MANAGEMENT OF LOW-LEVEL LIQUID WASTE FROM UNDERGROUND TANKS OF NPP A-1 IN SLOVAKIA – RETRIEVAL, TREATMENT, TRANSPORT AND DISPOSAL

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ABSTRACT

This paper describes the management of low-level liquid waste from underground tanks located on the territory of the NPP A-1 in Slovakia. The overall management system including special technologies for the retrieval, treatment, transport and disposal is described.

A branch of Slovak national electric company Slovenske Elektrarne, Inc. named SE-VYZ is generally responsible for the implementation of safe decommissioning and radioactive waste management. The NPP A-1 Decommissioning Project – 1st phase is carried out from 1998 till 2005 in cooperation with company VUJE, Inc. as a general contractor. One of the main priorities of the above-mentioned on-going decommissioning project is decontamination of big underground tanks, which are located outside the main building of the NPP. Tanks were used for the storage of liquid radioactive waste during and after operation of the NPP A-1. This part of project includes also management of existing and created liquid RAW.

INTRODUCTION

The first nuclear power plant operated in former Czechoslovakia is the NPP A-1, located in Jaslovske Bohunice, near the town Trnava and approx. 60 km from the capital of Slovakia – Bratislava. The only one unit of the A-1 NPP (reactor cooled by CO2, moderated by heavy water and with natural uranium as fuel) is in the process of decommissioning. Nuclear power plant A-1 was in operation from 1972 to 1977 and was finally shutdown after accident (level 4 according to the International Nuclear Event Scale). Reactor unit of the A-1 NPP is in the preparation stage for decommissioning of its components. All spent fuel was transported to Russia. The part of turbine building is used for processing and storage of radioactive waste. Liquid radioactive waste except water of the spent fuel pool has been reprocessed and some intermediate radioactive waste from the main production unit has been partially treated.

Six units are in operation in the Slovak Republic (1st and 2nd unit of V-1 NPP, 1st and 2nd unit of V-2 NPP and 1st and 2nd unit of Mochovce NPP) at the prsent time. Two units are under temporarily stopped construction (3rd and 4th unit of Mochovce NPP). All mentioned reactors are of Russian design WWER-440, type V-230 and V-213.

A branch of Slovak national electric company Slovenske Elektrarne, Inc. named SE-VYZ is responsible for the implementation of safe decommissioning and radioactive waste management. The NPP A-1 Decommissioning Project – 1st phase is carried out from 1998 till 2005 in cooperation with company VUJE, Inc. as a general contractor. One of the most important tasks carried out by VUJE is the preparation of underground structures for decommissioning (e.g. the exterior underground tanks of the Active Wastewater Purification Station – AWPS etc.) including management of low-level liquid waste [1].

Retrieval of Low-Level Liquid Waste from Underground Tanks

The Active Wastewater Purification Station was used for purification of waste water and water from the special canalization system of the reactor building of the NPP A-1. AWPS consists of the building, where the main technological equipment for receiving and treatment of liquid waste are placed and the exterior/outdoor system of underground storage tanks. Some of the equipment such as the evaporator and other systems are still in operation after their reconstruction. Conversely, other parts of equipment have already been taken out of operation.

The storage tanks are situated underground next to the main AWPS operations building. The tanks were dedicated to collection of different liquid waste streams from the A-1 NPP reactor building. The tank diameters ranged from 6 m to 16 m and their internal structure are of various types. They were constructed from concrete with a special polyester glass reinforced laminate coating – often referred to as PESL. After many years of their use their integrity could be broken and this fact represents danger of possible release of liquid radioactive waste to the environment if operations were continued.

Generally, after several years of operation, there was a layer of sludge on the bottom of each tank and a separate layer of water. Moreover, different pieces of waste such as polyester foil, gloves and even small flasks were thrown on the bottom of some tanks and in inspection shafts of the tanks. All of these materials represented sources of contamination and it was necessary to first remove them from the tanks before proceeding further.

For retrieval of liquid waste as well as for other purposes (retrieval of solid waste, decontamination, cutting of internal tubes etc.), special manipulator named DENAR-41 was developed (Figure 1). This manipulator has massive modular load-bearing structure, which can be placed over each storage tank. Manipulator bears hydraulic arm(s) installed on vertical telescopic mast. The main difficulties in the development of the DENAR-41 were the large diameter of the storage tanks and the small opening for the inspection access (approx. 540 mm x 540 mm), through which the manipulator's telescopic mast is inserted into tanks. The DENAR-41 could also hold and maneuver robotic arm MT-80 and/or tools that are required to assist in waste retrieval.

Most of the remote handling activities performed using the manipulators were first computer simulated with initial mock-up testing being performed in 2001. Field works on decontamination of the AWPS underground tanks were performed from 2002 to 2004. By the end of 2004, the nine underground tanks had been fully decontaminated using a high-pressure water jet technology. The PESL covering was removed from the tanks and all surfaces were cleaned. Moreover, it was decided to develop a new movable cementation facility for the cementation of radioactive sludge retrieved from the above-mentioned underground tanks by DENAR-41.

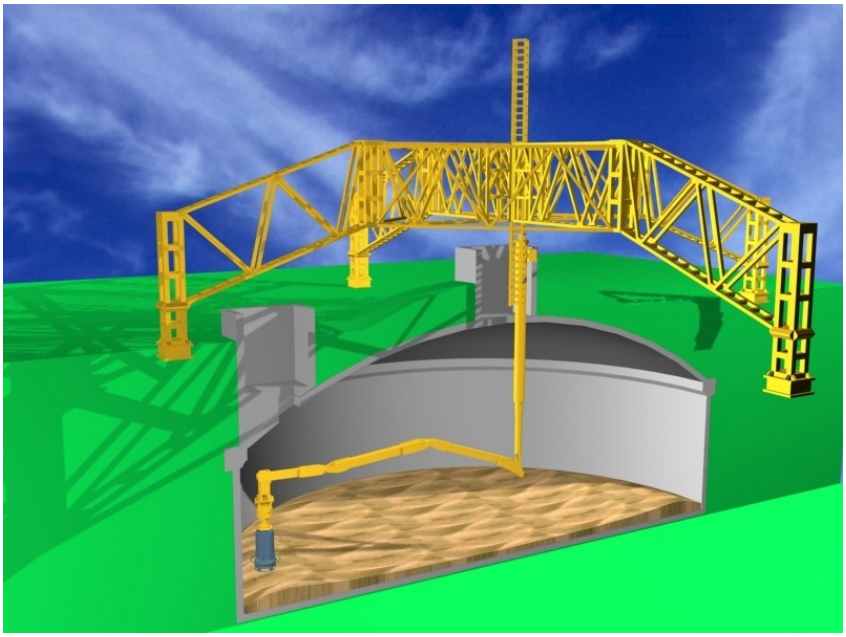

Fig. 1. Retrieval of waste from the underground tank (computer simulation)

Treatment of Low-Level Liquid Waste from Underground Tanks

A unique movable cementation facility was designed by VUJE, Inc. and SE-VYZ [2]. It is dedicated to treatment of liquid RAW and sludge or gravel retrieved from the underground tanks. Because the cementation facility is movable, it isn't necessary to use special transportation devices for sludge (e.g. special transport containers including fill up and drainage heads) between the underground tanks and the cementation facility itself. Sludge and/or gravel are pumped directly to the cementation facility (Figure 2).

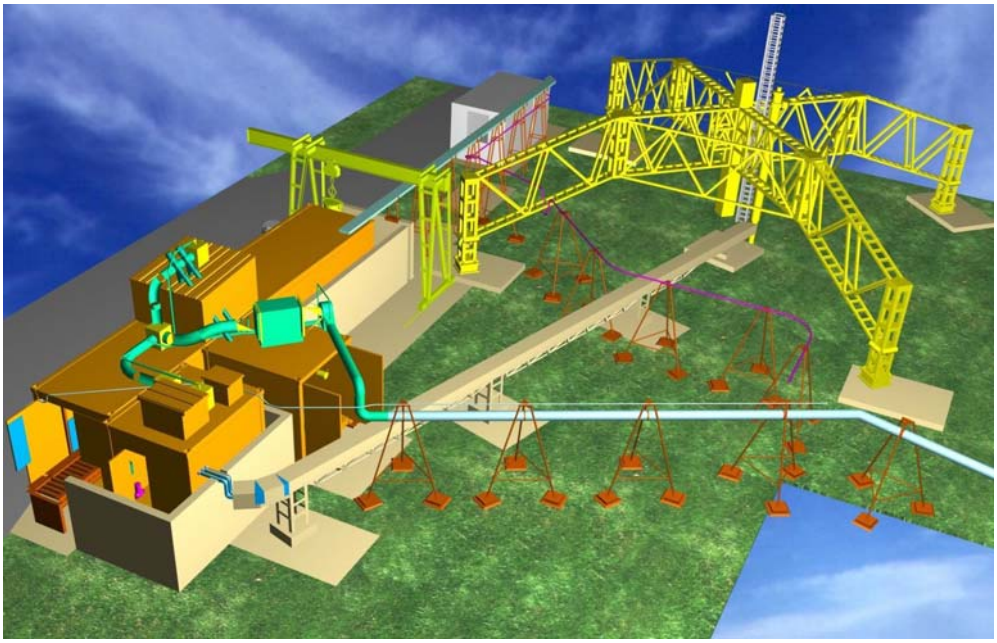

Fig. 2. Cementation facility and manipulator DENAR-41 (computer simulation)

Main equipment of the facility are installed inside standard ISO containers and thus the whole facility is relatively easy to transport and to install near any other tank with stored waste. Main technological equipment are shielded to protect the personnel. The most of technological operation are automatic and they are controlled from separate control unit. In-drum mixing technology is applied.

Standard 200 l drum with cemented product is the only output from the movable cementation facility. Expected output is from three to four drums per shift. Drums are transported by standard means to the Bohunice Waste Treatment Center to be placed and cemented in standard package for final disposal – fiber reinforced concrete container.

Transport of Radioactive Waste

Effective radioactive waste management should take the implications of transport into account. The act of Slovak Nuclear Regulatory Authority (NRA) on Peaceful Use of Nuclear Energy determines that all radioactive waste transports may be carried-out only on the basis of two kinds of Authority decisions. The first one is the approval for type of transport equipment used, represents the main conditions for the second decision, i.e. for transportation permission. Safety requirements are meet for both on-site and off-site transport on the basis of the IAEA Regulation No. ST-1. This regulation defines content and scope of documentation to be prepared by consignor as attachment of his request.

Presently the transport of the final product from the Waste Treatment Centre (NPP Jaslovske Bohunice locality) to the Disposal Facility (NPP Mochovce locality) is carried out by using packaging and transporting means approved for this purpose. Two pieces of containers are loaded on the truck (Figure 3). Before the container is sent for disposal, the package must be inspected to confirm that it meets demanding acceptance criteria at the repository. Possibility of

transport by train is now being considered. The prepared solution will make possible to transport twelve containers on three wagons within the frame of one transport.

Fig. 3. Transport of RAW from Jaslovske Bohunice to Mochovce Disposal Facility

Disposal of Radioactive Waste

Safety features of the near-surface disposal facility in Mochovce are ensured with engineering and natural barriers keeping the disposal vaults in dry conditions and avoiding the radioactivity release to the environment. The facility was built in geological formations with low permeability and high sorption capacity and the disposal vaults were surrounded by additional artificially constructed clay layer. The temporary and final covers are designed to avoid water penetration into the disposal vaults. The facility is designed for solid and solidified low and intermediate level radioactive waste disposed in special fibre reinforced concrete containers (license of French company Sogefibre approved by ANDRA) as an additional engineering barrier.

Disposal is the final step in the radioactive waste management system. The basic safety requirement is to avoid a radioactive release during its operation and institutional inspection. This commitment is covered by the protection barrier system. The method of solution designed and implemented at the disposal facility extension complies with the latest knowledge and practice of the repository developments all over the world and meets requirements for the safe radioactive waste disposal with minimum environmental consequences. Safety features of the near-surface multi-barrier disposal facility in Mochovce are ensured with engineering and natural barriers keeping the disposal vaults in dry conditions and avoiding the radioactivity release to the environment.

Construction of the disposal facility was executed from 1984 (project) to 1999 (finish). All contractors and subcontractors were from former Czech and Slovak Republic. There are

currently erected two double-rows at the Mochovce RAW National Disposal Facility, with the first one being covered by a steel hall. Each row consists of 20 concrete vaults. Each vault (18 x 6 x 5.5 m) has a capacity of 90 containers (Figure 4). Thus the current capacity of the facility 7.200 containers.

On June 14th 2000 was the first active cubical fibre reinforced concrete container with conditioned radioactive waste disposed in the facility. The testing operation of the facility was done to June 13th 2001. After the evaluation of it was execute and submitted to Slovak NRA. On the base of submitted documentation Authority issued the approval for full operation of disposal facility from September 2001.

Up to end of November 2004 there were disposed 766 containers. The operation of the disposal facility is the last part of RAW management. The Mochovce RAW National Disposal Facility safety is in compliance with current requirements on safety this type of nuclear facilities [3].

The radioactive wastes, which are not acceptable for the disposal facility will be stored at the integral storage installed at Jaslovske Bohunice site and after that will be disposed in the deep geological repository. The project of the deep geological repository is under development at the present time.

Fig. 4. Disposal of container into the concrete vault

CONCLUSION

The management of low-level liquid waste from underground tanks located on the territory of the Jaslovske Bohunice NPP A-1 in Slovakia includes retrieval, treatment, transport and disposal at the Mochovce RAW National Disposal Facility.

Retrieval and partially also treatment are provided within the NPP A-1 Decommissioning Project – 1st phase. Special retrieval and treatment technologies were developed and are used for the successful implementation of the project tasks.

Transport and disposal of the conditioned radioactive waste are the standard activities provided within the framework of the overall RAW management in Slovakia. Every part of the RAW management chain are now safely performed in Slovakia in accordance with relevant Authorities requirements and recommendations of the International Atomic Energy Agency.

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