EU TOPICAL PEER REVIEW

AGEING MANAGEMENT ASSESSMENT OF NPP

NATIONAL ACTION PLAN
REPUBLIC OF BULGARIA

Nuclear Regulatory Agency

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CONTENTS

1. INTRODUCTION

In 2014, the European Union (EU) Council adopted Directive 2014/87/EURATOM amending the 71/2009 Nuclear Safety Directive to incorporate lessons learned following the accident at the Fukushima Daiichi nuclear power plant in 2011. Recognizing the importance of peer review in delivering continuous improvement to nuclear safety, the revised Nuclear Safety Directive introduced a European system of Topical Peer Review (TPR) commencing in 2017 and every six years thereafter. The purpose is to provide a mechanism for EU member states to examine topics of strategic importance to nuclear safety, to exchange experience and to identify opportunities to strengthen nuclear safety. The process provides for participation, on a voluntary basis, of States neighbouring the EU with nuclear power programmes.

The 30th Meeting of the European Nuclear Safety Regulators Group (ENSREG) in July 2015 identified ageing management of nuclear power plants as the topic for the first Topical Peer Review. This selection was supported by a technical assessment performed by the Western European Nuclear Regulators Association (WENRA) in recognition of the age profile of the European nuclear reactor fleet and the safety significance of the topic. The Terms of Reference (ToR) and the Technical Specification (TS) of the first Topical Peer Review, as well as the Stakeholder Engagement Plan, were approved by ENSREG in January 2017.

According to the Terms of Reference and the Technical Specification, the peer review focused on the Ageing Management Programmes (AMPs) at Nuclear Power Plants (NPPs) and Research Reactors (RRs) above 1 MWt. On a voluntary basis, the participating countries extended the scope of their national assessment to encompass other Research Reactors. Several countries reported on specific aspects of ageing management related to long-term operation (LTO) of NPPs although LTO was not specifically required by technical specifications. In addition to reviewing the programmatic part of ageing management, the peer review process examined the application of the AMPs to the selected systems, structures and components (SSCs) in four thematic areas, namely: electrical cables, concealed piping, reactor pressure vessels, or equivalent structures, and concrete containment structures.

The objective of the first Topical Peer Review was to examine how well Ageing Management Programmes in the participating countries meet international requirements on ageing management (in particular WENRA Safety Reference Levels – (SRLs) and the IAEA Safety Standards). Moreover, the participating countries were enabled to:

- review their provisions for ageing management, to identify good practices and to identify areas for improvement;
- share experience and identify common issues faced by Member States.

The TPR provided an open and transparent framework for participating countries to develop follow-up measures to address areas for improvement.

The Topical Peer Review assessed the national reports and the good practices and areas for improvement identified therein. Following delivering of presentations and conducting of discussions, the ENSREG board published a Topical Peer Review Report and Country specific findings allocated per participating countries (country-specific findings). The findings were allocated as follows:

- TPR expected level of performance - recognised as a good performance for those countries which already meet this expectation;
- Area for improvement - an area in which the respective country does not satisfy the expected level of performance achieved by the other countries;
- Good practice - performance that exceeds the expected level of performance.

Due to the large variation of cables and their use at Nuclear Power Plants and lack of details provided in the National Assessment Reports and during the workshop presentations, the findings related to cables were not allocated to the countries and, therefore, country-specific findings related to cables are not included in the TPR report.

Within the framework of its obligations, the Republic of Bulgaria duly considered all the general findings and the respective country-specific findings.

This Ageing Management National Action Plan (NAP) was developed in the context of fulfilling the obligations of the Republic of Bulgaria as a member of the European Union in connection with the assumed responsibilities as a state operating a nuclear power plant.

The state control over the safe use of nuclear energy and ionizing radiation, and radioactive waste and nuclear fuel safe management is effected by the Bulgarian Nuclear Regulatory Agency (NRA) which is an independent specialised executive body. The requirements of the national legislation as regards NPP ageing management are specified in the following documents:

- Safe Use of Nuclear Energy Act;
- Regulation on ensuring the safety of nuclear power plants;
- Regulation on the procedure for issuing licences and permits for safe use of nuclear energy.

Additional instructions regarding the implementation of the requirements contained in the regulatory documents and relevant to the ageing management process are contained in the following regulatory guides:

- Guide on “Safe Operation of Nuclear Power Plants”;
- Guide on “Ageing management of structures, systems and components of nuclear power plants”.

The Republic of Bulgaria operates the Kozloduy Nuclear Power Plant with two VVER-1000 reactors, model B-320, operating in an airtight protective reinforced concrete structure (containment). The units were commissioned in 1987 and 1991, respectively, and their design lives expire in 2017, for Unit 5, and 2021, for Unit 6. Following the completion of review and analyses as well as the implementation of actions included in the plant life extension programme, in November 2017, the operating licence of Unit 5 was renewed for a 10-year period. Similar activities are being implemented on Unit 6 as well.

The Ageing Management National Action Plan of the Republic of Bulgaria presents the country position on each finding in the national report (2018) and the country-specific findings identified in the report of the review performed, through a summary of the actions (measures) and specific details (information) including timeframes and dates for their implementation.

Extended information was provided on the good practices identified during the TPR to ensure their dissemination.

This NAP provides information on the country's progress on all findings, including good practices, and is the basis for a future evaluation of the activities under the responsibility of the Republic of Bulgaria for the ageing of structures, systems and components (SSCs) in Kozloduy NPP.

2. FINDINGS ENSUING FROM SELF ASSESSMENT

This section of the national plan presents the position of the Republic of Bulgaria related to the findings provided in the national report from the self-assessment performed by the Republic of Bulgaria.

2.1. Overall ageing management programmes (AMP)

2.1.1. Finding No. 1 from the National Report

The regulatory frame introduced is generally compliant with the approaches adopted by the IAEA and WENRA regarding the ageing management processes. Respective provisions have been included in the applicable normative documents. To facilitate the licence-holder, and in view of a more comprehensive understanding and implementation of the regulatory provisions, due consideration should be given to the possibility of preparing a regulatory guidebook on ageing management. The objective of such a guidebook would be to provide more detailed instructions and directions for the practical application of the existing and modified normative documents.

2.1.2. Country position and actions taken/planned

The guide on “Ageing management of structures, systems and components of nuclear power plants” has been in force since the end of 2018. The guide has been developed on the basis of the national legislation, as well as the Ageing Management and Development of a Programme for Long Term Operation of Nuclear Power Plants (IAEA Safety Standards Series No. SSG-48).

2.1.3. Finding No. 2 of the National Report

Bearing in mind the comprehensive nature of the activities related to ageing management, and the large scale of the plant life extension project, it is required to review the processes on the grounds of which a long-term inspection programme on behalf of the NRA is developed. The purpose should be to optimise the programme scope in terms of types of SSCs and periodicity of inspections, which will enhance the effectiveness of the inspections performed.

2.1.4. Country position and actions taken/planned

Currently, there is an ongoing revision of the processes on the basis of which the NRA long-term inspections programme will be prepared. The measure is included in Table 7.

2.2. Electrical cables

2.2.1. Finding of the National Report

The National Report did not contain any findings related to electrical cables.

2.2.2. Country position and actions taken/planned

No action is required.

2.3. Concealed (buried) pipework

2.3.1. Finding No. 3 from the National Report

The following recommendations were formulated as a result of the conducted analyses and assessments for ensuring the operability, lifetime characteristics and reliability of the main underground pipelines of the QF system:

- reconstruction of pressure pipeline No 5 in the wall of manhole Ш 657 to ensure a radial gap on both sides of the pipe of not less than 20 mm;
- reconstruction of the penetration of pressure pipeline No 8 in the wall of the dosimetric control manhole of system III at unit 6, to ensure a radial gap on both sides of the pipe of not less than 20 mm;
- assessment of sections of pipelines Nos 5 and 8 that run through the penetrations and are subject to reconstruction.

2.3.2. Country position and actions taken/planned

Improve the system for monitoring and documenting the condition of buried/concealed pipeline.

The following monitoring activities are implemented for early detection of problems with the concealed QF pipework:

- monitoring the rate of metal corrosion of concealed pipework as per the programme for corrective treatment of the cooling water in circulation cooling systems with spray pools, including corrosion measurement equipment. The purpose of applying corrective treatment is to slow down corrosion rate using chemicals as per a programme of the company GE Water&Process Technologies, assisted by an automated computer system, type Pace Setter Platinum, pursuant to “Operating Procedure for the Service Water Corrective Treatment System at the Safety Related Loads in the Circulation Coolant Systems with Spray Pools”;
- periodic visual inspections for leaks along the concealed pipework routes;
- condition monitoring of penetrations and the visible parts of pipes in the shafts and manholes along the pipeline route, and the readings of instrumentation and control equipment.

Adhering to “Procedure for operation, monitoring and control of the built hydro-technical facilities for service water supply to Kozloduy NPP EAD”, which includes:

- monitoring of the groundwater level and leakages from concealed pipework using piezometers build in close proximity;
- monitoring of vertical deformation settlement of concrete supports for discharge pipework from the spray pools to the water abstraction shafts and the diesel generator station with the help of the installed reference marks;
- monitoring for occurrence of cracks in the walls when pressure pipelines run through them from the reactor building to the spray pools, or discharge pipelines - from the spray pools to the water intake shafts and the diesel generator station.

To improve monitoring for potential leaks of concealed pipework of the QF system, the following activities have been performed:

- further analyses within the KNPP Units 5 and 6 Lifetime Extension Project to identify critical sections of concealed pipework;
- enlarging the existing network of piezometers in proximity to the critical sections of concealed pipework;
- conduct of periodic walkdowns to inspect concealed pipework sections where the noncontact magnetometric diagnostics had registered anomalies of the lowest risk category 3 (of the existing three categories), and the anomalies related to the signals due to the impact of electric cables.

To improve the database, the following has been undertaken:

- update (latest update in August 2018) of the existing as-built diagrams of concealed pipework included in the Diagram Manual for In-service Inspection of Base Metal and Welded Joints along the QF System;
- clarify/confirm the steel type of pipework using spectral analysis of the chemical composition of the repaired sections, and the easily accessible sections;
- store in electronic format the results from the magnetometric diagnostics and non-destructive testing (visually and through ultrasonic thickness measurement), in the SmartDoc database, in order to ensure traceability of the material thickness as a result of corrosion processes.

Trenching and additional assessment of those sections of concealed pipework where anomalies have been registered of higher risk category - category 2, with a trend of reaching category 1 (with maximum stress concentration and critical distribution of the magnetic fields) as is evident from the conducted non-contact magnetometric diagnostics.

According to a recommendation from the “Conclusion on the technical condition and the residual life of concealed trunk pipelines of the QF system”, conducted within the frame of the project for plant life extension of KNPP Units 5 and 6, in 2017, non-contact magnetometric diagnostics was performed along the whole length of the concealed pipework. In accordance with the results from the assessment, recommendations have been made regarding the digging and further survey of the concealed pipework sections where anomalies have been registered.

The activities for trenching and further survey of the concealed pipework sections with registered anomalies have been performed as per the “Programme for survey of concealed pipework for service water of the QF system”, developed by Kozloduy NPP.

The measures have been described in section 7 of this report.

2.4. Reactor Pressure Vessel

2.4.1. Findings from the National Report

The National Report did not contain any findings related to reactor pressure vessels.

2.4.2. Country position and actions taken/planned

No action is required.

2.5. Concrete containment structure and pre-stressed concrete pressure vessel

2.5.1. Findings from the National Report

The National Report did not contain any findings related to civil structures.

2.5.2. Country position and actions taken/planned

No action is required.

3. COUNTRY SPECIFIC FINDINGS RESULTING FROM THE TPR

This part of the national plan presents Bulgaria's position related to the country specific findings presented in document “ENSREG 1st Topical Peer Review “Ageing Management” Country specific findings, October 2018, HLG_p(2018-37)_161 1st TPR country findings”, as Areas for Improvement (AfI) in the part “TPR expected level of performance”.

The good practices and general findings identified in the same document, as well as those contained in “ENSREG 1st Topical Peer Review Report “Ageing Management” October 2018, HLG_p(2018-37)_160 1st Topical Peer Review Report” are presented in section 5.

Bulgaria's position regarding the findings related to the electric cables, as they are presented in “ENSREG 1st Topical Peer Review Report “Ageing Management” October 2018, HLG_p(2018-37)_160 1st Topical Peer Review Report” is stated in section 4.

3.1. Overall ageing management programmes (AMP)

3.1.1. TPR expected level of performance: Area for Improvement:

Methodology for scoping of SSCs subject to ageing management: The scope of the integrated AMPs is reviewed and, where necessary, updated in accordance with the new IAEA Safety Standard, once it has been published.

3.1.2. Country position and actions taken/planned

Kozloduy NPP has developed and implements a METHODOLOGY for scoping of structures, systems, and components for ageing management that is in conformity with the requirements of the national regulatory framework that are in currently place and the applicable

IAEA guides NS-G-2.12 - Ageing Management for Nuclear Power Plants, SRS-57 - Safe Long Term Operation Of Nuclear Power Plants, SSR-2-2 - Safety of Nuclear Power Plants: Commissioning and Operation, TRS 338 - Ageing management methodology.

In 2018 the Methodology was reworked in compliance with the requirements of the regulatory guidebook on ageing management issued by the NRA, as well as the requirements of the IAEA safety guide - Ageing Management and Development of a Programme for Long Term Operation of Nuclear Power Plants, Specific Safety Guides No. SSG-48, IAEA, Vienna (2018), which replaced NS-G-2.12. The scoping of the SSCs covered by the ageing management system is entirely conformed to the criteria set in SSG-48. The scope covers both passive and active components.

To that end, the following measure was formulated and reflected in Section 7:

"Review and update of the list of SSCs covered by the ageing management system, in compliance with the new requirements resulting from the issuing of the new IAEA guide, Ageing Management and Development of a Programme for Long Term Operation of Nuclear Power Plants, Specific Safety Guides No.SSG-48".

3.1.3. TPR expected level of performance: Area for improvement:

Delayed NPP projects and extended shutdown periods: In case of prolonged periods of construction or extended shutdown periods for NPPs, respective ageing mechanisms have been identified and appropriate measures taken to control the initial stages of ageing or other phenomena.

3.1.4. Country position and actions taken/planned

This topic is not applicable to Kozloduy NPP. All the activities related to the PLEX measures have been performed within the framework of the annual outages of the units; there was no need to shut the units down for a longer period of time.

Although the country has not encountered such an issue so far, it is foreseen in the guide on "Ageing management of structures, systems and components of nuclear power plants" (PP-20/2018):

"In the event of delay of the NPP construction, the structures already constructed and the delivered equipment has to be stored under appropriate conditions, as defined by the manufacturer, that shall limit the effect of the material ageing stressors".

3.2. Concealed (buried) pipework

3.2.1. TPR expected level of performance: Area for improvement:

Inspections of safety-related pipe penetrations:

Inspections of safety-related pipe penetrations through concrete structures form part of the ageing management programmes, unless the absence of an active degradation mechanism is proven.

3.2.2. Country position and actions taken/planned

Pipe penetrations of concealed pipework of the Component Cooling Water System (CCWS) – QF.

The pipe penetrations of the QF system concealed pipework are covered by the “Ageing Management Programme for Concealed Pipework QF of Kozloduy NPP EAD Units 5 and 6”. However, this is not reflected in the National Report of the Republic of Bulgaria for the TPR.

Information regarding the ageing management of the pipe penetrations of the Component Cooling Water System (QF) concealed pipework is provided below.

After modification the penetrations in the gate valve shafts and ensuring water-tightness of the penetrations through the walls of the diesel generator station, the intake structure and water intake shafts, performed in the period 2003-2016, the causes for the occurrence of degradation mechanisms were eliminated, namely:

- cracks in the concrete penetrations of the gate valve shafts which formed due to uneven settling of the ground base around the spray pools; and
- localised corrosion between the pipe penetration and the concrete walls.

In accordance with the results of the analysis of defects and failures identified during the operating period of the of the pipework system, conducted in 1987 (the first leak was recorded in 1996), and considered in the ageing management programme, no breaches were found in the pipework areas running through the penetrations, which reduces the possibility for corrosion formation on the inner surface of the pipe penetrations.

The “Conclusion on the technical condition and the residual life of concealed trunk pipelines of the QF system of Kozloduy NPP Units 5 and 6”, developed within the frame of the project for concealed pipework life extension, no defects or dominating degradation mechanisms were identified in the pipe penetrations, that could hamper their further operation.

The “Procedure for in-service inspection of service water pipelines - essential loads, group A of Units 5 and 6 QF system” includes external visual inspection of the pipe penetrations at freely accessible locations while performing non-destructive examination of pipelines passing through them. If defects (degradation mechanisms) are identified in the penetrations or pipelines passing through them, an extensive examination of these sections is performed.

No action is required.

3.2.3. TPR expected level of performance: Area for improvement:

Inspections when possible (Opportunistic inspections):

Inspection of the concealed pipework is performed when the pipework is uncovered for other purposes.

3.2.4. Country position and actions taken/planned

The inspection when possible (opportunistic inspection) is not reflected in the National Report of Bulgaria for TPR, but it is described in the documents pertaining to the operating life extension of concealed pipework of the QF technical water system of Kozloduy NPP Units 5 and 6, as well as in the Ageing Management Programme for QF Concealed Pipework.

Inspection when possible (opportunistic inspection) is implemented in the following cases:

- during maintenance or replacement of sections of ground surface layer laid over the concealed pipework route;
- during modification or maintenance of the penetrations and structures of the gate valve shafts;
- when ensuring water-tightness of the penetrations through the walls of the diesel generator station, intake chamber (forebay) and water intake shafts;
- during installation or replacement of lens compensators and other actions related to the maintenance and repair of equipment that forms part of the service water system.

If high level of ground waters is present around the concealed pipeworks that is monitored in inspection boreholes, additional control activities are conducted to inspect their condition.

No action is required.

3.3. Reactor pressure vessel

3.3.1. TPR expected level of performance: Area for improvement:

Non-destructive examination of the base material of RPV beltline region:

Comprehensive NDE of the RPV beltline region base material is performed in order to detect any defects.

3.3.2. Country position and actions taken/planned

The information provided in i.5.1.3.4 of the Bulgaria's National Report for TPR regarding the scope of the performed non-destructive examination of the reactor pressure vessel beltline base metal states that ultrasonic testing of the lower ring (opposite the support brackets) of the cylindrical part of the vessel is performed during external RPV inspection, whereas during the internal vessel inspection ultrasonic testing of the base metal and overlay of the upper ring of the vessel cylindrical part (opposite the core) is performed. During the external unit 6 vessel inspection carried out in 2002, a continuous ultrasonic scanning was also performed of the reactor pressure vessel cylindrical part through the whole forgings' thickness, from the bottom welding to the lower ring up to upper ring welding to the support ring, i.e. base metal ultrasonic testing (insonification) was performed of the lower ring and the upper ring.

Besides, according to the methodologies for ultrasonic testing of the external and internal side of Units 5 and 6 reactor pressure vessels, during the welding testing the base metal of the area around the welds (100-150 mm) of the rings is also subjected to insonification through the whole thickness of the forgings to the edge of the overlay.

Item 5.1.2.9 of Bulgaria's National Report for TPR examines the activities of the Nuclear Regulatory Agency and Kozloduy NPP undertaken to address WENRA recommendations regarding the defects of the “hydrogen flakes” type recorded in 2012 in the reactor pressure vessels base metal at the Belgian NPPs Doel 3 and Tiange 2. Based on the conclusions it was inferred that Kozloduy NPP Units 5 and 6 reactors are manufactured under different technology and the occurrence of defects of the “hydrogen flakes” type in the RPVs base metal is of low probability - no extension of the testing scope beyond the framework of the existing metal control programmes is required.

We also provide herein additional information regarding the activities performed in November 2018 by the Nuclear Regulatory Agency and Kozloduy NPP on WENRA recommendations ensuing from the abnormalities with carbon microsegregations registered in 2014 in the French reactors manufactured at Le Creusot factory. After the conducted complex review and analysis of the possibilities for the existence of similar abnormalities in large-size forgings of Units 5 and 6 equipment (reactor pressure vessels, steam generators and pressurisers), the following conclusions were made:

The large-size forged components of the reactor pressure vessels, steam generators and pressurisers at Kozloduy NPP are manufactured from low carbon steel (0.13÷0.18%). For the sake of comparison, the maximum carbon (C) content in the components produced at AREVA Creusot Forge (ACF) is 0.32 weight percent (wt%), and in the components of Japanese Casting and Forging Corporation (JCFC) it is 0.39%. The regulatory French documents regarding the material specification RCC-M 16MND5 requires maximum carbon content in forgings of 0.22 wt%.

The manufacturing technology of large-size forged components for the reactor pressure vessels, steam generators and pressurisers at Kozloduy NPP is different from the one used in Le Creusot factory, and it prevents the formation of carbon segregations.

Kozloduy NPP has not identified any risk of carbon segregations in the large-size forged components of the reactor pressure vessels, steam generators and pressurisers.

According to the conclusions drawn by the Advisory Council on Nuclear Safety held on 11.07.2013 in relation to Kozloduy NPP actions with regard to the events at Doel 3 and Tiange 2 NPPs, as well as the implementation of WENRA recommendations:

- no detectable defects in Kozloduy NPP reactor pressure vessels base metal were recorded, including of the “hydrogen flakes” type;
- no new qualification of Kozloduy NPP Units 5 and 6 reactor pressure vessels base metal ultrasonic testing is required;
- there is no need to increase the scope of inspections beyond the frames of the In-service Inspection Procedure.

No action is required.

3.3.3. TPR expected level of performance: Area for improvement:

Environmental effect:

Fatigue analyses should take into account the environmental effect of the coolant on the material.

The ageing management programme does not cover boric acid corrosion as a potential degradation mechanism in the event of contact with the outside surface of the reactor pressure vessel or the reactor vessel head.

3.3.4. Country position and actions taken/planned

The analyses of fatigue, taking into account the environmental effect of coolant on the metal of the reactor pressure vessel components, are not mentioned in the National TPR Report, but are described in the RPV Ageing Management Programme.

The impact of the working medium/coolant can lead to an increase in the coefficients for the calculation of the fatigue stress of the elements compared to those used in the design, which have been determined without taking it into account. Within the framework of the activities for the life extension of the SSC at Kozloduy NPP, activities have been carried out taking into account the water environment (the primary circuit coolant), in accordance with the existing methodologies and guideline documents.

The impact of the working medium is taken into account in the analysis of:

1. Calculations of fatigue damage values at low cycle load, respectively without and with taking into account the impact of the working environment:

When considering the damage mechanisms due to low-cycle fatigue, the value of accumulation of fatigue damage at the calculation points taking into account all modes (NO - normal operation, AO - abnormal operation, DBA - design basis accidents) is considered as a lifetime characteristic. The given mechanism is manifested in points with stress concentration or in zones with high load from mechanical and thermal loads. The calculations are made taking into account the environmental and / or coolant impact on a given point of the RPV element. The boundary condition is regulated in accordance with the Norms for Strength Calculations of Equipment and Pipelines in Nuclear Power Plants. PNAE G-7-002-86, Moscow, Energoatomizdat. For example, at Kozloduy NPP, according to the results of the strength calculations performed for the zone with nozzles DN 850 and the separation ring of Unit 6 RPV, the maximum value of the accumulated fatigue damage during low cycle load, for a life span of 60 years, was calculated taking into account the environmental impact.

2. Calculations of boundary conditions and temperature fields:

The calculations of the limit conditions and the temperature fields are carried out by creating a simplified model of a calculation structure assembly and defining typical surface sections impacted by the coolant or the environment. For each of the surface sections, an algorithm is recorded to realise the heat exchange conditions for this section with the coolant or the environment. Besides, the temperature of the very surface of the defined section which changes in time is taken into account in the heat exchange conditions, which permits modelling the processes of boiling, condensing, free convection, etc., essentially dependant on the surface temperature. The values obtained are input data for the strength calculations obtained on the grounds of the results of the thermo-hydraulic calculations.

As can be seen from the examples, Kozloduy NPP uses the approach of an expected Cumulative Usage Factor (CUF) dependent on the environment.

No action is required concerning environmental effect.

Boric acid is a potential degradation mechanism for carbon and low alloy steels upon contact with the outer surface of the reactor and the vessel head lid during operation of the reactor plant, and depends on the boric acid concentration. This could occur as a result of leakage from the flange connections of the control rod nozzles and the temperature control of the vessel head. Non-destructive examination of all components and surfaces exposed to the potential risk of boric acid impact is included in the in-service inspection procedure.

The review of the "Ageing Management Programme for the RPVs of Units 5 and 6 of Kozloduy NPP" will include boric acid corrosion as a potential degradation mechanism upon contact with the outer surface of the vessel and the vessel head lid.

The measure is included in Part 7.

3.4. Concrete containment structure and pre-stressed concrete pressure vessels

No area for improvement has been formulated in this section.

4. GENERIC FINDINGS RELATED TO ELECTRICAL CABLES

In this part of the national plan is presented the position of the Republic of Bulgaria in relation to all findings regarding the electrical cables presented in the document "ENSREG 1st Topical Peer Review Report "Ageing Management" October 2018, HLG_p (2018-37)_160 1st Topical Peer Review Report".

4.1. Good Practice: Characterise the state of the degradation of cables aged at the plant

Cables are aged within the actual power plant environment and tested to assess the cable condition and determine their residual lifetime.

4.1.1. Country position

High voltage cables of 6kV age in their natural environment and are tested periodically according to a schedule. Depending on the results and trends obtained, the periodicity of the tests is modified and the residual life determined. For this purpose, an Ageing Management Programme for 6 kV cables connected to systems important to safety was developed and implemented, and expanded to include cables related to the reliability of power generation.

Low voltage 0.4 kV cables of the systems important to safety are subject of the Equipment Qualification Programme and samples are periodically taken from them for testing. The samples are further aged in accordance with the planned period of extended operation and in accordance with the actual environmental conditions, after which they are tested in HELB and LOCA environmental conditions in laboratories to confirm their qualification status for the specified period.

In order to provide representative test specimens, both inactive cables (left in the actual environment after decommissioning) and cables subjected to the most severe environmental conditions are used. Thus, the residual life of a wide range of cables can be assessed in a conservative manner.

4.1.2 Planned activities

The low voltage 0.4 kV cables located in MILD environment are actually operated under normal environmental conditions, which do not change either under normal operation or in case of design basis accidents. Until now, these cables have not been inspected to determine their residual life. These are cables of systems important to safety and those related to the reliability of electricity generation.

To that end, the following measure was formulated and reflected in Section 7:

The 0.4 kV low voltage cables from the systems important to safety (low voltage cables located in MILD environment) shall be assessed to determine their residual lifetime.

4.2. TPR expected level of performance: Documentation of the cable ageing management programme

The AMP is sufficiently well-documented to support any internal or external reviews in a fully traceable manner.

4.2.1. Country position

The AMP for cables of Kozloduy NPP stipulates what kind of documented information needs to be managed to allow for traceability in case of internal or external inspections. This information includes design documentation and manufacturer's documentation (including identification numbers, materials used, performance characteristics), degradation mechanisms, diagnostic methods, completed design changes, international experience evaluations, measurement methods and schedules. This also includes documentation related to the studies and analyses carried out with regards to qualification and residual life.

All relevant documents and activities are documented in a database that allows quick access and full traceability.

4.3. TPR expected level of performance: Methods for monitoring and directing all AMP-activities

Methods to collect NPP cable ageing and performance data are established and used effectively to support the AMP for cables.

4.3.1. Country position

The qualification programme and the AMPs provide for and have descriptions of the methods for collecting data on ageing of cables. The cables are entered into a database and all test and monitoring data (including monitoring of environmental parameters) are stored in the relevant database. In addition, some cables have been replaced due to their ageing or have been proactively replaced with more environmentally resistant cable types. Early detection and replacement actions taken are indicators of efficient cable AMPs.

4.4. TPR expected level of performance: Systematic identification of ageing degradation mechanisms considering cable characteristics and stressors

Degradation mechanisms and stressors are systematically identified and reviewed to ensure that any missed or newly occurring stressors are revealed before challenging the operability of cables.

4.4.1. Country position

The ageing assessment considers not just the cable's conductor but rather all of its components. It is commonly found that the most vulnerable parts of electrical cables are the jacket, the insulation and the termination boxes of the cables. In most cases the jacket and the insulation of the cables are made of polymeric materials such as polyvinyl chloride (PVC), ethylene propylene rubber (EPR), polyethylene (PE) or cross-linked polyethylene (XLPE). These materials can be damaged by environmental stressors e.g. temperature, radiation, chemical or mechanical impact, humidity and Joule effect, as well as induced electrical field (MV and HV cables). For all these stressors, degradation could affect the cable's functionality in particular when their level is beyond the manufacturers' specification or when one or another stressor has not been considered in the qualification programme.

The main mechanisms affecting insulation and sheath that have been evaluated and taken into account in the assessments carried out so far are:

- migration of additives;
- water dendrites (treeing phenomena);
- dehydrochlorination initiated by temperature;
- oxidation influenced by temperature and dose rate.

The main mechanisms impacting the cable termination boxes (mostly MV and HV cables) include mechanical damage thermal cycling, vibration and oxidation. Those could lead to local elevated temperature of the cable core and accelerate the degradation of the insulation.

The AMP describes and provides for monitoring and identification of existing stressors and mechanisms of degradation. The system of dissemination of internal and external operating experience supplements this process and provides information on possible identified new stressors or mechanisms of degradation. The operating experience collected and then shared within the industry is an important element of a proper implementation of AMP for cables. As documented in the National Report, our country places high importance on the use of its own and of international operating experience. In this connection, it is worth mentioning the participation of Kozloduy NPP in the IGALL project of the IAEA, where a database of the experience of the Member States in the field of ageing management is collected.

The programme has so far shown its effectiveness and we believe that no other action is needed.

4.5. TPR expected level of performance: Prevention and detection of dendrite structures

Approaches are used to ensure that water treeing in cables with polymeric insulation is minimised, either by removing stressors contributing to its growth or by detecting degradation by applying appropriate methods and related criteria.

4.5.1. Country position and actions taken/planned

Water treeing is a process that causes degradation of insulation performance. Water trees are one of the major causes of premature ageing and failure of extruded high-voltage polymeric cables without water-impermeable barriers. A water tree is typically initiated in the insulation's micro-cavities (defect of insulation, fatigue cracking, local heating due to impurities). Partial electrical discharges cause the propagation of water trees by degrading insulation and creating chemical conditions that could increase the size of cavities. When the length of a water tree increases, the electric field in front of the degraded area is amplified.

Preventing or minimising the growth of water trees at Kozloduy NPP is achieved by minimizing stressors contributing to the growth of water trees.

Modern, widely used methods are implemented to detect water treeing - mainly by measuring the polarisation index and the partial discharges. The results are stored in a database that allows for easy processing and trend determination.

The modern methods of control of high voltage cables from the systems important to safety at Kozloduy NPP are sufficient to maintain a high level of safety of the facilities.

4.6. TPR expected level of performance: Consideration of uncertainties in the initial environmental qualification

The accuracy of the representation of the stressors used in the initial environmental qualification is assessed with regard to the expected stressors during normal operation and design basis accidents.

4.6.1. Country position

Cables important to safety are (or should be) qualified for the environment they are subject to. This is to ensure their operability for the duration of design life including postulated accident conditions. The qualification should be reviewed in case of extended life of operation. Despite the qualification, the operability of the cables cannot be taken for granted, as the environmental stressors might change from those originally envisaged or effects may exist that had not been accounted for during the qualification process. Documentation reviews sometimes identify cables not being qualified for the environment they are deployed in or for functions they are supposed to fulfil. Therefore, the cables and their environment need to be monitored and the results of cable qualification verified throughout their entire lifetime.

The qualification programme provides for permanent monitoring of environmental conditions in order to refine the initial qualification assumptions. This could also serve to reduce unnecessary conservatism with subsequent requalification. Requalification of the cables under the programme is performed every 10 years.

Testing laboratories will seek to reduce the uncertainties arising from the initial qualification.

4.6.2. Actions taken/planned

To that end, the following measure was formulated and reflected in Section 7:

"Requalification of 0.4 kV low voltage cables subject to LOCA and HELB qualification, using, when possible, estimations to reduce uncertainties".

4.7. TPR expected level of performance: Determining the behaviour of cables under the strongest stressors

The cables necessary to mitigate the effects of accidents are tested to determine their ability to perform their functions under the conditions of extended beyond design basis accident conditions and throughout their expected life cycle.

4.7.1. Country position

Under the design for design basis accident conditions, cables are installed that are appropriately qualified for these conditions. Accordingly, the re-qualification of the cables is carried out for these conditions. This approach reflected the current standards at the time.

4.7.2. Actions taken/planned

To that end, the following measure was formulated and reflected in Section 7:

Qualification of the cables required to mitigate the effects of accidents in order to determine their ability to perform their functions under extended beyond design basis accidents conditions throughout their expected life cycle.

4.8. TPR expected level of performance: Methods for determining the degree of degradation of cables in inaccessible locations

Based on international experience, appropriate techniques and methods for detecting cable degradation in inaccessible locations shall be applied.

4.8.1. Country position

The subject of the AMP are Category 1 cables installed in inaccessible locations. To establish their degradation internationally established and modern methods are used, such as:

- Measurement of active insulation resistance (for MV, LV, SIG);
- Measurement of active/full insulation resistance (for MV, LV, SIG);
- Measurement of dielectric loss factor (Tan δ, phase angle) (for MV);
- Signal transduction behaviour (time/frequency domain) (for SIG);
- Measurement of the partial discharges (for MV).

So far, these methods have shown their effectiveness and no need for additional control methods have been identified.

5. ALL OTHER GENERAL FINDINGS

In this part the national plan presents the position of the Republic of Bulgaria regarding all the country's general findings presented in the document “ENSREG 1st Topical Peer Review “Ageing Management” Country specific findings, October 2018, HLG_p (2018-37)_161 1st TPR country findings”, as the position in the Areas for Improvement (AfI) in the “TPR expected level of performance” part is presented in Part 3 and the respective reference is made in the text.

The good practices of the Republic of Bulgaria have been examined with due depth in order to provide sufficient information for their implementation by the other Member States. Good practices established in the other Member States are reviewed and their applicability in the national AM Programmes analysed. Information on “good performance” established for the Republic of Bulgaria is also provided. All these general findings are addressed as detailed in “ENSREG 1st Topical Peer Review Report “Ageing Management” October 2018, HLG_p (2018-37) _160 1st Topical Peer Review Report”.

5.1 Overall ageing management programmes (AMP)

5.1.1. Good Practice: External peer review services

External peer review services (e.g. SALTO, OSART-LTO, INSARR-Ageing) are used to provide independent advices and evaluations of ageing management programmes of license holders.

5.1.1.1. TPR allocation for Bulgaria: Good Practice

5.1.1.2. Country position

As an independent expert review of the PROGRAMME and in the context of activities for lifetime extension of Units 5 and 6, KNPP has initiated the conduct of IAEA SALTO review mission in 2020. As part of the preparation for this mission in 2016, and 2018, IAEA expert teams conducted pre-SALTO preliminary missions on Units 5 and 6, respectively, in the following areas:

A: Organisation and functions, current licensing basis, configuration and modification management;

B: Scoping and screening and plant programmes relevant to LTO;

C: Ageing management review, review of ageing management programmes and revalidation of time limited ageing analyses (TLAAs) for mechanical components;

D: Ageing management review, review of Ageing Management Programmes, and revalidation of Time-Limited Ageing Analyses (TLAAs) for Electrical and I&C components;

E: Ageing Management Review, review of Ageing Management Programmes, and revalidation of Time-Limited Ageing Analyses (TLAAs) for Electrical and I&C components.

As part of the preparation for the pre-SALTO missions, self-assessments of the preparedness of Kozloduy NPP were made.

The non-conformances identified during the self-assessments, as well as the recommendations made by the IAEA experts during the two Pre-SALTO missions, led to the implementation of corrective measures aimed at improving and upgrading the existing ageing management system at Kozloduy NPP.

The SALTO mission is scheduled for 2020.

5.1.2. TPR expected level of performance: Data collection, record keeping and international cooperation

Participations in international research projects, exchange of experience within groups with the same reactor design, as well as existing international databases are used to improve the effectiveness of the overall NPP Ageing Management Programmes.

5.1.2.1. TPR allocation for Bulgaria: Good performance

5.1.2.2. Country position and actions taken/planned

Kozloduy NPP takes part in international projects which are related to ageing management, such as:

- Joint activities for improvement of the experimental and regulatory and methodological justification for ensuring the lifetime extension of the reactor pressure vessels of WWER-1000 reactors were carried out with Russian engineering companies.
- IAEA Project - Summary of experience and setting a database with ageing management programmes applicable to NPPs (IGALL, International Generic Ageing Lessons Learned). The objective of the IGALL project is to support the management teams of nuclear power plants and regulators to sustain the required level of safety during plant operation taking into consideration equipment degradation mechanisms as well as prepare new guidelines for criteria and practices of the separate countries applicable during plant lifetime extension.
- IAEA Project - Assistance in the preparation of the Lifetime Extension Programme for Kozloduy NPP Units 5 and 6. The project was intended to assist in the development of the Kozloduy NPP Unit 5 and 6 Service Lifetime Extension Programme, cooperation at various stages of the lifetime extension process to assist Kozloduy NPP to apply for extension of the operating life of Units 5 and 6.
- IAEA Regional Project - Qualification of In-core Ultrasonic Inspection of WWER-1000 Reactors. Parties participating in the project: Kozloduy NPP, Nuclear Regulatory Agency - Bulgaria, INETEC (Institute for Nuclear Technology) Croatia, HYDROPRESS Russia, EPRI (Electric Power Research Institute) USA, and IAEA.
- Qualification of eddy current inspection of steam generators and ultrasonic inspection of main circulation pipelines DN 850 at Kozloduy NPP, funded by the UK Department of Trade and Industry, and IAEA, with the participation of experts from Serco Assurance, Kozloduy NPP, the Bulgarian Academy of Science and the Nuclear Regulatory Agency.
- IAEA Regional Project - Qualification of ultrasonic inspection of reactor coolant pipelines DN 500 (WWER-440) at Kozloduy NPP. Parties participating in the project:

Kozloduy NPP, Nuclear Regulatory Agency, Řez Institute for Nuclear Research Czech Republic, and IAEA.

5.1.3. TPR expected level of performance: Methodology for determining the scope of SSCs subject to ageing management

The scope of the overall AMPs is reviewed and, where necessary, updated in accordance with the new IAEA Safety Standard, once it has been published.

5.1.3.1. Allocation by the TPR: Area for improvement:

5.1.3.2. Country position and actions taken/planned

The justification and the national position are presented in item 3.1.2. of this plan.

5.1.4. TPR expected level of performance: Delayed NPP projects and extended shutdown periods

In case of prolonged periods of construction or extended shutdown periods for NPPs, the respective ageing mechanisms have been identified and appropriate measures taken to control the initial stages of ageing or other phenomena.

5.1.4.1. Allocation by the TPR: Area for improvement:

5.1.4.2. Country position and actions taken/planned

The justification and the national position are given in item 3.1.4. of this plan.

5.1.5. TPR expected level of performance: Comprehensive ageing management programmes of research reactors

Systematic and comprehensive overall AMP is applied to research reactors in accordance with the graded risk approach, applicable national requirements, international safety standards and best practices.

5.1.5.1. Allocation by the TPR: Not applicable

5.1.5.2. Country position and actions taken/planned

No action is required.

5.2. Concealed (buried) pipelines

5.2.1. Good practice: Using the results of regular condition monitoring of the civil structures

In addition to providing information on soil and buildings subsidence, the results of regular monitoring of the condition of civil structures are used as input to the concealed pipelines ageing management programme.

5.2.1.1. Allocation by the TPR: Good Practice

5.2.1.2. Country position

The following activities are indicated in terms of condition monitoring of the civil structures in item 2.3.1.2 of the National Report of the Republic of Bulgaria for TPR:

- Monitoring of state of penetrations and the visible parts of pipes in the shafts and manholes along the pipeline routes and the readings of instrumentation and control systems;
- Monitoring of vertical deformation settlement of concrete supports for DN 1000 pipework from the spray pools to the water abstraction shafts and the diesel generator stations with the help of the installed reference marks;
- Monitoring for occurrence of cracks in the wall penetrations of DN 600 pipelines and DN 400 pipelines from the Reactor Building to the spray pools, and DN 1000 pipelines from the spray pools to the water intake shafts and diesel generator stations, in accordance with the Monthly Monitoring Instruction for Buildings and Facilities of the Component Cooling Water System (CCWS) for essential loads (civil and hydro-engineering part).

The civil structures monitoring data are used in the calculations for lifetime extension of the QF system concealed pipelines up to 60 years, as well as to determine, in the AMP, the dominant and potential ageing mechanisms of pipelines.

5.2.2. Good practice: Effectiveness/behaviour checks on new or innovative materials

In order to check the integrity of new or innovative materials, after a certain period of operation, parts of them are taken for inspection and confirmation that their properties meet the expectations.

5.2.2.1. Allocation by the TPR: Good practice in another party participating in the TPR

5.2.2.2. Country position

No new or innovative materials have been used in the repair of defective sections of the concealed pipelines. According to the inspection reports of findings following the QF system pipelines repairs performed, including also the results of testing of mechanical properties and spectral analysis of metal, low alloy structural steels were used in compliance with the design.

According to the Conclusion on the technical condition of the pipelines of the QF system according to the design for the lifetime extension of Units 5 and 6 of Kozloduy NPP, it is not necessary to replace the materials of the pipelines with another type.

5.2.3. TPR expected level of performance: inspection of safety-related pipe penetrations

Inspections of safety-related pipe penetrations through concrete structures are part of the Ageing management programmes, unless the absence of an active degradation mechanism is justified.

5.2.3.1. Allocation by the TPR: Area for improvement:

5.2.3.2. Country position and actions taken/planned

The justification and the national position are given in item 3.2.2 of this plan.

5.2.4. TPR expected level of performance: Scope of concealed pipelines included in the AMP

The scope of the concealed pipelines involved in ageing management includes pipelines that perform safety functions as well as non-safety related pipelines whose failure may affect SSCs performing safety functions.

5.2.4.1. Allocation by the TPR: Good performance

5.2.4.2. Country position and actions taken/planned

The Ageing Management System at Kozloduy NPP covers the safety-related concealed pipelines. The developed ageing management programme for concealed pipelines includes the service water system (QF) pipelines, used for the cooling of essential loads (ESW).

For other concealed pipelines, such as those of the fire safety system serving non-safety related loads, emergency and alternative supply pipelines to the spray pools, no additional monitoring activities are foreseen due to the modernisation and their replacement by high-density polyethylene (HDPE) pipes. HDPE pipes are flexible and elastic, non-susceptible to corrosion and have very good abrasion resistance. The lifetime of pipelines made of HDPE according to certificate data, in normal operation, exceeds 50 years.

5.2.5. TPR expected level of performance: Opportunistic inspections

Inspection of the concealed pipework is undertaken when the pipework is uncovered for other purposes.

5.2.5.1. Allocation by the TPR: Area for improvement:

5.2.5.2. Country position and actions taken/planned

The justification and the national position are given in item 3.2.4. of this plan.

5.3. Reactor Pressure Vessels

5.3.1. Good practice: Hydrogen water chemistry

Hydrogen Water Chemistry (HWC) is used in BWRs which may be vulnerable to intergranular stress corrosion cracking.

5.3.1.1. Allocation by the TPR: Not applicable

5.3.1.2. Country position

The presented good practice is not applicable to the water chemistry of WWER 1000 reactors, which are operated at Kozloduy NPP.

No action is required.

5.3.2. Good practice: Implementation of a shield

Shielding in the core of PWRs with relatively high neutron flux is implemented to preventively reduce neutron flux on the RPV wall.

5.3.2.1. Allocation by the TPR: Not applicable

5.3.2.2. Country position

The presented expected level of performance is not applicable to the water chemistry of WWER 1000 reactors, which are operated at Kozloduy NPP. The application of shielding in the core is not applicable to them in terms of their design.

5.3.3. TPR expected level of performance: Volumetric inspection for nickel base alloy penetration

Periodic volumetric inspection is performed for nickel base alloy penetrations which are susceptible to primary water stress corrosion cracking to detect cracking as early as possible.

5.3.3.1. Allocation by the TPR: Not applicable

5.3.3.2. Country position and actions taken/planned

The presented expected level of performance is irrelevant to the water chemistry of WWER 1000 reactors, which are operated at Kozloduy NPP.

5.3.4. TPR expected level of performance: Non-destructive examination in the base material of the beltline region

Comprehensive NDE of the RPV beltline region base material is performed in order to detect any defects.

5.3.4.1. Allocation by the TPR: Area for improvement:

5.3.4.2. Country position and actions taken/planned

The justification and the national position are given in item 3.3.2.of this plan.

5.3.5. TPR expected level of performance: Working environment factors

Fatigue analyses should take into account the environmental effect of the coolant on the material.

5.3.5.1. Allocation by the TPR: Area for improvement:

5.3.5.2. Country position and actions taken/planned

The justification and the national position are given in item 3.3.4. of this plan.

5.3.6. TPR expected level of performance: Suitable and sufficient irradiation specimens

For new reactors, suitable and sufficient irradiation specimens and archive materials are provided to support the reactor through its full operational life.

5.3.6.1 Allocation by the TPR: Not applicable

5.3.6.2. Country position and actions taken/planned

The presented expected level of performance is not applicable to Kozloduy NPP.

5.4. Concrete containment structures and pre-stressed concrete pressure vessels

5.4.1. Good practice: Monitoring of concrete structures

Complementary instrumentation is used to better predict the mechanical behaviour of the containment and to compensate for loss of sensors throughout the life of the plant

5.4.1.1. Allocation by the TPR: Good practice in other countries

5.4.1.2. Country position

An automated monitoring system at Units 5&6 of Kozloduy NPP was installed for monitoring the prestressed and deformed condition of the containment.

In order to better predict the mechanical behaviour of the containment and to compensate for loss of sensors throughout the life of the plant, a complementary automated containment prestressing tendon monitoring system (ACPTMS) is installed for on-line monitoring.

In connection with the improvement of the monitoring of the behaviour of the concrete structures at Kozloduy NPP, the plant personnel was provided with additional devices for concrete monitoring, such as:

- a concrete cover meter and rebar detector – Proceq Profometer PM-650 Al Meets: BS 1881 Part204, DIN 1045. Origin: Switzerland;
- a rebar locator identifying the presence and location of rebars in concrete) – Proceq Profoscope Plus; complies with BS 1881 Part204, DIN 1045. Origin: Switzerland;
- an ultrasonic concrete testing device Proceq Pundit Lab PL-200 PE. Meets: EN 61010-1/ IEC 61010-1 2011/2010, EN 61326-1/IEC 61326-1 2013/2012. Origin: Switzerland.

5.4.2. Good practice: Assessment of inaccessible and/or limited access structures

A proactive and comprehensive methodology is implemented to inspect, monitor and assess inaccessible structures or structures with limited access.

5.4.2.1. Allocation by the TPR: Good practices of other countries

5.4.2.2. Country position

For assessment of inaccessible and/or limited access structures at Kozloduy NPP, the following measures for containment monitoring have been adopted:

- non-destructive testing (NDT) of the weld joints of the containment structure steel lining including visual inspection with dye-penetrant liquids (dye-penetrant testing);
- NDT of the containment structure steel lining through ultrasonic thickness measurement (UT);
- NDT of the containment structure steel lining through metal hardness measurement;
- visual inspection for any deformations (swelling) of the containment structure steel lining;
- instrumentation testing to take a picture of the rebars in typical cross sections and elements of the bearing reinforcement concrete structure of the buildings, determining

the thickness of the protective concrete coating, and identifying the width and depth of potential cracks in the concrete;

- instrumentation testing to identify the potential compressive strength of concrete through wrenching;
- instrumentation testing to identify the potential compressive strength of concrete through measuring the elastic rebound;
- field and laboratory testing to determine the degree of progress of alkali-silica reaction (ASR) – Internal Swelling Reaction (ISR);
- field and laboratory testing to determine the concrete volumetric density and compressive strength;
- field and laboratory testing to determine the degree of progress of concrete ettringite corrosion (DEF).

These activities related to monitoring, inspection and surveillance, are included in the currently effective programmes/procedures for ageing management of the civil structures of the containment - "Procedure for lifetime management of civil structures at Kozloduy NPP" and "Procedure for condition monitoring of the containments at Units 5&6 of Kozloduy NPP", which provides for a more comprehensive and proactive methodology for inspection, monitoring and assessment of inaccessible structures or structures with limited access.

5.4.3. Monitoring of pre-stressing forces

Pre-stressing forces are monitored on a periodic basis to ensure the containment fulfils its safety function.

5.4.3.1. Allocation by the TPR: Good performance

5.4.3.2. Country position and actions taken/planned

The data resulting from the containment structures monitoring through the computer (automated) monitoring system for cable prestressing are documented in "Analysis of data from the containment cables prestressing computer monitoring system regarding the ten monitored tension cables of the prestressing system", and also in "Certificate of inspection of the containment cables prestressing computer monitoring system". The Act is issued quarterly, prior and following leak tightness tests of the containment structure, and also in case of incidents with the prestressing system, and/or earthquakes. Upon reaching of the operational limits, a Programme is drafted for cable retensioning, scheduled to be implemented during the nearest subsequent annual outage. In terms of the measured average force in the prestressing tendons, there are established acceptance criteria described in the "Procedure for condition monitoring of the containments of Units 5&6 at Kozloduy NPP" and "Procedure for lifetime management of civil structures at Kozloduy NPP", which are in compliance with the US NRC Regulatory Guide 1.35 "In-service inspection of ungrouted tendons in prestressed containments". Acceptance criteria have been established for the cylindrical, grouted and ungrouted tendons, as well as for the dome tendons regardless of their position.

Lift-off tests of at least of 10% for the pre-stressing tendons of the containment are undertaken once every 10 years. The lift-off test are carried out by lifting off the seat nuts of the anchoring devices. The requirements followed are those of the US normative documents: US NRC RG 1.35 “In-service inspection of ungrouted tendons in pre-stressed concrete containments”, US NRC RG 1.35.1 “Determining pre-stressing forces for in-service inspection of pre-stressed concrete containments”. When performing the lift-off tests if the measured pre-stressing forces of the pre-stressed tendons are below: the force specified for cylindrical grouted tendons, ungrouted tendons and dome tendons, retensioning should be performed of the relevant tendon until reaching the controllable pre-stressing force. The tensioning forces losses are not linear and they are calculated for each specific moment. The predictable subsequent losses due to concrete shrinkage or creep, and relaxation of reinforcement are calculated as a function of logarithm time variation.

6. STATUS OF THE REGULATION AND IMPLEMENTATION OF AMP TO OTHER RISK SIGNIFICANT NUCLEAR INSTALLATIONS

Not applicable to the Republic of Bulgaria.

7. TABLE: SUMMARY OF THE PLANNED ACTIONS

No	Installation	Thematic	Finding	Planned action	Deadline	Regulator's approach to monitoring
1.	NRA	Overall AMP	<u>Item 2.1.4</u> Bearing in mind the comprehensive nature of the activities related to ageing management, and in order to improve their effectiveness, it is required to review the processes on the grounds of which a long-term inspection programme of the NRA is developed.	Optimise the scope of the NRA inspection programme in terms of the type of SSCs and periodicity of their inspection.	December 2020	In accordance with the NRA Management system
2.	Kozloduy NPP	Overall AMP	<u>Item 3.1.1 TPR expected level of performance: Area for improvement:</u> Methodology for scoping of SSCs subject to ageing management: The scope of comprehensive AMPs is reviewed and, if required, they are updated in compliance with the latest IAEA Safety Standards published.	Review and update of the list of structures and components within the range of the ageing management system in compliance with the requirements resulting from the latest issued IAEA guidelines on Ageing Management and Development of a Programme for Long Term Operation of Nuclear Power Plants, Specific Safety Guides, SSG-48.	December 2020	By submitting to the NRA periodic reports (every 6 months) and implementing current and confirmatory regulatory control (fulfilment of the licenses conditions and inspections)
3.	Kozloduy NPP	Electrical cables	<u>Item 4.1 TPR Good practice:</u> Cables are aged within the actual power plant environment and tested to assess the cable condition and determine their residual lifetime.	The 0.4kV low voltage cables from the systems important to safety (low voltage cables located in MILD environment) shall be assessed to determine their residual lifetime.	December 2021	By submitting to the NRA periodic reports (every 6 months) and implementing current and confirmatory regulatory control (fulfilment of the

No	Installation	Thematic	Finding	Planned action	Deadline	Regulator's approach to monitoring
						licenses conditions and inspections)
4.	Kozloduy NPP	Electrical cables	Item 4.6 TPR expected level of performance: consideration of uncertainties in the initial environmental qualification: The accuracy of the representation of the stressors used in the initial environmental qualification is assessed with regard to the expected stressors during normal operation and design basis accidents.	Requalification of 0.4 kV low voltage cables subject to LOCA and HELB qualification, using, when possible, estimations to reduce uncertainties.	December 2027	By submitting to the NRA periodic reports (every 6 months) and implementing current and confirmatory regulatory control (fulfilment of the licenses conditions and inspections)
5.	Kozloduy NPP	Electrical cables	Item 4.7 TPR expected level of performance: determination of cables' performance under the impact of the strongest stressors: The cables necessary to mitigate the effects of accidents are tested to determine their ability to perform their functions under the conditions of extended beyond design basis accident conditions and throughout their expected life cycle.	The cables necessary to mitigate the effects of accidents are qualified to determine their ability to perform their functions under the conditions of extended Beyond Design Basis Accident (BDBA) Conditions and throughout their expected life cycle.	December 2028	By submitting to the NRA periodic reports (every 6 months) and implementing current and confirmatory regulatory control (fulfilment of the licenses conditions and inspections)

No	Installation	Thematic	Finding	Planned action	Deadline	Regulator's approach to monitoring
6.	Kozloduy NPP	Concealed pipework	Item 2.3.1 Reconstruction is required of the penetration of pressure pipeline No 5 in the wall of shaft Ш 657 to ensure the necessary radial gap on both sides of the pipe. Item 2.3.1 Reconstruction is required of the penetration of pressure pipeline No 8 in the wall of the dosimetric control manhole of system III at unit 6, to ensure the necessary radial gap on both sides of the pipeline.	Reconstruction of the penetration of pipelines Nos. 5 and 8 from the QF essential service water supply system	December 2020	By submitting to the NRA periodic reports (every 6 months) and implementing current and confirmatory regulatory control (fulfilment of the licenses conditions and inspections)
7.	Kozloduy NPP	Concealed pipework	Item 2.3.2 Implementation of the recommendations to ensure the availability, lifetime characteristics and reliability of the main underground pipelines of the QF system at Units 5&6 of Kozloduy NPP according to the Conclusions on the technical condition and residual lifetime of the main underground pipelines of the QF system at Units 5&6 of Kozloduy NPP.	1. Excavation and additional assessment of the section of concealed pipework with anomalies identified by the contactless magnetometric diagnostics. 2. Assessment of sections of pipelines No. 5 and 8 running through the penetrations and which are subject to reconstruction.	December 2020	By submitting to the NRA periodic reports (every 6 months) and implementing current and confirmatory regulatory control (fulfilment of the licenses conditions and inspections)
8.	Kozloduy NPP	Reactor Pressure Vessel	Item 3.3.3. The ageing management programme does not include boric acid corrosion as a potential degradation mechanism in case of contact with the external surface of the reactor pressure	Inclusion of boric acid corrosion as a potential degradation mechanism in case of contact with the external surface of the reactor pressure vessel and top closure head in the new revision of the Ageing	December 2019	By submitting to the NRA periodic reports (every 6 months) and implementing current and confirmatory

No	Installation	Thematic	Finding	Planned action	Deadline	Regulator's approach to monitoring
			vessel and top closure head.	Management Programme for the reactor pressure vessels of Units 5&6 at Kozloduy NPP.		regulatory control (fulfilment of the licenses conditions and inspections)