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DISPOSAL OF LOW AND INTERMEDIATE LEVEL WASTE IN HUNGARY

ODLAGANJE OTPADA NISKOG I SREDNJEG STUPNJA RADIOAKTIVNSTI U MAĐARSKOJ

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Abstract

There are two operating facilities for management of low and intermediate level radioactive waste in Hungary. Experience with radioactive waste has a relatively long history and from its legacy some problems are to be solved, like the question of the historical waste in the Radioactive Waste Treatment and Disposal Facility (RWTDF). Beside the legacy problems the current waste arising from the Nuclear Power Plant (NPP) has to be dealt with a safe and economically optimized way.

Sažetak

U Mađarskoj postoje dva operativna postrojenja za upravljanje otpadom niskog i srednjeg stupnja radioaktivnosti. Iskustvo sa radioaktivnim otpadom ima relativno dugu povijest i iz njegovog naslijeđa se moraju riješiti neki problemi kao što je pitanje povijesnog otpada u Postrojenju za obradu i odlaganje radioaktivnog otpada (RWTDF). Osim naslijeđenih problema, potrebno je riješiti na siguran i ekonomski optimiziran način otpad koji nastaje u nuklearnoj elektrani (NPP).

1. Introduction

The history of the Hungarian nuclear and radioactive applications reaches back to 1959, when the Budapest research reactor began its operation. Since then quite significant amount of radioactive waste has been generated, a part of this byproduct coming from the institutional sources (research and training reactors, universities, hospitals, industry, etc.) and a much bigger portion is from the operation of Hungary's only Nuclear Power Plant (NPP) in Paks. The responsibility of safe management, storage and disposal of all radioactive waste generated in Hungary is the duty of Public Agency for Radioactive Waste Management (PURAM).

Currently two waste disposal and storage facilities are in operation in Hungary. The older facility has a total disposal capacity of 5,040 m^3.

Hungary's other facility is the National Radioactive Waste Repository (NRWR) which is near Bátaapáti village and now it is partly in operation; its surface facilities are in operation and currently 3,000 drums of compacted radioactive waste from Paks NPP is puffer stored there. The underground disposal chambers are now under construction and the first chamber is going to be put in operation by the end of 2012. The NRWR is designed to accommodate all operational and decommissioning radioactive waste arising from Paks NPP.

In Hungary, radioactive waste disposal in geological formation was always considered as a final solution. The very first disposal facility was put into operation in 1960 in Solymár, which was a near surface repository with a capacity of approx. 900 m^3. It operated until 1976, when a newly designed near surface repository started its operation in Püspökszilágy.

The Püspökszilágy Radioactive Waste Treatment and Disposal Facility (RWTDF) adopted the radioactive waste from Solymár of which operation had been terminated, because of safety reasons and the all of the waste disposed in the very first site was retrieved. RWTDF's bigger capacity made it possible to accommodate all radioactive waste from previous facility and from all sources in the state.

Operation of Paks NPP started in 1982 and the solid waste (compacted, non-compacted waste in drums, air filters, etc.) generated here was transported to the RWTDF, and was disposed in the concrete vaults of the facility. The shipments from the NPP to the RWTDF were seized between 1990 and 1991 and finally terminated in 1996. In the meantime the management of the Paks NPP decided to expand the capacity of the RWTDF and after the expansion the final capacity of the repository has been achieved.

In 1993 a state research program was initiated in order to find suitable site for the low and intermediate level operational and decommissioning waste generated in

Paks NPP. After the site selection procedure the detailed geological survey of Bátaapáti area began in 1997. This area is found to be suitable for a geological repository with its granite host rock so the licensing procedure for the implementation of the facility began and the facility claimed its license in 2008. The license allow the facility to puffer store 3,000 drums with solid radioactive waste content, which is more than the three years waste production of the NPP.

2. Current status of the existing disposal facilities

2.1. Püspökszilágy RWTDF

The RWTDF is situated on a hilltop between the villages Püspökszilágy and Kisnémedi, approx. 40 km from the Capital. (Fig. 1) The facility is separated into two areas: radioactive waste treatment building and disposal site. In the technological building radioactive waste treatment and temporary storage are possible. A 50 kN compactor is installed to reduce the volume of the compactable waste, and cementing liquid radioactive waste also can be done in the facility. A hot cell was introduced in 2006, where spent sealed radioactive sources (SSRS) could be safely manipulated.

The disposal site has concrete vaults:

- "A" type, 60 x 70 m^3 and 6 x 140 m^3
- "C" type, 8 x 1 m^3.

Steel tubes for disposal of SSRS: "B" and "D" types (Fig. 2)

Initial disposal capacity of the RWTDF was 3,540 m^3, since the operational waste from the NPP used up most of this volume, an extension was carried out that increased the capacity to 5040 m^3.

2.1.1. Safety upgrade of the RWTDF

In 1999 PURAM took over the operation of the RWTDF and a performance assessment program was initiated involving foreign experts. After the safety analysis there were concerns about the long term safety of the facility. It turned out that there might be a scenario when the members of the public may suffer significant radiological impact. It may occur because of the lack of waste acceptance criteria in the earlier period of the operation and some long lived unconditioned radioactive sources were disposed in the shallow concrete vaults.

The facility is facing with another problem: by the end of 2005 all available disposal capacity was exhausted, therefore the only way to receive institutional waste was to use the temporary storage capacity in the basement of the technological building.

To improve the safety, PURAM started a safety upgrade program whose goal was to retrieve segregate, condition and redispose legacy waste using appropriate waste acceptance criteria. The side effect of the safety improvement is an increase in the capacity, which can be achieved by the proper conditioning of the historical waste. That means compaction of the compactible waste and optimized arrangement of the non-compactable waste.

The preparation period for the safety upgrade program started in 2003, with safety assessments and feasibility studies that ended with a license application. Physical intervention started in 2007 with the demonstration phase when four concrete vaults were opened up and their content was treated to fulfill the waste acceptance criteria. The goal of the demonstration phase was achieved: the feasibility of the intervention had been proven, the methods of the waste retrieval, characterization and recondition were tested.

The experience gained in the demonstration phase is a valuable input for the follow-up, when the first two "A" vault rows (soil covered in the Fig. 2) are going to undergo the safety upgrade procedure.

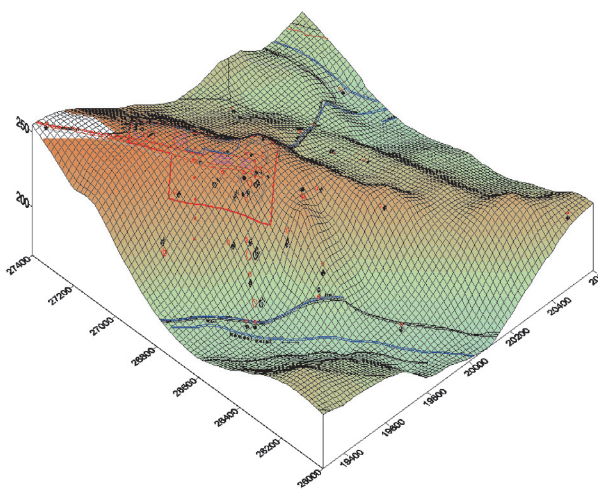

Figure 1. Location of RWTDF on the hilltop between two villages.

Slika 1. *Lokacija RWTDF na vrhu brijega između dva sela*

Figure 2. Aerial view of the RWTDF. On the left: technological building, on the right the disposal area: two soil covered "A" type vault rows and two without soil cover. "C" type vaults and the steel tubes for SSRS are situated between the soil covered and uncovered rows.

Slika 2. *Pogled iz zraka na RWTDF. Lijevo: tehnološka zgrada, desno, područje odlaganja: dva reda odlagališta "A" tipa prekrivena tlom i dva reda bez pokrova tlom. Odlagališta "C" tipa i čelični spremnici za SSRS su smješteni između tlom prekrivenih i nepokrivenih redova*

2.2. Bátaapáti NRWR

The estimated amount of the operational radioactive low and intermediate level waste (LILW) from the Paks NPP is about 18,000 m^3, not counting the radioactive waste from the dismantling of the plant. Currently an overview of decommissioning plan of the NPP is going on, with an in situ characterization. After its implementation of the throughout examination a reliable inventory of decommissioning waste is going to be available.

The amount of this waste requires high disposal capacity.In 2003, the Hungarian Geological Service dedicated Bátaapáti research area suitable to host the geological repository for low- and intermediate level waste (LILW) originated from the NPP. The idea was to build an underground repository in granite host rock. The disposal would be done in disposal chambers using concrete containers. It was planned to put nine 200 l drums (solid waste and ion exchange resins) into one container. For cemented radioactive liquid waste, 400 l drums would be used and in this case five drums would be put into one container.

License application for implementation was submitted to the authorities in 2007 and it was approved. The operational license for the surface facilities was gained in 2008 and the first shipment of solid waste drums was received in that year.

2.2.1. Description of the geological formation hosting the repository

The research program lasted until the access tunnels reached the level of the planned disposal chambers. During the excavation of the chambers numerous tests (i.e. multi-packer tests, geophysical measurements) were carried out and the results helped the experts to understand the hydro-geological behavior of the host rock.

It became obvious that the host rock in the Bátaapáti site is fractured and the water migration is only possible through the fractures in the granite. Studies on the modeling of hydro-geology and contaminant transport, (based on measured data) were carried out and found the roles of different fracture types in the contaminant transport.

The bulk of the fractures are in the background fracture system, these are small cracks, which have very advantageous property from the migration point of view: this is matrix diffusion. It is a property that gives a great robustness to the disposal system.

Some fractures have relatively high hydraulic conductivity (called Main Conducting Fracture – MCF); these formations can offer a fast reach pass way for contaminants. To avoid them, criteria were introduced which specifies the distance between the disposal chamber and MCF. Because of the hydro-geological criteria the first two chambers excavated in 2011 are slightly different from the original plans.

The formations that make Bátaapáti host rock unique are the zones which have very low hydraulic conductivity. Because of these sealing zones (Fig. 3) we can talk about separate hydro-geological blocks in the area. These areas are not hydraulically connected with each other only near the surface, where the high conductivity of weathered granite upper layer makes water flow possible between the separated areas. The blocks are behaving like basins, which have outflow only on their top.

Regarding this feature of the disposal system, it is very important to seal and plug the openings with special attention to the access tunnels, not to leave shortcut for the migration between the hydro-geological blocks.

2.2.2. Operation of NRWR

Currently only the facilities on the surface have operational license: receiving shipments from the NPP and buffer store drummed solid radioactive waste.

In the mid 2012 application for operational license of the first chamber is going to be submitted. According to the schedule, in the beginning of 2013 the first concrete containers are going to be disposed there. Final disposal will start with the oldest, so called "historical" waste. This kind of waste was generated before the waste acceptance criteria, and its application to the NPP: waste form specification entered into force. It would have taken much higher effort to reexamine these drums than to dispose them in concrete container.

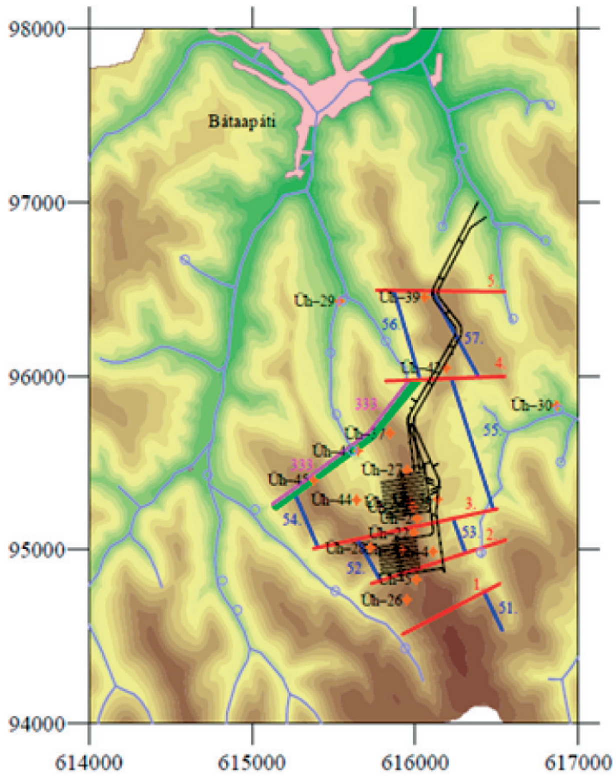

Figure 3. Approximate location of the sealing zones in the disposal area of the NRWR. (Axis are in meters)

Slika 3. *Približna lokacija brtvenih zona u odlagališnom području NRWR-a (Osi su u metrima)*

3. Future challenges in the repository program

3.1. Introducing VLLW category in Hungary

Updating decommissioning plans is a constant duty of PURAM. In the studies examining the decommissioning waste inventory, the same expectation formed as the worldwide experience: radioactive waste from dismantling nuclear facilities produce large volumes of debris and scrap metal waste, radioactivity concentration is just above the clearance level and the radioactive components are relatively short half-life isotopes.

There is no very low level waste category (VLLW) in the Hungarian legislation yet, but introducing this new type of waste (VLLW), will produce some oblivious benefits. A repository that guarantees the safe disposal of short-lived, very low active waste is a magnitude cheaper than the sophisticated disposal sites that have to last for thousands of years. Additionally site selection and licensing procedure might be a lot easier as well.

The procedure of introduction of VLLW category into the legislation system is just about to start and PURAM is planning to play pioneer role.

3.2. Optimizing LILW disposal system

As it was mentioned in chapter 2.2, concrete containers were originally regarded as disposal units for all kind of radioactive waste (solid or cemented waste forms). Because of the constant development of waste management in the NPP, a new way of the treatment of the liquid radioactive waste is just about to start industrial size operation. The result of the liquid waste treatment technology changes the waste forms to be disposed in the NRWR and radically decrease the volume of the waste itself.

Parallel with this improvement, NPP had decided to overview of the waste cementation technology and a new concept of solidification began to form: instead of cementing radioactive liquid into drums, radioactive grout (from liquid waste) is going to be used to fill up void in the disposal containers. In this case final waste package would be generated in the area of the NPP, instead of in the area of the NRWR. The new, smaller size container is planned to have reinforced steel walls.

The result of the new concept is a more compact, therefore a lot smaller waste package. According to the estimations one fourth of the number of the originally planned chambers would be enough to dispose all operational radioactive waste from the NPP 50 year's lifetime. This drastic reduction of waste volume would be a lot more economical way to dispose radioactive residue.

The new waste package requires a new way disposal as well. The planned change in the disposal concept is to build a high quality concrete vault in the disposal chamber and stack steel containers in them. (Fig. 4) The vaults are planned to have separate blocks, which could play two roles: reinforce the walls of the vault and make phased backfilling possible. Phased backfilling of the vaults enables the operator to create high quality engineer barrier near the waste with close control and without radical improvement of the "off-the-self" technologies.

Safety of the public is always above all economical optimization, therefore a safety assessment taking the considerations of the new disposal concept into focus was performed in 2011 and its results showed no doubts about disposal in steel containers and concrete vaults.

However it is long and hard way to improve promising plans into economic practice. NPP and PURAM initiated a joint project to work out details of the new disposal concept and gain the necessary support from the authorities. According to the schedule, 2017 is going to be the year when the first shipment of the compact waste package arrives to the NRWR.

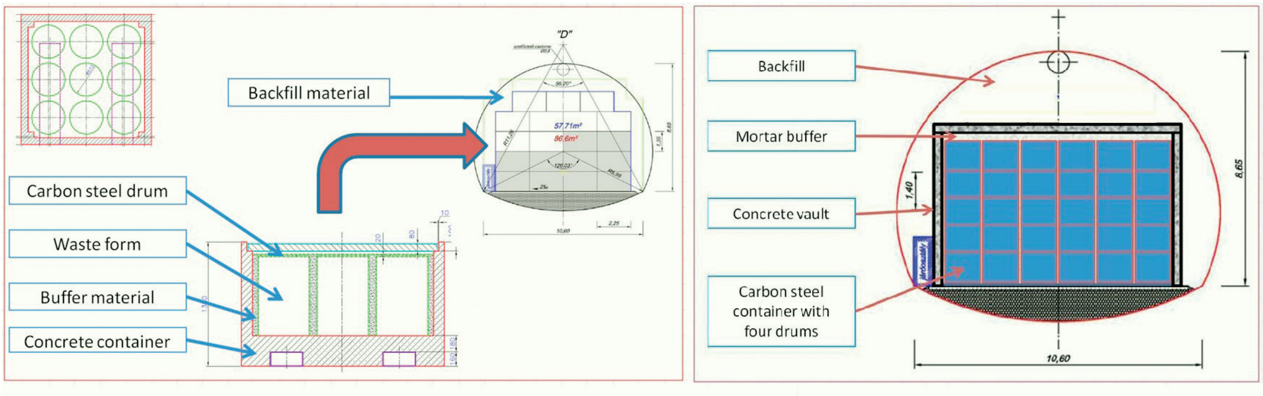

Figure 4. The originally planned disposal system of the NRWR on the left and new disposal concept on the right. On the left: 9 pcs of 200 l drums in one concrete container, filled with inactive mortar. 19 pcs (4x4+3) of concrete containers stacked in the disposal chamber. On the right: concrete vault introduced in the disposal chamber with steel containers stacked in it.

Slika 4. *Lijevo, izvorno planirani sistem odlaganja NRWR-a, desno, novi koncept odlaganja. Lijevo: 9 komada bubnjeva zapremine 200 l u jednom betonskom spremniku ispunjenom neaktivnim mortom. 19 komada (4+4+3) betonskih spremnika naslaganih u odlagališnoj komori.. Desno: betonski premnik smješten u odlagališnoj komori sa čeličnim spremnicima naslaganim u njemu.*

4. Summary

Because of the fact that Hungary is a relatively small country its specific nuclear capability is high, and from scientific and industrial applications radioactive waste is produced from the ‘50s. These facts indicate that management of LILW has to stand on a well-established system.

Safety upgrade in the RWTDF is a long and difficult job, but it is a necessary act to do, in accordance with the latest international safety principles. The driving force of this project is not to leave radioactive legacy for the future generations.

In a situation where current decisions form the fate of a large amount of radioactive waste, PURAM tries its best to have it done on a reasonably economic and a maximally safe way. The changes in the disposal system are going to be done with both these aspects taken into account.

Experience from the two operating facilities for the LILW lies behind PURAM, but it does not mean that there is no driving force for the constant improvement, optimization and self-examination. PURAM’s intention is to react with flexibility to the challenges waiting ahead.

5. Literature

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