THE COMBINED DISPOSAL AND STORAGE FACILITY FOR LLW AND ILW IN HIMDALEN, NORWAY: NOW IN OPERATION

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ABSTRACT

In March 1999, the Norwegian Radiation Protection Authority (NRPA) gave the Institute for Energy Technology (IFE) permission to start operation of the Himdalen facility for disposal and storage of low and intermediate level radioactive waste (LLW and ILW). Soon after the first transport left from the IFE's waste treatment plant at Kjeller, 25 km away from the Himdalen facility, with a load of LLW barrels. Up till now 96 transports have been carried out and about 1000 "drum equivalents" placed in the facility for disposal.

Norway does not have any nuclear power plants. The radioactive waste is generated from the operation of the IFE's two research reactors, IFE and other research institutes, hospitals and the oil industry.

The process to find a repository for all of Norway's low and intermediate level waste was started in 1989, by a governmental committee. The committee looked into disposal options and possible sites. In 1992 an impact assessment was performed for three sites and Himdalen was the recommended site. In 1994 the Parliament decided to go on with further site investigations at the Himdalen site but it was also decided that it should be a combined disposal and storage facility. Some of the Plutonium bearing waste is to be stored during the operation time of the facility. At the time of closure it will be decided either to take it out or to encase it in concrete.

The facility is a "rock cavern" facility with 4 caverns accessed by a 150 m long tunnel excavated from the crystalline rock. One of the caverns is used for storage. In each cavern are two sarcophaguses, each with two sections. The 210 l drums of waste will be stacked in four layers. After emplacing the drums will be encased in concrete to provide a new floor for the subsequent layer. When each sarcophagus is filled there will be a concrete roof on top with a water tight sealing.

Dose scenario calculations have been done for a flooded facility, and even with that situation the doses to critical groups will not exceed the limits set by NRPA. For realistic scenarios the dose to the most exposed individual would not exceed 1 γSv/y.

The facility is expected to be in operation until the year 2030. It will take care of all Norwegian LLW and ILW waste, including waste that will be generated during the decommissioning of IFE's nuclear facilities. The capacity of the facility is 10,000 drums (210 l). The total radioactivity inventory will be approx. 570 TBq.

After closure there will be an institutional control period of 300 – 500 years with monitoring and land use restrictions.

INTRODUCTION

The Norwegian Radiation Protection Authority (NRPA) is the regulatory body in Norway for both radiation protection and nuclear safety. NRPA has been responsible for evaluating the licences applications for the facility.

In 1989, a committee was appointed by the government to investigate possible solutions for final disposal of all the Norwegian LLW and ILW (1). In 1992, an impact assessment was performed that included three possible disposal sites, including the Himdalen site. The assessment recommended an engineered rock cavity facility in Himdalen, 25 km from the Kjeller waste conditioning plant (2). During Parliamentary committee deliberations on this recommendation it was proposed that the facility should be a combined storage and disposal facility, with storage of some of the plutonium bearing waste and disposal of the short lived waste. In April 1994 the Storting (Parliament) decided to proceed with investigations at the Himdalen site and that it should be a combined facility. It was also recommended that an IAEA - WATRP review should be performed before the granting of a construction licence. In December 1994 NRPA sent such a request to IAEA.

The construction of the facility started in Spring 1997 and operation two years later. The Institute for Energy technology (IFE) is responsible for the operation.

THE NORWEGIAN NUCLEAR PROGRAMME AND THE ORIGIN OF THE NORWEGIAN RADIOACTIVE WASTE

Norway does not have any nuclear power plants, although there are two research reactors. IFE operates these two reactors located in Halden (20 MW reactor), 110 km south-east of Oslo and at Kjeller (2 MW reactor), 25 km east of Oslo.

The origin of the Norwegian waste is summarised as follows:

- Examinations of irradiated fuel in the metallurgical laboratory II at IFE
- The Halden reactor
- Isotope (pharmaceutical) production
- Research (*IFE and other research institutions)*
- Medicine (*tracer examinations)*
- Industry (*sealed sources from industrial applications)*
- Laboratory scale fuel reprocessing plant (in operation 1961 - 1968)
- Exit signs and ionic smoke detectors
- Decommissioning of nuclear facilities

High level waste, spent nuclear fuel, high activity radiation sources, radium needles and scale (generated after 1-7-96) will not be disposed of at the Himdalen facility.

Waste amount and Radioactivity content

All low and intermediate level waste in Norway is presently conditioned and stored at IFE, Kjeller. Most of the waste is packed in 210 l steel drums. An equivalent of about 2500 drums are generated. Approximately 100-150 drums of waste are generated per year. About 75 per cent of the waste volume originates from the activities connected to the research reactor programmes.

In 1970 it was decided to bury the waste drums (210 l) that had been generated in Norway until then at the Kjeller site in a 4 m deep trench, stacked in two layers and covered by 2 m of clay. There are no engineered barriers (3). This waste will be retrieved, reconditioned and transferred to the new disposal and storage facility.

Up to the year 2030 it is estimated that an equivalent of about 10 000 drums of low and intermediate level waste with a total activity of approximately 520 TBq including about 110 g of plutonium will have been generated (4).

THE SITE SELECTION, LICENSING AND CONSTRUCTION PROCESS

The process to select a site for the disposal of low and intermediate level radioactive waste in Norway has been underway since 1989, when a steering committee was appointed by the government to investigate possible solutions for final disposal of all the Norwegian LLW and ILW (1).

In 1992, the Directorate of Public Construction and Property (Statsbygg) prepared its impact assessment for a repository for Norway's low and intermediate level waste in accordance with the Planning and Building Act. Three sites, the Killingdal Mine together with Kukollen and Himdalen in the Kjeller vicinity, were evaluated (2). The steering committee recommended Himdalen, 25 km from the Kjeller waste conditioning plant, as the preferred site, with an engineered rock cavity facility. During the Parliamentary committee deliberations on this recommendation it was proposed that it should be a combined disposal and storage facility, with storage of some of the plutonium bearing waste and disposal of the short lived waste.

In April 1994 the Storting (Parliament) decided to proceed with technical investigations at the Himdalen site and that it should be a combined facility, it was also recommended that an IAEA–WATRP (Waste Management Assessment and Technical Review Programme) review should be performed before the granting of a construction licence. In December 1994 NRPA sent such a request to IAEA. The scope included review of the legal framework, long-term safety and the site selection process. In September 1995 a review meeting was convened in Oslo where the team and IAEA representatives met with Norwegian experts and also visited the Himdalen site. Within the scope of the review the team was satisfied and believes that Himdalen with the technical concept as proposed is a suitable site (5).

In March 1996, Statsbygg's application for a building licence along with the safety analysis reports was sent to NRPA. The license was granted in February 1997 and construction started soon after.

In July 1997, the Institute for Energy Technology (IFE)'s application for a licence for operation of the facility, along with the safety report, was sent to NRPA. The license was granted in April 1998. The Statsbyggs safety report with updated safety analyses and verifications of site specific criterias were sent to NRPA in September 1998. In March 1999 all documentations needed was in place and NRPA gave permission to IFE to start operation. IFE's operation licence is valid for a 10 year period.

DESCRIPTION OF THE COMBINED DISPOSAL AND STORAGE FACILITY

The facility is built into a hillside in crystalline bedrock. It has four caverns (halls) for waste packages and one slightly inclined 150 metres long access tunnel for vehicles and persons. A

service and control room, with certain service functions for the personnel and a visitor's room, is located along the tunnel. The rock caverns are excavated so that about 50 meters of rock covering remains. The geological covering is for protection against intruders, plane crashes etc. and it is not intended to be taken into account as a main barrier in the long-term safety calculations.

In each cavern two solid sarcophaguses that have a concrete floor and walls has been created. When a section of the sarcophagus is filled a roof will be established. The roof of the sarcophagus will be shaped to shed infiltrating ground water and a waterproof membrane will be fixed to the concrete roof. Three caverns will be used for disposal in which drums and containers will be stacked in four layers. When one layer in a sarcophagus section is filled with waste packages it will be encased in concrete.

One cavern will be used for storage. Based on experience during the operational period and safety reports for closure, it will be decided whether to retrieve the waste in the storage cavern or dispose of it by encasing it with concrete. During operation it is not intended to retrieve any of the waste placed into the storage facility.

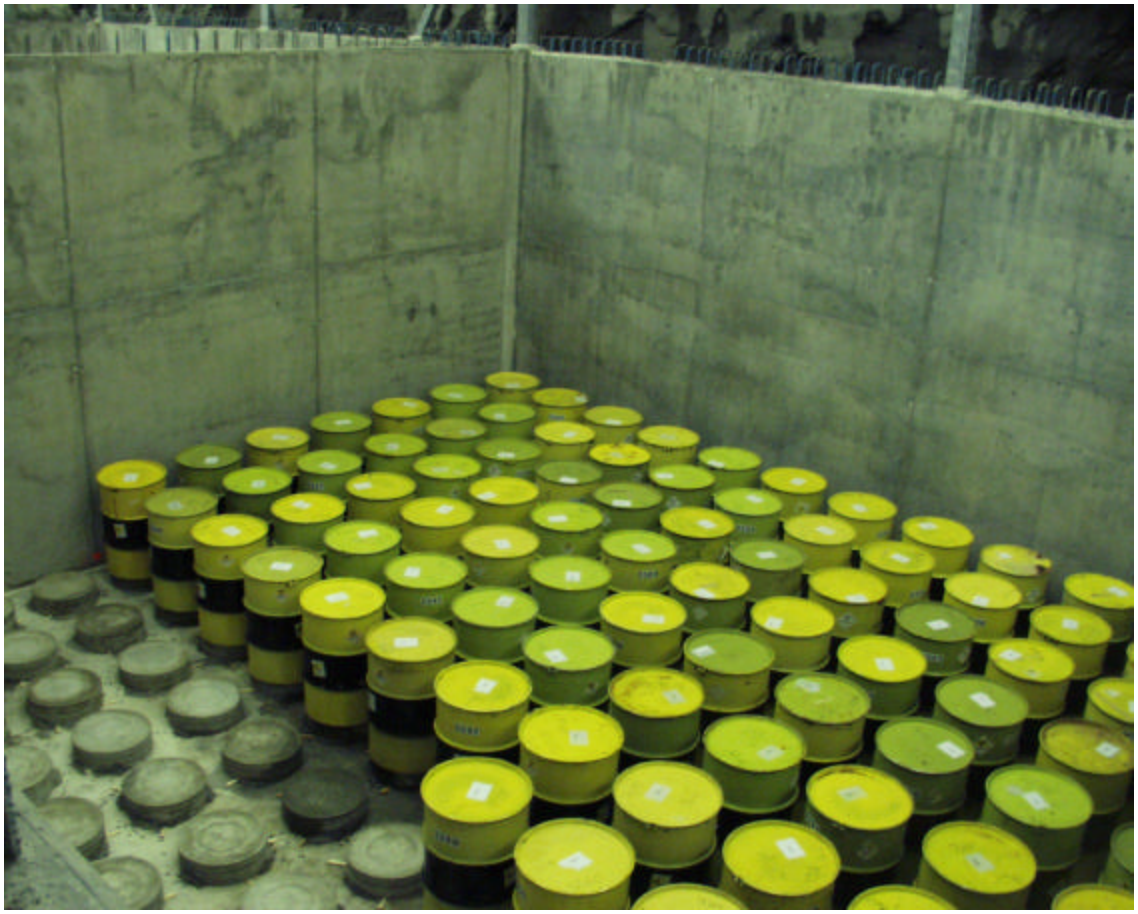

Fig. 1. Waste drums placed in the disposal facility

The facility is planned to be in operation until year 2030. The facility will be closed by backfilling the disposal caverns in such a way as to permit functioning of the drainage for a very long time because it is anticipated that the caverns will be maintained in a drained condition after

closure of the repository. It is intended to have an institutional control period of 300 - 500 years with monitoring of the discharges and restrictions on land use.

Criteria's and dose calculations

For the long-term safety of the facility, the Norwegian legal system provides for two basic requirements that must be fulfilled:

- future generations have the right to the same level of radiation protection as the present generation
- except for a certain period of institutional control of 300 to 500 years, the safety of the facility should not relay on future surveillance and maintenance.

Criteria's set by the Norwegian authorities are:

- for the likely scenarios and based on realistic calculations, a dose of 1 µSv per year to the most exposed individual should not be exceeded.
- for other scenarios, a dose of 100 µSv per year to the potentially most exposed individual should not be exceeded.

The dose criteria's are lower than those usually used and internationally recommended. One reason for this is to keep the dose limits at the same level as for the discharge levels at the IFE facilities. The waste should not give higher doses than the beneficial operation. It is also possible to achieve these low levels because of the relatively small activity inventory in the repository.

Dose calculations have been done for five main scenarios. Three for water release pathways and two for gas release pathways. The calculations were done for four different critical groups; a small landholder farming community located close to the facility by the stream, a small landholder farming community located by the river downstream of lake Øyeren, Hunter-gatherers consuming wild game from the area around the lake, and fishermen consuming fish caught in the lake.

TRANSPORTATION AND OPERATION

In March 1999 the NRPA gave IFE permission to start the operation of the facility. Soon after the first transport of waste containers from the storage at the Kjeller site to the Himdalen facility took place. The transportation is carried out on a normal lorry. The concrete or steel containers are placed in a transportation container. Before being loaded on the lorry they are monitored and checked. The 210 l drums are monitored in a "check-station" to establish the radiation levels, contact dose and dose at 1 meter and to make sure that there is no external contamination. When checked and cleared they are loaded on the lorry, in such a position that the drums with the highest radiation levels are placed in the middle, to reduce radiation to the driver. All regular transportation regulations must be fulfilled. IFE uses an escort car with Himdalen personnel and with emergency equipment in case of an accident. The lorry and the escort keep in contact via radio and phone.

At the facility the lorry drives into the tunnel and into the hall were the waste will be disposed of. Until now only hall 4 has been in use. The containers and drums are offloaded by a traverse crane and placed in one of the 4 sections. They are placed with 15 cm of space in between them

to allow proper cement encasement. Each waste package has an identification number and the exact location in the repository is registered.

Fig. 2. Off loading of waste containers in the facility

Because of space and practical reasons one layer in a section contains156 drums or 88 containers and 5 drums. When one layer is filled the drums and containers are encased in concrete. This is done in two steps, first cement is added up to the middle of the packages and allowed to set. The next day the second layer is poured covering the packages and extending to about 10 cm above the packages. This provides a new floor for the following layer of drums and containers.

Fig. 3. Encasing of drums in cement. The first layer (to mid-drum) is poured.

By mid November 2000, 96 transports to the facility had been accomplished, transporting two containers or 20 drums each time. 1014 drums and 88 containers have been placed in the facility for final disposal. Sections 3 and 4 in hall 4 were almost full (4 layers of waste containers) and waiting for the last layer of cement and the final capping (the roof).

CONCLUSIONS

It is now 11 years since the process to find a final solution for the Norwegian LLW and ILW started. 11 years may seem like a long period but it is necessary to have a detailed and careful process when building a radioactive waste repository. All safety aspects must be taken into account, and impact assessment, safety reports and dose calculations must be performed. It is also important that this careful and proper process take into account the interests of the public and the residents in the concerned municipalities.

We now have a combined disposal and storage facility that has been in operation for 1.5 years. The facility has functioned according to plans and there are no major changes or problems so far. There have been no accidents. The total construction cost was about 70 million Norwegian kroner (7-8 MUSD). At present there are no "protests" against the facility. It is visited by local school classes.

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