

**Feasibility Study on the Enlargement of the Surface Repository for LILW  
at Mochovce, Slovak Republic - 8373**

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**ABSTRACT**

In the Slovak Republic the sources of radioactive waste include the operation of the Mochovce and Bohunice nuclear power plants, decommissioning activities currently carried out and/or planned at Bohunice and elsewhere, as well as the use of radioactive sources in research, industry, and medicine. Pursuant to the Slovak policy low and intermediate level radioactive waste (LILW) containing predominantly short-lived radionuclides (LILW-SL), which is amenable for surface disposal, shall be disposed of at the National Radioactive Waste Repository (NRR) at Mochovce, which was designed to take all Slovak LILW-SL and which currently is in routine operation.

The NRR site covers approximately 11 ha, currently only some 20 % of this area is used with two double rows of 20 reinforced concrete vaults each. The dimensions of a vault are 17.4 x 5.4 x 5.5 m, with an effective volume of 510 m<sup>3</sup>. The total capacity of the two existing double rows (80 vaults) is enough to accommodate a net volume of radioactive waste of 22,320 m<sup>3</sup>. Until the end of 2006 some 17 % of that capacity had already been used up.

The NRR can receive in addition to the waste resulting from decommissioning the Bohunice A1 NPP pilot power reactor (under decommissioning since 1979) all the routinely produced Slovak waste until approximately 2020. However, the early shutdown of the Bohunice V1 Unit 1 end of 2006 and the planned shutdown of Unit 2 in 2008 with their following decommissioning will require additional disposal capacity well ahead of the initial time schedule. In this context it appears meaningful, to analyze anew the regulatory boundary conditions, existing disposal options and the corresponding waste categories.

The main purpose of the feasibility study is to analyze alternatives for optimization of LILW management in the Slovak Republic as well as for the enlargement of the NRR at Mochovce, which will allow to dispose of the waste generated by the decommissioning of the nuclear power plants Bohunice A1 and V1 as well as waste arising from the operation of the Mochovce and Bohunice V2 NPPs and institutional waste.

This paper describes the situation in the field of waste disposal in the Slovak Republic, the reasons leading to the decision of enlarging the NRR, the approach developed to select the optimum solution out of eight different enlargement variants, and first proposals and concepts for the enlargement of the NRR developed in the course of the project.

## **INTRODUCTION AND BACKGROUND**

The necessity to enlarge the Mochovce National Radioactive Waste Repository (NRR) arises from the commitment to discontinue operating the Bohunice V1 nuclear power plant unit 1 and 2 entered into by the Slovak Republic in the framework of its accession to the EU. One aspect of the early shutdown of these reactors is the fact that resulting decommissioning waste has to be disposed of at a suitable repository well ahead of the initial time schedule leading to the earlier requirement of additional disposal capacity.

In order to ease the burden for the Slovak Republic connected with the advanced decommissioning of Bohunice V1 a special fund has been created for financial support. This Bohunice International Decommissioning Support Fund (BIDSF) is administered by the European Bank for Reconstruction and Development (EBRD).

The project “Feasibility Study of Enlargement of the National Repository at Mochovce”, which deals with the evaluation of a number of alternatives that can be considered to extend the waste disposal capacity of the NRR in the Slovak Republic is one of the projects financed from the BIDSF.

The main objective of the project is the evaluation of different alternatives to create sufficient disposal capacity required for the early disposal of all low and intermediate level waste originating from decommissioning (Research reactor A1 in Bohunice and Bohunice V1), from operation of NPPs Mochovce and Bohunice V2, and from institutional waste producers.

The alternatives take into account the introduction of a new waste classification scheme as well as different potential locations for future repositories or repository units.

The project started end of June with a detailed definition of the approach to undertaking the work. Up to now, the initial steps of the project including the review and compilation of all relevant data needed for the evaluation of different enlargement options have been completed.

The project is executed by a Consortium of INITEC S.A.U. of Madrid, Spain and DBE TECHNOLOGY GmbH of Peine, Germany for Jadrová a Vyrad'ovacia Spoločnosť, a. s. (JAVYS) of the Slovak Republic under the framework of the Contract BIDSF 009 4 001. The local partners EGP Invest spol. s.r.o. and EKOSUR with offices respectively in Trnava and Jaslovské Bohunice, Slovak Republic are subcontractors to the consortium. The project management is with DBE TECHNOLOGY GmbH. The project financing is provided by the European Bank for Reconstruction and Development (EBRD) from the Bohunice International Decommissioning Support Fund (BIDSF).

## **Present situation in regard to LILW disposal in the Slovak Republic**

The sources of radioactive waste in the Slovak Republic are the Mochovce and Bohunice nuclear power plants, current and future decommissioning activities at Bohunice and elsewhere, as well as the use of radioactive sources in research, industry, and medicine. According to the Slovak policy at a first step all radioactive waste has to be conditioned into a form suitable for long-term storage or final disposal. Later steps include transportation to appropriate facilities and further storage and/or disposal. For low and intermediate radioactive level waste containing predominantly short-lived radionuclides (LILW-SL), disposal at the National Radioactive Waste Repository (NRR) at Mochovce is foreseen. Waste containing long-lived radionuclides with specific concentrations not acceptable for surface disposal, as well as spent nuclear fuel, shall be disposed of later in a future deep geological repository.

This policy is fully in line with usual practice in the European Union and in accordance with the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.

The Nuclear Regulatory Authority of the Slovak Republic (UJD SR) regulates the use of nuclear energy in regard to nuclear safety aspects. The Office of Public Health, Radiation Protection Section, which belongs to the portfolio of the Ministry of Health, regulates nuclear energy use in regard to radiation protection. UJD SR is therefore the supervisory and licensing authority for radioactive waste and spent fuel management as well as supervisor of nuclear materials.

JAVYS, the Nuclear Decommissioning Company and beneficiary of the current project, is the operator of Bohunice A1 and the two units of Bohunice V1. JAVYS further operates the NRR and RAW treatment facility in Mochovce as well as a waste conditioning center and an interim storage facility for spent nuclear fuel at the NPP Bohunice.

In the Slovak Republic, radioactive waste is defined as unusable material that cannot be released into the environment because of its content of radionuclides or because of its contamination with radionuclides. Basis of the waste classification is the disposal route. The different waste categories are defined in the Regulation Nr. 53/2006 of UJD SR [1], in which the following waste categories are distinguished:

1. *Transitional radioactive waste (TW)*, whose activity falls below the level for release into the environment during the storage period
2. *Low activity level radioactive waste and medium activity level radioactive waste (LILW)* whose activity is higher than the limit for release into the environment and with a specific decay heat lower than 2 kW/m<sup>3</sup>. There are two groups of LILW
  - a. *Short-lived low and medium activity radioactive waste (LILW-SL)*, which after conditioning meets the safe operation limits and the waste acceptance criteria for the near-surface disposal facility. The average specific activity of alpha nuclides is lower than 400 Bq/g
  - b. *Long-lived low and medium activity radioactive waste (LILW-LL)*, which after conditioning does not meet the safe operation limits and the waste acceptance

criteria of the near-surface disposal facility. The average specific activity of alpha nuclides is higher than 400 Bq/g

3. *High activity level radioactive waste (HLW)* whose residual heat production is equal to or higher than 2 kW/m<sup>3</sup>

### **The National Radioactive waste Repository in Mochovce**

The near-surface repository for disposal of LILW-SL at Mochovce started routine operation in 2001 and has been in continuous operation since then (Fig. 1.). At present, only some 20 % of the NRR site, which covers an area of approximately 11 ha, are used for disposal purposes with two double rows of 20 reinforced concrete vaults each. Until present all waste being disposed of here has been packaged in fiber-concrete containers (FCC) irrespectively of the activity content. Only waste forms meeting the acceptance criteria can be disposed of .The FCC has an effective (net) volume of 3.1 m<sup>3</sup> and occupies a (gross) volume of 5 m<sup>3</sup>. The dimensions of a vault are 17.4 x 5.4 x 5.5 m, with an effective volume of 510 m<sup>3</sup>. The total capacity of the two existing double rows (80 vaults) is enough to accommodate 7200 FCC, i.e. a net volume of radioactive waste of 22,320 m<sup>3</sup>. Until the end of 2006 some 17 % of the total NRR capacity had already been used up.



Fig. 1. The National Radioactive waste Repository in Mochovce, Slovak Republic.

The facility was designed as repository for all LILW-SL from the operation of Slovak nuclear power plants, from decommissioning nuclear facilities, as well as for institutional radioactive

waste from research, medicine and industry. Its capacity was calculated to be sufficient for the expected volume of waste resulting from decommissioning the Bohunice A1 NPP and all operational and institutional LILW-SL routinely produced in the Slovak Republic until approximately 2020. However, in contrast to the initial schedule for these waste streams, corresponding to the advanced shutdown of Bohunice V1, the volume of waste to be disposed of in the near future has significantly increased. This increase of volume causes the need to enlarge the repository capacity for LILW-SL in the Slovak Republic.

In this context it appears meaningful, to analyze anew the existing regulatory boundary conditions ruling the disposal of LILW-SL, especially in regard to disposal options and the existing waste categories.

## **PROJECT OBJECTIVES**

The purpose of the feasibility study project is to analyze alternatives for optimization of LILW management in the Slovak Republic as well as for the enlargement of the NRR at Mochovce to dispose of the waste generated by the decommissioning of the nuclear power plants Bohunice A1 and V1 as well as those arising from the operation of the Mochovce and Bohunice V2 NPPs.

The current Slovak waste classification does not distinguish between different activity contents inside the LILW-SL category. An optimization of waste management and disposal can be attained by adhering to the most recent advances in other European and overseas countries, in which it is distinguished between:

1. LILW-SL with lower activity, usually called (Spain, France) very low level waste (VLLW), and
2. LILW-SL with higher activity content, called for the purpose of this study LILW\*

Given the amount, nature, and activity level of the waste that will be generated in the future decommissioning activities, as well as some waste generated by the operation of NPPs and other institutional wastes, it appears reasonable to study in detail the strategy selected in some countries like Spain and France, that lead to implementing a very low level waste (VLLW) disposal facility, which specific waste disposal costs significantly lower than in existing surface disposal facilities.

Likewise, it appears meaningful to perform an optimization of containers currently in use at the NRR, taking into account the level of activity of the different waste streams.

In Slovakia currently all LILW-SL fulfilling the NRR's waste acceptance criteria is packed in FCC, irrespectively of their activity level. These packages are over-designed for VLLW as well as for some of the LILW\*. Improving the waste management by choosing an optimized waste packaging for these kinds of waste could potentially lead to substantial benefits by cost reductions, saving waste management time, and avoiding some system restrictions. The present feasibility study aims at studying such optimization alternatives.

With that, the objectives of the project can be more precisely defined as:

- *Conceptual design of a VLLW disposal facility*
- *Optimization of the packaging system currently in use for disposal of low and intermediate level waste by proposing a new container for some of these wastes (LILW\*) depending on the waste activity level.*

This will lead to a number of conceptual models to be considered in the further course of the project, consisting of one or more of the following facility designs:

- *The existing NRR disposal facility with existing packaging system,*
- *The existing NRR disposal facility using new containers for certain class of LILW\**
- *A new disposal facility for VLLW*

The different waste streams resulting in the Slovak Republic from the operation of Bohunice V2 and Mochovce NPPs and from decommissioning of A1 and V1 units 1 and 2 at the Bohunice site will be classified according to their activity levels for each of these mentioned disposal solutions.

Depending on the outcome of conceptual planning of alternative disposal options and the estimation for the different waste streams, the question of the optimum location for respective disposal facilities will be investigated and evaluated.

The alternatives to be considered as site for the NRR enlargement are

- *The existing NRR site*
- *The Mochovce nuclear power plant site*
- *The Bohunice nuclear power plant site*
- *A new site elsewhere in the Slovak Republic*

The final objective of the project is to study from technical, economical, scheduling, safety and environmental point of view eight given alternatives resulting from combining different containers, type of disposal facility and potential sites. On this basis a solution that optimizes waste management and disposal from the mentioned standpoints including the necessary enlargement of the existing NRR can be proposed.

## **PLANNED PROJECT OUTCOME**

The project results will be condensed into four deliverables, as follows:

1. Deliverable C9-D0: Implementation Methodology

2. Deliverable C9-D1: Input Data
3. Deliverable C9-D2: Conceptual Design Assessment of the Alternatives
4. Deliverable C9-D3 Preliminary Safety and Environmental Study

The Methodology for carrying out the work has already been established in detail, and consists of the following four work phases:

- During Phase I, work was focusing on obtaining and evaluating the necessary data and information needed to carry out the project. At the end of this phase Deliverable C91-D1 was submitted summarizing the state of knowledge and information available for the execution of the project. Together with Javys it was decided on how to deal with missing or uncertain data (collection of missing data, conservative assumptions, or sensibility studies, depending on the individual case).
- In the current Phase II, which started in October 2007, a number of alternatives for the enlargement of the NRR have been defined. This includes the conceptual design of these alternatives, the determination of the waste acceptance criteria for each new conceptual design and waste classification. In parallel, a set of ranking criteria and exclusion criteria are being defined for the early selection of feasible options and their later evaluation. These criteria will be discussed with all involved parties to decide on their suitability for minimizing the range of potential alternatives in order to concentrate the main effort on the most promising ones.
- In Phase III, which also started at the end of 2007 and which will run to a great extent in parallel to Phase II, the defined alternatives are being assessed from the technical, economical, scheduling, and safety/environmental point of view. One of the first steps during this phase will be the application of exclusion criteria to exclude non-suitable alternatives. The exclusion criteria will be continuously applied during the subsequent detailed investigation of the remaining alternatives. At the end of this phase the results for the remaining alternatives will be presented and the optimum alternative will be selected in agreement with Javys.
- During Phase IV, to start during the spring of 2008 the preliminary safety analysis and the preliminary environmental study will be carried out for the optimum alternative selected at the end of Phase III. At the end of Phase IV, the final detailed evaluation of the optimum alternative will be carried out, thus setting up the basis for future decisions on the NRR enlargement.

## **CONCLUSIONS AND OUTLOOK**

The Feasibility Study for the Enlargement of the National Radioactive Waste Repository at Mochovce has started earlier this year after a comprehensive international tendering procedure. The project is a key element in the process of decommissioning the NPPs Bohunice A1 and V1

Unit 1 and 2, as the enlargement of the repository capacity is necessary for disposal of the resulting radioactive waste.

An international team has been set up around the consortium of INITEC Nuclear S.A.U. of Spain and DBE TECHNOLOGY GmbH of Germany with the participation of EGP Invest of the Czech Republic and EKOSUR of the Slovak Republic as local subcontractors. Work started with the detailed definition of the approach selected to execute the project work and to review and compile all data and information necessary for the project execution. Currently the main emphasize is on the further elaboration of the developed conceptual design for a repository for VLLW and on waste volume calculations to estimate the required capacities for the planned enlargement.

The project is aimed at delivering a dedicated solution especially for the VLLW resulting from decommissioning the mentioned three reactor units, and is likely to become a valuable example for the decommissioning of further NPPs in Bulgaria (Kosloduy) and Lithuania (Ignalina), which also has been or will be phased out in the framework of the accession of these countries to the European Union.

## **REFERENCES**

1. Decree Nr. 53/2006 of the Nuclear Regulatory Authority of the Slovak Republic, Laying Down Details on Requirements for Handling of Nuclear Materials, Radioactive Wastes, and Spent Nuclear Fuel.