National concept for decommissioning and long-term storage of spent nuclear fuel and radioactive waste

Frantisek Huptych
ÚJV Řež, a. s.
Hlavní 130, 250 68 Husinec-Řež, Czech Republic
frantisek.huptych@ujv.cz

ABSTRACT

The Czech Republic operates six nuclear power reactors (VVER), four VVER-440/213 reactor units at Dukovany and two VVER-1000/320 reactors at Temelín. Czech government is fully responsible for the decommissioning and for the disposal of all radioactive waste (RAW) including spent nuclear fuel (SNF). The decommissioning strategy and concept of RAW management and SNF management in the Czech Republic which set out the relevant principles, objectives and procedures to be followed was approved by the Czech government. The legal framework is set by Atomic Act and subsequent legal regulations.

The Concept for decommissioning and radioactive waste is based on the current situation concerning low-level and intermediate-level RAW management, the development of a deep geological repository for RAW and SNF disposal, legislative changes, Government programming documents and international experience and trends. The Concept is further motivated by preparations for the construction of a new nuclear unit(s) in the Czech Republic, legislative developments within the EU and IAEA and OECD/NEA recommendations.

Actual decommissioning plans for Czech nuclear power plants includes both decommissioning strategies, immediate and deferred decommissioning. Deferred decommissioning involves a 30 years safe enclosure period following SNF removal and facility preparation and modification.

The purpose of the contribution is to share the results of ongoing decommissioning planning and implementation activities for preparation of decommissioning of Czech Republic NPPs. The contribution will focus in particular on the following:

- Approach for decommissioning of NPPs in the Czech Republic.
- The strategy of the long-term back-end nuclear fuel cycle in the Czech Republic.
- Time frames.
- Spent fuel storages.
- Radioactive waste management.

Keywords: *Decommissioning, Radioactive Waste (RAW), Spent Nuclear Fuel (SNF), Deep Geological Repository (DGR)*

1 INTRODUCTION

The paper refers to activities related to the assurance of sufficient storage capacity for Spent Nuclear Fuel (SNF) at the NPP sites during their overall planned lifetime and activities related to the preparation of their future decommissioning.

Czech Republic operates with six nuclear power reactors (VVER), four VVER-440/213 reactor units at Dukovany site and two VVER-1000/320 reactors at Temelín site and is currently planning to operate NPPs for 60 years, with construction of up to 3 new units at the sites of existing

NPPs. In addition, the Deep Geological Repository (DGR) is planned to be built up and operated in 2065.

2 LONG-TERM STORAGE OF SPENT NUCLEAR FUEL

Actually only the dry storage method in containers of special storage facilities is used in Czech Republic. SNF storage capacity needs will be increased in the case of extension of NPPs operation up to 60 years and construction of new NPPs (which is planned in Czech Republic at existing NPP sites).

One possible storage concept is to increase the existing storage capacity directly at the NPP sites until the DGR becomes operational. Currently, in Czech Republic, continue preparatory work and assessment of siting of DGR.

Another option is to build a Central Spent Nuclear Fuel Storage Facility (CSNFSF) at Skalka and to use this facility as an intermediate step before the planned construction of DGR (https://www.surao.cz/en/public/deep-geological-repository/safety-of-dgr/).

2.1 NNP Dukovany – increase of SNF storage capacity

The long-term concept of the NPP Dukovany (four reactors of the Russsian VVER 440/213) supposes the shutdown for reactor units 1 to 4 in the period 2045-2047. The current capacity of the SNF 2 storage is not sufficient for the operation of the NPP Dukovany for this planned 60 years.

From the fuel cycle analysis, it is estimated that there is a lack of capacity to store an additional 41 containers, which with sufficient margin represents a requirement for the creation of 60 new storage positions for the SNF containers.

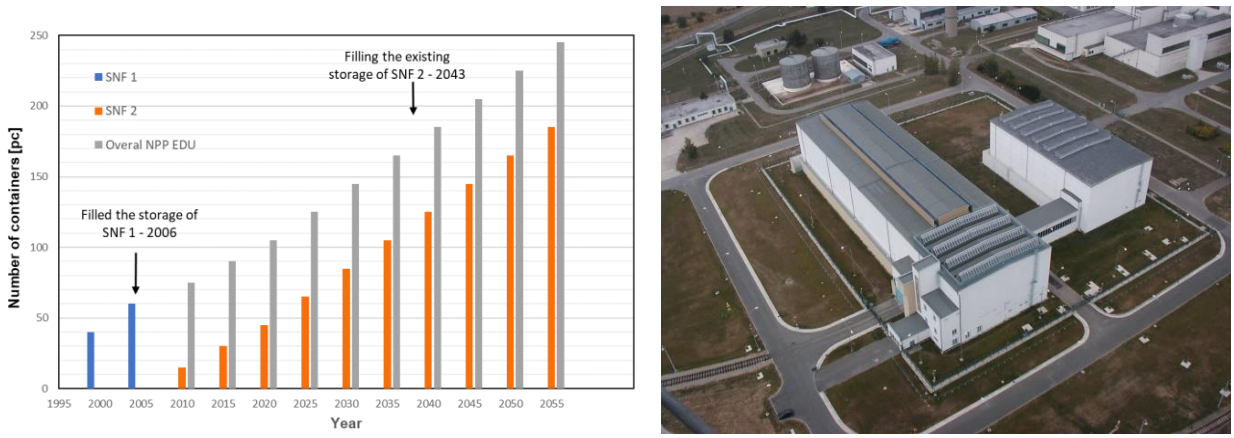

Figure 1: Number of containers with SNF for storage over 60 years of operation NPP Dukovany (left) and an aerial view of the storages SNF 1 and SNF 2

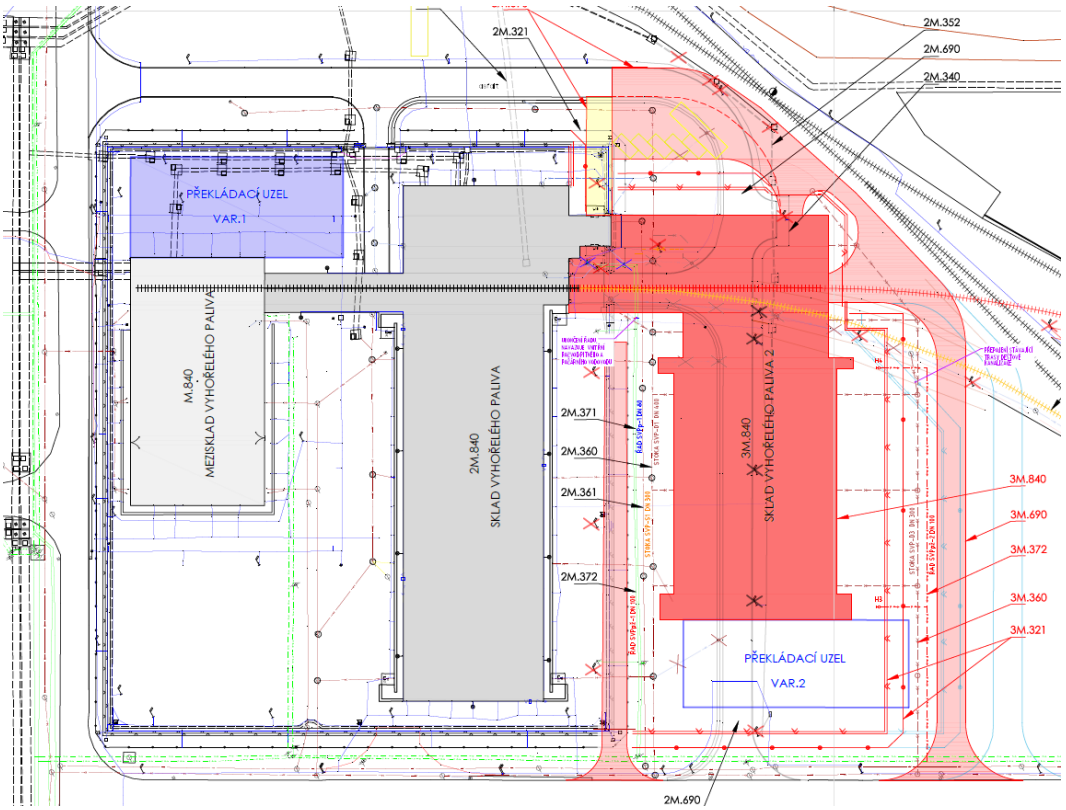

Figure 2: The analysed option for the construction of a new SNF storage (red building)

2.2 NNP Temelín – increase of SNF storage capacity

The long-term concept of the NPP Temelín (two reactors of the VVER 1000/320V type) supposes the shutdown for reactor units 1 and 2 in the period 2060 and 2062. A dry SNF storage facility was built at Temelín site with a capacity for the planned 30-year operation of the NPP. It allows to carry, to handle and to store of 152 pieces of containers. The current capacity of the SNF storage is not sufficient for the operation of the NPP Temelín for 60 years. However, the current SNF storage design allows to use in the future the receiving part for another SNF storage of the same capacity.

The existing SNF storage facility was commissioned in 2010, and new SNF storage capacity will be needed approximately in 2040.

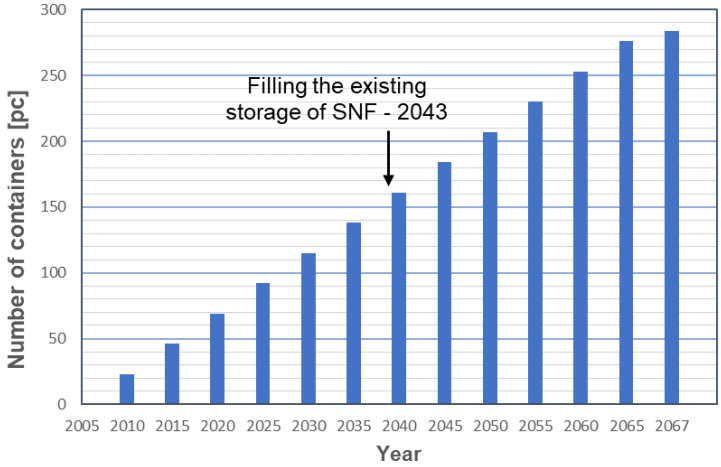

Figure 3: Amount of SNF (in containers) for storage over 60 years of operation NPP Temelín

2.3 FEASIBILLITY STUDY - Central Spent Nuclear Fuel Storage Facility Skalka

According to the decision of the CEZ company, which owns the Skalka site, until 2030 the site will serve as a stand-by site for storages situated in the NPP areas. Following an agreement between CEZ and the state organization RAWRA (DGR developer), a study was commissioned on other possibilities of using the Skalka site.

The aim of the Study was to evaluate the potential of existing storage facilities and to analyse the needs of the Czech Republic with regard to the planned lifetime of operating NPPs and planned new NPP units. The analysis and evaluation of storage facilities was based on the predicted amounts of SNF (see Figure 4) and RAW generated from operation of NPP Dukovany, NPP Temelín and new NPPs (1 unit at Dukovany site, 2 units at Temelín site) with a performance of 3 x 1200 MW including predicted amounts of radioactive waste (RAW) from decommissioning. The lifetime of the existing NPPs and new NPPs is assumed for 60 years.

The Study analysed and evaluated the impacts of the prolongation of SNF storage on the construction and technical design of the DGR, including quantification of the possible reduction of costs of the DGR depending on the time of prolongation of SNF storage. In the Study was described the schedule of the proposed life cycle of CSNFSF Skalka and assessed the impact of SNF storage in CSNFSF Skalka on the technical solution and life cycle schedule of DGR.

The Study compared the costs of operation of CSNFSF Skalka according to the proposed schedule, the designed impact of long-term storage of SNF on the size of the underground area of the DGR by reducing the residual heat output of SNF. The study compared the existing design of the DGR with the option of long-term storage of SNF and RAW and subsequent disposal in a modified DGR.

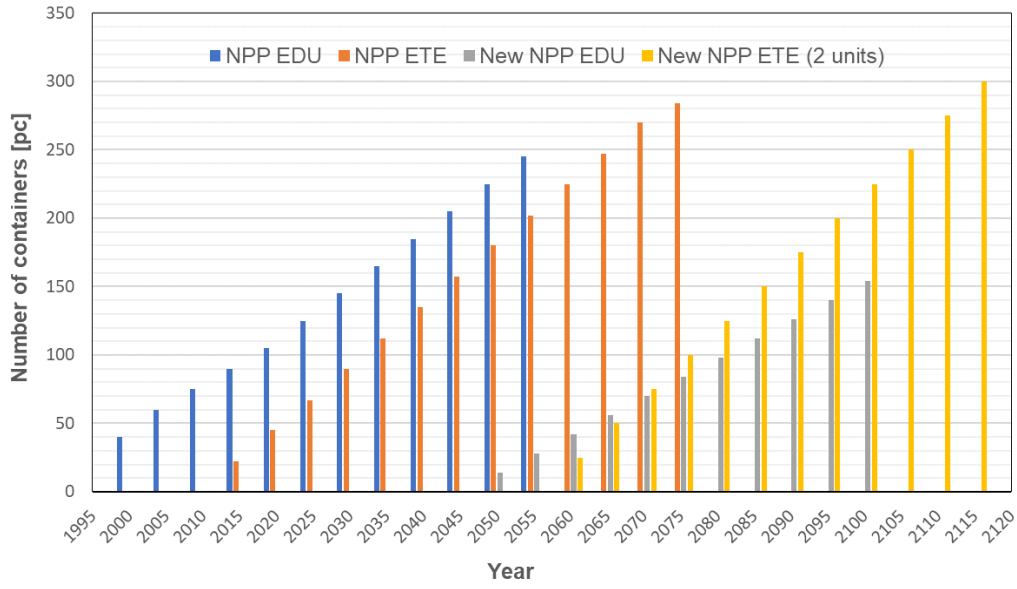

Figure 4: Number of containers for storage from NPPs in the Czech Rep. (including 3 new NPPs)

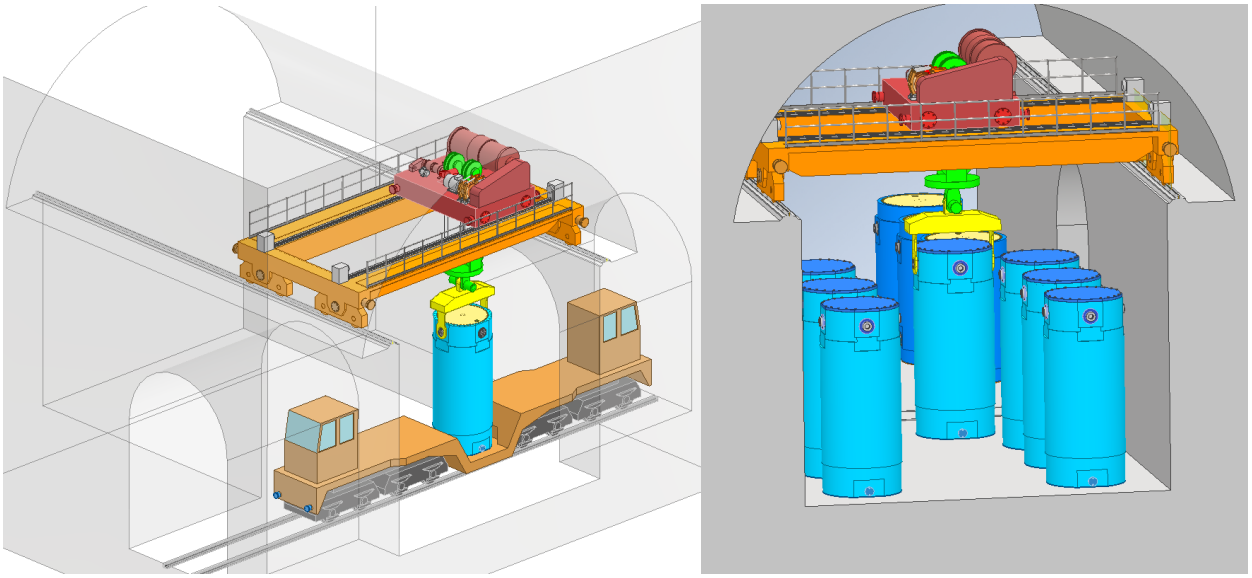

Figure 5: Model of the container with SNF from VVER 1000 on a transport railcar and positioning

3 DECOMMISSIONING

Czech government is fully responsible for the decommissioning and for the disposal of all RAW including SNF. The decommissioning strategy and concept of RAW management and SNF management in the Czech Republic which set out the relevant principles, objectives and procedures to be followed was approved by the Czech government.

The concept for decommissioning and radioactive waste is based on the current situation concerning low-level and intermediate-level RAW management, the development of the DGR for disposal of SNF and activated materials, legislative changes, Government programming documents and international experience and trends. The concept is further motivated by preparations for the construction of a new nuclear unit(s) in the Czech Republic, legislative developments within the EU and IAEA and OECD/NEA recommendations.

Actual decommissioning plans for Czech nuclear power plants includes both decommissioning strategies, immediate and deferred decommissioning. Deferred decommissioning involves a 30-years safe enclosure period following SNF removal and facility preparation and modification.

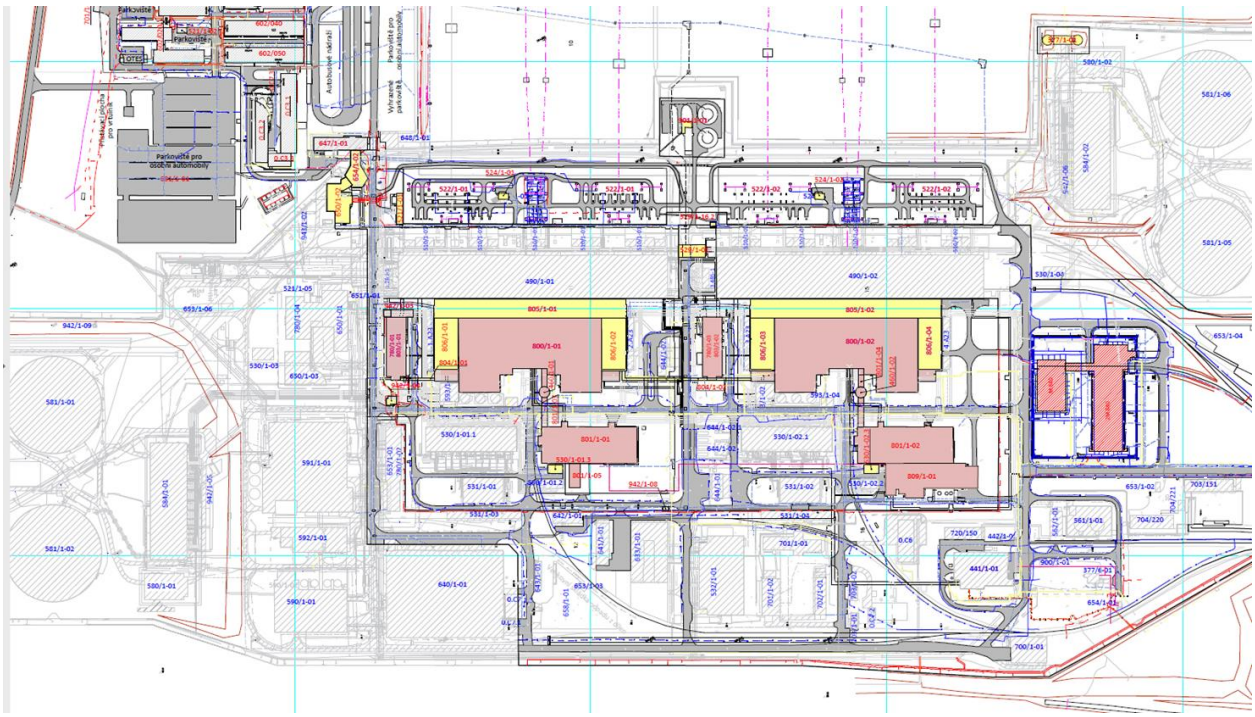

Figure 6: NPP Dukovany – layout of buildings during deferred dismantling (safe enclosure)

3.1 Decommissioning legislation in the Czech Republic

The legal framework for decommissioning nuclear installations is set by the Atomic Act (The Act No. 263/2016 Coll.) and subsequent legal regulations:

- Degree No. 377/2016 Coll., on the requirements for the safe management of radioactive waste and on the decommissioning of nuclear installations or category III or IV workplaces, and
- Degree No. 422/2016 Coll., on radiation protection and security of a radiation sources.

The preparation for decommissioning shall (in accordance with the Act) be included in each stage of the lifecycle of a nuclear installation (sitting, construction, commissioning, operation). The decommissioning program, including a respective decommissioning cost estimation, is an integral part of the operation license of a nuclear facility granted by the State Office of Nuclear Safety (SONS). Decommissioning cost estimates must be approved by the Radioactive Waste Repository Authority (RAWRA) before being submitted to SONS. The decommissioning plans and costs estimation is updated every five years.

- SONS is an independent central state administration body for the area of nuclear safety and radiation protection.
- RAWRA is a state organization responsible for ensuring the safe disposal of RAW.

3.2 Decommissioning concept

During preparation of a concept of NPP decommissioning the following principles were adopted:

- The locality will be used for future commercial activities of the operator. Utilization of the land for agriculture or residential purposes after the termination of decommissioning process is not considered.

- Upon the completion of decommissioning process, facility will be exempted from the effects of the Atomic Act. No radiological supervision is considered any more.
- Demolition of existing buildings, in which the technologic systems had been installed or which had been in contact with radioactive media, is considered.
- It is expected that RAWRA will provide sufficient disposal capacity for radioactive wastes generated during decommissioning process, as this organization is responsible for radioactive waste repository management in the course of decommissioning process. Within a framework of the duties set forth in the Atomic Act, RAWRA will be provided with the data on long-term production of RAW, including radioactive wastes generated during decommissioning process.
- According to the definition given in the Act, nuclear facilities are structural or operational systems, which comprise a nuclear reactor. A scope of the systems included into decommissioning process from the point of view of creating of financial provision for decommissioning, follows up from this provision of the Atomic Act.
- Financial provision for NPP decommissioning is created for decommissioning of "active" parts of a nuclear power plant (the buildings and the technological systems which came into contact with radioactive media).
- When a concept is selected, an aspect of the minimum radiation load of the staff engaged in decommissioning activities and an aspect of the minimum volume of RAW to be disposed of, are taken into account.

The decommissioning plans include a description of all decommissioning activities and define the conception and the scope of decommissioning activities, including the time schedule of these activities (especially decontamination, dismantling, demolition, radioactive waste treatment including transport, realization of protection barriers, safety assessment, radiation and physical protection).

The financial provision for decommissioning is calculated on the basis of costs estimation and an amount of annual creation. The financial provision is counted as the ratio of costs estimation to the number of years from the start of commission (in the case of nuclear power plants to radiation testing stage) till presumed termination of nuclear facility operation.

4 PREPARATION OF DGR IN THE CZECH REPUBLIC

The future DGR for radioactive waste in the Czech Republic will be constructed in a suitable crystalline rock mass around 500 metres below the earth’s surface. The start of operation is planned for 2065. The current DGR development phase is devoted principally to the determination of the optimum disposal concept and the selection of the most suitable site. On 21 December 2020 the Czech government approved the selection of four sites (from a total of nine sites) recommended for the location of the country’s DGR – Březový potok, Horka, Hrádek and Janoch.