# SERVICE LIFE EXTENSION of UNITS 5 and 6 at KOZLODUY NPP PLC -IMPLEMENTATION STRATEGY and STAGES



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## **PRACTICE WORLWIDE**



In recent years, most of the nuclear operator countries have adopted the extensive method of continuous development of their nuclear power plants.

This approach disposed of the outdated concept of "design life" of the nuclear power units. It is now considered that the reactor units operation timelines are subject to the condition of "safe operation until this is economically viable". Therefore, efforts have been redirected to modern technological solutions to improve the safety and effectiveness of the existing units in order to enhance their load factor (LF) and extend their service life.

At the end of 2015, over 50% of all the 438 nuclear power reactors operating worldwide had been in operation for more than 30 years, and 14 % of these had been in operation for more than 40 years.



## **GENERAL INFORMATION**

Kozloduy NPP was the first nuclear power plant in southeast Europe. Currently, it has 40 years of operating experience.



The plant is the largest electricity generation company in the country. The nuclear power units 5 and 6 provide about 33,6% of the national electricity output.

To ensure the future of nuclear energy in Bulgaria, the service life extension of units 5 and 6 appears to be the most appropriate solution. It is based on solid pragmatic considerations that balance all the engineering, economical and political arguments in the context of our national interests.

Over the years 2014 - 2019, the management of Kozloduy NPP PLC has had as its major priority and commitment the implementation of the project for extending the operating lifetime of units 5 and 6. The project has been declared as one of strategic and great public importance.

The Energy Strategy of the Republic of Bulgaria until 2020 includes as one of its priority tasks the plant life extension of units 5 and 6.



## **GENERAL INFORMATION**



### Unit 5

- Type WWER-1000
- In operation since 1987
- Operating Licence by 05 November 2017
- Fuel campaigns 22



### Unit 6

- Type WWER-1000
- In operation since 1991
- Operating Licence by 02 October 2019
- Fuel campaigns 21

The two units have been in operation as per the operating licences series E, № 03000 and 03001 issued by the BNRA as of 02 October 2009.



### SUBSTANTIATION

The activities for residual life assessment and management of the SSCs important to safety are subject to the annual Maintenance, Investment and Production Programmes, as well as of the accomplished Modernisation Programme for Kozloduy NPP Units 5 and 6.

Over the years 1987 – 2010, more than 4000 design modifications were implemented on units 5 and 6, with the aim of enhancing their safety and operational reliability. The Modernisation Programme comprised 212 measures, and one of the reasons for its establishing was to ensure the conditions for extending the service life of units 5 and 6 beyond their design lifetime.

The analyses of Kozloduy NPP Units 5 and 6 undertaken after the large-scale modernisation, demonstrated a high level of nuclear, radiation, and technological safety commensurate with that of the best plants of similar design.

The design and operational practices conform to the requirements of the national legislation and the IAEA recommended international safety standards.

This provides us sufficient grounds for the implementation of the project for plant life extension.



# PLANT LIFE EXTENSION OF UNITS 5 AND 6

Pursuant to the Act on the Safe Use of Nuclear Energy, and the currently effective operating licences, the Bulgarian Nuclear Regulatory Agency (NRA) has defined the requirements that need to be fulfilled if the plant contemplates operating units 5 and 6 following the expiry of their design lifetime.

#### REQUIREMENTS

• Evaluation of the residual lifetime of the systems, structures and components (SSCs), which will remain in operation, and the SSCs required to be replaced with new ones;

- Justification of the new plant lifetime;
- Development and implementation of a programme to prepare each unit for service life extension.

#### **KEY PRIORITIES**

- Ensure and continuously enhance the level of nuclear safety and radiation protection;
- Electricity generation with safety guaranteed;
- Sustain and enhance safety culture;
- Environmental protection;
- Effective, socially oriented plant management with staff motivation;

• Financial stability (underpinned by sustainable revenues, expanded market share, cost optimisation, and effective control).



## PLANT LIFE EXTENSION OF UNITS 5 AND 6

Pursuant to the above requirements and adhering to its main priorities, Kozloduy NPP PLC launched the implementation of a large-scale project to ensure the conditions for service life extension of units 5 and 6.

### **STAGES**

The activities for units 5 and 6 operating life extension were allocated into two main stages:

• Stage 1: Comprehensive assessment and development of programmes for the residual lifetime evaluation of the equipment and facilities of Kozloduy NPP units 5 and 6;

• Stage 2: Implementation of the Programmes of Units 5 and 6 Preparation for Lifetime Extension (long-term operation)



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# PLANT LIFE EXTENSION OF UNITS 5 AND 6

**<u>Stage 1:</u>** Comprehensive assessment and development of programmes for the residual lifetime evaluation of the equipment and facilities of Kozloduy NPP units 5 and 6

The comprehensive assessment comprised:

- Analysis of the main systems, civil structures, and hydro-engineering facilities, and identification of the main (critical) components to be assessed;
- Determining the most important mechanisms affecting the ageing and degradation processes of the main (critical) components;
- Development of relevant procedures and methodologies for residual lifetime assessment;
- Residual lifetime assessment of separate systems;
- Justification of packages of recommendations and measures on ensuring the lifetime, integrated into the Programme for the units' lifetime extension preparation.

Preliminary assessment results for units 5 and 6 demonstrate that the greater portion of elements covered possess the required residual lifetime.

Screening has been completed of the elements for which further activities are needed such as study, technical condition assessment and justification of the residual lifetime, estimations of the main mechanical properties, thermohydraulic calculations and confirmation of the residual life values. As a result of the assessment, recommendations have been given and specific measures have been identified for accomplishment during the second stage of the project.



**Stage 2:** Implementation of the Programmes of Kozloduy NPP Unit 5 and 6 Preparation for Lifetime Extension (long-term operation)

A <u>stage 2</u> project management plan has been issued for the operating lifetime extension of KNPP units 5 and 6.

The goals of the Stage 2 project management plan include:

- Scoping of the activities, resources required, timelines, substages and deliverables for implementing the second stage of the project;
- Regulating the organisational aspects, inclusive of roles and responsibilities for implementing the projected activities, and the communications between the project manager, the team members, the subcontractors, and the Nuclear Regulatory Agency;
- Ensuring the correct definition and documenting of the second stage activities towards achieving the ultimate goal of the project:
- Meeting the conditions of section 22 of Operating Licences series E № 03000/02.10.2009, for unit 5, and series E № 03001/ 02.10.2009, for unit 6, in view of their renewal;
- Substantiating the units' safe operation over the long-term operation period.

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# PLANT LIFE EXTENSION OF UNITS 5 AND 6

The second stage of the project draws on the results of the integrated assessment and residual life evaluation of SSCs at units 5 and 6 completed during the first stage of the project.

The project second stage includes:

• development, approval and agreement with the Nuclear Regulatory Agency of Preparatory Programmes for Kozloduy NPP Units 5 and 6 Service Life Extension;

• implementation of the actions scheduled in the Programmes, namely organisational, technical and methodological activities for extending the operating life of units 5 and 6, while providing due justification of their long-term operation timeframes.

The programmes for preparation of units 5 and 6 for long-term operation provide the necessary technical and organisational measures resulting from the comprehensive assessment of the actual condition and evaluation of the residual lifetime of equipment, as well as the timelines for assuring the service life of structures, systems and components. (The Programmes have been agreed by the Nuclear Regulatory Agency).

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2014 - 2017





## PLANT LIFE EXTENSION OF UNITS 5 AND 6

A separate organisational structure was established for implementing of the Project Stage 2. The Safety and Quality Council (S&Q) exercises control over the implementation of all the project activities.





### **PROJECT MANAGEMENT PLAN - Stage 2**

**Unit 5:** a total of 265 measures planned and included in the project management Plan for Service Life Extension:

- 244 measures scheduled for implementation to the end of the licensing period;
- 21 measures scheduled to be implemented in the coming licensing period.

Unit 6: a total of 228 measures planned and included in the project management Plan for Service Life Extension:

- 203 measures scheduled for implementation to the end of the licensing period;
- 25 measures scheduled to be implemented in the coming licensing period.

The plant life extension project is a dynamic process that requires timely updates to the investment intentions and the financial resources planned, corrections of the delivery due dates for reasons of technological, administrative or other nature. This necessitates periodic updates of the PLEX project management documents as per the procedure described in the project management plan.

The project measures updates cover:

- implementation scheduled dates correction;
- specifying the implementation modes.





The organisation for activities implementation envisages, if necessary, compensation actions such as:

- Preparedness to rearrange activities within the approved annual outage schedules;
- Attracting of additional human resources;
- Justified modification of activities outside the outage scope, which do not affect the plant safety.





### INTERACTION WITH THE NUCLEAR REGULATION AGENCY

- The Bulgarian Nuclear Regulatory Agency (NRA) exercises due control on the adherence to the normative requirements, approves and issues design modification permits;
- Approves the working reports on the Stage 1 implementation;
- Agrees and approves the programmes developed as a result of the activities accomplished in stages 1 and 2 for units 5 and 6;
- **Controls the second stage measures implementation.**
- The NRA inspection of the "Project Management Arrangements for Service Life Extension of Units 5 and 6 at Kozloduy NPP" issued the following conclusions:
- The necessary project management arrangements are in place;
- The financial resources required have been provided;
- Persons with adequate production and organisational experience have been involved in the process;
- Provisions have been made for the arguins needed to control the progress on the activities



### ADDITIONAL ACTIVITIES FOR LICENCE RENEWAL

To date, no slippage has been incurred regarding the scheduled dates in the programmes for life extension of Kozloduy NPP units 5 and 6.

All the measures have been performed in conformity with the regulatory requirements valid for the Republic of Bulgaria, and the IAEA.

All the documents have to be submitted to the NRA not later than 12 months prior to the expiry of the current licences. Thus, the licence renewal applications will be submitted by



- 05 November 2016, for unit 5;
- 02 October 2018, for unit 6.





### ADDITIONAL ACTIVITIES FOR LICENCE RENEWAL

To substantiate the safety of units 5 and 6 during their new licence periods, activities need to be performed that accompany their operating licence renewal:

Conduct a Periodic Safety Review (PSR);

Prepare and submit to the NRA the updated Safety Analysis Report;

Conduct a SALTO mission (Safe Long Term Operation) of the International Atomic Energy Agency (IAEA).

The effective implementation of the measures ensuing from the assessment of the current condition and residual lifetime evaluation of SSCs on units 5 and 6 will provide grounds for the licence renewal of Kozloduy NPP units 5 and 6. In the long term, this will guarantee a considerable growth of the electricity generation and economic benefits for the company, the country and national business.

### БЛАГОДАРЯ ЗА ВНИМАНИЕТО!

