemption from the Species Protection Ordinance.

In conjunction with the establishment of the activity in Forsmark, a new road bridge is planned across the cooling water channel, which involves work in water for abutments and intermediate piers.

The groundwater that seeps into excavation pits and rock caverns during construction and operation of the final repository facility will have to be diverted and discharged into the Baltic Sea. The size of this seepage will depend on the depth and geometry of the facility, the permeability of the rock and the sealing measures undertaken during construction. The impact area is limited to no more than ten properties, three of which are owned by SKB. The number of concerned parties with respect to the water operations, including the holders of different rights in the area, is roughly ten. See Appendix RS.

In order to avoid the consequences of a groundwater lowering that could affect natural values, water may have to be infiltrated. SKB judges that no other damage will occur as a result of groundwater lowering.

Within the scope of the future handling of storm water and process water, an existing lake (Tjärnpussen) will be used for nitrogen removal. In order to adapt the treatment process to future flows and seasons, the lake's outlet will be regulated.

The water operations will be conducted on SKB's own properties Östhammar Forsmark 3:32 and 6:20 and on a property where SKB has an easement for the operations in question (Forsmark 6:5).

7. NON-RADIOLOGICAL ENVIRONMENTAL IMPACT AND ENVIRONMENTAL CONSEQUENCES

7.1 Clink

The **land areas** that will be used temporarily will be restored as far as possible into natural areas after the work is finished. The use of the land during construction and operation is judged to entail insignificant consequences for the natural and cultural environments.

The impact on **the groundwater level** that exists today around Clab will change only marginally during the construction and operation of the encapsulation facility. After dismantling of Clink, the groundwater table will be restored close to its original level.

During the construction phase, as well as during the dismantling phase, transport activities, use of heavy equipment, rock drilling, blasting and excavation will cause **noise and vibration**. As for the rock works, the caution required due to the closeness to Clab's two rock caverns will be used. During the operating phase, ventilation fans will be the dominant noise source. Noise suppression measures are planned to meet applicable guideline values, and calculations show that the levels at surrounding housing will be below these limits.

The two most important sources of **atmospheric emissions** are related to the civil engineering works and the sea shipments of fuel-filled canisters to the final repository facility. There are great uncertainties in the calculations of atmospheric emissions, since the activities will be of such long duration. The emissions are not judged to entail any risk that relevant environmental quality standards will be exceeded.

During the construction of Clink, **discharges to water** will occur. These discharges will consist of drainage water, storm water and waste water. The drainage water from the construction activity will be treated and diverted to the existing storm water system for Clab, with outlet in the nearby bay Herrgloet. The storm water will be allowed to run off and infiltrate into the ground. The waste water will be diverted to the Oskarshamn Nuclear Power Plant's treatment plant before being discharged into Hamnefjärden. During the operating phase, the storm water will be managed according to the principle of local management of storm water.

Light pollution from construction sites can impact the surrounding environment. The nearest residence is located about 500 metres from the work site and will probably not be affected by the light. Both Clab's and the Oskarshamn Nuclear Power Plant's activity sites are illuminated today.

Waste will be generated during the construction phase, consisting mainly of building waste. The quantity is not expected to exceed one percent of the quantity of material supplied for the building.

Energy use associated with transportation and operation of heavy equipment has been calculated to be about 6,600 MWh for the entire construction phase. Total annual energy consumption for Clink during the operating phase in the encapsulation facility has been estimated to be 21,000 MWh per year. The cooling water from the interim storage pools can be used to heat the facility.

Total annual **water consumption** for Clink is estimated at about 16,000 cubic metres. Average annual water consumption (process water and deionised water for the pools) at Clab amounts to about 14,500 cubic metres. Raw water will be taken from Götemaren Lake and treated in the nuclear power plant's treatment plant.

7.2 The final repository facility

Land use mainly involves infilling of ponds in the area. The new above-ground parts and a parking lot with a new road to the facility will be built. Some of the existing housing consisting of barracks for temporary accommodation will be torn down to make room for the rock heap, covering approximately 40,000 square metres. A new road bridge is planned across the cooling water channel. One or more ventilation stations will be built to ventilate the repository's underground part.

Groundwater will seep into the facility as long as any part is kept open. The seeping water will be collected and pumped up to the ground surface for further handling. Extensive model analyses have been done to calculate the changes in groundwater head in the rock and the lowering of the groundwater table (drawdown) in the area. The results are reported in the EIS.

The **noise impact** of the activity is reported for the different phases of the project. Besides blasting, rock crushing is the work that will cause the most noise. No housing is expected to be exposed to noise levels above the Swedish Environmental Protection Agency's guideline values for noise. The increase in the noise levels due to the planned activity will be marginal. Most of the transport activities will take place during the daytime. The blasting work will give rise to **vibrations**, but the distances to objects in the affected area are great. FKA and SKB have, after completed studies, agreed on a maximum permitted vibration level for the nuclear power plant.

The **atmospheric emissions** caused by the facility, during both construction and operation, stem primarily from construction and transport activities. Calculations show that SKB's activity will contribute only a small portion of the nitrogen deposition in the surrounding area: less than 0.00001 gram per square metre and year, which is less than 0.002 percent of the background level.

The facility's **discharges to water** will be of several kinds. *Waste water* will be diverted to FKA's treatment plant for treatment. *Drainage water* will pass through sedimentation basins before being discharged into Söderviken. *Leachate* from the rock heap will be treated to remove nitrogen from the explosive. A flooding area will therefore be created next to the rock heap. In order to permit denitrification during the warm part of the year, Tjärnpussen will be regulated to store water during the winter. *Storm water* will be treated locally within the operations area so that no contaminants are discharged to receiving waters.

A variety of products are used during construction and operation that give rise to **waste**. It is estimated that approximately 50 tonnes of hazardous waste and about 1,100 tonnes of other waste will arise during the construction phase. During the operating phase, the waste quantity produced remains relatively constant over time and is estimated at five tonnes per year for hazardous waste and 120 tonnes per year for other waste.

To reduce **energy use**, heat recovery from the facility's exhaust air and from the drainage water is planned. Ventilation can be regulated as needed. A total of 60 gigawatt-hours (GWh) of electricity is projected to be used during the construction phase. In addition, about 600 cubic metres of diesel fuel will be used by vehicles and heavy equipment.Total electricity consumption during the operating phase is estimated at about 1,080 GWh. Total diesel consumption has been estimated at 5,400 cubic metres.

In order to avoid **light pollution** from the construction work, the lighting can be aimed and screened.

It is estimated that a total of about 1.6 million tonnes of **rock spoil** will arise during the construction phase. Rock excavation will continue during the operating phase, and the total amount of rock spoil is estimated at about 5.4 million tonnes. Most will be surplus rock for which a market can be found. A smaller fraction of the rock, about 10%, can be used as fill within the operations area.

8. CONDITIONS AND PROTECTIVE MEASURES

8.1 Discussion of conditions

8.1.1 Nuclear safety and radiation protection

In the case of Clab, experience has shown that the limit values of the Radiation Protection Act and associated regulations will be met and that the activity will not have any significant radiological impact. In the case of Clink and the final repository facility/final repository, the environmental impact statement and the safety analysis report for each facility show that limit values will be met.[15] The total dose contribution from radionuclide releases to air and water from Clink is expected to be virtually negligible in relation to the applicable limit value. The final repository facility does not give any radiation doses to man or the environment during operation. The total risk for a final repository in Forsmark after closure lies well below SSM's risk criterion, even over a million years, and SKB's conclusion is thereby that a long-term safe KBS-3 repository can be built in Forsmark.

Regarding the issues of nuclear safety and ionising radiation, the premises for the licence examination under the Nuclear Activities Act and permit examination under the Environmental Code are different. The examination under the Nuclear Activities Act, for example, includes occupational safety conditions within the examined facility. The preliminary examination under the Nuclear Activities Act will also be followed up by recurrent examinations of the facility's safety report. The legal force (*translator's remark:* res iudicata) of a licence under the Nuclear Activities Act is more limited than that of a permit under the Environmental Code, and SSM can, independently of the Environmental Code permit, prescribe new licence conditions when nuclear safety requires it. SSM can also issue new regulations that are also applicable to licensed nuclear facilities.

In the case of environmentally hazardous activities, the conditions for the permit are determined with the aim that the environmental impact should be acceptable with respect to human health and the environment. Via the conditions, the environmental court specifies the contents of the general rules of consideration in Chap. 2 of the Environmental Code. As far as impact on the environment is concerned, the environmental court can issue conditions for ionising radiation as well.

The examination under the Environmental Code is a preliminary examination for activities that in this case will be of very long duration and does not include all radiation protection aspects. Since SSM as a regulatory authority continuously oversees radiation protection during the various phases of the activities, SKB deems that it would entail difficulties if nuclear safety and radiation protection were also regulated by detailed conditions under the Environmental Code. This application therefore does not contain any proposals for specific conditions in this respect.

Support can be found for this point of view from the Superior Environmental Court's opinion in its examination of expanded activity at the nuclear power plant in Ringhals (MÖD 2006:70). The court noted that an examination of radiation protection and nuclear safety under the Environmental Code should take place at a more general level.

8.1.2 Vibration and subsidence during construction

A constructability analysis shows that the thickness of the rock between the existing storage pools in Clab, the planned channel tunnel and the encapsulation building's planned pool section is sufficient. The rock blasting that is necessary for the encapsulation facility can be carried out without affecting safety in Clab. The analysis of the impact of the blasts on the existing facility shows vibration levels well below the recommended limit values. Vibration that can occur during construction and operation

[15] See Clink PSAR, Appendix F Chaps. 7, 8, SR-Operation Chaps. 7, 8 and SR-Site Chap. 15

of the final repository is dealt with in collaboration between SKB and FKA, which owns the nuclear power plant, see also section 7.2.

8.2 Damage-prevention measures and compensatory measures

The diversion of seepage water that is done at Clink and the final repository is a prerequisite for operation of these facilities. As is evident from the EIS, groundwater diversion is not expected to lead to any damage or detriment for private interests. In order to prevent any adverse impact on natural values due to groundwater lowering, water may be infiltrated. Since the impact area harbours high natural values, for example wetlands with protected species, SKB will perform an infiltration test on a limited scale. The purpose of the test is to have knowledge of how such a protective measure should be done in practical terms, already when the underground works are commenced.

The infilling of a few small water areas in Forsmark is done to achieve rational operation of the final repository facility. Infilling entails that an important habitat for the pool frog, protected under the Species Protection Ordinance, will be lost. This loss is compensated for by the creation of new water areas.

The road bridge is planned so that shipments of e.g. spent nuclear fuel from the industrial port to the final repository facility can be carried out separately from shipments to and from the Forsmark Nuclear Power Plant, which is an important traffic safety measure.

8.3 Proposed conditions

SKB proposes that the following final conditions be prescribed for the applied for permit:

General

Unless otherwise stated in the conditions set forth below, the activities – including measures to reduce water and air pollution, waste and other disturbances to the environs – shall be conducted in essential compliance with what SKB has stated or undertaken in the case.

Noise

Noise from the activities may not give rise to a higher equivalent sound level outdoors at residences than

Daytime (07.00–18.00 hrs)	50 dBA
Nighttime (22.00–07.00 hrs)	40 dBA
Other hours	45 dBA

During the period of construction of the encapsulation facility, as well as during the period of construction of the final repository facility until deposition commences, noise from the activities shall be limited in accordance with what is stipulated in the Swedish Environmental Protection Agency’s general guidelines for construction sites.

The noise condition will be monitored by performing calculations or near-field measurements in combination with calculations.

Waste

Chemical products and hazardous waste shall be stored so that spillage and leakage cannot contaminate the environs.

Inspection

There shall be inspection programmes for the activities for assessment of compliance with the conditions. The inspection programmes shall stipulate measurement methods, measurement frequency and evaluation methods.

9. PERMISSIBILITY

There are a number of circumstances that make this examination different from an ordinary preliminary examination under the Environmental Code. The application covers activities at geographically separated locations. The Riksdag has already clarified via legislation the need for the applied- for activity by prescribing in the Nuclear Activities Act that spent nuclear fuel that is not reused shall be finally disposed of. The activities are in part subject to overlapping examination under different laws, and the intention of the legislator is that the examinations should be coordinated. Examination under the Nuclear Activities Act also entails that the provisions of the Radiation Protection Act should be applied. Under the Nuclear Activities Act, the examination is limited to the nuclear activities in the facilities, while the examination under the Environmental Code is much broader.

The Government, which examines licensing under the Nuclear Activities Act and permissibility under the Environmental Code, has, via its recurrent decisions regarding the RD&D programmes, given SKB valuable directions for the research and development activities, which influences the supporting material for application.

This section begins with a general account of how SKB, after consultation with SSM, considers that the examinations should be handled in relation to one another. This is followed by SKB’s argumentation in the permissibility matters pursuant to the Environmental Code.

9.1 The applications under the Nuclear Activities Act

Clink

In November 2006, SKB applied for a licence under the Nuclear Activities Act for construction, ownership and operation of an encapsulation facility situated at Clab. After an initial review, then-SKI requested that the application be supplemented with an integrated account of the co-siting of the facility with the existing Clab and with a preliminary safety report for the integrated facility, Clink.

The application was supplemented with the requested documents in October 2009. Clab and the encapsulation facility will be operated integrated as one nuclear facility, Clink. Supporting material showing that the facility satisfies the requirements laid down in the Nuclear Activities Act and the Radiation Protection Act, with ordinances and regulations, was appended to the aforementioned application. In conjunction with the submission of this permit application, the application under the Nuclear Activities Act for Clink will be supplemented with an appendix, common for all applications, concerning the general rules of consideration and an EIS common for all applications.

The final repository facility/the final repository

In conjunction with the submission of this permit application, SKB will also apply for a licence under the Nuclear Activities Act for construction, operation and ownership of the final repository facility, that will become a final repository after closure.

SSM will thus deal with two applications: one for Clink and one for the final repository facility. The applications will be sent to a number of regulatory authorities, concerned municipalities and county administrative boards for them to submit statements of opinion. SSM has announced plans for an external review of SKB's report on post-closure safety in the final repository (SR-Site) by international experts. When SSM's reviews are concluded, the matters will be submitted to the Government with SSM's own review statement.

9.2 Application under the Environmental Code

This application, which is being submitted at the same time as the application under the Nuclear Activities Act for the final repository facility, concerns a permit under the Environmental Code for the facilities and activities that require a permit and that are included in the planned system for final disposal of spent nuclear fuel. The application also includes the activity in the existing Clab.

The Government will thus decide on the following questions:

1) licence under the Nuclear Activities Act for Clink
2) licence under the Nuclear Activities Act for the final repository facility
3) permissibility under the Environmental Code for the facilities in the final repository system

Under the provisions of the Environmental Code, the Government may not grant permissibility for Clink or the final repository facility without the municipal councils in the concerned municipalities having approved the application, except under certain specified circumstances.

According to the travaux préparatoires for the Code, licensing under the Nuclear Activities Act and examination of permissibility under the Environmental Code should be coordinated. Both the environmental court and the concerned municipal council should have access to SSM's review statement before they make their decisions and submit their review statements to the Government. The Government's final preparation and decisions under the two laws should also be coordinated (Gov. Bill 1997/98:90).

When the Government has declared the applied for activity permissible, the case is sent back to the environmental court for issuance of a permit with conditions.

9.3 Continued licensing under the Nuclear Activities Act

The continued licensing procedure under the Nuclear Activities Act after the Government has issued permission and SSM has prescribed licence conditions under the Nuclear Activities Act and the Radiation Protection Act is described in brief below.

9.3.1 Application for transport licence and approval of canister transport cask

SKB will apply to SSM for a licence to transport canisters of spent nuclear fuel in a manner similar to that in which spent fuel transports takes place today. The transport casks required for the encapsulated nuclear fuel will undergo extensive testing before they are approved (licensed), and this will be done before SKB applies for the necessary transport licences.

9.3.2 Approval before construction, trial operation and routine operation

Before the nuclear facilities may be built, and before any major rebuilds or alterations of an existing facility may be carried out, a preliminary safety report (PSAR) must be compiled and submitted to SSM for approval.

Trial operation entails that nuclear material is brought into the facility in question and handled there. Before trial operation may commence, the preliminary safety report must be updated to a safety report (SAR) so that it reflects the built facility. SKB will submit applications for permission to commence trial operation to SSM when systems and processes work as intended.

After trial operation, before a facility may be put into routine operation, the safety report (SAR) must be supplemented taking into account experience gained from trial operation.

Both the preliminary safety report and the updated and supplemented safety report shall at every stage be safety-reviewed under specific provisions[16]and be examined and approved by SSM.

Under the Nuclear Activities Act, a recurrent overall assessment of nuclear safety and radiation protection is required at least every ten years, entailing a periodic examination of the activity.

9.3.3 Applications for decommissioning and dismantling

In the case of Clink, the facility's decommissioning plan must be supplemented and incorporated in the safety analysis report before dismantling and demolition of the facility may begin.

When all spent nuclear fuel has been deposited in the final repository facility, it will be closed. In the case of the final repository facility, a final safety report must be approved by SSM before closure may begin.[17]

9.4 Permissibility under Chap. 2 of the Environmental Code – Operations and the general rules of consideration

How SKB satisfies the general rules of consideration in Chap. 2 of the Environmental Code, which will also be applied in the licensing under the Nuclear Activities Act, is described in greater detail in Appendix AH. A summary of the most important parts is provided below. It should be noted initially that SSM has issued a large number of regulations under the Nuclear Activities Act and the Radiation Protection Act which define the requirement level when it comes to safety and radiation protection according to the general rules of consideration. Compliance with these regulations therefore entails compliance with the general rules of consideration with regard to the issue dealt with in the regulation.

The knowledge requirement

The principles of nuclear safety and radiation protection have guided the choice of technology and design of the facilities and the activity that is the subject of this application. SKB has complied with the requirement in SSMFS 2008:1 that available, proven or evaluated technology shall be used. SKB has therefore built the Canister Laboratory to develop and demonstrate the copper canisters that will contain the spent nuclear fuel. Technology and methods for the buffer that will protect the canisters are being developed in the Bentonite Laboratory. SKB is conducting full-scale research and development of deposition at the Äspö Hard Rock Laboratory in preparation for the construction and operation of the final repository facility.

The precautionary principle and the principle of best available technology

The special laws on nuclear safety and radiation protection contain detailed nuclear safety and radiation protection requirements governing the design and operation of the nuclear facilities.

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[16] SSMFS 2008:1, Chap. 4
[17] See SSMFS 2008:21

Technology and methods for storage, encapsulation and final disposal are described in Appendix TB.

Spent nuclear fuel has been managed and stored in pools of desalinated water that cools the fuel and shields its radiation at Clab for more than 20 years, with good results. The same technology is also used in the nuclear power plants and complies with the principle of tried and tested technology in SSMFS 2008:1. The spent fuel will be transferred from Clab to the encapsulation facility in storage canisters via water-filled pools. SKB has developed technology for sealing and non-destructive testing of canisters and tested it on a full scale in the Canister Laboratory. The method for transferring the canisters has also been tried out and evaluated there.

A fundamental requirement on a final repository is that it must be based on a system of passive barriers. Together, these barriers must contain, prevent and retard the escape of radioactive substances. SKB has developed the KBS-3 method because it enables the spent fuel to be kept isolated from the biosphere in an effective manner for such long periods of time that SSM’s requirements on safety and radiation protection are met. Releases of radionuclides can only occur if the copper canisters are breached. The safety assessment (appendices SR-Operation and SR-Site) shows that the probability of canister breaches is non-existent during operation and very small after closure of the repository, in a million-year perspective.

The safety assessment also confirms that the design of the copper canister with a nodular iron insert is the best available technology. Erosion of the buffer after a long time cannot be ruled out under certain conditions, but the safety analysis report shows that the radiological risk resulting from this is very small.

Every facility in the final repository system is optimised with respect to safety and radiation protection. Since the facilities are dependent on each other for the whole system to work, the interaction between the facilities is also adapted so that the whole system will satisfy the requirements on nuclear safety and radiation protection.

The site selection principle

The choice of the site for the final repository is the result of 30 years of investigations. To find the most suitable site, SKB has conducted regional general siting studies, local feasibility studies and site investigations on selected sites. (See also Chap. 3 for a summary account of site selection).

A thorough presentation of the siting process is provided in Appendix PV.

The planned facilities and activities are compatible with the relevant detailed development plans and the activities are not expected to entail non-compliance with any relevant environmental quality standard.

9.5 Permissibility under the management provisions in Chaps. 3 and 4 of the Environmental Code

It is above all the municipalities that have to make overall assessments of what, from a general viewpoint, constitutes appropriate use of the land and water within the municipality. The municipality’s assessments should be based on the management provisions in Chaps. 3 and 4 of the Environmental Code and be expressed in a detailed development plan, area regulation or comprehensive plan in accordance with the Planning and Building Act. When a detailed development plan exists and the plan has gained legal force, the use of the land is decided.[18]

[18] Cf. Gov. Bill 1985/86:3 page 154

Detailed development plans exist for the Oskarshamn Nuclear Power Plant's activity area, the Äspö HRL, OKG, Clab and other activities. The most recently adopted detailed development plan for Clab etc. permits the construction of an encapsulation facility. The detailed development plan has gained legal force.

The detailed development plan in force for the Forsmark NPP covers a relatively large land and water area. Amendments were made in the plan in 2008 to enable a final repository to be built under parts of the plan area. At the same time, a new detailed development plan that permits surface and underground facilities for the final repository was adopted. The detailed development plans have gained legal force.

It can thereby be concluded that the management provisions in Chaps. 3 and 4 of the Environmental Code do not constitute an obstacle to the applied- for activity. It can be noted that the two applied- for sites lie within areas designated as being of national interest for final disposal of nuclear waste.

9.6 Protection of areas under Chap. 7 of the Environmental Code

Neither the activity area for Clink nor that for the final repository are covered by shore protection or any other area protection under Chap. 7 of the Environmental Code.

9.7 Protection of species under Chap. 8 of the Environmental Code

As stated above, the establishment of the operations area in Forsmark entails that a few small water areas will be infilled, which means that the pool frog, which is protected under Chap. 8 of the Environmental Code, is affected. Furthermore, groundwater lowering due to the final repository facility can lead to consequences for protected species within the impact area. SKB will implement preventive measures and compensatory measures (see section 8.2). These measures are described in greater detail in the EIS. The question of exemption under the species protection provisions is dealt with by the County Administrative Board in Uppsala County.

9.8 Permissibility under Chap. 11 of the Environmental Code

9.8.1 Socio-economic permissibility

Permits exist for the water operations at the existing Clab, and the question of socio-economic permissibility is thereby already decided. The additional water operation consists of draining the additional groundwater that seeps in during construction and operation of the encapsulation facility. Drainage is a prerequisite for operation of Clink. The costs of the water structures that are needed for drainage can be estimated at SEK 0.5 million. The benefit of keeping the facility free of seeping groundwater is great. As is evident from the EIS, drainage is not expected to lead to any damage or detriment for third parties or the environment.

The water operations for the final repository facility involve infilling of small water areas, construction of a road bridge, drainage of underground parts and construction of a dam for regulation of Tjärnpussen Lake. The purpose of these water operations is to permit operation of the final repository facility, whose siting is determined on the basis of such factors as nuclear safety and radiation protection. The benefit of the water operations is therefore great.

The road bridge is being built so that shipments of e.g. spent nuclear fuel to the final repository facility can be carried out separately from shipments to and from the Forsmark Nuclear Power Plant, which is an important traffic safety measure. The dam in Tjärnpussen permits treatment of storm water from parts of the activity area and leachate from the rock heap.

The costs of the works in water and the water structures can be estimated at about SEK 150 million. The water operations with the measures described are not expected to cause any damage or detriment for third parties or the environment. In SKB's opinion, the socio-economic benefit obviously outweighs other considerations.

9.9 Permissibility under Chap. 16 of the Environmental Code

9.9.1 Time limit under Chap. 16, Sec. 2 of the Environmental Code

The reasons that, according to the travaux préparatoires, justify a time limit for the permit are not relevant in view of the ongoing re-examination of the nuclear activities that takes place under the Nuclear Activities Act.

9.9.2 Financial security in accordance with Chap. 16, Sec. 3 of the Environmental Code

Chap. 16, Sec. 3 of the Environmental Code states that the party that is liable for paying a fee or pledging a guarantee under the Act (2006:647) on Financial Measures for the Management of Residual Products from Nuclear Activities (the Financing Act) does not have to pledge a guarantee for measures covered by such fees and guarantees.

The Swedish nuclear power companies are subject to the Financing Act and therefore pay fees to the state Nuclear Waste Fund in accordance with the Financing Act. SKB's owners finance the activities for which SKB is now applying for permits and licences with money taken from the Nuclear Waste Fund, and therefore, there is no need to pledge a special guarantee according to the Environmental Code.

9.9.3 Consequential activities under Chap. 16, Sec. 7 of the Environmental Code

Under Chap. 16, Sec. 7 of the Environmental Code, the activities shall be examined with a view to consequential activities that are necessary in order for the applied for activity to be pursued in an efficient manner. However, the scope of the examination must be limited so that only consequential undertakings with an immediate connection to the applied for activity are considered. The scope of the EIS has therefore been limited to including consequential activities in the form of transport to and from the facilities in question.

9.9.4 Compensatory measures etc. under Chap. 16, Sec. 9 of the Environmental Code

See section 8.2.

9.10 Summary of permissibility

It is evident from the EIS and the facilities' preliminary safety reports that SKB will be able to build and operate the facilities in question in a way that is safe and that entails that man and the environment are protected from the harmful effects of ionising radiation.

The application and the EIS also show that the activities in the facilities will not give rise to unacceptable damage and detriment for human health and the environment. The overall environmental consequences of the activity will be limited by the damage-prevention and damage-mitigating measures which SKB has undertaken to implement.

SKB has thereby shown that the applied for activity is permissible under the Environmental Code.

10. CONSULTATIONS

10.1.1 Consultations under the Environmental Code

SKB has conducted extensive consultations in accordance with Chap. 6 of the Environmental Code. The views expressed in the consultations have been taken into account in the preparation of this application with appendices. Further information on the consultations is provided in the EIS and in the the consultation report included as an appendix to the EIS.

10.1.2 Consultations under the Espoo Convention

SKB has also carried out, via the Swedish Environmental Protection Agency, the first part of the written consultations with the countries around the Baltic Sea concerning possible transboundary environmental impact, in accordance with the Espoo Convention. When SKB's applications have been submitted, a second and concluding portion of the consultations will be carried out with relevant parts of the application documents, with e.g. safety reports and the EIS as supporting documents.

11. MONITORING OF ENVIRONMENTAL IMPACT

A proposal for a monitoring programme for the activity at Clink and the final repository facility is provided as an appendix (KP) to this application. There, it is described how environmental monitoring for non-radiological environmental impact will take place.

12. MISCELLANEOUS

12.1.1 Basis for examination fee

The costs for the work in water and the planned water structures exceed SEK 100 million, which means that the examination fee should be set at SEK 400,000.

12.1.2 Document keepers etc.

Since the applied for activity will be carried out on two geographically different sites, two document keepers are proposed: one in Oskarshamn Municipality and one in Östhammar Municipality, as follows.

Oskarshamn Municipality: Municipal Executive Board Secretariat, Varvsgatan 8, Box 706, 572 28 Oskarshamn, tel. +46 (0)491-88 000.

Östhammar Municipality: Municipal Secretariat, Stångörsvägen 10, Box 66, 742 21 Östhammar, tel. +46 (0)173-86,000.

Suitable newspapers for public notification are: the national newspapers Dagens Nyheter and Svenska Dagbladet and the local newspapers Upsala Nya Tidning, Östhammars Nyheter, Oskarshamns-Tidningen and Nyheterna (in Oskarshamn).

12.1.3 Meeting room

Proposals for meeting rooms can be provided on request.

12.1.4 Contact person in technical matters

SKB's contact person in technical matters is Olle Olsson, e-mail olle.olsson@skb.se and telephone +46 (0)8-459 84 00.

Stockholm, 16 March 2011
Svensk Kärnbränslehantering AB, through

Per Molander (by proxy)	Bo Hansson (by proxy)