M. BARTKO, J. BALÁŽ, B. PANDULA

ISSN 0543-5846
METABK 53(1) 105-108 (2014)
UDC – UDK 550.378.002:68:351.78.006:437.6=111

SLOVAC REPUBLIC REPOSITORY OF RADIOACTIVE WASTE

Received – Prispjelo: 2013-03-29
Accepted – Prihvaćeno: 2013-05-30
Review Paper – Pregledni rad

The Slovac Republic Repository of Radioactive Waste (radwaste) in place Mochovce presents a multi-barrier repository of the surface type designed as an ultimate storage of treated solid and fixed, low-and very low-level radwaste generated during the operation and decommissioning of the nuclear power plants, in research institutes, laboratories and hospitals in the Slovak Republic. The isolation of the radwaste and retardation of the radionuclides are provided by the barrier system of the repository. To assess the complete system and parts of one of the most important barriers – the multi-barrier ultimate shielding of the repository – the model of the ultimate shielding of the repository was designed. The monitoring results of the model " in situ" will be applicable for projecting the ultimate shielding of the repository.

Key words: radioactive waste – storage, safety bariers, special long containers, special galeries and shafts

INTRODUCTION

The term radioactive waste (radwaste) refers to any byproducts of nuclear power generation which cannot be transported into the environment due to its high-level content of radionuclides and causing non-removable surface contamination.

The liquid and solid radwaste generated in operation in nuclear power plants is treated by suitable technologies to achieve a state meeting requirements on ultimate disposal. The long-term international experience proved that for ultimate disposal of these types of waste the most appropriate repository has to be situated in a natural geological environment proving optimal characteristics. Both the natural characteristics of the nearby geological environment and the engineering ones provide required conditions for the isolation of the radwaste from the environment.

The process of the ultimate disposal of treated low and very low-level radwaste generated in operation in the nuclear power plants and in other operations in the area of SR was completed by the construction of the Republic Repository of Radwaste and its putting into service in Mochovce (Figure 1).

CONSTRUCTION AND OPERATION OF THE RR OF RADWASTE IN MOCHOVCE

The construction of the repository was performed in two stages. Within the first stage in the period of 1986 - 1992 there were constructed two double-row reinforced concrete disposal boxes, the operational facility and road communications.

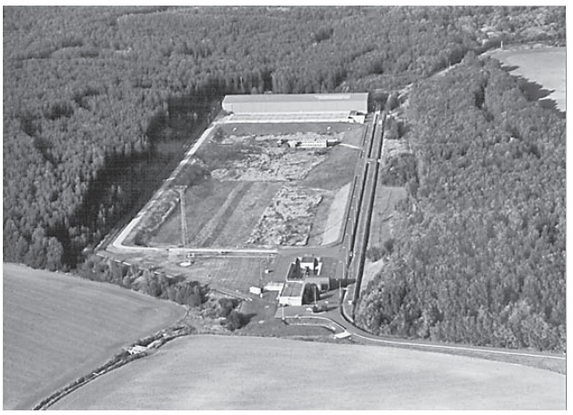

Figure 1 Site of the Republic Repository of Radwasts

The second stage of the construction in the period of 1996-1999 was focused on completing processes in compliance with international procedures MAAE (WATRP), 1994 and locus standi of Nuclear Regulating Authority of SR of 20 January 1995 which set the requirements on a repository to be put into service and after meeting the above listed requirements the process started .

The most demanding issues from the viewpoint of completing the process were the followings:

- working out of drainage system design including treatments and measures in order to provide collecting water from individual disposal boxes and measuring water activities.
- provision of repository shielding during the whole process of storage.

Within the initial stage of this process it was requirable to resolve the problem of perspective drainage, dewa-

M. Bartko, Intergeo, Bojnice, Slovakia, J. Baláž, Javys, Bratislava, Slovakia, B. Pandula, Technical University of Košice, Institute of Geosciences, Košice, Slovakia

Figure 2 Monitoring tunnels

tering and monitoring systems in order to be in compliance with the requirements of Nuclear Regulating Authority of SR. First some alternative static measurements have to be performed of perspective laying down and deflection of the repository after its successive filling and moreover the method of new drainage tunnels boring performed longitudinally the repository in compressed clay, furthermore the method of interconnecting of underground tunnels, chambers and disposal boxes, protection of inforced concrete boxes as well as protection of tunnels against the penetration of rain water and a lot of other technical issues were resolved (Figure 2) [1 - 4].

The Nuclear Regulating Authority of SR issued a regulation on Nuclear Facilities RR of Radwaste to be put into service on 25 October 1999.

On 14 June 2000 the first fiber reinforced concrete container (FRCC) with radwaste was stored within a year pilot run of the repository. Consequently after the complete assessment of the pilot run the Nuclear Regulating Authority of SR due to its Regulation No. 172/2001 approved the operation of the Republic Repository of Raswaste, i.e. from 14 September 2001 the repository is in permanent operation [5].

After ten years of operation there were performed periodical assessments of the nuclear safety of the repository. According to the results of the periodical assessment the Nuclear Regulating Authority of SR issued the Regulation 490/2011 allowing the operation of the repository for next ten years. At the end of the year 2012 the total amount of 3090 FRCC with radwaste was stored**.** In the recently stored containers comprise fixed waste from the operations SE-EBO, SE-EMO and from the commissioning of the nuclear power plant A-1.

CONSTRUCTION ACCOMPLISHMENT OF THE REPUBLIC REPOSITORY OF RADWASTE IN MOCHOVCE

Currently two double-rows of disposal boxes are in operation in the RR of Radwaste in Mochovce which present the capacity of 7200 FRCC with radwaste while waste is being stored in the first double-row of the disposal boxes.

In the original project the site of the RR of Radwaste in Mochovce (ca 11,2 ha) was designed for placing ca 10 double-rows of disposal boxes, each one with the capacity of 3600 FRCC with radwaste and moreover the construction of new disposal boxes was planned with a sufficient additional storage capacity after filling the current free ones.

There emerged the necessity to accomplish the construction of the repository of radwaste in a quicker way as two blocks of the nuclear power plant in Bohunice were decommissioned earlier and it was necessary to store radwaste resulting from the process of decommissioning. The next reason for carrying out this operation was that it was supposed that ca in the year 2014 the first double-row of the repository would be filled with stored FRCC with radwaste.

Due to the above listed issues it was decided on a gradual construction accomplishment of the RR of Raswaste in Mochovce. Within this stage of lifecycle of the repository there will be performed the following investment operations:

- Putting into service of the second double-row disposal boxes
- Construction accomplishment of the RR of Radwaste (Figure 3):

1. Construction of the 3. double-row of the repository for storage of low-level radwaste
2. Construction of the disposal for the storage of very low-level radwaste [6].

All the listed activities will be carried out in the current site of the nuclear facility of the RR of Radwaste in Mochovce.

MODEL OF ULTIMATE SHIELDING OF THE REPUBLIC REPOSITORY OF RADWASTE IN MOCHOVCE

The basic safety principle of RR of Radwaste is to prevent release of radionuclides contained in radwaste into the environment during its operation and institutional inspection in order to not achieve higher radiation exposure values than those determined by current legislation in force.

The function of the barriers system of the repository is to prevent the release of radionuclides contained in the radwaste:

- natural geological barriers
- engineering barriers:

fixing matrix, steel-reinforced concrete facilities of RR, fiber-reinforced concrete containers, filling of the interspace among boxes (backfilling), drainage system, clay sealing bed around double-rows, multi-barrier ultimate shielding (Figure 4).

Figure 3 Design proposal of construction accomplishment of RR of Radwaste

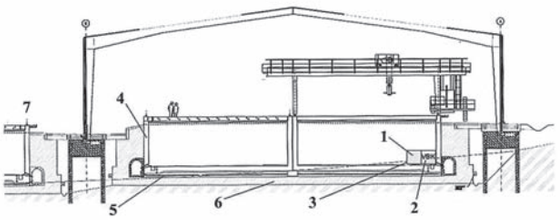

Figure 4 Barriers of the repository, 1- matrix, 2 - fiber-reinforced concrete container, 3 -backfilling, 4 - steel-reinforced concrete facilities of disposal boxes, 5 - drainage layer, 6 - clay sealing, 7- geological formation

One of the most important engineering barriers is the multi-barrier ultimate shielding of the repository. The aim of the ultimate shielding is to ensure separation of the stored radwaste from the environment by the system of filling and shielding layers which will prevent penetrating of surface water into the repository and its contact with stored radwaste and during the period of institutional inspection it will be sufficiently resistant against further errosive activities of the natural environment. The project design of the repository shielding is proposed with the aim of minimizing the maintenance needs of individual parts of the repository during the institutional inspection of it. Therefore a stabile system of passive barriers was selected for shielding of the repository.

The basic idea of the project design of the model of shielding of RR of Radwaste is currently in process of project finalizing focusing on the selection of those parameters influencing the long-term functionality of shielding, monitoring the parameters of the shielding and the last task is to conclude the issues of the technical solutions.

In 2000 there was worked out a project design presenting the proposal of a miniature model of the repository shielding of RR of Radwaste in Mochovce. In 2005 this model was constructed and put into service in the site of the repository.

The shielding model of the repository is aimed at a long-term monitoring of those parameters necessary for providing long-term functionality of the ultimate shielding of the RR of Radwaste in Mochovce. The model in situ refers to monolitic solution of the shielding applying one clay-sealing layer with 2 m thickness protected by shielding layer consisting of soil and gravel mixture with 1 m thickness. The dimensions of the model fitted on the steel-reinforced concrete bearing plate are approximately 50 m x 50 m with the hill slope 1 : 2,3 a 1 : 4,6. The model is situated in the southwest part of the site of RR of Radwaste in Mochovce [7].

In the model the features of the most important part of the ultimate shielding will be monitored – i.e. the sealing clay layer. Currently the features of the shielding soil layer are being monitored as well which protects the clay layer against the atmospheric exposures. The monitoring results are applied as initial data for mathematical modelling of the geotechnological issues of the shielding and in the future they will create the base for design of the optimal ultimate shielding of the repository. Long-term monitoring (15 - 20 years) is assumed depending on monitoring results and requirements on capacity extension of the repository.

Four parameters such as the geometric shape of the model, surface erosion, surface deformation of the shielding layer, condition of vegetal shielding are monitored in a long-term period and moreover five parameters (soil humidity of the sealing and shielding layers, soil temperature of the sealing and shielding layers, content weight of the sealing layer soil, filtration coefficient of the sealing soil and shielding layers, climatic influences).

Due to the actual monitoring of the shielding model it can be assessed that our assumptions on and the reasons for its successful construction in the site of RR of Radwaste in Mochovce have been met. The most important issue is monitoring of the sealing layer compactness which proves to be well-preserved due to sample taking and the assessment of physical properties of the soil and moreover according to measurements results of content humidity, content weight and the determined filtration coefficient. The monitoring confirms and verifies the long-term seafety of the repository and meets the basic assumptions applied in the evaluation of long-term safety [8].

The ultimate shielding of the repository provides complete safety solution of the repository and its implementation into the environment. The perspective project design is based upon actual know-how, technological options as well as upon own solution of the repository and geological conditions [9 - 13].

The shielding of the repository will be performed in two stages. After laying of the double-row disposal boxes with FRCC containers the so-called first stage of repository shielding will start. This stage will consist of filling the interspace among disposal boxes the so-called backfilling, the construction of monolitic steel-reinforced concrete plate with isolation layers and diversion of rain water from the space of the clay bed. After the

planned disposing of all FRCC with radwaste in the repository and decision on disposal finishing in the site, the accomplishment of the first stage of the shielding of all double-rows the II. stage of the repository shielding will be proceeded. Within this stage there will be constructed the ultimate shielding of the repository consisting of two meter thick compressed clay layer with one meter thick sealing(protective) layer of soil and with gravel drainage layers. Both the shutdown of the operation of RR of Radwaste and the accomplishment of the II. stage of the shielding are assumed to be concluded approximately in 2080 [14].

CONCLUSION

By the construction and putting into service of the Republic Repository of Radioactive Waste in Mochovce there was completed the last stage of treating radioactive waste (storage of radwaste). The main issue of storing treated and processed low-level radwaste from the operation and decommissioning of the nuclear facilities is to provide separation and proper isolation from man´s environment. To prevent the penetration of rain water into the stored waste and the release of radionuclides contented in radwaste into the environment it is requirable to provide a barrier system of the repository. The ultimate shielding of the repository is one of the most important barriers which has to meet significant requirements. This shielding will be exposed to stress and influenced by different external factors (climate, erosion and last but not least man´s activities in this area and nearby environment). As a consequence this interdisciplinary issue concerning the structure and thickness of layers applied in different stages of the shielding construction has to be taken into cosideration and dealt with already in the operational period of the repository. Only due to the substantial assessment of appropriate parameters of the repository shielding can be made a design project of a sophisticated, long-term functional ultimate system of the repository shielding. Taking into consideration all the above cited reasons for monitoring the individual parameters of the shielding in the site of the RR of Radwaste there was constructed a model of ultimate shielding of the repository.

Acknowledgement

This article was created with the support of the OP Research and Development for the project: ITMS 2620220031, co-funded by European Regional Development Fund.

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Note: The responsible translator for English language is H. Semanová, Department of Languages, Technical University of Košice, Slovakia