THE INTERIM SPENT FUEL STORAGE AT PAKS NPP

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ABSTRACT

There are several nuclear power plants in the world, which have changed the back-end strategy of their fuel cycle in the meantime of operation. In the past, the spent fuels of Paks NPP, the only nuclear power plant in Hungary, was transported back to Soviet Union and later to Russia. Because of various reasons the Paks NPP has made a decision to change his back-end strategy and construct an Interim Spent Fuel Store (ISFS) at the existing, licensed site.

The ISFS facility is of modular type. This means that the construction of the reception building incorporates the equipment and systems necessary for fuel handling and the vault modules of the storage can be expanded to east and west, with further modules. The commissioning of the storage was performed in 1997 and its operation started in the same year.

During the first two years of its function 948 spent fuel assemblies were loaded to the storage. The operation of the Spent Fuel Storage Facility can be evaluated from radiation protection aspects, based on the radiation exposure of workers and neighbouring population, on the releases as well as the environmental impact.

The design and the construction of the facility was carried out taking into account the limits proposed in the latest international radiation protection recommendations as well as the ALARA principle. Comprehensive radiation protection surveillance is performing during the operation. The surveillance covers the personal exposures, the radiation and contamination conditions in the storage as well as the monitoring of the releases and the evaluation of the environmental impact of the facility.

On the basis of the data, resulted from the radiation protection surveillance the following statements can be done:

- The loading if the 948 spent fuel assemblies resulted a 4,6 man*mSv collective dose, which is a favourable low value.

- The release of the gaseous and liquid radioactive materials from the store since the beginning of the operation was dominantly below the detection limits in spite of the sensitive measurement techniques used. The activity of the released radioactive isotopes was negligible compared to the limits. The resulted excess radiation exposure of neighbouring population was found non-significant.

- The operation of the store had no measurable effect on the radiological situation in the environment and on the radioisotope concentration of the environmental elements.

INTRODUCTION

Like many other nuclear power plants in the world the Paks NPP had changed the back-end strategy of their fuel cycle already during operation. Earlier the spent fuels of Paks NPP after 5 years decay period were transported back to Soviet Union and later Russia according to an annually revised contact. Because of uncertainties of transportation and the Russian law concerning the storage of radioactive waste from abroad the Paks NPP made a decision to construct an interim spent fuel storage at the existing licensed site.

SELECTION OF INTERIM STORAGE TYPE

In the nuclear business there are many different types of interim store for spent fuels. Almost all of them have been licensed in one or more countries. It has to be emphasised, there is no single right way for selection the best store concept for an actual NPP, a number of conditions have to be taking into account, for example the type of the spent fuel, its burn-up level, the radiation protection requirements and site conditions.

At Paks NPP the selection of the spent fuel storage facility was based on a well-established decision process. The expert of NPP determined the format and content requirements of the Feasibility Studies, prior asking the potential vendors to prepare them. The received seven Feasibility Studies were evaluated by participation of authorities and domestic and independent foreign expert companies. The International Atomic Energy Agency (IAEA) was also involved in the evaluation process, many technical details have been discussed with the Advisory Group of IAEA. The final decision were made by representative experts of NPP taking into account the suggestion and recommendation of above mentioned participants and using a scoring model.

As a result of decision process the MVDS (Modular Vault Dry Store) offered by GEC ALSTHOM (UK) has been selected.

GENERAL FEATURES OF THE FACILITY

At the GEC ALSTHOM designed modular vault dry storage system the spent fuel assemblies are stored separately in stainless steel tubes, which are hermetically sealed and filled with nitrogen gas. The storage tubes are accommodated in concrete vault modules, which is so designed, that the shielding requirements are met. Storage of spent fuel assemblies takes place in dry atmosphere, the generated heat is removed by buoyancy driven air-flow. The planned 50 years lifetime of the MVDS can be ensured by normal maintenance.

A total of 450 spent fuel assemblies can be accommodated in each vault module, the modular storage is so designed, that it can be easy extended. The full extension may be 33 vault modules with capacity of 14850 storage place.

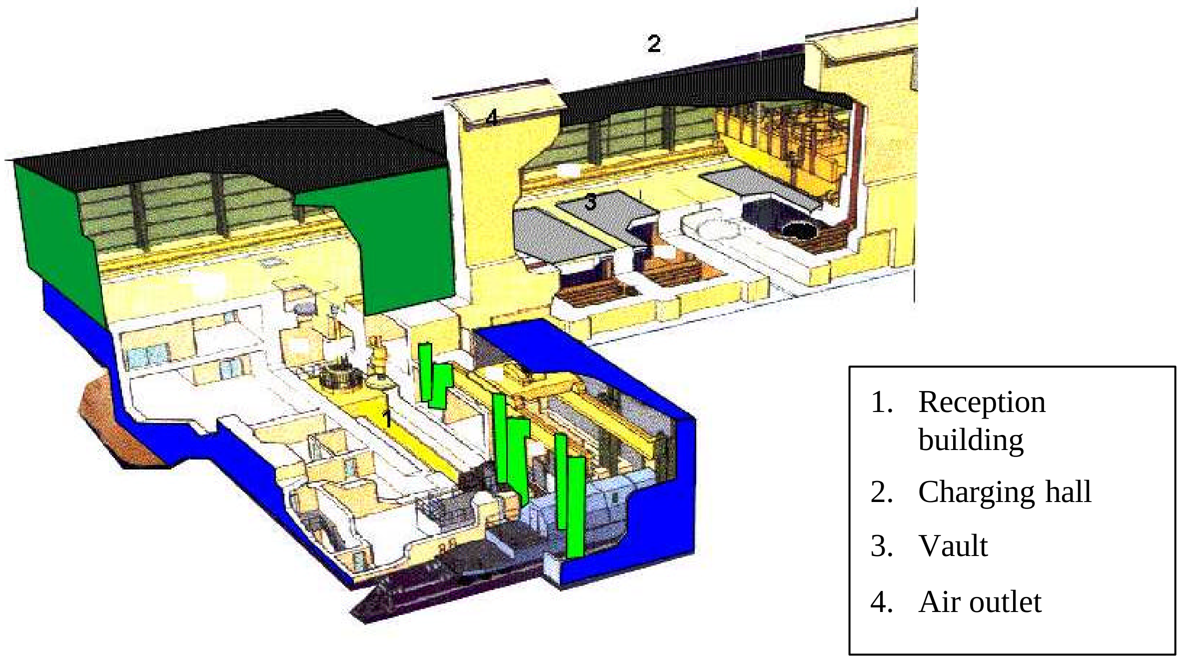

Fig. 1. Modular Vault Spent Fuel Storage

RADIATION PROTECTION OF STORAGE

Effective and reliable performance of the radiation protection in connection with the interim store is based on the design of storage, a well-founded radiation protection programme and well-qualified health physics personnel.

Radiation Protection Design Features of MVDS

The special considerations of design of MVDS are providing conformance with the ALARA in respect of personal and environmental doses.

The radiation of spent fuel assemblies are minimised by bulk and labyrinth shielding. The spent fuel assemblies are stored in hermetically sealed tubes to prevent the spreading of contamination during the storage phase. When loading of spent fuel assemblies to storage the spreading of contamination is prevented by ventilation systems which controlling the direction of air flow form the less contaminated areas to the more contaminated one and also HEPA filters which are mounted close to the contamination release.

The control instrumentation is located in low dose intensity areas. The MVDS essentially is such a passive system, which requires minimum maintenance. The required maintenance works are performed with special tools and from low dose intensity areas.

Radiation Protection Programme

The radiation protection program of MVDS is based on the Plant Radiation Protection Code. The controlled are of the MVDS is classified to three different zones taking into account the radiation and contamination conditions, the access to zone red and yellow is seriously controlled. During loading of spent fuel assemblies to the MVDS the radiation protection survey continuously ensures by one RP technician. Any activity presumably involving a radiation exposure in excess of the personal control level for a day (0,2 mSv) is subject to approval using Radiation Work Permit. For presumably higher radiation risk activities (activities with spent fuels and activities where the dose rate of the working area > 4 mSv/h), a separate programme reconciled with the Radiation Protection Department and approved by top management is necessary also in the MVDS.

In MVDS the radiation protection monitoring covers personal dosimetry, area monitoring of controlled area, releases monitoring and environmental monitoring, however the environmental monitoring system is common with NPP.

Also important part of the radiation protection programme of MVDS the assessment of radiation protection experience and the feedback of conclusions which are summarised annually complied report. This detailed report includes the radiation protection findings and evaluations, and the experiences, which should be considered for accomplishing the radiation protection objectives during the subsequent operation of MVDS.

OCCUPATIONAL EXPOSURE AND ENVIRONMENTAL IMPACTS FROM THE OPERATION OF MVDS

The MVDS started the operation with three vaults module in 1997 and the second module with four vaults vent into operation in 1999. Thanks to the earlier mentioned design features and the well established and implemented radiation protection programme the operation of MVDS resulted very low individual and collective doses of personnel and practically not measurable environmental effects.

During the past four years operation the individual and collective doses of workers were very low, the radiation exposure was well below the in advance estimated value (see Table I). It should be mentioned that internal radiation exposure was not occurred till now.

Table I. Radiation exposure of workers.

	*Estimation by designer	1997	1998	1999	2000**
Loaded spent fuel assemblies (pieces)	500	450	498	400	500
Collective dose (man mSv)	100	2.4	2.2	1.5	1.9
Highest individual dose (mSv)	< 20	0.03	0.03	0.14	0.07

* : Assuming 500 spent fuels loading to storage
**: Data relates for Jan.-Oct.

The radioactive releases of the MVDS as that shown in Table II and Table III were within the corresponding authority limits. During operation the liquid releases exceeded the corresponding design value in case of some isotopes. Expect of tritium these did not mean really releases, but indicate the used conservative approach of calculation of releases. As per authority prescription when the measuring result is below than LLD of measurement the releases should be calculated using the LLD.

Table II. Airborne releases from MVDS

Isotopes	*Estimation by designer	*Authority limit	1997	1998	1999	2000**
	Bq					
Mn-54	2.3E5	1.1E11	1.4E4	2.2E4	1.2E4	1.3E4
Co-60	6.4E5	7.8E9	1.6E4	2.3E4	1.4E4	1.4E4
Ag-110m	6.4E4	7.1E9	1.4E4	4.1E4	1.3E4	1.3E4
Tritium	5.4E7	2.1E14	1.7E8	2.3E7	2.8E7	2.3E7

* : Assuming 500 spent fuels loading to storage
**: Releases data relates for Jan.-Sept.

Table III. Liquid effluents from MVDS

Isotopes	*Estimation by designer	*Authority limit	1997	1998	1999	2000**
	Bq					
Mn-54	1.1E4	1.8E12	9.3E4	1.2E5	3.3E4	1.3E4
Co-60	1.8E4	3.1E10	3.1E5	3.1E5	9.9E4	1.4E4
Ag-110m	1.1E6	1.3E12	8.8E5	2.4E5	5.1E4	1.3E4
Tritium	3.1E7	1.6E15	6.3E6	2.3E6	2.3E6	6.2E6

* : Assuming 500 spent fuels loading to storage
**: Releases data relates for Jan.-Sept.

In the environment there were no any measurable results of the operation of MVDS, so the excess radiation exposure of the surrounding population can be calculate only based on the measured releases and meteorological data. The yearly achieved calculation showed negligible doses, Table IV.

Table IV. Estimated radiation dose of a member of the surrounding population

*Estimation by designer	Authority limit	1997	1998	1999	2000**
110 nSv	10000 nSv	0.2 nSv	0.2 nSv	0.1 nSv	0.1 nSv

* : Assuming 500 spent fuels loading to storage

** : It is not based on calculation only estimation

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