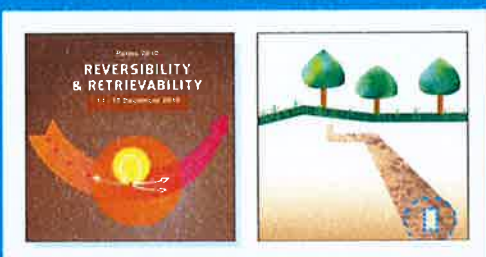


Radioactive Waste Management
2012

Reversibility and Retrievability in Planning for Geological Disposal of Radioactive Waste

Proceedings of the "R&R" International
Conference and Dialogue
14-17 December 2010, Reims, France



**Reversibility and Retrievability in Planning
for Geological Disposal of Radioactive Waste**

Proceedings of the "R&R" International Conference and Dialogue

14-17 December 2010
Reims, France

© OECD 2012
NEA No. 6993

**Nuclear Energy Agency
Organisation for Economic Co-operation and Development**

The EKRA Studies and the Formulation of the Swiss "Long-term Monitored Geological Disposal" Concept

Walter Wildi

Institute F.A. Forel, University of Geneva
Switzerland

Introduction

The Swiss "Law on Nuclear Energy" (LENu, 2003) prescribes the elimination of radioactive wastes according to the following principles:

- The waste producer must eliminate waste in a safe and permanent manner, either in a "deep geological repository" in Switzerland, or (as an exception) in a safe facility in a foreign country (art. 30, 31, 34).
- After an appropriate procedure of investigation and safety analysis, the final authorisation for the exploitation of the repository is conditioned by the favourable conditions of the site as demonstrated during the construction phase, and the demonstration that waste can be retrieved with a "reasonable effort" until the final closure of the repository (art. 37).
- The owner of the repository has to establish during the "observation phase" (meaning: until final closure of the repository) a monitoring of the repository and its environment. The federal government may order further monitoring after closure of the repository (art. 39).

The topic of this conference talk is the presentation of the basic concept of the "deep geological repository" as formulated by the law (the so-called "EKRA concept of monitored long-term geological disposal") and of its option of reversibility, and to give a short overview of the process on the long way to go as described in the official planning ("Sectoral Plan for Deep Geological Repositories") (FOE, n.d.).

Switzerland has currently five commercial nuclear reactors, producing approximately 40% of the electric power of the country. Nuclear wastes from these plants, as well as from industry, research and medicine, are planned to be eliminated in two different repositories, depending on waste activity and duration of radiotoxicity:

- A repository for about 77 000 m³ of low- and intermediate-level waste (L/ILW).
- A repository for about 7 500 m³ of high-level waste (HLW), composed of vitrified waste and conditioned spent fuel. The attribution of about 2 600 m³ of alpha-toxic waste to one of these facilities remains open.

The national co-operative society NAGRA has the task of planning and realising the repository as a mandate from the waste producers, under the control of the federal authorities.

The EKRA concept

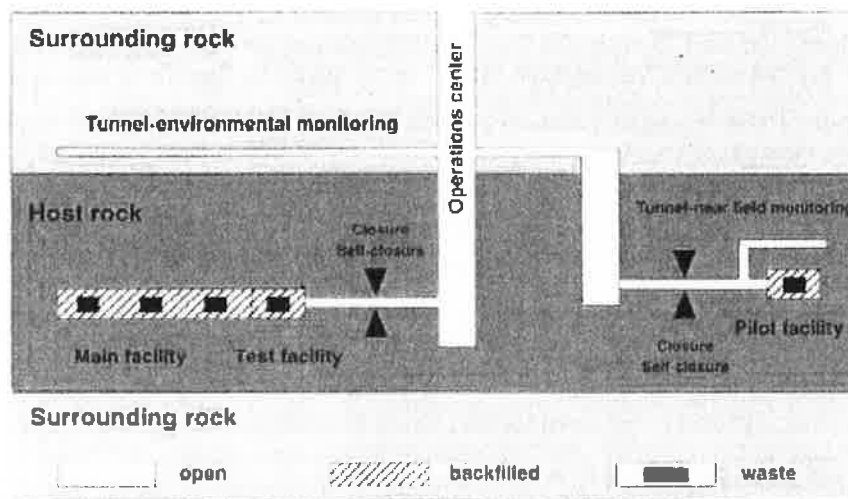
The concept established by the working group EKRA (Wildi, 2000), is based on three basic findings:

- Safe disposal of radioactive waste is a responsibility of the generation that takes profit from the electricity production of the nuclear power plants.
- The only currently internationally recognised method for safe long-term disposal of radioactive waste is disposal in deep geological repositories in appropriate host rocks in a stable geological context.
- Monitoring of the repository and the possibility to retrieve waste in case of necessity are a demand of a large part of society.

The ethical requirements of EKRA for a sustainable and safe repository have therefore been formulated as follows:

- guarantee for the permanent protection of humans and the environment;
- no undue burden on future generations;
- no undue restrictions of options for future generations;
- possibility for corrective actions;
- adequate societal decision-making process for repository implementation.

Figure 1: Schematic concept and system elements of the monitored long-term geological disposal facility (Wildi, 2000; Hufschmied, 2002)



From the technical point of view, EKRA put forward a concept based on a deep geological repository combining three different facilities (Figure 1):

- **Test facility:** This facility serves as a rock laboratory for the site-specific studies that are necessary for the safety demonstration required for the operation of the repository. The facility is constructed once the site has been selected and may remain in use during the operation of the main facility.
- **Main facility:** Most of the waste is disposed of in this facility. The architecture of the facility (access, cavern system for the disposal and its geometry), the installation and the backfilling have to be conceived and realised in a way that retrieval remains a technical option. Once the waste has been emplaced in the caverns, these are backfilled and sealed. However, access and service tunnels will remain open, and waste can be retrieved

without any excessive effort and at relatively low cost, e.g. using remote-controlled tunnelling equipment. The time of closure and sealing of the facility will be decided by the government.

- **Pilot facility:** This is a key facility of the technical part of the concept of monitoring and reversibility. Representative volumes of the different wastes and waste forms will be deposited of in this separate pilot facility, with the aim of validation of long-term predictions as well as identifying possible early indications of safety barrier failures. The main functions of the facility are the following:
 - monitoring the long-term evolution of the engineered barriers and the near-field;
 - verifying the predictive models to demonstrate long-term safety;
 - serve as a demonstration facility, which allows long-term control beyond the closure of the test facility and the main facility.

In relation with the pilot facility the following activities are planned:

- monitoring of the engineered and near field natural barriers (host rock), development of monitoring instrumentation and their replacement due to ageing and technical progress;
- development of repairs and improvements to the engineered barriers;
- tests on clean-up measures in the case of unexpected release of radionuclides into the near-field and the geosphere;
- development of retrieval techniques of waste.

Sealing and closure of the facility (or the retrieval of waste from the pilot facility) will be decided later as a function of experience and monitoring results.

In addition to this technical part, EKRA also recommended in its first (Wildi, 2000) and second reports (Wildi, 2002), institutional and organisational measures, and measures with respect to the schedule of radioactive waste disposal. Among these recommendations, one may mention [for a complete listing see (Wildi, 2000, 2002)]: The need for a permanent public debate to resolve the problem; the need to adapt the legislation to the requirements of the programme for waste elimination, including monitoring and the option of reversibility; the need for a clear schedule and follow-up for the programme; the need for independence from waste producers of the programme and the agency in charge of the elimination programme (Nagra); the need for independent research, in order to guarantee the scientific follow-up of the programme, as well as the maintenance of know-how.

Key messages

- Reversibility of radioactive waste disposal was a demand of large parts of Swiss society in the 1990s.
- A concept was developed by an interdisciplinary expert group, and introduced into the Swiss Law on Nuclear Energy in 2003, combining the safety requirements of final disposal, and the possibility of reversibility over the long term.
- Key elements of reversibility are an appropriate layout of the repository and long-term monitoring of both the repository and the environment in a way that the decision of either sealing of the main repository or retrieval of waste is open to a future generation.
- To be implemented, this concept needs a permanent public dialog on nuclear waste disposal and appropriate mechanisms of public involvement. Conservation of know-how has to be guaranteed by an open research and education programme.

Implementation of the concept

The concept of monitored long-term geological disposal has been widely accepted by public opinion. Some parts of the concept have been implemented, others have not yet been considered.

Implemented elements of the EKRA concept include:

- The technical aspects of the EKRA concept have been included in general terms, and partly in detail, in the frame of the Law (LENu, 2003) and Ordinance (OENu, 2004) on Nuclear Energy.
- The establishment of a detailed technical programme for elimination has also been included in the law.
- The implementation programme, including a detailed schedule for site selection and mechanisms of public involvement, has been fixed by the federal government in the Sectoral Plan for Deep Geological Repositories (FOE, n.d.) and is currently under way.

Elements of the EKRA concept that have not been considered and open questions:

- Switzerland still has very little independent research on long-term disposal questions, as well in the field of social sciences, as in natural and engineering sciences. Most research is funded by and depends on the waste producers. No education programme (e.g. doctoral school) on the university level is oriented towards key aspects of long-term storage.
- The agency in charge of the elimination programme (Nagra) still depends exclusively on the waste producers. This may be perceived negatively by public opinion.
- Questions concerning technical and institutional aspects of long-term monitoring and reversibility, as outlined by EKRA, have not been further developed in adequate depth and still need to be embodied.
- Co-ordination of the technical plan for the elimination of radioactive waste, in particular concerning questions related to waste quality (gas-producing elements) and other technical aspects, and of the Sectoral Plan for Deep Geological Repositories remains difficult. Also, within the Sectoral Plan, the question of what action, or what geological investigation has to be performed in which phase of the project is still open for debate.

References

Federal Office of Energy (FOE), Sectoral Plan for Deep Geological Repositories, Conceptual Part, Federal Office of Energy, Bern, Switzerland, www.bfe.admin.ch/radioaktiveabfaelle.

Hufschmied, P. et al. (2002), "Monitored Long-term Geological Disposal – A New Approach to the Disposal of Radioactive Waste in Switzerland", *Transact. Europ. Nuc. Conf., Europ. Nuc. Soc.*, Brussels, Belgium.

LENu (2003), Nuclear Energy Law of 21 March 2003, Swiss Confederation, Law No. 732.1.

OENu (2004), Nuclear Energy Ordinance of 10 December 2004, Swiss Confederation, Ordinance No. 732.11.

Wildi, W. et al. (2000), *Disposal Concept for Radioactive Waste*, EKRA – Report I, Group on Disposal Concepts for Radioactive Waste, EKRA, Federal Office of Energy, Bern, Switzerland.

Wildi, W. et al. (2002), *Umsetzung von Entsorgungsstrategien in der Schweiz*, EKRA – Report II, Group on Disposal Concepts for Radioactive Waste, EKRA, Federal Office of Energy, Bern, Switzerland.