Safety Upgrading of Maišiagala Site - 10416

Stasys Motiejūnas*, Algirdas Vaidotas*,
Michel Dutzer**, and Arūnas Gudelis***
* Radioactive Waste Management Agency, Lithuania, Vilnius
** ANDRA, France, Paris
*** Institute of Physics, Lithuania, Vilnius

ABSTRACT

From 1964 till 1989 unconditioned institutional radioactive waste from Lithuania and neighboring countries was disposed of in Maišiagala repository. Short-lived waste and long-lived waste were buried together. An increase of tritium concentration in groundwater was observed soon after conservation of the site. A new capping system above a concrete vault with waste was installed in 2006. A new cover consists of two layers of a HDPE membrane. The ground water monitoring results confirm performance of the new capping system. The properly installed plastic membranes can provide sufficient isolation of the disposed waste and could be an optimal solution for rehabilitation of old repositories.

INTRODUCTION

Maišiagala Radon-type repository for solid radioactive wastes was built in 1963 and was operated from 1964 till 1989. The repository consists of a vault with volume of about 200 m^3. Walls and a floor of the vault were made of monolithic reinforced concrete.

Burial of a waste was started in 1964. An institutional radioactive waste from hospitals, industry and research centers was buried at the Maišiagala. Sections of the concrete vault were filed in chaotic way with unconditioned solid radioactive waste. Static electricity neutralizers containing plutonium and plates with tritium were loaded into the vault through an open hatch. Disused sealed sources were disposed of with or without biological shielding. Every year the waste in the vault was poured with a concrete. During closure in 1989, the vault was covered by a concrete slab and a layer of sand was filled above it.

Up to 80 different radionuclides were buried in the vault. Long-lived radionuclides (Cl-36, Pu-239, C-14, Ra-226, Ni-63, Bi-207, Cs-137, Sr-90, Eu-152, H-3) were buried here together with short-lived ones. At the closure date the total activity of the waste was about 340 TBq. At that time an inventory of tritium in the waste was about 275 TBq. Activities of Cs-137 and Co-60 were 56 and 7 TBq respectively. In addition, significant amounts of long-lived nuclides were buried here: about 0.3 TBq of Pu-239, 0.1 TBq of Ra-226, and 0.18 TBq of C-14.

Tritium is very mobile nuclide and can easily migrate in the environment. Significant tritium concentrations (up to nearly 30 kBq/L) were observed in the surrounding groundwater soon after conservation of the site. It was an indication of leakages from the disposal vault. The Radioactive Waste Management Agency (RATA) responsible for maintenance of the closed repository proposed to improve its safety. A repository's upgrading project was implemented in years 2004-2006 by a consortium consisting of two French companies (THALES and ANDRA) and two Lithuanian institutes (Lithuanian Energy Institute and Institute of Physics).

SAFETY UPGRADING MEASURES

The consortium mentioned above suggested an additional isolation of the repository in order to stop the migration of the radionuclides with ground water. Installation of a new cover above the vault with waste was the main improvement. Experts of the consortium investigated suitability of several cover design options: clay capping, metallic shelter, impervious membrane, and concrete dome. For comparison of these options they applied the following criteria: water permeability lower than 10^{-10} m/s, sufficient durability, limited weight, request for maintenance, failure detection, robustness to intrusion if the site was abandoned, complexity, and cost [1]. The four different capping techniques were compared:

- A clay layer of 0.5 – 1 meter, covered by a protecting soil layer;
- A metallic roof;
- PVC or HDPE plastic membranes emplaced above the vault and covered with natural soil protecting against sun rays;
- A concrete dome built above the vault.

Obviously, the layer of compacted clay is robust and would provide the required isolation during sufficiently long period of time. The main disadvantage of the clay will be an additional burden on the existing structures due to thick protecting layers. A dynamic stress during clay compaction could significantly damage integrity of the concrete vault. Also, the clay is rather vulnerable to bio or human intrusions.

The main disadvantage of the metallic shelter is a need for continuous maintenance.

A properly installed concrete capping would not present additional burden on the vault and makes the intrusion difficult. However, it would be difficult to assure very low water permeability. Also, the concrete must be well protected against frost. A special concrete might be required. Construction of the concrete dome is difficult and expensive. Also, the dome makes difficult to retrieve the buried waste if needed.

The PVC or HDPE membranes easily provide the required isolation if properly installed. This technique is very often applied at conventional waste disposal facilities; quality assurance measures are well developed. The membranes can be applied without any significant additional burden on the vault. However, the membranes would not significantly delay the intrusion into the repository. Currently, membrane manufacturers guarantee longevity of few decades only, however, durability of the membranes must be significantly longer in case of absence of chemical aggressiveness and ultraviolet rays. An assumed durability of the HDPE sheets is up to 150 years. Finally, the membrane capping option was selected to improve safety of the repository.

Also, the consortium developed a special seepage monitoring system in order to proof performance of the system and to detect failure of the membrane. The proposed cover consists of double watertight membrane system. The first membrane prevents infiltration of rain or snow melting water. The second introduced below the first has to catch any leakage through the first membrane in a case of its failure.

The consortium designed a new multilayer cover based on combination of two membranes with gravel and sand layers [1]. The cover has the following structure (from above):

- A layer of humous soil with thickness of 20 cm; the growing grass should prevent against erosion of slopes;
- A 40 cm thick protective layer consisting of sand and gravel;
- An impervious welded 2 mm thick HDPE membrane;
- An intermediate layer of gravel;
- Second HDPE membrane providing the monitoring;
- A layer of compacted sand above the concrete vault.

In the both cases Geotextile non-woven polymer felts are introduced above and below the HDPE membranes. They must to facilitate water drainage and to prevent the plastic membranes against punching. The total thickness of the cover is 1.2 m. According a technical specification of the membrane a water infiltration rate is less than 3 L/m^2/year and infiltration rate is less than 10^{-10} m/s. The soil layer above the polyethylene membranes protects them against solar radiation and intrusion of small animals.

In summer 2006 RATA installed the new capping system consisting of the additional double barrier on the top of the vault. The first watertight membrane stops infiltration of rain water into the vault and surrounding soil at a distance of about 5 m. The second control membrane collects eventual water leakage trough the first membrane. The water is collected by the second control membrane into watertight gutters filled with gravel. The gutters are connected with purpose-made stainless steel inspection tanks.

An Environmental Monitoring Program has been elaborated in order to demonstrate performance of the capping system. The inspections tanks were regularly checked, however no water was found here. Several water monitoring boreholes were installed and content of radionuclides in the groundwater is regularly measured. The tritium monitoring results are presented in the Fig. 1.

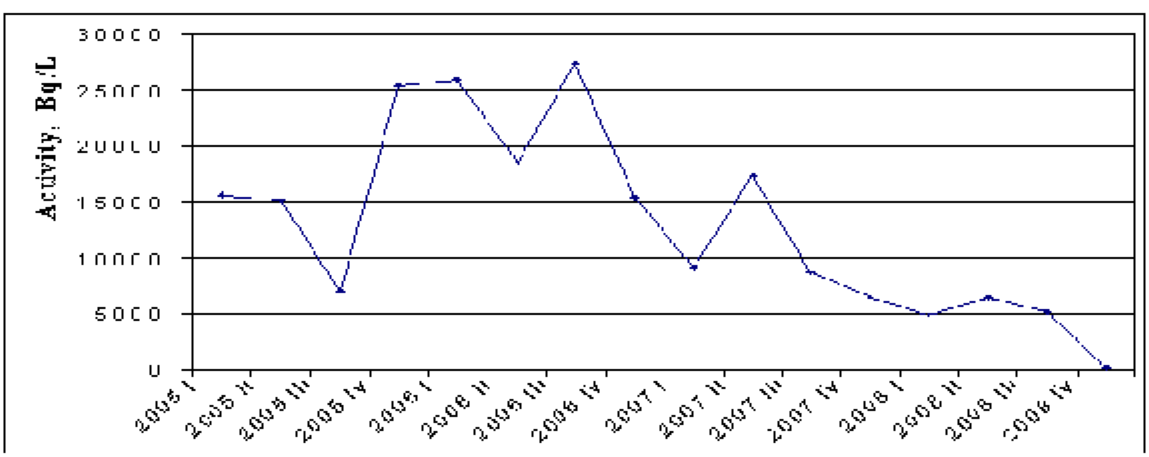

Fig. 1. Variation of tritium activity concentration in the ground water

A clear decline tendency was observed after two years of tritium concentration monitoring. In 2008 the measured tritium activity concentration in the groundwater only slightly exceeded 5000 Bq/L. The monitoring results confirm performance of the new capping system.

It is necessary to point out that the new capping system is not sufficient taking into consideration the inventory of waste. As fare as the content of long lived nuclides is rather high, the intrusion risk after institutional control period is too big. Due to it, first of all due to high alpha activity the disposed waste would be retrieved as soon as geological disposal will be feasible. The new capping system does not present additional trouble during eventual retrieval.

CONCLUSIONS

Properly installed HDPE membrane can provide sufficient isolation of the disposed waste and could an optimal solution for rehabilitation of old repositories. The predicted service time of membrane is up to 150 years. The longevity of the membrane would be sufficient for repositories containing short-lived nuclides only.

Emplacement of the plastic membranes above the disposed waste is simple, and reliable. The membrane welding technique is well developed and its quality easily controlled. A failure monitoring system could be easily installed and the cover repaired if needed.

The waste could be easily retrieved from vaults capped with the plastic membranes.

REFERENCE

1. "Safety Assessment and Upgrading of Maišiagala Repository (Lithuania). Safety Analysis Report", THALES, ANDRA, Institute of Physics, and Lithuanian Energy Institute (2005).