Review of Decommissioning, Spent Fuel and Radwaste Management in Slovakia

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Abstract

Two nuclear power plants with two WWER reactors each are currently under operation in Jaslovské Bohunice and NPP A-1 is under decommissioning on the same site. At the second nuclear site in the Slovak Republic at Mochovce third nuclear power plant with two units is in operation. In accordance with the basic Slovak legislation (Act on Peaceful Utilisation of Nuclear Energy) defining the responsibilities, roles and authorities for all organisations involved in the decommissioning of nuclear installations Nuclear Regulatory Authority requires submission of conceptual decommissioning plans by the licensee.

The term "decommissioning" is used to describe the set of actions to be taken at the end of the useful life of a facility, in order to retire the facility from service while, simultaneously, ensuring proper protection of the workers, the general public and the environment.

This set of activities is in principle comprised of planning and organisation of decommissioning inclusive strategy development, post - operational activities, implementation of decommissioning (physical and radiological characterisation, decontamination, dismantling and demolition, waste and spent fuel management), radiological aspects, completion of decommissioning as well as ensuring of funding for these activities.

Responsibility for nuclear installations decommissioning, radwaste and spent fuel management in Slovakia is with a subsidiary of Slovak Electric called Nuclear Installations Decommissioning Radwaste and Spent Fuel Management (acronym SE VYZ), established on January 1, 1996.

This paper provides description of an approach to planning of the NPP A-1 and NPPs with VVER reactors decommissioning, realisation of treatment, conditioning and disposal of radwaste, as well as spent fuel management in Slovakia. It takes into account that detail papers on all these issues will follow later during this meeting [1-4].

1. NPPs Decommissioning

1.1. NPP A-1 decommissioning

Nuclear power plant A-1 a 150MWe gross, with metallic natural uranium fuelled, CO_2 cooled and heavy water moderated reactor had been in operation from Dec. 25th 1972 to Feb. 22nd 1977 when due to an incident had been shut down.

Incident was caused by disruption of the technological channel serving as a barrier between heavy water moderator and fuel assembly. Damage of this barrier enabled heavy water leakage into the primary circuit with partial fuel elements cladding damage and following additional contamination of the primary circuit.

During two consecutive years after the incident main effort focused on activities related to personnel and environment protection, moderator draining, reactor defueling, dry cleaning of

the primary circuit, repair and maintenance of equipment as well as on detailed technical and economic analysis requested to decide on the future of the plant.

Based on the analysis results and on the Federal Ministry for Fuel and Energy recommendations the government authorities decided not to restore the A-1 operation and have issued an order in May, 1979 to start the NPP A-1 decommissioning.

1.1.1 An approach to the NPP A-1 decommissioning

After decision on permanent cessation of operations decommissioning of the plant started and research and development programmes had been established. Since 1980 year the work was carried out in two basic and parallel directions:

1) research on various issues of decommissioning

2) works on NPP A-1 decommissioning, including planning

This approach was accounted to and progress in this field have been influenced by the following issues:

a) lack of preliminary plans for NPP decommissioning
b) incident in the NPP A-1
c) financial and technical constraints (no funds have been collected for decommissioning, lack of some methods and equipment for radwaste management)
d) lack of regulatory process for decommissioning of nuclear facilities
e) development of decommissioning policy in the later phase of R&D through various alternatives evaluation and yearly budget approval for decommissioning activities

The work carried out in both research and decommissioning activities in the NPP A-1 was focused primarily on:

- development of methodology for NPPs decommissioning
- characterisation of radioactive deposits on the surfaces of the circuits and development of decontamination methods
- development of NPP A-1 decommissioning strategy.
- development of techniques and equipment for radioactive waste management
- measures for protection of personnel and environment
- management of spent fuel and development of techniques and equipment for spent fuel shipment off the site
- maintenance and control of barriers and equipment containing radioactive liquids
- dismantling of non-radioactive and radioactive systems for verification of cutting equipment, obtaining experience on organisation of dismantling tasks and gaining free rooms for installation of experimental equipment and store rooms.

1.1.2. NPP A-1 decommissioning project

On the basis of analysis of technical and economic possibilities and safety of NPP A-1 decommissioning the following four phases have been suggested for the NPP A-1 decommissioning:

1) introduction of NPP A-1 into dry safe state - I. phase
2) preparation of the safe enclosure - II. phase

3) safe enclosure - III. phase
4) deferred dismantling - IV. phase

It was expected originally that end of the I. phase of NPP A-1 decommissioning would be achieved in a reasonable time by a successive solution and realisation of short and long term planned tasks and tasks under research. During execution of this approach regulatory authorities in accordance with world wide trends requested more strict requirements for granting approval of activities and operations in the NPP A-1 and reactor hall got contaminated during spent fuel preparation for transport off the site. All this circumstances have led to successive delay of time originally planned to achieve an end of the I. phase of NPP A-1 decommissioning. Because of this Government of the Slovak Republic required to develop up to the end of 1994 the year a Project for the I. phase of NPP A-1 decommissioning.

Approach to the planning of this first phase, planning procedure itself as well as results achieved in the Project up to present time are described in the other paper [1].

1.2. Planning of NPPs with WWER decommissioning

Based on lessons learned during NPP A-1 decommissioning preparation and realisation a thorough and timely approach has been chosen for selection and justification of strategy for NPP V-1 decommissioning preparation as a generic approach for NPPs with WWER reactors decommissioning. This approach has been reflected in elaboration of appropriate documentation serving to this purpose. There were:

a) elaborated two feasibility studies of NPP V-1 decommissioning in the 1991 and 1992 (long before decommissioning plan was required by the Atomic law in 1998)

b) preferred decommissioning option selected

The following five decommissioning options were analysed in detail in these feasibility studies:

1. Immediate total NPP dismantling after final shutdown.
2. Safe enclosure of the so called "hermetic area" (where primary circuit is located) for each unit separately.
3. Safe enclosure of the reactor cavity with each reactor separately.
4. Safe enclosure of the whole reactor building.
5. Nuclear power plant closure under surveillance.

Options 2, 3, 4 are options with various extent of equipment in the safe enclosure. 70 years were assumed as a duration of this safe enclosure. The final goal for each option is dismantling to "a green field" after the safe enclosure. Important parameters necessary for decision had been estimated for every option. Approach to development of the feasibility studies, methodology used as well as detail results from the estimation of the parameters will be presented in a separate paper [2].

Feasibility studies for NPP V-2 and NPP Mochovce seen as conceptual decommissioning plans have been developed. Conceptual decommissioning plans for all nuclear installations have been developed or are under development in accordance with the requirements in the Atomic law.

1.3. Regulations and legislation

As the most important legislation in the Slovak Republic related to defining of the responsibilities, roles and authorities for organizations involved in the design, manufacturing, operation, waste management and decommissioning of nuclear facilities can be introduced:

a) The Act on Peaceful Utilization of Nuclear Energy (Act No. 130/98 Coll.)
b) The Act on Protection of Population Health (Act No. 272/1994 Coll.) and its amendments No. 222/1996 Coll., and No. 290/1996 Coll.
c) Decree on Nuclear Safety in Radioactive Waste Management
d) Act on Establishing the State Fund for Decommissioning including Spent Fuel and Radioactive Waste Management.

Details on the legislative issues related to decommissioning and radioactive waste management will be presented in a separate paper [3].

2. Radioactive waste management

All activities, administrative and operational, that are involved in the handling, pretreatment (collection, segregation, decontamination), treatment (volume reduction, removal of radionuclides from waste, change of composition), conditioning, transportation, storage and disposal of waste arising in a nuclear facility during all stages of its lifetime are understood under waste management.

Waste collection, segregation of waste in some extent and storage systems were designed and installed in every NPP, but technologies necessary for conditioning of stored waste have not been available at the beginning of NPPs operation and they have been provided later. Therefore practically all operational liquid radioactive waste from NPPs with WWER is now stored in tanks after pretreatment (evaporation to concentrate) and solid waste treated by low pressure is stored in storage vaults. Liquid radwastes from NPP A-1 operation and decommissioning activities have been conditioned and are stored within the site. Solid radwastes are stored.

Technologies for the conditioning of radwaste, together with equipment for retrieval of stored wastes as well as transport means for their transport to these technologies have been delivered on the NPP at the end of the 1980s and during the 1990s as a results of research and development, or on the contract with suppliers. The following waste treatment technologies are under operation or tests at Jaslovské Bohunice at present time:

- Experimental incineration facility (VÚJE) for low level waste. It is in operation since 1992 including a small facility for cementation of incinerator ashes which is in operation since 1995. Solid burnable wastes from NPP V-1 and V-2 have been treated there.
- Two bituminization facilities (output 100 dm^3/h of evaporated water) are in commercial operation. About 500 m^3 concentrate from NPPs A-1, V-1 and V-2 has been conditioned on these plants. Dowtherm (mixture of bi-phenyl oxide and bi-phenyl, used as an cooling medium for the spent fuel from NPP A-1) may be conditioned on one of these plants (owner VÚJE).
- Non active tests have been executed on the third bituminization plant and a licence for active tests is sought in present time.

- Active tests -1. phase commenced in January of this year on the Bohunice conditioning and treatment centre for radwaste, comprising cementation plant, incinerator and supercompactor.
- Small vitrification plant for chrompik (cooling medium for the spent fuel from NPP A-1) is in operation and already treated some 11 m^3 of chrompik. Product of vitrification is stored in intermediate store installed for this purpose in the production building.
- Size reduction facility for metal is in operation.

Further details on the waste treatment is available in the paper [4], presented on this seminar.

Very important part of waste management is availability of disposal facility for radwaste. Design and construction of disposal facility for low and intermediate waste at Mochovce site started in the year1986 and the first stage was finished in 1992. Disposal facility encompassed two double row of iron reinforced concrete vaults with necessary infrastructure. Each double row consisted of 40 vaults (internal dimensions 17,4x5,4 m with average height 5,5 m).

After submission of pre-operational safety case and it's assessment by the Nuclear Regulatory Authority of the Slovak Republic this Authority invited international mission from IAEA called WATRP. Based on assessment of the report and recommendation of this mission the Regulatory Authority imposed some requirements for the backfitting of the facility. Backfitting of the facility in accordance with requirements was finished and agreement to active tests have been granted by the Regulatory bodies in the 1999 so now all elements necessary for radwaste management from NPPs are available in the Slovak Republic.

3. Spent fuel management

In the Slovak Republic were two types of spent fuel which have to be dealt with:

a) spent fuel from the NPP A-1.
b) spent fuel from NPPs with WWER.

Spent fuel assemblies from NPP A-1 were after short cooling temporary stored in storage cans filled at the beginning of NPP operation with "chrompik", (an aqueous solution of $K_2Cr_2O_7$ with concentration of 3 - 5 %), later with "dowtherm (mixture of bi-phenyl oxide and bi-phenyl). The cans were placed in a storage pond filled with water. A technology and equipment have been developed for preparation of the spent fuel for transport and all the fuel assemblies were successfully prepared for the transport and were transported off the site for final storage in the USSR and later in the Russian Federation so none spent fuel from NPP A-1 is on the site.

A wet interim spent fuel store for the spent fuel from NPPs with WWER was constructed and commissioned in 1987 in Jaslovské Bohunice with total capacity corresponding to about 10 years production. Because of a new strategy for the spent fuel management Slovak electric as an owner of NPPs made a decision in the early 1990s to reconstruct the interim store. The aim was to increase storage capacity by compaction of storage racks so that it will provide for storage of the entire spent fuel production for planned operation lifetime of units at Jaslovské Bohunice and to seismically qualify the store. The reconstruction of the store was finished at the end of 1999 year.