SPAIN

1. Introduction

Spanish low and intermediate level radioactive wastes are disposed of at the El Cabril Disposal Facility, in the province of Córdoba (SPAIN).

The fundamental safety objective of the facility consists of the immediate and longer term protection of people and the environment. This objective leads to the need to isolate the wastes from the human surroundings, such that any release of the radionuclides contained in them does not pose any radiological risk for either people or the environment over the necessary time period.

Consequently, it is necessary to fully protect the wastes against external aggression, from both the climatic and biological point of view (infiltration of water, temperature variations, chemical action of water, attacks by living macro and microorganisms, plants, etc.). This waste isolation is achieved by means of a multi-barrier system separating the activity stored from the aforementioned actions. The system is made up of the following barriers:

- The first is formed by the immobilizing matrix of the wastes themselves and by an isolating storage container.

- The second consists of the bottom of the structures housing the containers, a low permeability cover which is placed over the structures following their closure and a seepage control network. This second barrier limits the access of water to the waste packages and makes it possible to control whatever water might have come into contact with them, including subsequent treatment if necessary.

- The third or geological barrier is made up of the surrounding terrain. This barrier would limit the impact of any eventual leaching in the event of an accident or in the hypothetical case of complete degradation of the first two, adopted for the phase subsequent to the foreseen duration of these barriers.

- Finally, a final cover will be installed, made up of a series of layers isolating the storage structure from the biosphere. This cover is required to maintain its characteristics throughout the lifetime of the facility.

The functions to be provided by the final cover are as follows:

- Impermeability to infiltration,
- Protection of the subsurface barriers.

2. General requirements

The requirements applied by the Spanish Regulatory Authority include the need to draw up a closure plan, which must contain all the aspects of relevance for evaluation. A generic list of the relevant factors would include:

- final inventory of waste and radioactivity emplaced,
- design of definitive cover,
- radiological impact of closure,
- safety or performance analysis,
- surveillance of seepage and groundwater,
- quality assurance, including real operational and construction records.

Many of these aspects have already been quantified in order to obtain the operating permit for the facility. It is of paramount importance to have a good tracking of the emplaced activity to support the detailed safety analysis for the closure. A closure Final Safety Analysis report is considered as important in support of the closure and surveillance operations. A radiological dose limit should be defined for the surveillance and post-surveillance period. In Spain a limit of 0.1 mSv/yr (risk of 10^{-6}) has been defined by the Nuclear Safety Council.

3. Definition of surveillance concept

Considerations are given to establish a surveillance concept for the repository post-closure period. Included in the considerations are:

- marking,
- records,
- definition of surveillance responsibilities,
- cost of surveillance,
- funds management,
- length of surveillance period as a consequence of emplaced radionuclide inventory,
- risk limits,
- safety assessment,
- minimization of maintenance,
- security (if required),
- files requirement,
- intervention in case of necessity.

4. Conceptual design of final cover

In view of the fact that the fundamental function of the cover is to protect the storage structures against the infiltration of rainwater, erosion by external agents, both physical and biological, and, ultimately, protect mankind and the environment from possible leaks. To meet the aforementioned requirements, the closure system designed will consist of the following series of layers (Figure A.9):

- backfill made up of duly compacted excavated material which is in contact with the storage structure,
- a layer of sand, designed to provide drainage,
- bituminous membrane which acts as the first impermeable barrier,
- a layer of sand serving as a filter,
- a layer of compacted clay,
- a layer of sand for further filtration,

- a layer of coarse gravel, over which is placed a layer of soil (The gravel and soil make up the biointrusive barrier, preventing animals and the roots of certain plants from penetrating the clay layer),
- a layer of soil in which are planted suitable plant species (rapid growth and shallow roots),
- a mixture of gravel and soil placed over the previous layer to prevent erosion, at both the top and the slopes.

Other conceptual designs cannot be excluded. At least one alternative option is under consideration: a synthetic membrane (polyethylene or bituminous) on a form layer of crushed rock from the area, with a drainage layer on it and protected by a thick crushed rock layer to provide protection and stability.

The design of the cap have to be consistent with safety assessment requirements as approved by the regulatory authority and other facility design. In this sense, and in the specific case of El Cabril, the cap has to consider the following parameters:

- infiltration rate to the cap (1.5 $l/m^2/yr$),
- specific weight of the cap (1.8 t/m^3),
- minimum thickness (2 m: derived of human intrusion events),
- duration of institutional control (300 years).

5. Design confirmation program

In order to confirm the suitability of the design of the final cover, it is necessary to develop and perform a research program making it possible to confirm all the parameters considered as being characteristic of the system.

The parameters to be analyzed as part of the aforementioned program would be as follows:

- differential settling,
- drying of the clay layer,
- erosion of the cover slopes,
- cover drainage,
- seepage.

6. Model for evaluating erosion events

Since 1990 ENRESA (Empresa Nacional de Residuos Radiactivos, S.A.) has been carrying out theoretical and experimental studies for the establishment of soil erosion rates in the area of El Cabril (Córdoba). The experiments are being carried out in both natural and anthropogenic areas with special attention to the taluses of the storage emplacement. The objectives of the experiments are to:

- evaluate spatial distribution of erosion rates in the area,
- calibrate a physically-based erosion model to provide a procedure for (a) evaluating soil loss in every event and (b) designing the final cover for the protection of the emplacement.

Initially the study was carried out applying the Universal Soil Loss Equation (USLE) with theoretical values for the parameters. However, difficulties calibrating the USLE with field data were encountered and it was decided to calibrate a physically-based erosion model, namely the European Soil Erosion Model, EUROSEM.

EUROSEM is a distributed event-based erosion model that, in addition to predicting total runoff and soil loss, produces hydrographs and sediment graphs. An experimental layout was designed, after a detailed inspection of study area, to collect data for EUROSEM calibration. The experimental sites were selected to be representatives of the 90–95% of the spatial variability in the area. The experimental layout consist in:

- 8 plots of 10 × 3 m in anthropogenic taluses,
- 2 plots of 20 × 3 m in areas with natural vegetation,
- 2 catchments.

Total runoff and sediment production from every event are collected in a tank at the base of the experimental sites. The size of the tanks were determined from plots or catchment size and expected runoff calculated from rainfall data and soil characteristics.

7. Spanish experience

The El Cabril low and intermediate level waste Disposal Facility is currently in operation, depletion of its storage capacity being foreseen for the year 2015. For this reason, the necessary site specific characterization work described is planned to start in the year 2002, beginning with the installation of the experimental caps. The main items to optimise are water infiltration and resistance to erosion as these are considered to be the major failure mechanism at El Cabril site.

ENRESA has already decommissioned the Andújar uranium mill, and a definitive cover made up of multiple layers has been constructed. The surveillance of the performance of this engineered cap is also considered as a part of the confirmation process for the cap technology used.

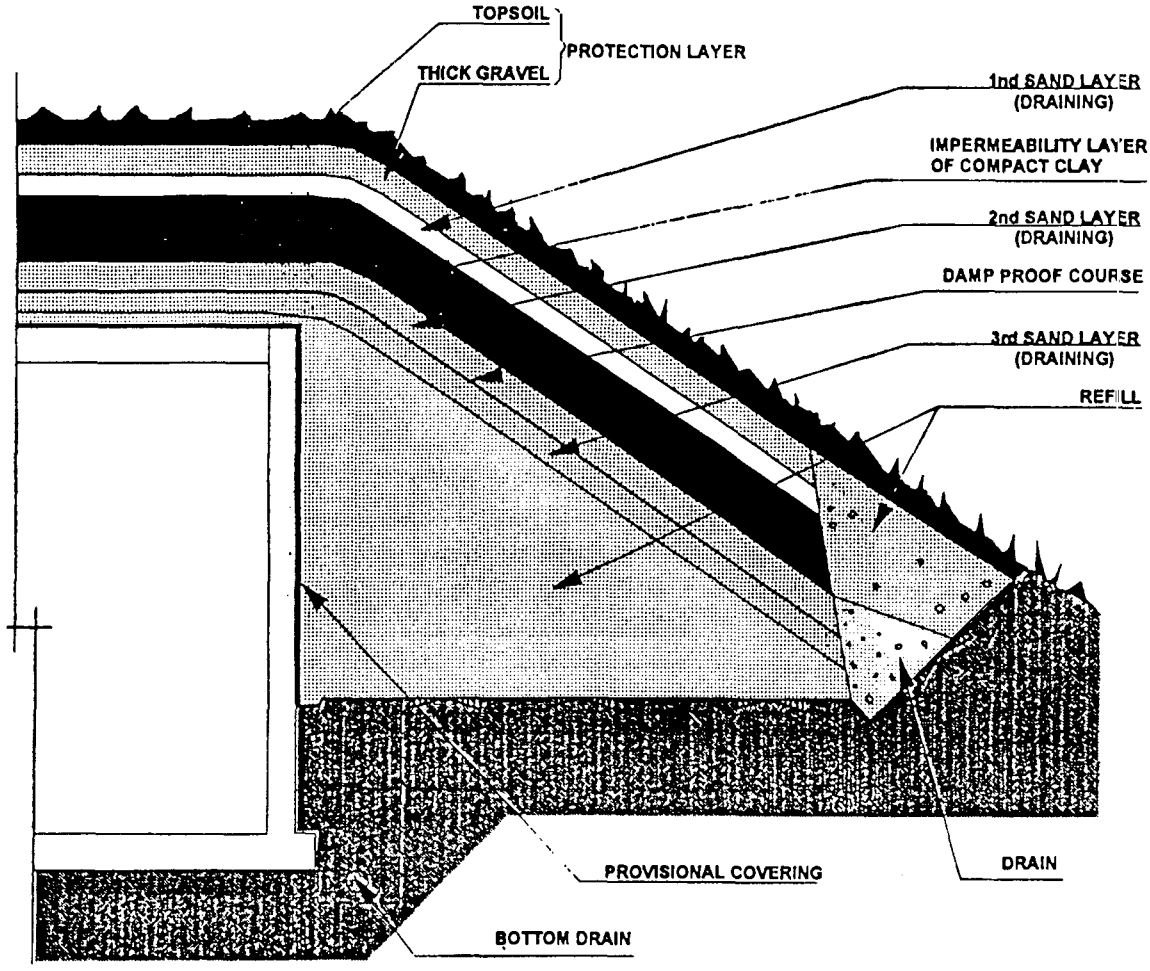

FIG. A.9. Concept of the final cover cap for El Cabril repository (Spain).