

## **Current Status of The Romanian National Deep Geological Repository Program - 8393**

M. Radu, R. Nicolae, D. Nicolae  
CENTER OF TECHNOLOGY AND ENGINEERING FOR NUCLEAR OBJECTIVES  
(CITON)  
409, Atomistilor Street, Magurele, ILFOV County, ROMANIA  
Zip Code 077125

### **ABSTRACT**

Construction of a deep geological repository is a very demanding and costly task. By now, countries that have CANDU reactors, have not processed the spent fuel passing to the interim storage as a preliminary step of final disposal within the nuclear fuel cycle backend.

Romania, in comparison to other nations, represents a rather small territory, with high population density, wherein the geological formation areals with radioactive waste storage potential are limited and restricted not only from the point of view of the selection criteria due to the rocks natural characteristics, but also from the point of view of their involvement in social and economical activities.

In the framework of the national R&D Programs, series of “Map investigations” have been made regarding the selection and preliminary characterization of the host geological formation for the nation’s spent fuel deep geological repository. The fact that Romania has many deposits of natural gas, oil, ore and geothermal water, and intensively utilizes soil and also is very forested, cause some of the apparent acceptable sites to be rejected in the subsequent analysis.

Currently, according to the Law on the spent fuel and radioactive waste management, including disposal, The National Agency of Radioactive Waste is responsible and coordinates the national strategy in the field and, subsequently, further actions will be decided. The Romanian National Strategy, approved in 2004, projects the operation of a deep geological repository to begin in 2055.

### **INTRODUCTION**

By signing the International Atomic Energy Agency’s (IAEA’s) “Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management”, Romania agreed to fulfil all the therein defined IAEA requirements and recommendations regarding the safety management of its own radioactive waste.

It must be stated that, because of its economical difficulties during the former regime and the transitional period, there are certain delays in establishing and implementing a national policy and strategy regarding radioactive waste management.

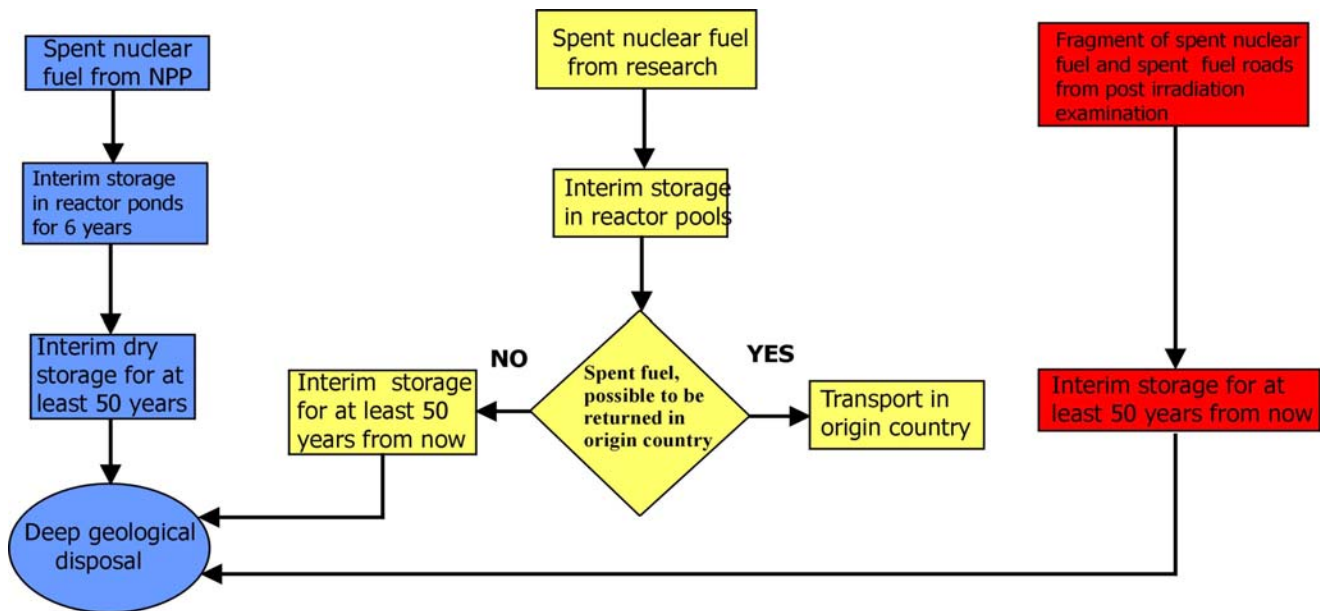
After 1996, when the first Cernavoda NPP Unit became operational, the spent fuel management problem became more complex. When the National Agency of Radioactive Waste (ANDRAD),

was founded in 2003, Romania finally came up with a National Radioactive Waste Management Strategy, [1] which is currently being updated. The final geological disposal of spent fuel and other long-lived radioactive waste (HLW) resulting from the functioning of the present and future operational units of Cernavoda nuclear power plant (NPP) site is one of ANDRAD's responsibilities.

## THE ROMANIAN RADIOACTIVE WASTE MANAGEMENT STRATEGY

The National Radioactive Waste Management Strategy was developed by ANDRAD and is integrated into the National Nuclear Policy. In 2007, the related financial contribution of the nuclear waste producers was established by law. The management of the financial funds is the responsibility of ANDRAD and it will be done according to the National Radioactive Waste Management Strategy and the ANDRAD's yearly Plan of Activities.

In order to achieve the general and specific objectives included in the National Radioactive Waste Management Strategy regarding the safe management of radioactive waste, ANDRAD must identify the long-term solutions for the safe management of spent nuclear fuel. The current strategy is presented below in Fig. 1. Nation-wide coordination of the spent fuel management process is being done in accordance with the international agreements Romania is a part of, as well as with Romanian laws and norms.



**Fig. 1. Current strategy in ROMANIA.**

The development of a deep geological repository (DGR) requires the division of responsibilities between the Romanian Government, the Regulatory Body (CNCAN) and ANDRAD.

The Government is required to provide a national legal framework appropriate for developing safe nuclear activities and to ensure the financial support for the National Commission for Nuclear Activities Control and for R&D and technological engineering activities.

The Regulatory Body shall establish the regulatory requirements for the development of a DGR. It shall also set out the procedures for meeting the requirements for the various stages of the licensing process.

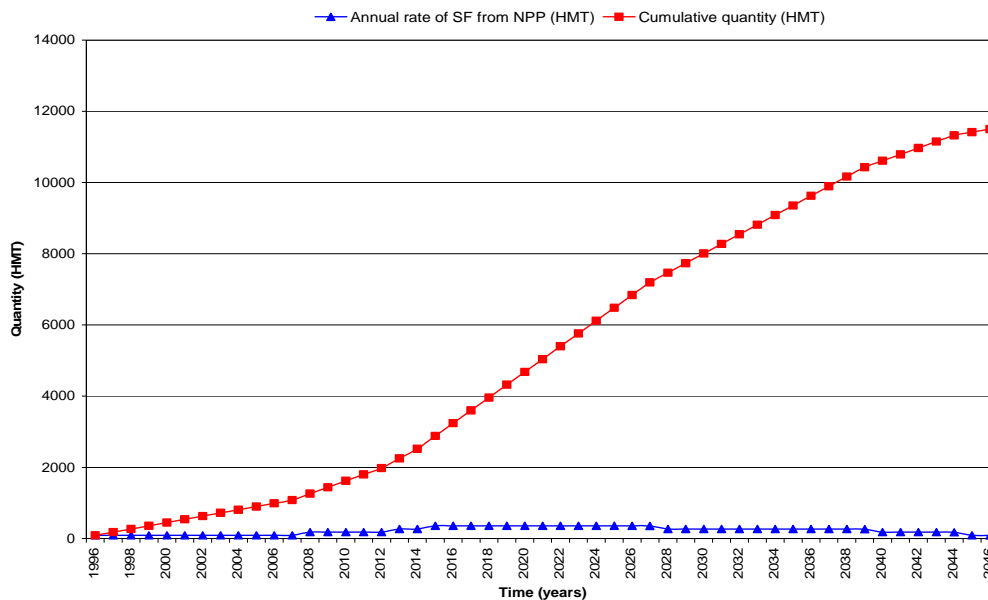
The National Agency for Radioactive Waste, together with the Romanian institutions involved in radioactive waste management, has the responsibility to accomplish the National Radioactive Waste Management Strategy requirements according to the actual legislation.

## ROMANIAN NUCLEAR SPENT FUEL PRODUCERS

The main producers of spent fuel in Romania are and will be the Cernavoda NPP units. The status of these CANDU units is the following:

- Unit 1 - in operation since December 1996,
- Unit 2 – is just put in operation this year, and
- Units 3 & 4 are projected to be put in operation in 2014 and 2015, respectively.

CANDU spent fuel quantity per year is 118.5 HMT or 5,000 fuel bundles. The projected amount of spent fuel produced in Cernavoda by all 4 units through 2046 is shown in Fig. 2.



**Fig. 2. Spent fuel resulting from the four units at the Cernavoda NPP site through 2046**

There is also spent fuel produced by the following Nuclear Research Institute (SCN) research reactors: Pitesti; and “Horia Hulubei” (IFIN) from Bucuresti - Magurele.

According to the Agreement signed between Romania and USA, the highly-enriched uranium (HEU) type spent fuel from the TRIGA reactor from Pitesti shall be kept in the storage bay until 2009, and then will be returned to USA. Spent fuel produced by the Russian reactor at Magurele has to be returned to Russia.

## **STATUS OF THE ROMANIAN RADIOACTIVE WASTE MANAGEMENT PROGRAM**

In cooperation with other Romanian institutes, the Center of Technology and Engineering for Nuclear Objectives (CITON) has performed, for several years, studies regarding the safe final disposal of spent fuel and HLW, as mentioned in the National Radioactive Waste Management Strategy [1].

The studies performed under different R&D programs were mainly desk studies with the main purpose of identifying the most promising type of host rock and the adequate area for sitting, and also rating the identified types of host rocks, considering the IAEA recommendations and selection criteria for such sites.

Support studies were also performed with the aim of identifying a standard concept for deep geological disposal. These were very general results, and this subject - being an issue of the National Radioactive Waste Management Strategy - will be developed in the next years.

The National Radioactive Waste Management Strategy foresaw as steps for the back-end of the fuel cycle from Cernavoda NPP site an interim storage stage of 50 years, followed by final disposal into a DGR.

In 2003, the Spent Fuel Interim Dry Storage Facility for CANDU fuel was put in operation on the Cernavoda NPP site. The facility uses a Canadian technology, CANSTOR module, and has license for 150.000 bundles (about 5.400 HMT), which is equivalent to the amount of spent fuel obtained after 30 years of operation of 2 NPP units. After the interim storage period, the spent fuel will be disposed of in a DGR, which has to be operational by the year 2055.

### **Site Selection Process**

In Romania, the research for a suitable geological environment for a DGR of spent fuel and HLW is in its early stages. CITON anticipated this necessity and initiated R&D work in 1995 together with other institutes like GEOTEC [2]. In order to select a site for a DGR, in 1995, a geological study dedicated to finding the host rock of the repository was initiated. Tackling these aspects and applying the experience of other developed country, the following six types of geological formations have been analyzed: (1) granites, (2) basalts, (3) green shists, (4) clays (argillites), (5) rock salt, and (6) volcanic tuff.

The sources of information which have been in the foreground of the preliminary definition and organizing of geological formations proposed for hosting a DGR were:

- Romania's geological maps, especially the ones produced by the Geological Romanian Institute (IGR), at scales 1:200.000 and 1:50.000;

- technical publications regarding aspects within the mineralogical, petrographical, geochemical, geophysical, tectonical, hydrogeological and mechanic-physical array;
- published documents regarding the economical potential of the respective areas, both from the accretion of ore deposits point of view and the existent perspectives under this aspect;
- conference given by specialists from the boards of the Bucharest University and IGR;
- publications regarding the development state of research from different countries in similar geological formations to those that exist on Romanian territory.

The analysis started with the exclusion criteria for the formation, which include the minimum requirements regarding the depth, the total area, the thickness, tectonic state, fissures, mineralogical or petrographic homogeneity and permeability.

The minimum requirements for the geological formation studied as possible site for a DGR were covering the following aspects: geological, hydrogeological and seismic general conditions, existing ore mining or hydrotechnical facilities, climatic conditions, land use, transport distance, and distance to localities in the region.

A total number of 27 sites have been qualified (5 in green schists, 4 in basalts, 4 in granites, 9 in clays, 4 in salt, 1 in volcanic tuffs). As a result of applying the IAEA recommendations [8], we consider that the most favourable host rocks, which will be investigated further, may be: green schists, granites and salt.

### **DGR Concept**

At this moment, the following general features were taken into consideration as the starting point for the facility concept:

- The facility is a Final Disposal Facility;
- Deep Geological type;
- Non retrievable facility.

In all the studies for a DGR, the following basic assumptions were applied [1]:

- DGR facility will dispose both spent fuel and long lived radioactive waste from four Cernavoda NPP units (30 years operational life) and the decommissioning of them.
- The disposal capacity of the repository is evaluated to accommodate approx. 14,500 HTM and approximately 2 000 reinforced concrete disposal modules with long lived radioactive waste (one module capacity: 18 waste drums with 30-tonne module weight).
- The concept is generic and has not been based on conditions at any particular site. A host rock has not been established, nor has a site been proposed. It is assumed to be a generic site.
- It is assumed that the repository will be located at a depth between 500 - 1000 m below the ground surface for both waste types.

We consider that the DGR concept will cover the following main operations:

- Receiving the spent fuel from Cernavoda IDSF (fuel encapsulated in stain steel storage baskets);

- Receiving the disposal modules with HLW, conditioned at the Treatment and Conditioning Wastes Plant (outside of the DGR site);
- Encapsulation of the spent fuel bundles in disposal canister and placed into the used fuel containers (UFCs);
- Producing the bentonite jackets and buffer blocks;
- Place the UFCs and HLW modules in the DGR;
- Conditioning the radwaste obtained in the encapsulation process for shipment to the low-level radioactive waste (LLW) repository.

The Romanian DGR concept will be based on a well-known technology adapted to the local conditions regarding the host rock that will be chosen.

## CONCLUSION

Science and technology grow and develop – a never-ending process of learning and improving. Requirements for radioactive waste management will change as national and European programs evolve. The prospect of change is inevitable and does not prevent rational, informed decisions and actions being taken at any point in time – if it did, our advanced society would never have developed. All these years of Romanian and European R&D have now brought us close to our goal: the implementation of Romanian National Radioactive Waste Management Strategy regarding the DGR, taking into account the assumptions made, as follows:

1. The geological investigation will continue in order to determine the proposed host rock/site.
2. The DGR concept will use a **demonstrated technology**, adapted on local conditions (site).

However, in implementing the geological disposal, we must always be aware of developments, be able to respond to change, and to make the best use of new advances when it is appropriate, and in this spirit a R&D detailed comprehensive program is absolutely necessary for performing this facility in due time.

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