Operational experience from SFR – Final repository for low- and intermediate level waste in Sweden

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ABSTRACT

SFR, the Swedish Final Repository for Radioactive Waste, has been in operation since April 1988. It was designed for short lived LLW/ILW from the operation and maintenance of all Swedish Nuclear Power Plants.

The first stage was constructed for 63 000 m^3 which was assumed to give a margin and flexibility for the preliminary operational period. Today this volume represents the whole prediction of operational waste. Until the end of 2005 SFR has received 30 930 m^3 waste.

In average it has been 2-3 derivations per year at the repository. The most derivations happened in the years 1993-1995, and that was also the years when the repository received the most volume of waste. The most of the derivations those years was related to the waste packages.

The doserate to the personal has always been very low in the latest years the collective dose has been under 0,1 mmanSv/year.

1. Introduction

SKB (Swedish Nuclear Fuel and Waste Management Co) is owned by the Swedish Nuclear Power utilities and has been appointed as responsible for the management of Sweden's radioactive waste. The final repository for radioactive operational waste, SFR, has been in operation since 1988. All the short-lived waste; low level waste (LLW)and intermediate-level waste (ILW) from the operation and maintenance of the nuclear power plants is disposed in SFR, along with radioactive waste from medical use, industry and research.

SFR is owned by SKB and the operation and maintenance of the repository is performed by Forsmarks Powergroup who is contractors to SKB.

SFR has five different rock chambers for disposal of different kind of waste. The most active waste is disposed of in a concrete silo surrounded by a clay buffer. The other four chambers consist of a cavern for LLW (BLA), two caverns for concrete tanks with dewatered ion exchange resins (BTF1 and BTF2), and a cavern for ILW (BMA). BMA and the silo are for ILW and the three other caverns are for LLW.
The repository is located close to the nuclear power plant at Forsmark, in crystalline bedrock, 60 m under the bottom of the Baltic Sea. The entrance is at the Forsmark harbour and two tunnels leads to the disposal area, 1 km from the shore. SFR consists of an aboveground section and an underground section. The above ground section consists of office, workshop, terminal building for transport containers and the ventilation building.

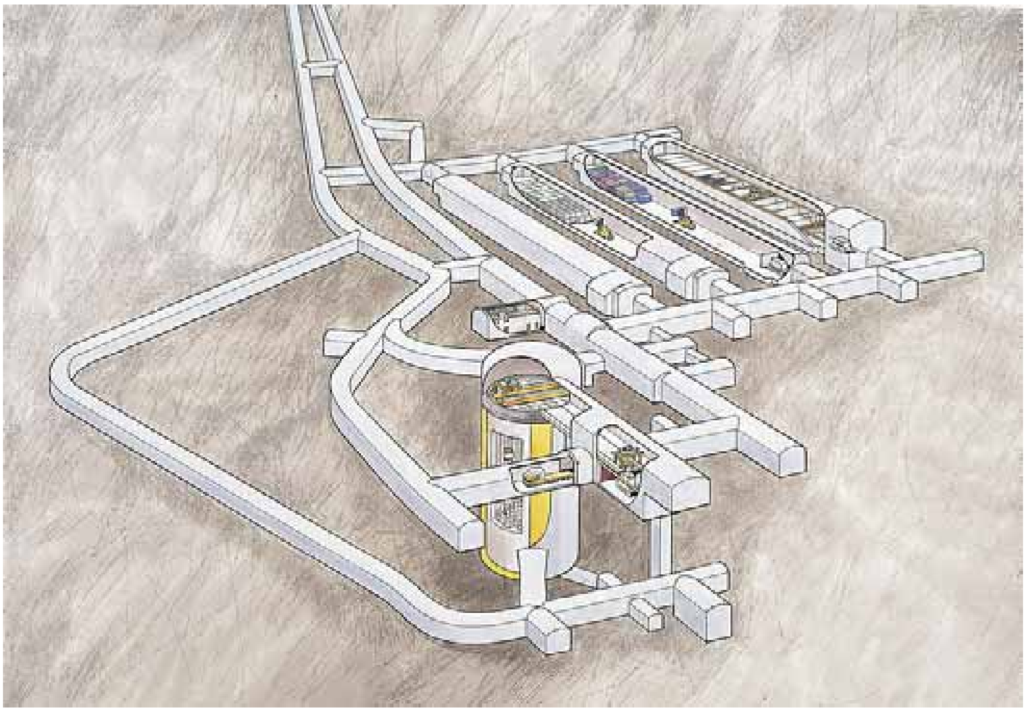

Fig 1. SFR

The five rock chambers have different barrier systems. The most active waste is deposited in a 50 m high concrete silo surrounded by a clay buffer. Besides the silo the repository consists of four more simple rock caverns. These four caverns have a length of 160 m each.

In the three caverns for LLW the waste packages are handled with a fork lift truck. In the cavern for ILW in the silo the waste packages are handled with remote controlled overhead cranes.

2. Operation experience compared to design phase assumptions

SFR has been in operation since 1988. When SFR was constructed in 1980 the repository was dimensioned for prediction of operational waste, 90 000 m^3. The first stage was constructed for 63 000 m^3 which was assumed to give a margin and flexibility for the preliminary operational period. Today this volume represents the whole prediction of operational waste.

SFR was designed for disposal of 30 m^3 waste per day but today only about 1000 m^3 waste is disposed a year. This because of that the waste producers have become better on minimising the amount of waste and the very LLW are disposed of at the power plants in surface disposals.

In the beginning of operation the transport vehicle that transports the waste down to the repository was remote controlled and electrically operated without any driver in the vehicle. We soon discovered that it was better to have a driver in the vehicle but it was still electrically operated. This gave us a lot electrical problems because of among other thing the humidity in the repository. So today the vehicle is diesel powered.

It’s important that the slope down to the repository is kept free from snow and ice in the winter season. Otherwise it can be problems for the fire brigade to drive down to the repository in case of fire. For that reason a electrical cable was laid in the roadway to melt the snow, this has risen the electrical costs. To minimise the costs for heating of the roadway we nowadays use waterborne heating using the heat from the ventilation from the rock.

A large problem in the repository is the high humidity; in late summer the humidity are 100 %. Because of the high humidity in the repository we have problems with corrosion of metal parts. For example we have had high costs for exchange of ventilation tubes in the repository in the end of the 90ies and we now have a new exchange campaign of metal parts ahead of us. We also have some corrosion problems on some waste packages. (See 4.3) We are now investigating how we can try to reduce the humidity in the repository and we try to warm the ingoing air as much as possible. To do that we use two heat pumps.

3. Radiation protections and occupational dose rate experience

The only part of the handling in SFR that is done manual of unshielded waste packages are deposition of waste in three of the disposal caverns, BTF1, BTF2 and BLA. The handling in those caverns is done whit forklift trucks.
The maximum surface dose rate of the waste in BTF1 and BTF2 is 10 mSv/h and in BLA 2 mSv/h.
In the original safety report the calculated doses were 7,5 mSv/year for disposal work. At that time the assumption was that 250 transport containers should be disposed each year. The representative quantity of transport containers is 30-60/year.
Also the transportation of the containers down to the repository caverns was supposed to give a dose of 7,5 mSv/year. In that case an assumption is made of 250 transport containers, a driving time of 3 hours/container and a doserate of 0,01 mSv/h. This is also a very conservative value compared with the operational experiences.

Transportation and deposition of the containers have given rise to very low personal doses.
From the operation start in April 1988 to the year of 2005 the collective and personal doses has been low. In the first 12 years when the deposition activity was higher the collective doses has been under 1 mmanSv/year. After the year of 2000 when the volume of disposed waste has been lower, the collective doses has been under 0,1 mmanSv/year.

The tasks that have given rise to the highest doses in the repository are different closure methods. For example, in one of the caverns, drums with ashes are disposed. These drums are grouted with concrete. The first time this was done, it gave rise to a dose of 6 mmanSv. The method has after that been modified to minimise the doses and the fourth and latest time the dose was 2 mmanSv.

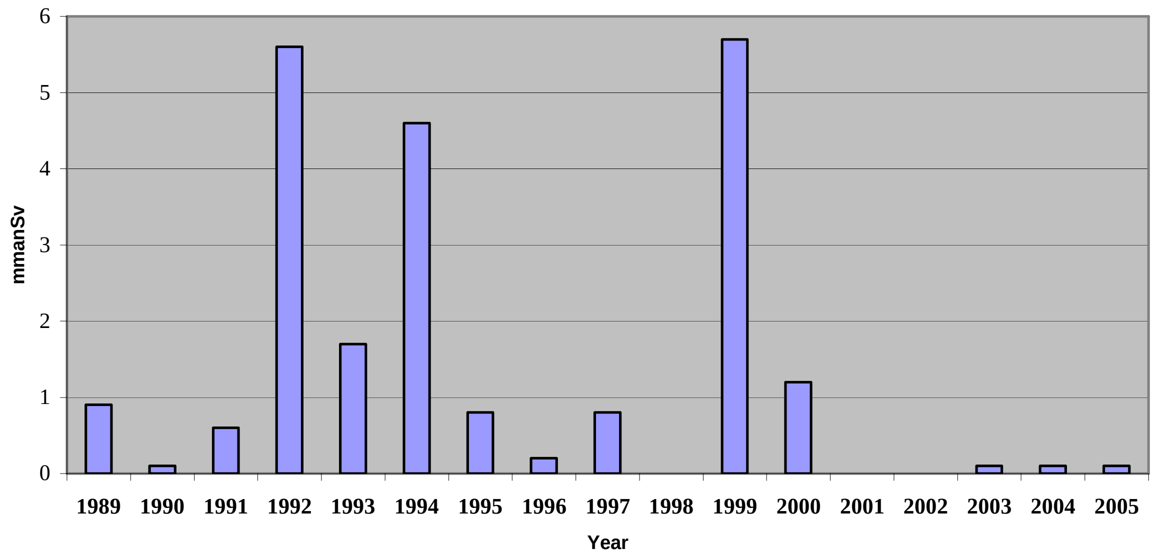

Fig 2. Collective doses at SFR

4. Type of incidents reported and corrective actions

In average it has been 2-3 incidents per year at the repository. Most incidents happened in the years 1993-1995, and that was also the years when the repository received the most volume of waste. The most of the incidents those years was related to the waste packages.

4.1 contaminated transport containers

Some transport containers has been contaminated from the waste packages. The contamination consists in several cases from contaminated water from corroded steel drums. The corrosion was caused by a fault in the drier equipment at the waste producer. After that the routine for the control of the container was made more stringent and all steel drums that could be corroded were put in a steel box before transportation to the repository.

4.2 Containers with broken lid

ISO containers with low level waste are being disposed in the repository and there fore the waste producer use used containers. Sometimes the conditions of these containers were relatively bad and containers with hole in the sides and on the lid arrived to the repository. To solve this problem the requirements on the waste producer was made stricter and the waste producer now use special lids for the containers sent to SFR.

4.3 Detected contamination in drainage water

When SFR was constructed it was assumed that the drainage water that passed throw the disposal compartments in the cavern for intermediate level waste, BMA, could be slightly contaminated. Therefore a separate collecting system for the drainage water was constructed. The drainage water collected in this system are analysed for activity.

In the summer of 2005 the activity level was increasing but the value was still under the limiting value. The probable cause for the increasing of the activity is that one or more of the steel drums in the compartment has been corroded. It is the same waste type that gave the problem with contaminated transport containers see 2.3.1. Too stop the increasing of the activity in the drainage water a mobile roof has been constructed over the compartment with this waste to avoid the water to drip over the waste drums. Today almost no water comes from the compartment. The compartment will be sealed as soon as possible.

This incident show us that the drainage system work and that we in a early stage find out when we have activity in the drainage water and we can take care of the problem immediately.