Background

The nuclear power programme

Sweden has twelve nuclear power reactors (3 PWRs and 9 BWRs) with a combined capacity of 9 900MW net electric power. They generate about 66 TWh (≈7.8 MWh per capita) annually which corresponds to about 50% of the total electricity consumption.

According to a resolution passed by parliament in 1980, Sweden will terminate its use of nuclear power in the year 2010, at the latest. Thus, an assessment can be made of the total volumes of spent nuclear fuel and other types of waste generated in this programme.

Waste management guidelines

According to generally accepted guidelines, the spent nuclear fuel will be kept in interim storage for a approximately 40 years after which, according to present plans, it will be deposited in geological formations in Sweden. No reprocessing will be performed.

The interim storage for the spent fuel will provide for considerable decay of the radioactivity and consequent reduction of the heat generation. This will facilitate the design and construction of a final repository. Another advantage of the interim storage is that it leaves ample time for the R&D work needed.

Responsibilities

According to Swedish law, the primary responsibility - technically and financially - for the safe handling and disposal of the radioactive waste rests with the owners of the nuclear power plants. In compliance with this requirement, the nuclear power companies have commissioned their jointly owned Swedish Nuclear Fuel and Waste Management Company (SKB) to develop, construct and operate facilities for spent fuel storage and waste disposal.

In order to fulfil this task, SKB is conducting a comprehensive research, development and demonstration programme for the disposal of spent fuel and is operating the Interim Spent Fuel Storage Facility (CLAB) and the Swedish Final Repository for Radioactive Waste (SFR) which is designed to accommodate short-lived waste.

Moreover, a principle has been established that the total costs for the waste management shall be borne by those who benefit from the electricity generated by nuclear power. Thus - also in accordance with Swedish law - fees are paid on the electricity and the money is set aside in interest-bearing accounts. The fees, together with the interest accumulated, are estimated to cover all costs - now and in the future - for handling and disposal of high-level waste and for decommissioning of the nuclear power plants.

The nuclear activities of the industry in Sweden are overseen by three government agencies: *the Swedish Radiation Protection Institute (SSI), the Nuclear Power Inspectorate (SKI) and the National Board for Spent Nuclear Fuel (SKN).*

SSI oversees the industry's activities with regard to protection of the employees as well as of the public against radiation hazards. SKI oversees the safety of nuclear power plants and any other facility where nuclear waste and fissile material is handled. SKN evaluates and supervises SKB's R&D programme on the management and disposal of spent nuclear fuel and the decommissioning of nuclear power plants. SKN also administers the system for financing and is responsible for making impartial information on nuclear waste matters available to the public.

Interim storage

The currently estimated total quantities of spent nuclear fuel to be generated in the Swedish programme is about 7 800 tonnes.

Since 1985, the spent fuel is stored in the *Swedish Interim Spent Fuel Storage Facility (CLAB)* located at the site of the Oskarshamn nuclear power plant. The storage is of the wet type comprising large water pools located in crystalline rock about 25 meters below the surface. The store has a present capacity of 3 000 tons of spent fuel (counted as uranium metal) and at the end of 1990 the store contained 1 350 tons.

The plant has operated according to plans and the performance has been good. The occupational doses as well as the releases have all been well below the regulatory limits.

SKB has found that the storage capacity can be increased to 5 000 tons if new compact storage cassettes made of the neutron absorbing material borated steel are used. In late 1989, the government gave its consent for the use this method. The compact cassettes are expected to be licensed and in use by March 1992.

Transportation

Since all nuclear reactors in Sweden as well as CLAB and SFR are located at the coast with good harbour facilities, a transportation system based on

a sea vessel and terminal vehicles has been developed.

The system consists of the specially designed ship called *M/S Sigyn*, 10 transport casks for spent fuel, 2 transport casks for core components, 27 IP-2 type containers (ATB) for transport of low- and intermediate level waste and 5 special vehicles for loading and unloading as well as transfer at the terminals of casks and containers.

The shipments of spent fuel and wastes from reactor operation have been carried out in accordance with the plans and without disturbances. The doses to the crew have been below the detection limit.

Disposal of high-level waste

SKB R&D Programme 89

As required by Swedish law, SKB submitted its second R&D programme to SKN for review in September 1989.

The major elements of this plan are as follows. 1991-2000: construction and operation of a hard rock test laboratory, system selection, site selection. 2001-2010: siting application, preliminary safety report, SSI and SKI review, final safety report. 2011-2020: construction and commissioning of encapsulation plant and final repository.

SKNs evaluation of the R&D Programme 89 was based on comments from a number of other government agencies (including SSI and SKI), organisations and interest groups. Several recommendations were made eg that SKB should investigate whether the disposal could be achieved in stages which would make it possible to re-evaluate the situation at the end of each stage.

In its decision, the government ruled that, in general, SKB should adopt or respond to the advice given by SKN. The government also expressed as its opinion that very deep boreholes and very long tunnels under the seabed of the Baltic (suggested by SKB as alternatives to the KBS-3 concept) appear to be less suitable as disposal systems.

The Äspö Hard Rock Laboratory

The construction of the *Äspö Hard Rock Laboratory (HRL)* was initiated in October 1990. At present (September 1991), 900 meters of tunnel have been excavated to a depth of 130 meters. The main excavations are expected to be finished in July 1994 but several experiments will be carried out in parallel with the construction work.

The objective of the HRL is to test which methods that are most appropriate for investigating the bedrock, to refine and demonstrate methods for how to adapt a final repository to the local properties of the rock and to collect material and data of importance for assessing the safety of the final repository.

New safety assessment studies

The latest comprehensive description of a possible Swedish disposal system for spent fuel, called KBS-3, appeared in the safety analysis by SKB in 1983. This is still the reference concept of SKB although also other alternatives are studied.

According to the KBS-3 concept, the spent fuel will be enclosed in thick copper canisters which are to be deposited into holes drilled in the floors of tunnels with compacted bentonite as buffer and backfill. The tunnels will be excavated in good quality crystalline rock at a depth of about 500 meters.

In August 1991, SKI presented the results of *Project-90*. The project was initiated in order for SKI to acquire a basis for formulating guidelines and to prepare itself for future reviews of license applications. Project-90 is a performance assessment study of a reference repository with basic characteristics from the KBS-3 concept and with a synthetic reference site. The work comprises an identification and characterization of scenarios as well as a sensitivity study of the release and transport of radionuclides.

At the end of 1991, SKB is expected to report its new safety assessment study called *SKB 91*. The study is in particular aimed at illustrating the significance of rock properties for the total safety of the system. In the study, a KBS-3-like repository is placed at a site having a rather high hydraulic conductivity in the bedrock.

International co-operation

Much of the work conducted by SKB and by the government agencies SKI, SKN and SSI is carried out in an international context. SKB, in particular, has many agreements on international co-operations.

Only a few examples of this international work is mentioned here.

Under the sponsorship of OECD/NEA, seven countries are co-operating in the *Stripa Phase 3 project*, lead by SKB. The experimental part of the program is now completed and work is in progress to compile and evaluate the results. There are two main areas of work:

- Fracture flow and nuclide transport with site characterization and validation as the major subproject.
- Ground water flow path sealing using grouting techniques.

The Stripa mine is now filled with water and future hard rock laboratory work will be carried out at the Äspö facility.

The *Äspö Hard Rock Laboratory (HRL)* mentioned above is attracting international interest. At present (October 1991) SKB has signed agreements for co-operation with CRIEPI and PNC in Japan and AECL in Canada.

Five countries have participated in the natural analogues project called *Poços de Caldas* which is now closed. Sweden was represented by SKB.

Since April 1989 AECL (in Canada) and SKB are engaged in the *Cigar Lake* natural analogue project and the results of the first phase were reported at a workshop in Pinnawa in April 1990. The main objective of the second (ongoing) phase is to describe and model the water-mineral interactions in the uranium deposit and the trace element migration around it.

A new Nordic three year R&D programme on radioactive waste and decommissioning was started in 1990. Of particular interest in the present context are the studies of *geological and climatological processes of importance for long term repository performance* and of *information conservation* which are actively supported from the Swedish side by SKB, SKI, SKN and SSI.

SKI, SSI and the nuclear safety and radiation protection authorities in the other Nordic countries have published a joint consultative document on *criteria for final disposal of high-level radioactive waste*. Another similar document has recently appeared as a result of collaboration between the Swedish authorities and HSK in Switzerland.

Much of the work within the SKI Project-90 mentioned above was carried out in an international context.

SKI has also managed the international project *INTRAVAL* which closed its first phase in 1990. The purpose of the study was to increase the understanding of how various phenomena of importance for the transport of radionuclides from a repository can be described by models.

SKI has also initiated the co-operative project *DECOVALEX* which held its first meeting in early 1991. The purpose of this project is to develop models that describe coupled thermo-hydro-mechanical processes that are potentially important for determining eg repository induced alterations of the rock mass as well as faulting and other large scale phenomena.

BIOMOVS (BIOsphere Model Validation Study) is an international co-operative effort to test biospheric models designed to calculate the environmental transfer and bioaccumulation of radionuclides and other trace substances. The first phase of BIOMOVS - which was managed by SSI - was concluded in Stockholm 1990. A second phase was initiated at a meeting in Madrid in February 1991.

In february 1991, SKN signed a letter of understanding with the United States Technical Review Board. So far co-operation has been initiated in the areas of *canister materials and excavation methods*.

UNITED KINGDOM

Background and General Issues

1. The UK's nuclear generating capacity comprises some 3200 MW Magnox and 5100MW AGR operated by Nuclear Electric (NE) and 2450MW AGR operated by Scottish Nuclear (SNL) together with 400MW Magnox operated by British Nuclear Fuels plc (BNFL). The only additional nuclear capacity currently under construction is the 1175MW Sizewell B PWR owned by NE and which is expected to be in operation in 1994.

2. Further expansion of the UK's nuclear generating capacity will depend on the outcome of a Government prosed review in 1994. Although planning permission for the proposed Hinkley Point C PWR station was approved i September 1990, construction approval will hinge on the Government's 1994 review. NE are currently indicating a preference for a twin reactor station at Sizewell (Sizewell C) as the next stage of its development programme. All of the Nuclear Generating Companies in the UK have a controlling Government shareholding.