



DANSK DEKOMMISSIONERING

Preliminary Studies for the Final Repository for Denmark's Low- and Intermediate-Level Radioactive Waste

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Introduction

In 2003, the Danish Parliament gave its consent for the Government to start preparing what was called the 'basis for decision' for a final repository for Denmark's low- and intermediate level radioactive waste. The 'basis for decision' was completed in 2008 and describes the principles on safety and the environment that are to be followed in the establishment of the final repository for the radioactive waste in Denmark.

The 'basis for decision' outlines three parallel studies that are to be carried out prior to the establishment of the final repository. These studies are: 1) an investigation of repository concepts in relation to geology and safety analyses, 2) a study on safe transportation of radioactive waste, and 3) a geological study describing areas in Denmark suitable as sites for a final repository. Together, the three studies will constitute the basis upon which the final decisions on geological environment, repository concept, and repository location will be taken.

Among the requirements for the preliminary studies are that Danish radioactive waste must be stored on Danish territory, and that the repository can hold the existing radioactive waste, the waste from the decommissioning of the nuclear facilities at Risø, and the radioactive waste produced in Denmark for a number of years to come (from hospitals, universities and industry). It is recommended that the final repository should not depend on future generations to carry out safety procedures or monitor the waste. The document also states that the process towards finding the final repository for Danish radioactive waste must be characterised by high-quality information and openness and dialogue with the public.

Danish Decommissioning (DD) is responsible for the preliminary investigation into repository concepts in relation to geology and safety analyses, (see 1) above).

So far, two of the three Danish reactors have been decommissioned (DR1 and DR2). The DR3, a Hot Cell facility, a utility area, and the Waste Management Plant have yet to be decommissioned.

The preliminary investigation

The preliminary investigation carried out by DD will include theoretical studies of three different concepts for the repository, each located in four different typical Danish geological settings (see below).

The potential spread of radioactive material to the environment will be modeled for a number of scenarios, and safety analyses will be carried out covering each combination. The final report will include considerations on design, construction and materials for the repository building, as well as considerations on the requirements for waste conditioning. It will also consider the question of reversibility and options for the future expansion of the repository as well as economic perspectives for the different repository concepts.

The process is planned to be iterative in the sense that waste conditioning and the concept and design of the repository will be reviewed and reconsidered until at least one, but preferably several safe combinations of repository concept, design, waste conditioning and typical Danish geological settings have been arrived at. The combinations which are found acceptable with respect to safety and cost will be identified and recommended for further consideration in the process of finding a suitable repository. The final report will include estimates of the cost of setting up the repository.

The repository must be designed and located so there is a high probability that the radioactive waste will remain isolated from human beings and the environment for a period of at least 300 years. The repository will contain a number of materials, such as e.g. lead and cadmium, which will remain a hazard to the environment after the radioactivity is no longer a problem, so it is possible that the repository will be nominated as a repository for hazardous waste at that time.

In October 2009, Danish Decommissioning contracted COWI environmental and engineering consultants to carry out the technical side of the preliminary studies under the supervision of DD. In this work, COWI will collaborate with STUDEVIK AB, ENVIROS environmental consultants, and Hasløv and Kjærsgaard architects and town planners.

The preliminary studies started in October 2009 and will be carried out over a period of 18 months, lasting until April 2011.

Repository concepts

The concepts for the repository chosen for the preliminary investigation are:

- a) a near-surface(0-30 m depth) repository for storing all the present Danish radioactive waste,
- b) a near-surface repository with the addition of a deep borehole because the amount of long-lived waste may be a decisive factor in the design of the repository, and
- c) a repository for all the waste at intermediate depth (30-100 m below the surface).

As mentioned above, the repository's design and construction materials will be considered with respect to safety, and the possibility for reversibility will be studied. Moreover, the effect of the presence of the repository in the landscape must be considered.

Geology

The preconditions for a location suitable for the final Danish repository include a requirement that the geology must consist of uniform and coherent layers of rock. The surrounding geology is usually an important part of the physical and chemical barrier system between the waste and the environment, so a geology consisting of stable layers of rock with low permeability is preferable. The 'basis for decision' recommends that the repository should be placed in an area which is stable with respect to earthquakes and without faults or fractures. The protection of present and future drinking water resources has to be considered.

For the preliminary investigation, it has been decided to study four different geologies representative of a large part of the natural Danish geology. These geologies are:

- Clay - plastic, fat
- Clay till, meltwater clay, marine, quaternary clay
- Limestone
- Crystalline rock

The goal of the present preliminary investigation is to study concepts as opposed to 'real' existing locations and structures. This means that the geologies used for the modeling are artificial geologies constructed to simulate 'typical Danish geologies'. In the process after the preliminary studies, when a number of possible areas for the final repository have been selected, the natural geologies will be used in the models.

The Waste

Radioactive waste in Denmark can be grouped as

- Decommissioning waste from the nuclear facilities at Risø
- Existing waste of low activity originating from the operations at the nuclear facilities at Risø and from external users
- Existing waste of intermediate activity originating from the nuclear facilities at Risø
- Special waste (mainly spent fuel used for post irradiation experiments and larger α -sources)
- Contaminated concrete and tailings (the latter classed as potential waste only)

In the preliminary investigation, the estimate of a total amount of 10,000 m³ waste will be used.

A large part of the waste has been conditioned in 210-litre concrete-lined waste drums. Waste packed in large ISO or steel containers has not yet been conditioned. The conditioning of the 'special waste' in particular will depend on the choice of repository concept.

Safety analyses

The term 'safety analyses' covers the systematic evaluation of the repository's consequences for human beings and the environment. In the preliminary investigation, the safety analyses will be carried out for all the combinations of repository concept, waste conditioning and geology. The following matters need to be evaluated

- The repository design and materials
- Any natural processes which could affect the repository (groundwater levels, the flow of groundwater, stability of the surrounding geological layers, the possibility of earthquakes, climate changes, etc.)
- Possible reactions between the waste and the surrounding barriers (the conditioning material, the repository building and the surrounding geology)
- The possibility of human intrusion – intended or unintended.

The safety analyses will be carried out using models simulating the escape of radioactive material in a number of scenarios. They will cover the whole 'operative' period', (the period of time when waste is being received at the repository) and the period after the final sealing of the repository.

During the operative period, the population could potentially receive radiation from the escape of radioactive material to the atmosphere, streams, lakes or sea near the repository. We will model the doses that might be received by the 'critical group', defined as the part of the population which would receive the largest radioactive doses from the repository.

The 'basis for decision' suggests that these doses will be similar to those applied to the existing nuclear facilities (0.1 mSv/year).

After the final sealing of the repository, any potential escape of radioactive material will be a consequence of the natural break-down of the man-made or natural barriers forming the repository, a consequence of natural events/disasters, or a consequence of human intrusion into the repository.

At present, no maximum acceptable figure has been set for the escape of radioactive material from the future repository. The 'basis for decision' suggests a maximum of 0.01 mSv/year, similar to the criteria set for the release of radioactive material from DD.

The process after the Preliminary Studies

As mentioned in the introduction, the present preliminary investigation is one of three parallel preliminary studies for the final Danish Repository. The Geological survey of Denmark and Greenland (GEUS) will be carrying out preliminary studies to indicate 20 possible areas where the final Danish Repository could be located. The National Institute of Radiation Protection (SIS) will be carrying out studies on the safe transportation of the radioactive waste to the future repository. When the three parallel studies have been concluded, the 20 possible locations will be narrowed down to 5-10, based on the joint conclusions of the preliminary studies. For the remaining 5-10 locations, the preliminary reports, the results of environmental investigation of the areas and any limitations on local planning set by the Ministry for the Environment will be sent for public hearing. As detailed investigations are costly it is recommended that the 5-10 locations be further narrowed down to 2-3 locations, for which the detailed field investigations will be carried out. After the public hearing, Parliament will make a decision on the detailed environmental impact assessment (VVM) for the various locations and determine the final location for the repository.

During the process that leads to the decision on the location of the final repository, particular emphasis will be placed on informing and involving the public in the process. This can be done by publishing working papers and other material on relevant websites, by establishing contact with relevant NGOs, local authorities, Regions and associations, as well as holding public meetings and preparing relevant information material for the public.