PLANTA DE PROCESO DE MINERAL RETORTILLO - SANTIDAD

TECHNICAL NOTE
CONSIDERATIONS ON LONG-TERM RADIOACTIVE WASTE MANAGEMENT IN THE RETORTILLO PROJECT

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1 Background

In accordance with the current Spanish regulations the Retortillo-Santidad radioactive facility is categorised as a first category radioactive facility of the nuclear fuel cycle which includes the uranium mill (heap leaching process) and the mined pit as the disposal facility of the milling waste (considered radioactive waste).

2 Inventory of Operational and Decommissioning Radioactive Wastes

The planned production of radioactive can be categorized in two main streams:

- Heap Leaching Process Waste (namely 'ripios') and minor operational (HLPW stream) and
- Mill Dismantling and site Restoration Waste (D&R W stream).

The HLPW stream will occur routinely during the mill operational period while the D&R W stream will only appear after such operational period.

The main characteristics of the HLPW stream are (estimated):

- Mass:=20.5 Mt,
- Bulk Density: 2.18 t/m\(^3\),
- Particle size: 1 mm -63 mm (sandy gravel),
- Residual moisture: Low (around 15%),
- Features: dense, homogenous, granular, etc.,
- U-238 activity \(\cong 8\) TBq (natural uranium around 16 TBq),
- Th-230 Activity < 74 TBq,
- Ra-226 Activity \(\cong 74\) TBq (in equilibrium with daughters),
- Gross Activity \(\cong 83\) TBq (from U-238 and U-235 series) (38 Bq/g around).

The potentially contaminated materials from the dismantling process and the site restoration were estimated in less than 10,000 t though once decontaminated, the total amount will range to 1,000 t (10%) or less. D&R radioactive wastes will consist of concrete and other miscellaneous materials with a minor amount of metallic scraps.
Summarizing, the total radioactive wastes to be managed will be estimated in 20.5 millions of tons with gross activity concentration average of 38 Bq/g. These wastes are classified by the IAEA standard nº GSG-1. Vienna 2009, as Very Low Level Waste or Exempted Waste (see Figure 1).

![Waste Classification Scheme](image)

Figure 1: Illustrative example of the application of the waste classification scheme, adapted from GSG-1 (Source: ARPANSA. SAFETY GUIDE. Classification of Radioactive Waste Radiation Protection Series Publication No. 20. April 2010)

### 3 Proposed Design for the Long Term Disposal Solution

All the above mentioned 20.5 Mt radioactive wastes will be disposed in the Retortillo mined pit. The pit will be progressively lined and backfilled during the operational period.

The conceptual structure of this disposal facility is described in the Project application and engineering reports. Only to mention the main safety aspects considered in the design include:

- SITE GEOLOGY AND SEISMOLOGY (including Stratigraphic Features, Structural and Tectonic Features, Geomorphic Features, Seismicity and Ground Motion)
• GEOTECHNICAL STABILITY (including Site and Uranium Mill Waste Characteristics, Slope Stability, Settlement, Liquefaction Potential, Disposal Cell Cover Engineering Design, Construction Considerations, Disposal Cell Hydraulic Conductivity)

• SURFACE WATER HYDROLOGY AND EROSION PROTECTION (Site Hydrologic features, Flooding Analysis, Water Surface Profiles, Channel Velocities, and Shear Stresses, Erosion Protection, Erosion Protection Covers)

• WATER RESOURCES PROTECTION (Site Characterization, Ground-Water Protection Standards, Hazard Assessment, Exposure Assessment, Corrective Action Assessment and Compliance Monitoring Program, Ground-Water Corrective Action and Compliance Monitoring Plans, and

• RADIATION PROTECTION (Disposal Cell Cover Radon and Gamma Attenuation and Radioactivity Content, Decommissioning Plan for Land and Structures, Radiation Safety Controls and Monitoring).

According this design, the radioactive wastes together with the acidic water bearing waste will be encapsulated by means of a low permeability isolation barrier which will be surrounded by a high permeable barrier (acting as drainage) to drive the underground waters far from the encapsulation cell (see Figure 2). This cell will be protected from any external agents with a multilayer system up to the ground level as per the scheme in Figure 3.
Figure 2: Conceptual Disposal Cell Structure

In case of any leach from the disposal cell, low flow from radioactive material is expected, nevertheless it will be difficult to be distinguished from the existing underground naturally radioactive water which set up the existing background. Initial studies indicate that such low levels are potential in short term. However, experience in other projects indicates an initial transient (excursion) could be possible. Our current estimate is that this transient will be smooth, if any (due to the background levels), due to the backfilling of the pit is performed during the operational period (the last 9 years) and the transient period shall be shorter than the operational. This could be very different if reshaping of the dump and the protective layers are placed when the backfilling is completed. Therefore, the long-term groundwater conditions would be achieved in a short period of time after the complete disposal cell closure.

The project takes also into account the monitoring of the underground water during the lifecycle of the disposal cell: Pre-construction, Construction, Operation, Restoration and Closure phases. In addition, an environmental monitoring network is put in place to implement the corresponding Environmental Radiological Monitoring Program agreed by the Nuclear Safety Council. This monitoring program includes the levels of radioactive (U, Ra, Po, Pb radioactive isotopes, gross alpha, etc. concentrations) and non-radioactive parameters (pH, Eh, conductivity, heavy metals concentrations, etc.) in soils, waters and other environmental media.
The foreseen duration of the post-closure monitoring phase will be of a minimum of five years, in accordance with the Spanish Mining Regulation. However, this phase will last until the level of radioactivity is indistinguishable from the levels of surrounding underground natural water or the levels specified by the authorities in the corresponding license (see section 4).

4 Post-closure disposal management

The Royal Decree 102/2014 on February 21\textsuperscript{st}, on the safe and responsible management of spent nuclear fuel and radioactive waste (\textit{Council Directive 2011/70/EURATOM} of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste transposition) established as general management criteria the following:

a) The radioactive waste generation will be minimized in activity and volume as reasonable achievable, using design, operation and decommissioning adequate actions, including recycle and reuse of these materials;

b) The interrelationship between all the stages in the spent nuclear fuel and radioactive waste production and management will be considered;

c) The spent nuclear fuel and radioactive wastes will be managed safely; including a long-term management will be performed using passive safety systems. Passive safety is such that is based on the intrinsically safe design with components, which function lay on physical laws, being independent from external energy;

d) The costs of the management of the spent nuclear fuel and the radioactive waste will be borne by the producer, with the applicable legal exemptions (Law 54/1997, 6th additional disposition);

e) Management measures of the spent nuclear fuel and radioactive waste will be applied following a graded approach. Therefore, the analysis, documentation and action level will be proportional to the magnitude of the associated risks, the relative relevance to the safety, the objective and characteristics of the facility or activity and to any other factor that could be considered as relevant;
f) The decision process taken will be based on evidence and documentation over all spent nuclear fuel and radioactive waste management stages.

Moreover, article 4 states that:

- The prime responsibility in respect to the spent nuclear fuel and radioactive waste lies on the producer or the authorized legal entity;
- Generators of materials or holders of authorizations to which the preceding paragraph refers shall set up and implement integrated management systems including quality assurance, giving due priority to safety in the overall spent nuclear fuel and radioactive waste management, and which may be subject to periodic verification;
- The spent nuclear fuel and radioactive waste management, as well as the nuclear facility decommissioning, is an essential public service reserved to the State;
- The State will assume the ownership over spent nuclear fuel and radioactive waste once its final disposal is granted. It will also assume the monitoring of disposal sites after closure.

The first final disposition included in this Royal Decree 102/2014 modifies the Royal Decree 1836/1999 on Regulations on Nuclear and Radioactive Facilities. Specifically:

1) New Article 12, Section 1, paragraph g):

g) Decommissioning and Closure Authorization of facilities for the disposal of spent nuclear fuel and radioactive waste allows the licensee to initiate final engineering activities and any other required to ensure the long-term safe disposal, as well as the decommissioning activities of the determined ancillary facilities, allowing ultimately, the delimitation of the areas that should be under control and radiation monitoring, or under any other type, for a determined period of time, and the controlled release of the remaining areas of the site. The decommissioning and closure process will end in a closure statement issued by the Ministry of Industry, after the report of the Nuclear Safety Council.

The aspects of nuclear safety and radiation protection during decommissioning and closure of the facility, and during the control and
post-closure monitoring stage, including the scope and content of the safety demonstration or study at every stage, will be governed by an Instruction of the Nuclear Safety Council.

2) New article 20 paragraph j):

j) Provisions decommissioning and closure report\(^1\): It will describe, among others, those issues concerning the final management of generated radioactive waste and the study of the cost and the economic and financial forecasts to ensure that decommissioning and closure are feasible. For this purpose, the applicant must provide securities aimed at covering costs and contingencies that may arise from the facility decommissioning and closure processes, even in case of insolvency, cessation of activity or any other contingency, specifying such guaranteed amounts and the way of payment, except for those facilities for which funding for decommissioning and closure was prescribed by the sixth additional provision of Law 54/1997 of 27 November, declared effective by Law 24/2013, of December 26, the Electricity Sector.

3) A new paragraph at the end of Article 20 is added as follows:

The security required under paragraph j) of this Article shall be placed so that the operating permit is granted. The Directorate General for Energy and Mines Policy, following a report from the Nuclear Safety Council, could authorize such security update if there is a change or an event that might have a significant impact on the decommissioning and closure, or on the basis of the work already undertaken in relation to these activities. This security shall be independent of any other amount required by environmental or mining legislation."

4) The new Section1 of Article 36 shall read as follows:

1. Radioactive facilities of the nuclear fuel cycle will require the following authorizations:
   a. Prior (Site) authorization;

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\(^1\) Licensing document requested for Operating license
b. Construction authorization;

c. Operating authorization;

d. Authorization for decommissioning and License termination statement or Authorization for decommissioning and closure and closure statement and;

e. Where appropriate, approval of modification and change of ownership.

5) Article 37 shall be read as follows:

The application, processing and granting of prior (site), construction, operation, modification, change of ownership, dismantling, decommissioning, decommissioning and closure authorizations, decommissioning statement and closure statement of nuclear fuel cycle first class radioactive facilities, be subject to the provisions of Title II of this Regulation, in which authorizations are regulated nuclear facilities, with the adaptation of documents corresponding to the special characteristics of these facilities.”

Therefore, the new aspects that must be included in the Project because of the eventually updated regulation are:

1) The concept of “Closure” is introduced for this type of facilities and as a result its corresponding Long-Term Safety Assessment (Performance Assessment) must be developed by the license holder.

2) A new set of authorizations and statements was defined to be incorporated in the project documents

3) The operating authorisation application requires a new security for the provision of funds to accomplish the decommissioning and closure activities.

4) New licensing process for the end of the lifecycle of the facility, as follows :

   a. Decommissioning and closure authorization to start activities of uranium mill decommissioning, site restoration and Disposal site closure;

   b. Decommissioning statement to declare the license termination of the Uranium mill;
• Control and post-closure monitoring stage, to control and demonstrate the closure of the disposal site and its correct performance; and finally

• Disposal Site Closure Statement and Declaration to transfer the waste disposal site ownership to the State (ENRESA) and the system of Institutional Control will be implemented.

In summary, the project takes into account all applicable regulations, and additional set of documents, including the closure plan, will be delivered when appropriated and according to the timeframe set up in the existing legislation.
Figure 3: Disposal Cell Cross Section