

Management of Ongoing Decommissioning Projects at Kozloduy Nuclear Power Plant Units 1 to 4, Bulgaria – Guarantee for Safe and Timely Decommissioning Process

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Abstract. Nuclear safety and security are absolute priorities for the European Union countries and this applies not only to nuclear power plants in operation but also to their decommissioning. The decommissioning process, like any other process with priority to safety and security, must be performed through a clear and achievable strategy. Also in order to minimize the costs and environmental impact during decommissioning it should be given considerations to the choice, the development and the implementation of the most adequate process of dismantling, treatment and storage of.

In this paper the main projects in support to achieve safe and effective decommissioning process of the Units 1 to 4 at Kozloduy Nuclear Power Plant (NPP) are presented.

Keywords: Decommissioning, Project Management, Licensing, Environmental Impact Assessment (EIA), Radioactive Waste Management

1 Introduction

The decommissioning process like any other process with priority to safety and security must be performed through a clear and achievable strategy. The selected decommissioning strategy in each case must ensure safe management of spent fuel and radioactive waste through the implementation of appropriate projects, which will contribute to optimally/ fully achieve the goals. The project management should be structured in a way to achieve the most efficient application of capital and resources, but there is no “right way” to structure a decommissioning project. In each case, depending on the chosen strategy, the technical characteristics of the facilities and available human and financial resources a number of project models can succeed. The essential characteristic is a suitable sharing of risks and benefits.

The analysis for the choice of the best practices and the identification of the appropriate technology, engineering, contractor or supplier for decommissioning of Units 1 to 4 at Kozloduy NPP, is conducted by working groups composed of engineering, licensing, commercial and quality assurance experts from the State Enterprise RADIOACTIVE Waste (SERAW) personnel, supported by consultant team. It must be drawn attention to the importance of management of the decommissioning projects in schedule and in compliance with the base line plan of the approved decommissioning strategy.

Bearing in mind that the decommissioning process of nuclear facilities is a new challenge facing all countries having nuclear power, the adequate decommissioning project management is essential for the compliance of the processes with the legislative framework, to ensure safe management of radioactive waste, to provide adequate funding and to lead to positive socio-economic impact.

The start of the decommissioning process for Units 1–4 at Kozloduy NPP was determined in 1999 by a memorandum, signed between the Bulgarian Government and the European Commission, to shut down and decommission these units. Units 1 and 2 were shut down on 31 December 2002, followed by Units 3 and 4 on 31 December 2006, within the agreed deadlines.

Subsequently, by decision of the Council of Ministers, Units 1–4 at Kozloduy NPP were entrusted to the State Enterprise Radioactive Waste (SERAW), the Bulgarian national operator for management of radioactive waste. SERAW is responsible for managing the Units 1-4 at Kozloduy NPP in compliance with the national strategy for radioactive waste and spent nuclear fuel management, and with the relevant international practices.

2 Decommissioning Strategy

A two-stage decommissioning strategy is selected for Kozloduy NPP Units 1-4. It is a continuous dismantling strategy, without a long safe enclosure period, that plans to result in a brown field site in 2030. The approach aims for a smooth, even and continuous utilisation of human and financial resources, as well as of waste management facilities.

Stage 1 involves immediate dismantling of equipment outside of the safe enclosure area, including the auxiliary buildings and stacks.

Stage 2 covers dismantling of the equipment in the safe enclosure area (the reactor buildings, parts of the sanitary buildings and interconnecting passageways) and release of the buildings for reuse.

The time scale of decommissioning the Kozloduy NPP Units 1–4 is presented in Figure 1.

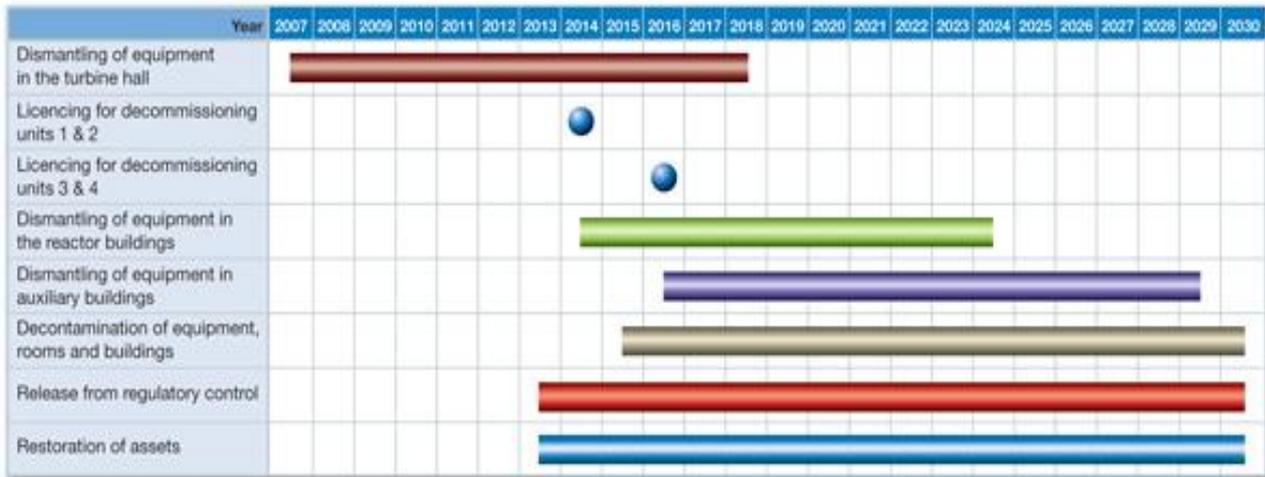


Figure 1. Time scale of Kozloduy NPP (Units 1–4) decommissioning:

- 2007 – 2018 Dismantling of equipment in the Turbine Hall;
- 2014 – 2024 Dismantling of equipment in Reactor Buildings;
- 2016 – 2029 Dismantling of equipment in AB;
- 2015 – 2030 Decontamination of equipment and buildings;
- 2013 – 2030 Release from regulatory control;
- 2013 – 2030 Restoration of assets.

The complete decommissioning process for Units 1–4 is outlined in the general decommissioning plan. The plan takes into account the extensive decommissioning experience from projects internationally – particularly in UK and France – and also lessons learned in Germany, Spain, Italy, Hungary and Slovakia.

The decommissioning process will involve competent and qualified personnel who have previously worked on the Kozloduy site and have knowledge of Units 1–4 and their operational history. As such, a number of personnel have been transferred from Kozloduy NPP Units 1–4 to SERAW, under the direction of the Council of Ministers.

The number of staff needed for the decommissioning project is expected to decrease in stages as activities progress. Around 700 SERAW employees are involved in the project today, and this is expected to fall to around 400 in the 2020s and to 275 in 2030.

3 Pre-Decommissioning Activities

The scope of this work, currently underway, includes:

- Development of required decommissioning documentation
- Evaluation of the material backlog and radiological inventory of Units 1–4
- Removal of hazardous, toxic, flammable, and combustible materials, and treatment of asbestos waste backlog

- Procurement of equipment for dismantling and decontamination
- Dismantling of uncontaminated, non-safety related-SSC in the turbine hall
- Radiological surveys and free release disposal
- Implementation of projects related to design and construction of infrastructure for decommissioning and radioactive waste treatment, conditioning and storage.

With the implementation of projects under the Decommissioning support programme of Units 1 to 4, cutting machines for size reduction, along with containers, transportation and lifting equipment, ventilation equipment and other handheld electric tools for dismantling activities have been delivered to the turbine hall.

This work included, in August 2013, the installation of a band saw machines for cutting the dismantled equipment. Personnel have already received training on the machines, and diamond-wire saw cutting is currently being used to dismantle heavy and complex reinforced concrete structures to facilitate transportation and storage.

Materials from the turbine hall undergo radiological investigation before dismantling, after dismantling and before removal from the turbine hall.

During 2010–2013 more than 4500 tons of equipment was dismantled from the turbine hall of Units 1&2. This is just a small proportion of the 70,000 tons that is expected to arise from decommissioning. After processing, the

materials will be classified in three categories, depending on the level of the radioactive contamination: materials that are free of contamination (category I); potentially-contaminated materials (category II) and contaminated materials (category III). An important goal of the dismantling work is to achieve maximum reuse and recycling of dismantled materials, especially metals.

4 Key Ongoing Decommissioning Projects

The implementation of the decommissioning projects corresponds to the Updated Decommissioning Strategy – 46 projects are currently in progress.

In order to minimize the costs and environmental impact during decommissioning it should be given a serious consideration to the choice, the development and the implementation of the most adequate process of dismantling, treatment and storage. Therefore this point is focused on projects managed by SERAW, which main objective is to provide the necessary reliable infrastructure and proven techniques and equipment to achieve as a final result the safe and cost effective decommissioning.

4.1 Facility for treatment and conditioning of solid radioactive waste with high volume reduction factor (plasma melting facility)

The project includes design, engineering and supply of equipment with high coefficient of volume reduction and immobilization of low and intermediate level radioactive waste at the Kozloduy NPP. The principle of operation will be a fusion plasma arc and will be able to process waste. (See Figure 2)

The construction of the facility is permitted with a two construction permits issued by the Ministry of Regional Development in July 2014 and by the Bulgarian nuclear regulatory agency (BNRA) on 24h April 2015, which are currently in force.

The construction phase is underway and the forecasting completion date of the project is at the end of July 2017.

4.2 Facility for retrieval and processing of the solidified phase from evaporator concentrate tanks

One significant project is the implementation of a facility for retrieval and processing of the solidified waste from evaporator concentrate tanks.

Ten tanks, each with a capacity of 500m³, store concentrates resulting from the evaporation of contaminated water treatment systems. Five tanks are located in Auxiliary Building 1, with five more in Building 2.

The project aims to separate the concentrates into clean boric crystals and category 1 waste (which can be considered as conventional waste after five years of decay).

The project is implemented in two phases:

- Phase 1: Retrieval and characterization of samples from the evaporator concentration tanks – have been completed in October 2015.
- Phase 2: Design, delivery, installation and commissioning of industrial installations for the retrieval and processing of solidified phase. For the implementation of this phase a new Tender process is expected.

4.3 Retrieval of ion exchange resins

The project involves the design and manufacture of equipment for sampling and retrieval of Ion exchange (IX) resins from storage tanks. The resins were used to treat contaminated water during power plant operation. They are currently stored in six tanks: one intermediate-level-waste tank and two low-level-waste tanks in each of the auxiliary buildings. A manhole above each tank is the only means of access.

A consortium of ENSA & Gas Natural Fenosa Engineering has been awarded a contract for retrieval and conditioning of the IX resins. The project includes development of a methodology for sampling and characterization, along with a sampling plan. SERAW personnel are responsible for carrying out the sampling and analysis.

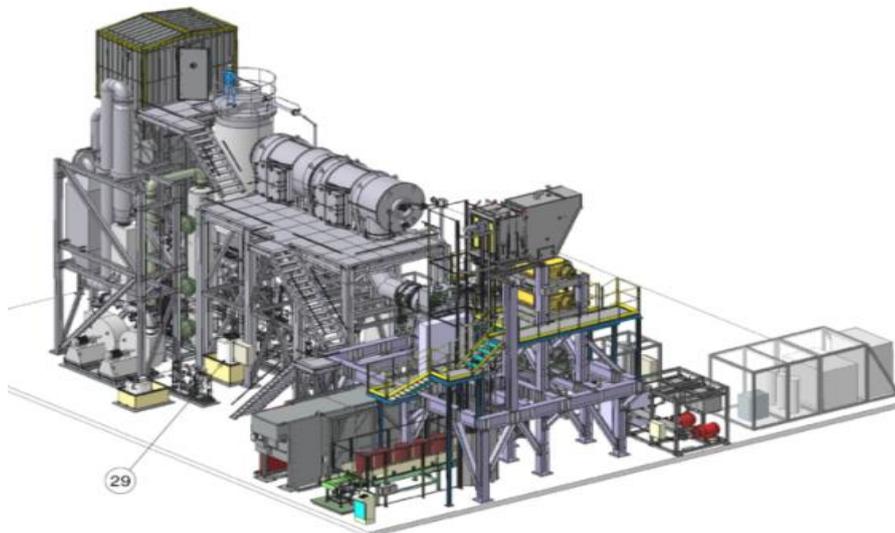


Figure 2. Plasma melting facility.

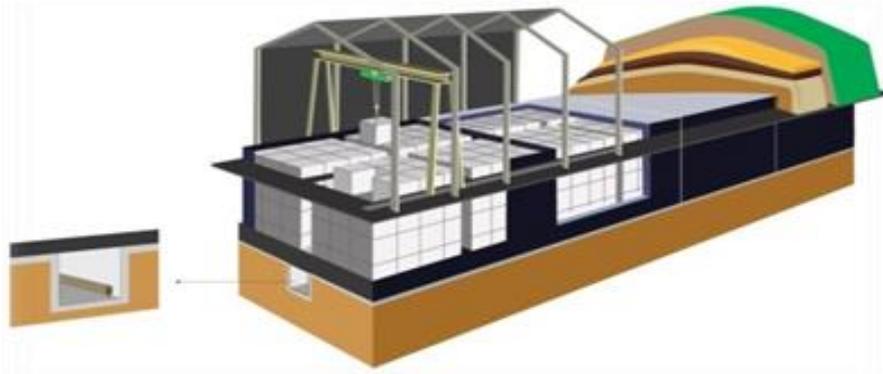


Figure 3. Model of NDF.

The contract also includes a preliminary assessment of the available radiochemical laboratories to characterize samples. A list of any additional equipment needed will be prepared. Delivery of this equipment is part of another project.

The engineers' estimate for contract completion is February 2018.

4.4 Size reduction and decontamination workshop

The project is for design, construction, supply, installation and testing of a workshop (including equipment) for size reduction and decontamination of materials arising from the dismantling of Kozloduy NPP Units 1–4. The main contractor for this project is a consortium of ONET Technologies and RISK Engineering.

The workshop will be used for size-reduction of materials by cutting, decontamination using mechanical, chemical and electrochemical methods to reach the levels of radioactive contamination allowing release from regulatory controls or levels at which the materials will be processed as RAW category 1, as well as packaging of the treated materials in pallets and placement in 20-foot ISO containers for transport to the Free Release Measurement Facility. Construction Works on Site commenced on 3 November 2014. The workshop is expected to enter in operation by mid-2017.

4.5 Temporary storage sites

The project is for a design, construction, licensing and commissioning of four sites intended as temporary storage facilities for 20-foot ISO containers, and one site for temporary storage of skips containing non-radioactive materials (scrap) from the decommissioning activities at KNPP. The project is a priority for the implementation of decommissioning activities, and is due to be completed by the end of 2016.

5 Repository Plans

In 2013, SERAW started a project to build a national repository for the disposal of low- and medium-level radioactive waste generated from nuclear facilities and other nuclear applications. The National Disposal Facility (NDF) is of significant importance for the implementation of con-

tinuous dismantling at Kozloduy NPP. The construction of the facility will provide stable and reliable isolation of radwaste that is currently in temporary storage at the site.

The repository will be a surface-based, trench-type facility with multiple-barrier protection for permanent storage of treated waste packaged in concrete containers (See Figure 3). It will be located in the radiation-protected area of the Kozloduy site and will have capacity for 138,200 m³ of radwaste. Construction of the repository has been designated as 'high priority' over the next year. Construction is expected to be completed in 2020, and the facility will have an anticipated operational life of 60 years.

6 Funding for Decommissioning

The total decommissioning costs for Kozloduy NPP Units 1–4 over the period 2003–2030 are estimated at €1.1 billion. The financing of activities for decommissioning units 1–4 is carried out by the Kozloduy International Decommissioning Support Fund (KIDSF), administered by the European Bank for Reconstruction and Development (EBRD), as well as two Bulgarian national funds: the Radioactive Waste Fund (RWF) and the Fund for Decommissioning of Nuclear Facilities (FDNF).

EU funding via the KIDSF is available to support pre-decommissioning activities such as the construction of the infrastructure for management, treatment and conditioning of radioactive waste.

7 Conclusion

The investment program to support the decommissioning of Units 1 to 4 at Kozloduy NPP has been established on the basis of a performed preliminary analysis of the resources needed to provide the necessary infrastructure and equipment for dismantling, waste treatment and storage. The program provides a sustainable way to achieve the objectives set in the terms of the Updated decommissioning strategy for continuous dismantling, approved in June 2006, as well as in the current Strategy for spent fuel and radioactive waste management, which envisages completion of the decommissioning of Units 1 to 4 at Kozloduy NPP to the end of 2030.

The ultimate goal is to realize safe and effective decommissioning and to minimise the costs and environmental

impact of decommissioning Kozloduy NPP Units 1–4. One of the main challenges being faced at this stage relates to the selection of the appropriate technology, methods and tools for the dismantling of activated components like the reactor and its internals. Another challenge is to preserve knowledge and engage appropriately-qualified personnel for the work. SERAW's stakeholder engagement plan includes a number of activities aimed at ensuring public support during the decommissioning process.

References

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