

OVERVIEW OF THE SPANISH PROGRAM FOR HIGH LEVEL WASTE DISPOSAL

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ABSTRACT

The Spanish Senate and the Spanish Government have recently provided recommendations and guidance on how to develop the high-level waste management policy. On the basis of the new strategic guidelines, this paper provides an update of the Spanish program for the final disposal of spent fuel, and discuss the mayor objectives and activities for coming years.

INTRODUCTION

The general strategy for radioactive waste management is under review by the Ministry of Industry and Energy, taking into account the difficulties encountered in the site selection process, the socio-political and public acceptance aspects and the experience of other national programmes.

Due to the great relevance of the political/public acceptance issues in the siting process and the trends in other countries towards a volunteer system, the Spanish Senate decided at the end of 1996 to create an Inquiry Committee to study the various aspects related to the controversy of radioactive waste in Spain and to provide guidelines to the Government to further develop the legal framework which could facilitate the decision making process.

This paper reviews the disposal strategy for high level waste in Spain and highlights major past achievements and future objectives. Recent developments on disposal facility design and total system performance assessment are presented too.

HIGH LEVEL WASTE DISPOSAL PROGRAMME

ENRESA is since 1987 developing a disposal programme aimed at providing a final solution for the spent fuel and high level waste. The programme comprised three major areas of activity: identification of suitable sites, conceptual design and performance assessment of a geological repository, and research and development.

The identification of suitable formations carried out through a step-wise screening process gave as a result the confirmation of the existence of a great amount of favourable areas for geological disposal in Spain. However, although the final aim of this process was to propose candidate sites to construct an underground research laboratory, the reaction of the public advised to discontinue any field work in 1996.

Due to the difficulties encountered to make any further progress in the siting process, the Spanish Senate decided at the end of 1996 to create an Inquiry Committee to provide recommendations to the Government on how to develop the radioactive waste management policy. The Committee has reviewed the approaches of different countries and has realized that most disposal programmes are based on a deep geological disposal strategy but the option

of transmutation of long-lived radionuclides has gained interest at the international level. Partitioning and transmutation could reduce the radiotoxicity and lifetime of some long-lived radionuclides, thereby changing (but not eliminating) the needs for deep geological disposal.

The Committee has been reported on the opinions and viewpoints of different experts as well as representatives of different professional groups and institutions. High level waste disposal is recognised as a societal problem which demands the adoption of decisions that guarantee maximum safety, transparency, public information and participation. Decisions needed should have a high and broad level of socio-political consensus and all different administrations and Institutions should be involved to achieve the highest possible degree of public acceptance. Based on the final report content, legal initiatives could be promoted to bring the Commission findings into legislation.

In the meantime, early 1998, the Spanish Government has provided additional guidance on waste management policy which may be summarised as follows:

- No decision on the final disposal of high level waste will be taken up to 2010. At that time, the Parliament should evaluate the technological advances and the results of the research activities and decide on the final disposal system to be adopted.
- No further siting activities will be performed until 2010. A voluntary process can be expected if siting activities are to be restarted after 2010.
- Deep disposal will continue to be studied but the feasibility and implications of new technologies, such as partitioning and transmutation (P-T), should also be analysed. Research activities on P-T, consistent with the technical capability of the country, should be promoted.

ENRESA is at present modifying its high level waste disposal strategy to accommodate the above changes in policy. Major highlights of the new strategic approach are the following:

- Identification of suitable sites: No further field work will be performed and the existing geological data will be elaborated to be used in the performance assessment of the deep repository.
- Design and Performance Assessment: Safety assessments will continue to play an important role in the HLW programme, integrating geological information, repository design and R&D data and will be used to illustrate the evolution of the repository, to guide R&D activities and to optimize facility designs.
- Research and Development : A new R&D Plan (1999-2003) is under preparation and will include research on partitioning and transmutation in addition to the continued effort on geological disposal. International collaboration on underground laboratories and on partitioning and transmutation will be promoted.

DISPOSAL FACILITY DESIGN

Non-site specific conceptual repository designs have been developed for three candidate host rocks (clay, granite and salt) in order to provide a basis for the research and development activities and the performance and safety assessments studies of the repository system. An effort of systematization and optimization of the disposal concepts design work has been made taking advantage of the existence of common repository design elements.

The repository's surface facilities have been designed to receive non-conditioned spent fuel, providing the capacity to handle and encapsulate the expected waste production over a period of 30 years. Four openings connect the surface facilities with the underground repository and ensure independent ventilation systems for the waste emplacement and construction areas.

A number of 20,000 spent fuel assemblies, containing about 7,000 tonnes of uranium, will be loaded at the surface facilities into unshielded carbon steel canisters, which will be disposed of underground centrally along a system of horizontal disposal drifts and surrounded by a suitable backfilling material.

A mined-type repository will be excavated at a depth of 250 m for clay, 500 m for granite, and 600 m for salt. As it is shown in Figure 1, the repository layout consists of an array of full-face drilled drifts for spent fuel disposal and a completely separated repository area (drifts for clay, silo for granite and caverns for salt) for ILW disposal. The disposal canisters will be emplaced horizontally in circular disposal drifts with a diameter of 2.40 m. A 0.75 m thick buffer (bentonite for clay and granite options, and salt briquettes for salt option) with suitable properties will completely surround the disposal canister.

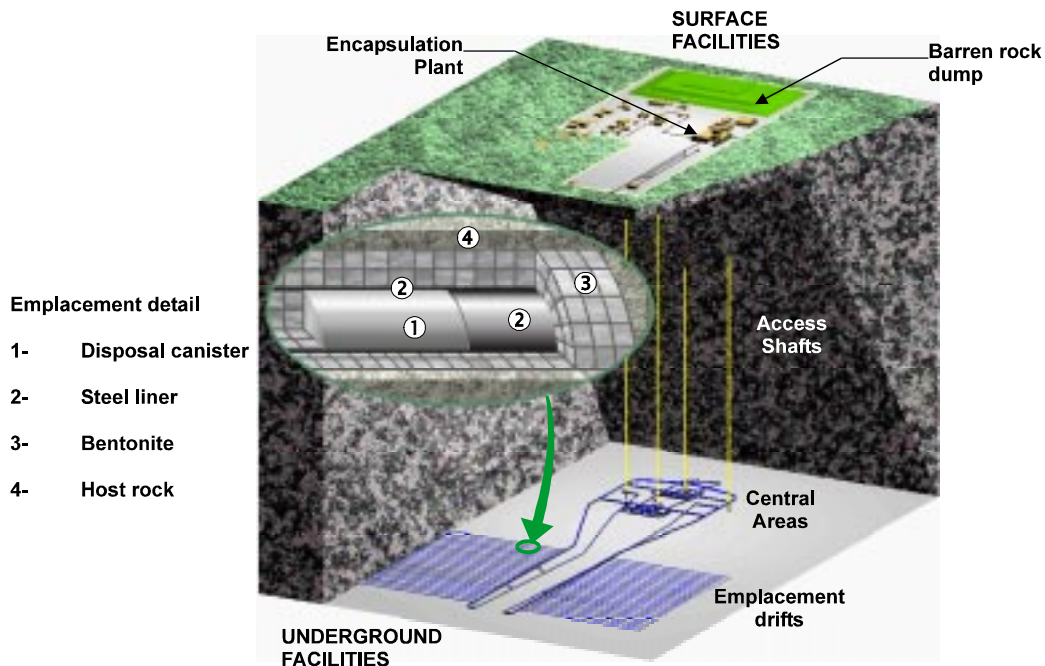


Figure 1 Spanish HLW repository layout (granite option)

The conceptual designs rest on two simplified hypothesis: (1) all disposal canisters will have the same residual thermal power at the time of disposal, and (2) the disposal canister emplacement sequence is performed at a constant rate along the repository operational lifetime. These hypothesis allow for an easy and flexible repository design, but in reality the heat output of the spent fuel elements is very different from one to another. The diversity of cooling times for the spent fuel assemblies to be managed requires an evaluation of the availability of spent fuel assemblies which could be mixed within a canister to achieve a heat canister output as close as possible to the design values.

A computational tool has being developed which permits the optimization of the logistics of the repository and some related features, such as emplacement time sequence, spent fuel cooling at disposal time, year of repository commissioning, and repository operational lifetime and allows to define the loading sequence of disposal canisters at the repository site, the disposal canister's loading capacity, the spacing between emplaced canisters and the expected repository cost that optimise the aforementioned repository features.

RETRIEVABILITY

To date retrievability is neither an official option nor a regulatory requirement for the final disposal of HLW in Spain. Current ENRESA's disposal concepts could allow but do not include specific provisions for waste retrieval. In recent years, the issue of retrievability has gained increased attention at the international arena and is being looked as a way of improving public acceptance of geological disposal and enabling decisions by future generations about the closure of the facility. In addition, a recent draft report by a Senate Inquiry Committee on Radioactive Waste Management recommends to perform R&D efforts on the feasibility of waste retrieval.

ENRESA is looking at retrievability as a way to give freedom for future generations to make their own decisions on waste management and allow a step back in the repository implementation process, if so decided, for technological, economical or safety reasons, e.g.:

- Development of new future technologies, specially transmutation, for better waste treatment or storage.
- Reuse of energy resources (U, Pu), and
- Overlooking of something essential for the repository safety

The basic requirements that are considered for implementing retrievability in the Spanish deep geological disposal concepts are: (1) not to jeopardize the repository's long term and operational safety, and (2) to carry out waste retrieval in safe conditions. To fulfil these requirements different types of constraints have to be considered: constraints imposed by the disposal concept itself (disposal concept configuration, backfilling and sealing strategy, duration of time zones), constraints imposed by long-term processes (buffer saturation, canister-liner corrosion, gas generation, deformation of the metallic liner, deformation/stability of the gallery walls, integrity of the concrete liner), constraints imposed by ambient conditions during retrieval (high temperatures and high gamma radiation dose rates).

Preliminary conclusions indicate that waste retrieval in the Spanish disposal concepts is technically feasible. Depending on the time zone considered, the retrieval conditions will be different. While during the operational phase, waste could be retrieved basically by reversing operations, for the post-operational phase some modifications in the repository concept may be needed to facilitate waste retrieval. Finally, if waste retrieval had to be carried out during the post-closure phase, a great amount of destructive work or remining (clay option) will be required

PERFORMANCE ASSESSMENT

The performance assessment strategy established by ENRESA for the deep geological disposal project is based on a systematical process that will permit through successive approximations, to predict the performance of the different barriers of the disposal system, and its capability to comply with the assigned safety functions and with the established safety criteria.

Within this context a first probabilistic performance assessment of a repository in a generic granite formation was completed in 1997 and has permitted the investigation of the relative importance and role of the various repository components, including examination of the sensitivity of performance estimates to parameter variations. A similar safety assessment for a repository in a generic clay formation was completed in 1998.

The main conclusions obtained from these studies are as follows:

- The disposal concepts in clay and granite are anticipated as safe and viable solutions for the disposal of spent fuel (Figure 2 and 3).
- A basic performance assessment methodology covering different aspects of the repositories in granite and clay, has been developed. This methodology is applicable for successive exercises and permits to incorporate the findings of the research and development activities.
- An adequate framework for the coordination and communication between the Performance Assessment, R&D and site characterization teams have been established and will be in used the next Performance Assessment designated as ENRESA-2000, that will be an integrated exercise with the full participation of all groups.

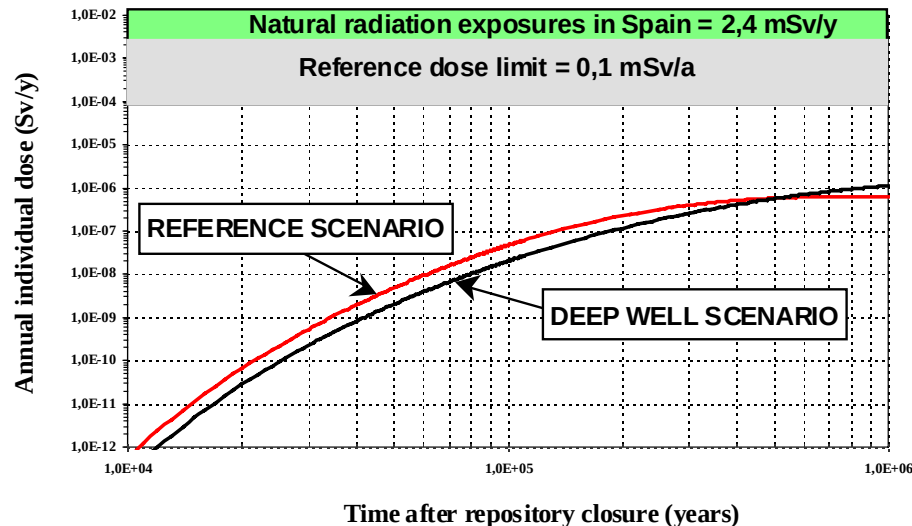


Figure 2. Average annual individual dose for the scenarios analysed (ENRESA-98, study for clay concept)

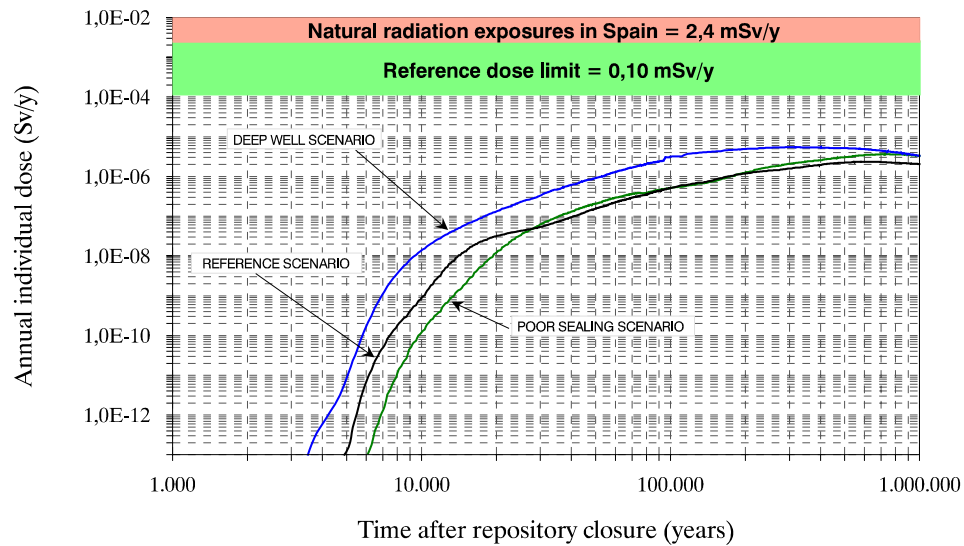


Figure 3. Average annual individual dose for the three scenarios analysed (ENRESA-97, study for granite concept)

The ENRESA-2000 assessment will play an important role in the HLW programme, integrating site information, repository design and R&D data and is performed to provide quantitative indications of the evolution of the repository system as well as to provide input to the site selection, to guide R&D work and to optimise and compare conceptual facility designs.

The necessary integration between performance assessment and scientists is achieved by the so-called integration (GTI's) groups. The main function of these integration (GTI's) groups is to provide expert judgement in an informally and formally elicited ways in order to establish a well structured decision making process, that can be very useful for future demonstration of compliance with safety regulations and to support essential parts of the information used in the ENRESA-2000 exercise. This would also contribute to focus research in the areas that are more relevant to performance assessment and should improve the overall confidence in the evaluation

The general strategy designed for the ENRESA-2000 exercise is shown in figure 4.

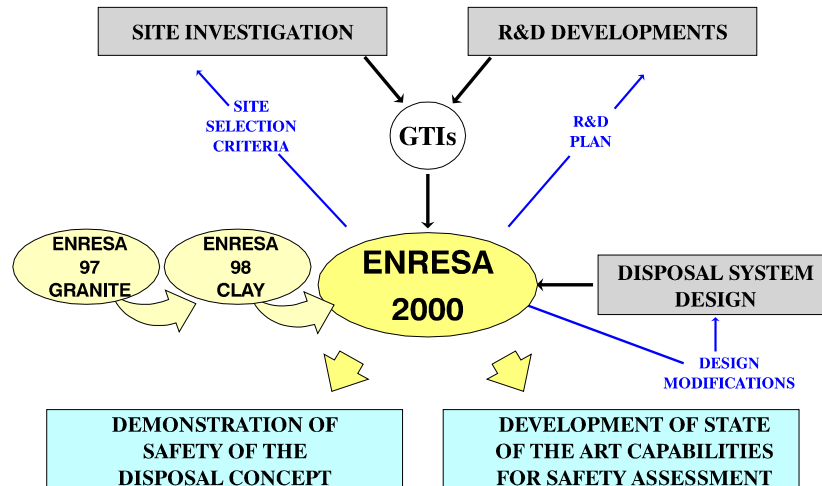


Figure 4. ENRESA-2000 strategy

RESEARCH AND DEVELOPMENT ACTIVITIES

The R&D data has provided the necessary scientific and technical support to the siting, design and performance assessment activities. Work on the 3rd R&D Plan (1995-1999) continues with two main objectives:

- Development and verification of instrumental and numerical technologies for the characterisation of sites and geological barriers.
- Development of a scientifically founded basis for the understanding, conceptualisation and modelling of the phenomena and processes expected to take place in the engineered and natural barriers.

The 3rd ENRESA R&D Plan is very much linked to the 4th R&D Framework Programme on Nuclear Fission Safety of the Commission of the European Communities (CEC), which foster continued and new international collaborations and partnerships. These interactions and cooperative efforts with other agencies are in a variety of radioactive waste management and disposal disciplines essential to achieve our objectives and provide mutually beneficial progress and cost savings.

An important part of the research activities are carried out at underground research facilities, which offer the possibility to test and demonstrate methodology and techniques, and contribute to improve the overall confidence on the safety of the repository. ENRESA is at present participating in the following underground laboratories:

- A full scale engineered barrier experiment in crystalline host rock (FEBEX) in Grimsel (Switzerland).
- A large scale in-situ demonstration test for repository sealing in argillaceous host rock (RESEAL) in Mol (Belgium).
- A clay instrumentation programme for the extension of an underground research laboratory (CLIPLEX) in Mol (Belgium).
- A Backfill and Plug Test and Tracer Retention Understanding Experiment in Äspö (Sweden).
- A series of experiments on the evolution of the excavated damaged zone, heating and diffusion in argillaceous rocks in Mt. Terri (Switzerland).
- A backfill behaviour experiment in emplacement drifts and boreholes in salt in Asse (Germany).

A new R&D Plan (1999-2003) is under preparation taking into account the new time frames and guidance provided by the Government. The basic goals for that period will be the following:

- Continue R&D on geological disposal to provide data and models for the ENRESA-2000, and maintain the technological know-how developed for site characterization and barrier performance evaluation.
- Promote R&D on partitioning and transmutation, consistent with the technical capabilities of the country, in order to evaluate the feasibility and implications of these new technologies in the final disposal.
- Intensify international collaboration through the 5th R&D Framework Programme of the EU and/or bilateral agreements with other agencies to continue research on underground laboratories and participate in P-T international projects.

Research in multi-national underground laboratories will continue to play a key role in the new R&D Plan, as they provide excellent opportunities for:

- Verification and testing of characterisation methodologies.
- Testing the performance of repository components under in-situ conditions.

- Building confidence in the understanding and modelling of the relevant processes that take place in the engineered and natural barriers.
- Development and training of multidisciplinary teams.
- Demonstration of the feasibility of disposal operations.
- Enhancement of the confidence of the scientific community and the general public.

Key areas for future work in underground laboratories will be the following:

- Engineered barriers.
 - Long-term experiments on THM/THG performance of the engineered barrier system.
 - Impact of gas generation and gas transport through the engineered barriers.
 - Near-field chemistry evolution with time.
 - Transport and retardation mechanisms.
 - Compatibility and interaction between near-field materials.
 - Performance of near field/geosphere interface.
- Natural barriers.
 - Radionuclide transport/retardation processes (matrix diffusion, redox, sorption).
 - Impact of gas and two-phase flow through the geological barrier.
 - THM/THG Performance of clayey rocks.
 - Transport/retardation processes in clayey rocks.
 - Verification and testing of geophysical geomechanical and hydraulic characterisation techniques.

In the field of partitioning and transmutation, the new R&D activities will be closely associated to the 5th R&D Programme of the European Union and will include the following key areas:

- Partitioning.
 - Separation of minor actinides by hydrometallurgical processes.
 - Separation of minor actinides by pyroprocessing.
- Transmutation.
 - Computer simulations of accelerator driven systems (ADS).
 - Participation in international verification experiments on ADS principles.
 - Development of basic nuclear data.
 - Participation in international intercomparison/benchmarking exercises.

CONCLUSIONS

This paper has reviewed the Spanish Program for the final disposal of spent fuel and has discussed the major objectives and activities in siting, deep repository project and research and development. The Spanish Senate has been studying the various aspects related to the final disposal of radioactive waste and a final report is expected shortly. In addition the Spanish Government has provided some guidance on waste management policy and ENRESA is accordingly modifying its disposal strategy.