Regulatory Challenges in the Licensing of a Spent Nuclear Fuel Repository in Sweden – 14483

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ABSTRACT

Since March 2011, the Swedish Radiation Safety Authority (SSM) is reviewing the Swedish Nuclear Fuel and Waste Management Company´s (SKB's) license applications for an encapsulation plant and a deep geological repository for the final disposal of spent nuclear fuel. The initial licensing review phase included a broad review of all primary licensing documents in order to make a first assessment of the quality and completeness of the application, the identification of scientific and technical areas for in-depth review, and requests for complementary information. The SSM's related overall conclusion is that SKB's reporting is sufficiently comprehensive and of sufficient quality to justify a continuation to the main review phase.

In reviewing the license applications, SSM evaluates SKB's choice of method and site to ascertain that the proposed repository system is feasible and can be operated as assumed in SKB´s preliminary safety assessment with a high degree of confidence that regulatory requirements on nuclear safety and radiation protection can be fulfilled in the step-wise authorization process that follows a Government licensing decision. Depending on the capacity of SKB to submit essential complementary information that has been requested for the continued compliance evaluation in the on-going main review phase, the aim of SSM´s current review plan is to submit a final statement to the Swedish Government in early 2016.

INTRODUCTION

Since March 2011, the Swedish Radiation Safety Authority (SSM) is reviewing the Swedish Nuclear Fuel and Waste Management Company´s (SKB's) license applications for an encapsulation plant in the municipality of Oskarshamn and a geological repository for the final disposal of spent nuclear fuel at the Forsmark site in the municipality of Östhammar (Figure 1). The applications are reviewed in accordance with the Swedish Nuclear Activities Act. In parallel, the Swedish Land and Environment Court reviews an application for the entire system of handling and disposal, in accordance with the Swedish Environmental Code.

The available licensing review staff numbers 40 to 50 experts drawn from the whole organization, with a core group of about 15 experts. Nearly 40 external experts have been contracted, mostly international researchers and consultants. In reviewing the license applications SSM evaluates SKB's choice of method and site to ascertain that the proposed repository system is feasible and regulatory requirements on nuclear safety and radiation protection can be fulfilled. The aim of SSM´s current review plan is to submit a statement to the Court in early 2015 and a final review statement to the Government in early 2016.

BACKGROUND

Of the twelve Swedish nuclear reactors built in the 1970's and 80's in southern Sweden (Figure 1), ten reactors are presently in operation at three sites. The Forsmark, Oskarshamn and Ringhals nuclear power plants (Figure 1) provide about 45 % of the total Swedish electrical power production. Two reactors at the Barsebäck site have been permanently closed down since 1999 and 2005, in line with previous political decisions to phase out Swedish nuclear power. A recent Parliament decision has opened up for new-build and in 2012 SSM received an application from power company Vattenfall for the replacement of one to two reactors at existing sites in operation.

Spent fuel, after cooling at the reactor sites, is transported by ship to the central interim wet storage facility (Clab), next to the Oskarshamn power plant. A central disposal facility for short-lived low- and intermediate level operational waste (SFR) is located next to the Forsmark power plant (Figure 1).

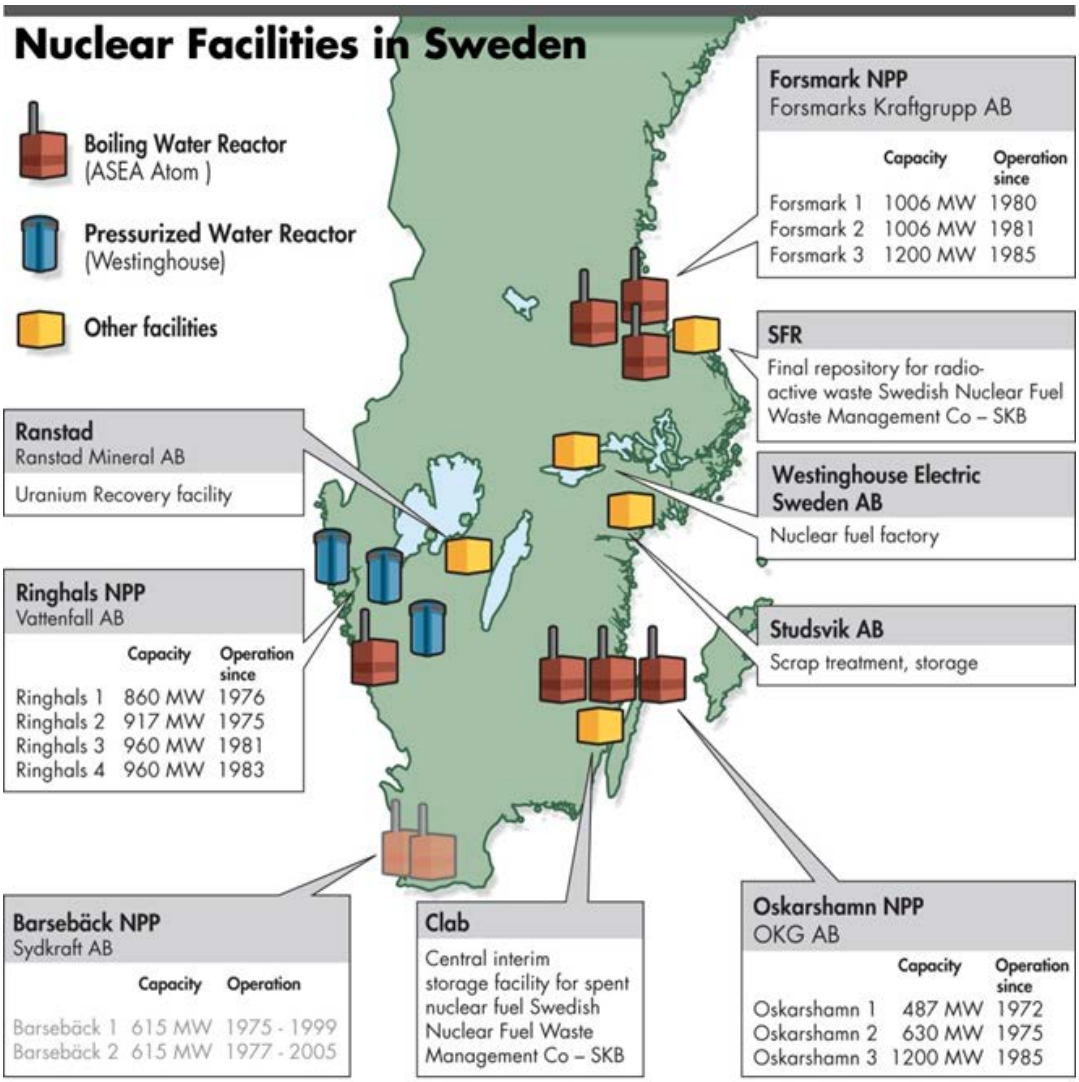

Fig. 1. Map showing locations of Swedish nuclear power plant sites and the related infrastructure for safe nuclear waste management and disposition.

The nuclear facilities licensees have prime responsibility for the safe operation of its facilities and transports as well as the safe disposal of spent fuel and radioactive waste. The national strategy for spent nuclear fuel is direct disposal without reprocessing, i.e. spent fuel is managed as waste and not as a resource in the Swedish programme.

Swedish nuclear power plant licensees also have a common obligation for the research and development of disposal solutions and for carrying out cost calculations as a basis for payments to the Swedish Nuclear Waste Fund. The utilities for this purpose in the early 1980s established the Swedish Nuclear Fuel and Waste Management Company, SKB, as a private entity. At present, SKB is responsible for all handling, transportation and storage of spent fuel and nuclear waste outside the nuclear power plants and it operates the Clab and SFR facilities (Figure 1). SSM, as the regulator, supervises SKB and the power plant operators in fulfilling their responsibilities. A very clear division of responsibilities.

SKB has produced up-dated research, development and demonstration programmes every three years since 1986. The programmes are submitted to the regulator for review and a public consultation. Based on SSM´s review recommendations, the Government approves or disapproves of the general direction of the continued programme. SKB operated research and demonstration facilities include the Äspö underground

hard rock laboratory for the investigation of engineered and geological repository barriers, the Canister laboratory for the development of a sealing technology for copper canisters and the Bentonite laboratory for the testing of buffer properties and development of methods for the backfilling and plugging of repository tunnels, all situated in the Oskarshamn area (Figure 1).

Central facilities that remain to be licensed and established are a final repository for spent fuel, a final repository for decommissioning waste and a final repository for long-lived low and intermediate level waste. The license applications for an encapsulation plant in Oskarshamn and a repository for spent nuclear fuel in Forsmark were submitted in March 2011. In 2014, SKB plans to submit a license application for an extension of the SFR facility to also accommodate decommissioning waste. A repository for long-lived low and intermediate level waste is planned to be in operation by 2045.

The method developed by SKB for the disposal of spent nuclear fuel (KBS-3) is the concept of a deep geological repository in hard rock, with a system of engineered barriers ensuring post-closure safety over very long periods of time. The safety features are passive, i.e. designed without the need for maintenance and supervision after closure. According to SKB´s license application, a total of 12 000 tons of spent fuel will be encapsulated in 6 000 copper lined canisters with cast iron inserts and deposited in granitic rock at the depth of approximately 500 m below ground. Each canister will be surrounded by a bentonite clay buffer and the deposition tunnels will be backfilled with compacted clay.

SKB´s siting process has included a national screening and subsequent feasibility studies in eight municipalities during the 1990´s. More detailed surface-based surveys were initiated in 2002 at two candidate sites in the Östhammar and Oskarshamn municipalities. SKB in 2009 selected Oskarshamn for the encapsulation plant location and Forsmark in Östhammar as the repository site. The concerned municipalities have participated in the siting process on a voluntary basis, with the possibility to back out during all stages.

Preceding the license application SKB had conducted formal consultations with stakeholders in accordance with applicable Swedish Environmental Code requirements. There were also a series of consultations between SSM and SKB on the format and content of the pending application. To actively participate in consultations, host municipalities, regional authorities and certain environmental organisations receive financial support through the Nuclear Waste Fund. Several of these stakeholders have been involved over a long time, are well informed and have built a good capacity for dialogue with the authorities. In practice, this arrangement has been very beneficial to the overall quality and public acceptance of the licensing process for a spent fuel repository.

SSM reviews the applications for a geological repository and an encapsulation plant in accordance with the Swedish Nuclear Activities Act. In parallel, the Land and Environment Court review an application for the entire system of handling and disposal, in accordance with the Swedish Environmental Code (Figure 2). The applications are also remitted for public consultation and there will be a public hearing by the Court before SSM and the Court submit review statements to the Government. The Government decides on the permissibility of the proposed activities according to the Environmental Code and a license to construct, possess and operate a spent fuel repository according to the Nuclear Activities Act. The concerned host municipalities have a right to veto and shall formally declare their support or denial of the Government´s decision (Figure 2). In principle, this stage in the licensing process is the last opportunity for a broad societal participation.

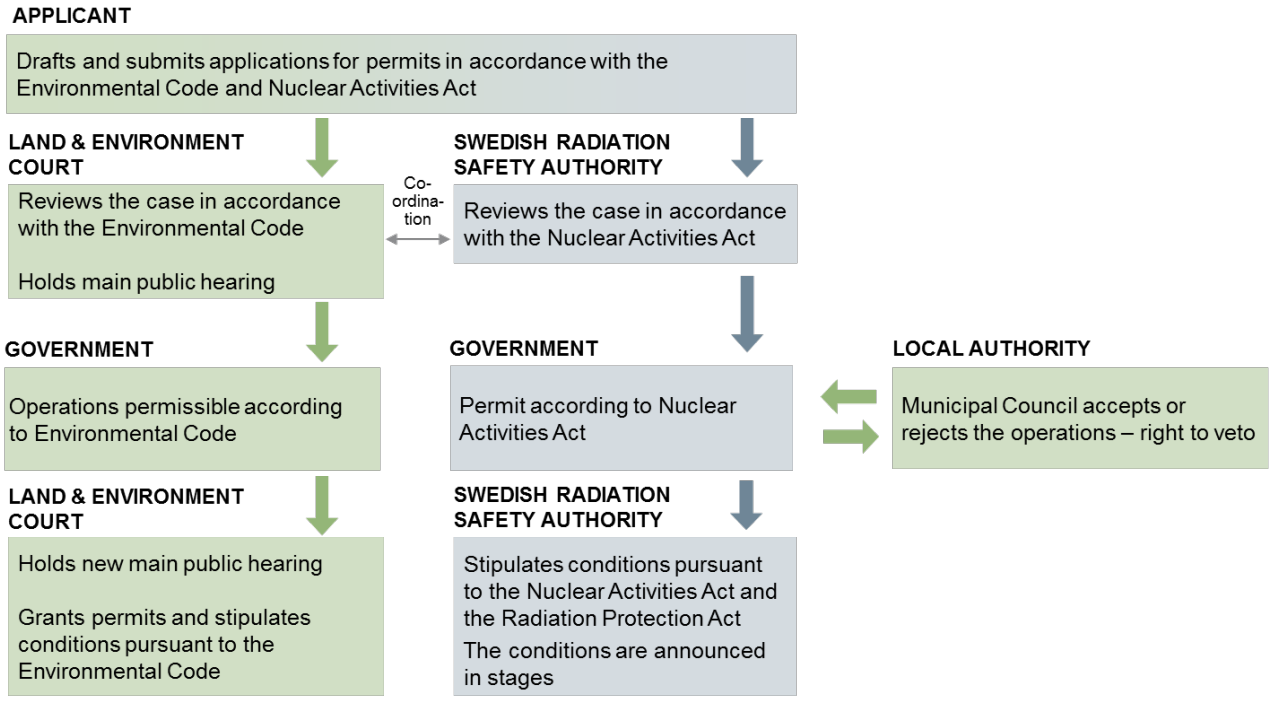

Fig. 2. The licensing procedure for a nuclear facility in Sweden, e.g. an encapsulation plant in Oskarshamn and a spent fuel repository in Forsmark.

Following a Government approval, SSM is tasked to authorize the start of constructions, trial operations, routine operations and the future closure of the facility in a continued step-wise process of regulatory licensing and supervision (Figure 3). The safety analysis report (SAR) is central in the review process and shall be kept to date through all the steps. A preparatory preliminary SAR is included SKB´s licensing application.

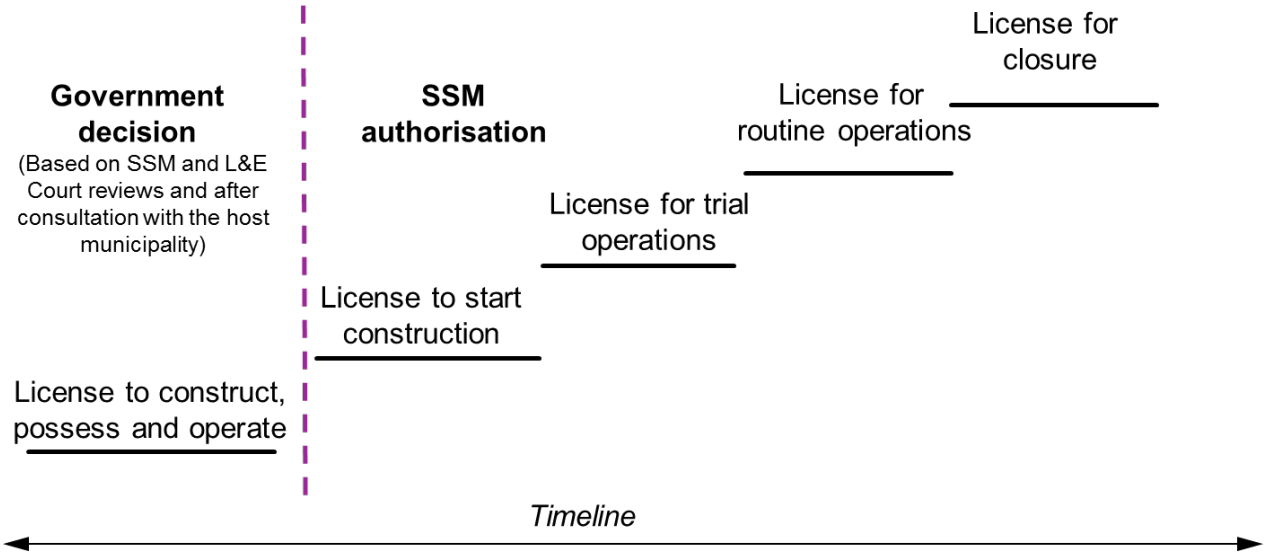

Fig. 3. The step-wise process of regulatory authorisation and supervision following a Swedish Government decision licensing SKB to construct, possess and operate an encapsulation plant and a spent fuel repository.

RESULTS

The initial licensing review phase has included a broad review of all primary licensing documents in order to make a first assessment of the quality and completeness of SKB's application, the identification of scientific and technical areas for an in-depth review and requests for complementary information. The overall SSM conclusion is that SKB's reporting is sufficiently comprehensive and of sufficient quality to justify a continuation to the main review phase. SSM has requested complementary information in a number of areas, e.g. related to canister performance, more comprehensive information on the safety reporting for the encapsulation plant and a more conclusive reporting on the weighing of alternative methods such as deep borehole disposal.

The initial review phase has also benefited from an international peer review of SKB´s post-closure safety case, organized by the OECD Nuclear Energy Agency (OECD/NEA), as commissioned by the Swedish Government in 2011. The scope of the peer review was to provide an international perspective on the repository license application, with the remit to give a general statement on the safety arguments and assessment methods, the feasibility of engineering solutions and the justification of the disposal method and site selection. Important to note is that the peer review is not a formal part of the licensing and was not performed as a compliance evaluation, but has provided a valuable complementary support to SSM´s licensing review as an independent assessment on the maturity of SKB´s program. The NEA peer review team overall conclusion was that the post-closure safety case reporting is a sufficient basis for a licensing decision in this stage.

The review progress is coordinated with the parallel review conducted by the Land and Environment Court as described above. The aim of SSM´s current review plan is to submit a statement to the Court in early 2015, as a basis for the public hearing, and a final review statement to the Government in early 2016. To achieve this very much depends on the capacity of SKB to submit the requested complementary information that is essential for the continued compliance evaluation in the on-going main review phase.

DISCUSSION

The licensing review is a regulatory challenge to SSM. Over the past 25-30 years, SSM, and the former Radiation Protection Institute (SSI) and Nuclear Power Inspectorate (SKI), have reviewed SKB´s research programmes, followed SKB´s siting process, performed pilot safety assessments, taken part in pre-licensing consultations, participated in international projects and carried out independent research on geological disposal. Successively, a strong knowledge base has been developed within SSM, especially on post-closure safety case assessments.

With the licensing applications the initiative has changed from the implementer, i.e., SKB, to the regulator, i.e., SSM. From having followed SKB´s work SSM now has an obligation to produce the informed decisions on recommended actions, within a reasonable time frame and with the right quality of work for the licensing stage at hand. The timely availability of competent staff and experts with experience in safety assessments and the licensing of nuclear facilities is critical to the review. As a small regulator SSM has limited resources, the review staff numbers 40 to 50 people drawn from the whole organization, with a core group of about 15 experts. Nearly 40 external experts have also been contracted, mostly international researchers and consultants.

The integrity of the regulator, i.e., SSM, has become increasingly vital with the progression of the licensing review. Strict internal rules apply on the interaction with the applicant and on independence from the nuclear industry. All staff and contracted experts have been screened to ensure that they have not been associated with SKB related activities. The independence of the regulator is stated in the Swedish legislation, but it is also a matter of public service culture and values. A strong, independent and fully accountable national authority is confident and trustworthy in upholding high safety standards.

A key regulatory challenge of the licensing review is the evaluation of safety assessment uncertainties in

SKB´s application. The KBS-3 method applied for has been developed over 30 years and to some extent demonstrated in SKB's research facilities, but no underground excavation or construction on site has as yet been performed. From a geological point of view all deep geological disposal sites have unique characteristics and with the proposed Forsmark site being the first spent fuel repository of its kind there is no proven technology to support a licensing decision at this time. Therefore, SKB in its license application has to make probable that the proposed repository system is feasible and can be operated as assumed in the preliminary safety assessment, with a high degree of confidence that regulatory requirements on operational and post-closure safety can be fulfilled. In each step in the step-wise authorization process that follows a Government licensing decision (Figure 3), safety assessment uncertainties have to be reduced as the proposed repository approaches industrial operations and more detailed information on safety performance is available. SSM in the on-going licensing review has to determine whether identified uncertainties are critical for the Government´s licensing decision or can be accepted for mitigation in later stages. With a Government decision, the role of SSM to authorize and supervise construction works, trial operations and routine operations of a spent fuel repository will be central in ensuring the fulfilment of safety requirements and licensing conditions.

CONCLUSIONS

Building confidence in the decision making process for a spent fuel repository strongly benefits from a national system with consistent long term strategies and planning. In Sweden; the financial arrangements are in place and working since almost 30 years, a research and development programme on waste management and disposal has been continuously on-going for almost 30 years and long term strategies are being implemented. The Clab and SFR storage and disposal facilities, respectively, (Figure 1) have been in operation since the 1980s, an application for a spent fuel repository has been under review since 2011 and in 2014 an application for the extension of the SFR facility to accommodate decommissioning waste is expected.

The licensing of a spent fuel repository has also benefited from the provisions for a transparent and predictable siting and licensing process, with an active involvement of stakeholders. Key factors of the national system include:

- the nuclear industry's common obligation for waste management and disposal solutions, with the tri-annual regulatory reviews of the research, development and demonstration programmes and associated public consultations,
- the local communities voluntary participation in the siting process and right to veto, and
- the financial support to stakeholders that has made it possible for local communities and environmental organisations to build the capacity to take an active part in formal consultations.

The timely availability of competent staff and experts with experience in safety assessments and the licensing of nuclear facilities is critical to the licensing of a spent nuclear fuel repository. Also, the integrity of the regulator and a strong safety culture have become increasingly vital to public confidence in the licensing review. An independent international peer review organized by OECD/NEA has provided a valuable complementary support to SSM´s licensing review, adding to the credibility of the Swedish licensing process.

In reviewing the applications SSM has to evaluate if the proposed repository system is feasible and can be operated as assumed in SKB´s preliminary safety assessment, with a high degree of confidence that regulatory requirements on nuclear safety and radiation protection can be fulfilled. Following a Government licensing decision, SSM in a step-wise authorization process has to ascertain that the operational and post-closure safety assessment uncertainties are successively reduced as the repository approaches industrial operations and more detailed information on safety performance is available.