WM'05 TUCSON

A EUROPEAN PROJECT OF TECHNOLOGICAL DEMONSTRATORS

JL. Gaussen
Andra

Background

Geological disposal of high level radioactive waste has been studied by various organisations, notably radioactive waste management agencies together with major research organisations, for the last 30 years. The feasibility of such geological disposal, from a scientific viewpoint, has reached a very mature level. European research works have been generally carried out in the framework of international cooperation programs. Most of the resulting outcomes of these studies are shared by the scientific community of the concerned countries.
On the other hand the technological aspect of geological disposal has not been addressed with the same international effort. However the feasibility of a geological disposal depends not only on scientific studies but also on engineering ones. As a matter of fact the scientific component is mainly linked to the long term performance assessment whereas the technological one is linked to the industrial feasibility and the operational safety.

The goal of this paper is to present an international project, managed at a European level, which is a first of its kind insofar as it focuses primarily on the technology applicable to the geological disposal.

Objective and Spirit of the project

The ESDRED project (Engineering Studies and Demonstrations of Repository Design) is born from the initiative of 9 European countries which decided to work together on engineering and technology. This project is supported by the European Commission in the field of nuclear energy (EURATOM) under contract nº FI6W-CT-2004-508851 (6th Framework Program).

This project is carried out by a consortium consisting of 13 Radioactive waste management agencies and R&D organisations belonging to 9 European countries : ANDRA France, AITEMIN Spain, ENRESA Spain, CSIC Spain, DBE TECHNOLOGY Germany, EURIDICE Belgium, GRS Germany, NAGRA Switzerland, NIREX United Kingdom, NRG The Netherlands, ONDRAF/NIRAS Belgium, POSIVA Finland and SKB Sweden.

The objective of this project is mainly twofold :

- The first objective is to fabricate full scale technological demonstrators and to show that a given technique can be applicable to several concepts in different host rocks.
- The second objective is to promote a shared European vision in the field of technology.

Content and organisation of the project

The identification of the key technological issues has been performed through a review of the various national concepts which vary from country to country depending, for instance, on the type of waste to be disposed and/or the nature of the host rock.
This review exercise has highlighted a number of common elements that are of importance to the European waste management agencies. These include, among others, heavy load transportation technology, waste canister emplacement technology, retrievability, buffer fabrication and placement, monitoring activity, lining and temporary sealing with specific types of cements.
As well a special focus has been put on developing disposal concepts with minimal environmental impact particularly in terms of the ratio of disposed volumes of waste versus total excavated volume of host rock. This reduces the amount of muck (broken host rock) that must be stored on surface and it also minimizes the disturbance within the host rock horizon.
Recently most waste management agencies in Europe have shown a strong interest in horizontal disposal concepts although concepts for waste disposal in deep vertical boreholes are also being developed.

The structure of the ESDRED project has been derived from this analysis. The project is divided into 4 technical modules :

- The module # 1 is related to the buffer construction technology for horizontal disposal concepts. Three demonstrators are planned. They address the various methods of buffer preparation and emplacement : prefabrication of large blocks the shape and the size of which mirror the shape of the drift, granular buffer (pellets) emplaced around the waste already in place in the disposal drift or a combination of both methods.
- The module # 2 is related to the waste canister (spent fuel as well as vitrified waste) emplacement into disposal drifts. Two demonstrators are planned : one for horizontal tunnels and the other for vertical deep boreholes.
- The module # 3 is related to the use of the fluid cushion technology (air or water cushion) for the emplacement of heavy cylindrical loads (prefabricated buffer rings or spent fuel canister) into horizontal tunnels. Three demonstrators are planned.
- The module # 4 is related to the use of low-pH concrete and of the shotcreting technology for ground support and for the closure of horizontal drifts. One demonstrator is planned.

In term of organisation the Technical Module Leaders are the following :

- ONDRAF/NIRAS (Belgium) for Module # 1,
- DBE TECHNOLOGY (Germany) for Module # 2,
- SKB (Sweden) for Module # 3,
- ENRESA (Spain) for Module # 4.

The ESDRED Project is coordinated by ANDRA (France). ANDRA is also responsible for the integration of the various technical activities and for the training & communication activities.

With a total budget of 18,7 Millions Euros (of which 7.3 million is from the Framework Programme), the project runs over a period of 5 years. It started in 2004 and will finish by the end of 2008.

The general schedule of the project is shown in figure 1.

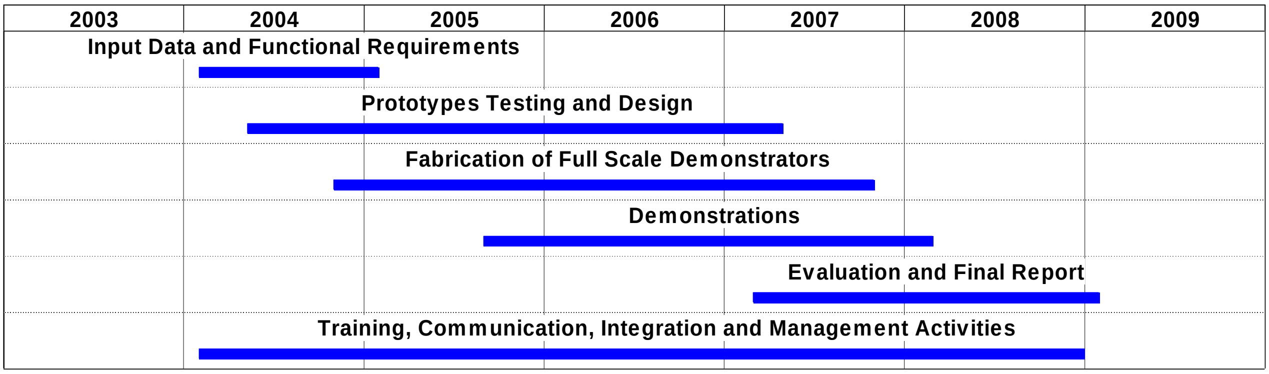

Figure 1 : General schedule of the ESDRED project

Example of a Technology Applicable to Various Concepts : the Fluid Cushion Technology

Module 3 is a good example which shows how a given technology can be applied to various applications. It illustrates the specificity of the project. The challenge of module 3 is to demonstrate that fluid cushion (air or water cushion) technology can be used to emplace a heavy cylindrical load into a circular drift with a tight clearance between the outside diameter of the load and the inner diameter of the drift. Such cases are encountered when emplacing waste canisters, or other loads such as prefabricated buffer, into a drift or a tunnel. In order to limit friction that must be overcome when moving such heavy loads in a confined area, the option of using fluid (air or water) cushion technology is considered.

The air cushion technology is widely used in civil engineering. However this technique, which consists of blowing compressed air in between two flat horizontal surfaces, is not directly applicable to the geological disposal processes for two main reasons. First, in the cases mentioned hereabove, the surfaces on which the compressed air should be blown are circular. The second reason is linked to the condition of the working surfaces which may be altered by the construction processes or by the corrosion of the materials.

It is therefore necessary to adapt this technique and to develop specific designs for the emplacement equipment.

Three possible applications have been identified :

- The first application is related to the emplacement of a supercontainer (consisting of a canister of spent fuel assemblies surrounded by a bentonitic buffer : weight = 45 t ; diameter = 1,80 m) into a drift excavated in a granitic rock (Swedish concept KBS-3H ; cf. Fig 2). In this particular case the possibility of using water instead of air is considered because it increases the uplift force and therefore compensates somewhat for the loss due to the uneven surface of the drift which is not protected by a lining.

- The second application is related to the emplacement of sets of prefabricated buffer rings (weight = 15 t ; diameter = 2,3 m) into a steel lined drift excavated in clay (French concept ; cf. Fig 3).

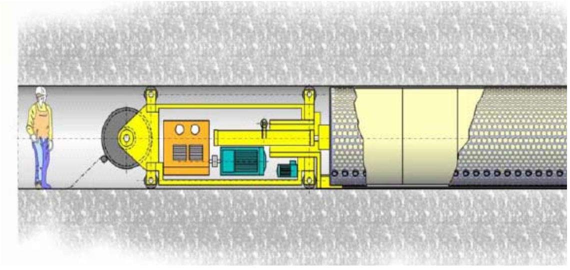

Figure 2 : Water cushion technology used for the emplacement of a supercontainer into a drift excavated in granite

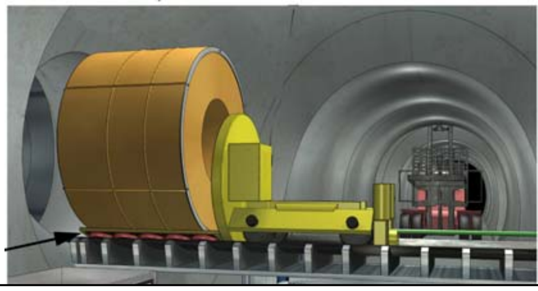

Figure 3 : Air cushion technology used for the emplacement of bentonitic rings into a drift excavated in clay

- The third application is related to the emplacement of a canister of spent fuel assemblies (weight = 43 t ; diameter = 1,25 m) into a steel liner surrounded by a bentonitic buffer in a drift excavated in clay (French concept ; cf. Fig. 4).

The planned demonstration includes prototype testing, fabrication of full scale equipment and in situ emplacement in Aspö (Sweden) and Bure (France) URL. The figure 5 shows a picture of a bench test already fabricated and used to verify the feasibility of the air / water cushion technology in the case of the small diameter canister (1,25 m).

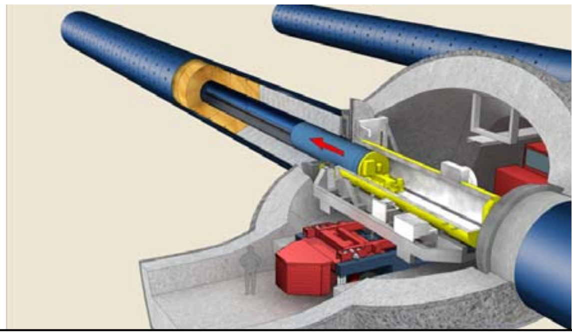

Figure 4 : Emplacement by air cushion of a spent fuel canister into a bentonitic buffer

Figure 5 : Prototype test of the aircushion principle applied to a small diameter canister

Conclusion

The ESDRED project provides an opportunity for European waste management organisations to work together efficiently in the field of technology applied to the geological disposal. This project also involves the training of engineers and the transfer of technologies. This is particularly intended for the new Members States of the European Union and will be proposed throughout the project, primarily in the form of secondment opportunities and/or seminars.

This project promotes a common European vision in term of engineering and available technology. It also contributes to create a common corpus of technical data as well as regulatory and operational requirements. The comparison of these data lead the participants to cross examine the various national concepts. This cross examination and the common development of the technological demonstrators strengthens the robustness of the European concepts considered.