REPUBLIC OF BULGARIA

EIGHTH NATIONAL REPORT

UNDER THE CONVENTION ON NUCLEAR SAFETY

Sofia, 2019

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A. INTRODUCTION

The Republic of Bulgaria joined the Convention on Nuclear Safety (the Convention) in 1995. The Convention was ratified by an Act of the National Assembly, and entered into force on 24.10.1996. With its accession to the Convention, Bulgaria confirmed its national policy to maintain a high level of nuclear safety, ensuring the necessary transparency and implementing the highest safety standards.

The Republic of Bulgaria took part in the seven previous meetings for national reports review, as well as in the two extraordinary meetings in 2009 and 2012, and presented regularly its national report at each meeting, respectively. In accordance with the rules adopted for the review process, answers have been promptly provided to any questions raised to the national report. All the national reports of the Republic of Bulgaria have been published on the web page of the Bulgarian Nuclear Regulatory Agency (NRA):

http://www.NRA.bg/bg/documents/conventions/reports/cns-reports

National policy

In the Republic of Bulgaria, nuclear energy continues to be a major factor in the country's energy mix under conditions of high technological effectiveness and production efficiency, competitive prices, upholding a high level of nuclear safety and radiation protection. Ensuring the safety of nuclear facilities is a national policy in the development of nuclear energy in the Republic of Bulgaria. In this context, it is the paramount duty of the government to develop and implement adequate legislation in this area. Adopted in 2002 and amended and supplemented in 2018, the Safe Use of Nuclear Energy Act (SUNEA) with the regulations thereto, consider and implement in the national legislation the relevant international conventions and treaties to which Bulgaria is a party, as well as the EU legislation, and IAEA safety standards and guidelines.

The National Energy Policy and the currently effective Energy Strategy of the Republic of Bulgaria to 2020 stipulate the preservation of the nuclear energy share (of about 33%) in the electricity generation. Active effort is made towards extending the operational lifetime of Kozloduy NPP units 5 and 6, and opportunities for new build are being considered. A new “Strategy for Sustainable Energy Development to 2030, with a Horizon to 2050” is being developed.

National nuclear programme

The Bulgarian nuclear energy programme was launched in 1974 with the commissioning of the first nuclear power unit of the Kozloduy Nuclear Power Plant (KNPP). The Bulgarian nuclear facilities are concentrated at the KNPP site where six power units have been built.

Nuclear facilities in operation

The Kozloduy NPP Units 5 and 6 feature WWER-1000 reactor type, model B-320, (2000 MW of installed electrical capacity), protection containment and triple redundancy of the safety systems. They were commissioned in 1987 and 1991, respectively. In 2008, a large-scale modernisation programme was completed. In 2016, the plant life extension project activities for Unit 5 were completed. The analyses confirm the technical capability for safe operation of the power unit. In 2017, on the grounds of the safety justifying documents submitted, the Nuclear Regulatory Agency (NRA) renewed the operating licence of Unit 5 for the maximum statutory term of 10 years. In 2018, the plant life extension project activities for Unit 6 were finalised. The analyses proved the technical capability of the power unit to operate safely. In late 2018, the NRA received the documents needed for renewal of the operating licence for the next 10-year period. Licence renewal is expected to be issued in 2019. In 2016, the Unit 6 programme for

thermal power uprate to 3120 MW was fulfilled, and an advanced fuel cycle using TVSA-12 assemblies was adopted in practice. As a result, the quantity of spent fuel assemblies generated annually is reduced from 42/48 to 42 assemblies. The plan for 2019 envisages finalising the activities for thermal power uprating to 3120 MW of Unit 5. The start of introducing an advanced fuel cycle on Unit 5 using TVSA-12 is scheduled for 2020.

The other facilities in operation on the site of Kozloduy NPP are:

- "Wet" spent fuel storage facility (WSF): the facility is intended for long-term (not less than fifty years) storage of spent fuel from reactor types WWER-440 and WWER-1000, following an initial storage in the spent fuel pools lasting at least three years. The facility's operational licence was extended to 2024 in 2014;
- Dry Spent Fuel Storage Facility (DSFSF): it is designed for long-term storage (not less than fifty years) of SNF from KNPP reactors WWER-440, using the "dry storage" technology. The DSFSF obtained a 10-year operational licence in 2016. Currently, the facility holds 15 casks loaded with spent fuel assemblies.

Facilities in the process of decommissioning

Units 1-4 with reactor type WWER-440, model B-230 (units 1 and 2), and advanced model B-230 (units 3 and 4), were shut down in 2002 and 2006, respectively, prior to the expiry of their design life, in pursuance of commitments undertaken by the Republic of Bulgaria during its accession to the European Union (EU). With a decree of the Council of Ministers, dated 20.12.2008, concerning units 1-2, and another decree of 19.12.2012 concerning units 3 - 4, these power units were declared facilities for management of radioactive waste (RAW) and together with the required movable and immovable property were transferred to the Radioactive Waste State Enterprise (SE RAW). In 2014 and 2016, the Nuclear Regulatory Agency issued decommissioning licences to units 1 and 2, and units 3 and 4, respectively.

Plans for new build facilities at the Kozloduy NPP site

A decision of the Council of Ministers, dated April 2012, provided an approval in principle for the construction of a new nuclear unit of the latest generation on the site of Kozloduy NPP. In August 2013, the NRA issued a site selection permit for the new nuclear unit. The documents developed in this connection are: a feasibility study to justify the construction of a new nuclear unit at the Kozloduy NPP site: a survey and selection of the preferred site for the construction of a new nuclear power unit, also a preliminary safety analysis report (PSAR), and an environmental impact assessment report (EIA-R). In 2016, a procedure was initiated for appealing the decision on EIA before the Supreme Administrative Court (SAC). In April 2019, the SAC rejected the appeal and approval of the Decision on EIA followed. In early April 2019, Kozloduy NPP - New Build filed a request for approval of the selected site.

On 29.06.2018, the Council of Ministers passed a decision to cancel the decision of March 2012 for suspending any further action on implementing the Belene Project, and assigned the Minister of Energy with the task of seeking opportunities for the construction of the power plant jointly with a strategic investor. This government decision was in pursuance of the decision made on 07.06.2018 by the Bulgarian National Assembly to recommence the action for searching opportunities to build Belene NPP. In this connection it should be assumed that the government has renewed its political commitment to build Belene NPP, and that at present the legal and factual obstacles to continue implementing the project have been removed.

Further information on the Belene Project is provided in Article 6 - Construction of new capacities.

Institutional framework

The Republic of Bulgaria has in place the institutions required to establish and implement the national policy on the safe use of nuclear energy and to apply state regulation and control

measures. The responsibilities and functions are clearly defined and allocated among the respective authorities as follows:

- Nuclear Regulatory Agency (NRA) - performs state regulation of the safe use of nuclear energy and ionising radiation, and the safe management of radioactive waste and spent nuclear fuel. The NRA establishes regulatory requirements on nuclear safety and radiation protection, issues licences and permits, carries out regulatory control and imposes enforcement measures to ensure compliance with the normative requirements;
- Ministry of Energy (ME) - carries out the state policy on energy development and implementation of the national energy policy. The Ministry proposes and implements the national strategy for energy development and the national strategy for management of spent nuclear fuel and radioactive waste;
- Ministry of Health (MH) develops and implements the state policy aimed at protecting the health of population by establishing mandatory health standards, requirements and rules for radiation protection and by ensuring a healthy living environment. The Ministry of Health carries out specialized functions in the field of health protection in the use of nuclear energy and ionizing radiation through its bodies - the National Center for Radiobiology and Radiation Protection and the Regional Health Inspectorates with Radiation Control divisions;
- Ministry of Environment and Water (MEW) directs, coordinates and supervises the development and implementation of the state policy on environmental protection, conservation and use of water and the earth's interior. The Ministry is in charge of the National System for Environmental Monitoring and is the competent decision-making body in respect of any environmental impact assessment performed.
- Ministry of Interior (MoI) ensures the security of nuclear facilities and related sites, identified as particularly important in terms of their physical protection. The Ministry, through the Chief Directorate for Fire Safety and Civil Defence, coordinates the activities for protecting the public and the national economy in case of natural disasters or accidents, including the conduct of risk assessment, preventive measures, rescue and emergency recovery works, and for providing international assistance.

The Minister of Transport, Information Technologies and Communications and the Minister of Defence also perform specialised functions in the field of using nuclear energy and ionising radiation. The SUNEA provides that the coordination among the different authorities is within the responsibilities of the NRA Chair.

Content and structure of the Report

The current eighth National Report was developed with the participation of all the responsible institutions in the area of safe use of nuclear energy as well as the nuclear facilities licence-holder. This report describes the country developments following the seventh meeting, and provides information on the progress of the major activities and the implementation of the measures planned for safety enhancement of the nuclear facilities. The report discusses in detail the safety assessments and analyses performed during the reporting period, the methodologies used, the results obtained and the major conclusions. Special attention has been given to the safety improvement measures completed on the nuclear power units in operation, the programmes undertaken for plant life extension, the implementation of the actions in the updated action plan following the stress-tests fulfilled (UNAP), and the resolution of safety significant issues outlined in the preceding review. The safety of nuclear facilities in operation has been reviewed, and also the regulatory practices for updating of the statutory framework, licensing, safety assessments and analyses, surveillance and inspection activity.

The national report is structured in conformity with the minutes of the organisational meeting for the eighth Convention review held in October 2018. Section B, Brief Summary,

presents the consistent efforts of our country to achieve the objectives of the Convention, the performance of the activities and measures planned during the latest review, the conformity with the principles of the Vienna Declaration on Nuclear Safety, adopted on 9 February 2015, and the accomplishment of the measures in the wake of the lessons learned from the Fukushima accident. Section C provides the information on the Convention implementation, adopting the article-by-article approach for review, in compliance with the provisions in INFCIRC/572/Rev.6 - Guidelines regarding National Reports under the Convention on Nuclear Safety, and in the letter of the president of the meeting to the member-countries on the 8th review under the Convention.

The following appendices have been attached to the Report:

Appendix 1: List of operating events reported over the period 2016-2019.
Appendix 2: List of the peer reviews conducted in Bulgaria.

B. EXECUTIVE SUMMARY

The current eighth National Report of the Republic of Bulgaria on the Convention on Nuclear Safety describes the country developments following the seventh review meeting, and provides information on the progress of the key activities and the implementation of the measures planned for safety enhancement of the nuclear facilities. The eighth national report has been developed as a stand-alone document that does not require reading of the previous reports and at the same time clearly depicts the development in the respective areas.

National nuclear programme

Over the past three years, no changes have been made to the National Energy Policy or the Energy Strategy of the Republic of Bulgaria to 2020. A new "Strategy for Sustainable Energy Development to 2030, with a Horizon to 2050" is being developed. Nuclear energy remains the key factor of the national energy balance with a share of about 33% of the electricity generated. Kozloduy NPP operates Units 5 and 6 with reactors WWER-1000, model B-320. The design operational lifetime of Unit 5 expired in 2017. The design operational lifetime of Unit 6 will expire in 2021. In 2017, Unit 5 was issued a 10-year operating licence. The NRA will review the submitted documents for renewal of the licence for operation of Unit 6 for a period of 10 years.

A decision of the Council of Ministers, dated April 2012, provided an approval in principle for the construction of a new nuclear unit of the latest generation on the site of Kozloduy NPP. A design company was established - Kozloduy NPP - New Build EAD. In August 2013, the NRA issued a site selection permit for the new nuclear unit.

On 29.06.2018, the Council of Ministers passed a decision to cancel the decision of March 2012 for suspending any further action on implementing the Belene Project, and assigned the Minister of Energy with the task of renewing the activities for seeking opportunities for the construction of the power plant jointly with a strategic investor. This government decision was in pursuance of the decision made on 07.06.2018 by the Bulgarian National Assembly to recommence the action for searching opportunities to build Belene NPP.

Further information on the progress of the Belene Project and the project of Kozloduy NPP - New Build is provided in Article 6 - Construction of new capacities.

The Republic of Bulgaria has not made any changes to the institutional and statutory framework required to establish and implement the national policy in the area of safe use of nuclear energy, and to carry out the state regulation and control.

Review of the secondary legislation

In the course of 2016–2019, the following regulations have been amended:

- Regulation on radiation protection;
- Regulation on implementing the safeguards agreement under the nuclear weapons non-proliferation treaty;
- Regulation on the conditions and procedure for notification of the Nuclear Regulatory Agency for events in nuclear facilities and sites and activities with sources of ionising radiation and in the transport of radioactive substances;
- Regulation on the procedure for issuing licences and permits for safe use of nuclear energy;
- Regulation on ensuring the safety of nuclear power plants;
- Regulation on ensuring the safety of nuclear research installations;
- Regulation on radiation protection in activities with radiation flaw detectors;
- Regulation on radiation protection during work activities with materials of increased natural radionuclide content;
- Regulation on emergency planning and emergency preparedness in case of nuclear and radiological emergencies;
- Regulation on ensuring the safety of spent nuclear fuel;
- Regulation for safe management of radioactive waste;
- Regulation on the procedure for payment of the fees collected pursuant to the Safe Use of Nuclear Energy Act.

Further information on the essence of the more significant amendments and supplements made to the identified regulations relevant to the report is contained in the text of the individual articles.

Over the period considered, 2016 - 2019, the following new regulatory guides have been published, and they are relevant to the current Report:

- Ageing management of structures, systems and components of nuclear power plants - PP-20/2018;
- Application of the requirements for safe transport of radioactive materials - PP-19/2017;
- Performance of periodic safety review of nuclear power plants - PP-18/2016;
- Criteria for the authorisation and control of radioactive discharges and for environmental monitoring - PP-15/2016.

Issues important to safety

The solving of a number of issues important to safety is included in the Kozloduy NPP safety improvement programmes, the Nuclear Action Plan in the wake of the Fukushima accident, the Long-Term Operation Programme for Units 5 and 6 and the Integrated Programme for implementing measures for continuous improving the safety of the units. Some of the more important among these include as follows:

- safe operation of Unit 5 in terms of the plans for transition to advanced nuclear fuel cycle (advanced nuclear fuel TVSA -12) while the reactor installation is operating at thermal power uprate to 104% of the rated power;

- replacement of equipment the operational life of which will expire in the frame of the extended operational life of the power unit;
- implement engineering solutions for corium containment in case of a severe accident;
- implementation of the major actions in the National Action Plan related to the Fukushima NPP accident, such as:
  - implement a new Emergency Response Centre outside the KNPP site;
  - install measuring channels to monitor and evaluate the concentration of water vapour and oxygen within the containment space;
  - install an additional pipeline to the spent fuel storage pool cooling system as an external source back-up;
  - study the possibility for direct water supply to the reactor core from an external source;
  - implement a direct water supply circuit to SG from external sources.
- update the PSA level 1, for operation at full power, low power and with shutdown reactors of Units 5 and 6, also expanding the PSA scope to include consideration of possible internal and external hazards characteristic of the KNPP site, including the mutual impact of the units;
- PTS analyses of a set of leaks at the primary circuit and transients with loss of residual energy removal mode for the operational states as defined in the PSA for a shutdown reactor of Unit 5 or 6.

Throughout the past three years activities continued to be implemented as per the programmes planned for maintaining and enhancing the safety of nuclear facilities, the more significant of which can be summarised as follows:

Periodic Safety Review

In November 2017, the licence for operation of unit 5 was renewed on the basis of the completed periodic safety review, and activities for lifetime extension of the unit.

The licence for operation of Kozloduy NPP Unit 6 will expire in October 2019. In this connection, a renewal application for the licence for operation of Unit 6 was submitted in September 2018 at the Bulgarian NRA. The application comprises a document package with reports from the periodic safety review and other documents in compliance with the requirements of the Regulation on the Procedure for Issuing Licences and Permits for Safe Use of Nuclear Energy. The documents review process will continue in 2019, in accordance with the programme approved by the NRA Chair.

Thermal power uprate to 104%

In 2018, following the successful implementation of the programme for unit 6 transition to uprated power operation, and the positive results from the tests performed, the NRA approved the transition of unit 6 to uprated power operation. The similar activities currently in progress on unit 5 are expected to be completed by the end of 2019.

Transition to advanced nuclear fuel cycle

In order to improve the fuel cycle effectiveness and safety of unit 6 operating at increased thermal power, in 2015, Kozloduy NPP applied for a permit for staged transition to operation with enhanced nuclear fuel type TVSA-12. In 2016, the NRA issued a permit for a staged transition of Unit 6 to operation using fuel type TVSA-12. Currently this transition to TVSA-12 is ongoing on unit 6 and by 2019-2020 homogeneous core loading with the new fuel type is expected to be accomplished.

Similar activities were performed so as to obtain an authorisation from the NRA to load the same TVSA fuel on Unit 5 in May 2017. The licence for operation of Unit 5was renewed in November 2017 and it considers the possibility to operate with the old and the new type of fuel. At present, Unit 5 operates with the old TVSA fuel type at the insistence of ESA (Euratom Supply Agency).

Implementation of the Updated National Action Plan in the wake of the Fukushima NPP accident"

The NRA oversees the implementation of the updated National Action Plan (UNAP) through the KNPP quarterly submissions of reports on the progress status of measures. Following the completion of each measure, a close-out report is issued. The performance of the measures is also supervised during the performance of different types of inspections related to the oversight activities.

As at the beginning of 2019, of a total number of 78 measures, 73 (94%) have been completed, while 5 are in progress.

Safety significant issues addressed in the previous CNS review

The seventh review as per CNS reported on the progress made in implementing the measures planned in the sixth National Report, and a number of measures planned in the sixth Report to improve the nuclear facilities safety and the challenges faced by the Republic of Bulgaria (reporter's report). The current report reviews the performance of these measures, and their status is described in detail as appropriate in the texts of individual articles, namely:

- the plant life extension project has been completed. Unit 5 had its operating licence renewed for a period of 10 years. In 2019, Unit 6 is expected to receive a renewed licence for operation for a 10-year period;
- periodic safety reviews of units 5 and 6 were performed in 2016 and 2018, respectively. This was part of the renewal process of the licences for operation.
- in 2018, Unit 6 passed to uprated power operation. The similar activities currently in progress on unit 5 are expected to be finalised by the end of 2019.
- at present, TVSA-12 fuel type is being used in the Unit 6 core. The staged transition of Unit 5 to the new fuel type is expected to start in 2020.
- as at the beginning of 2019, of a total number of 78 measures in the Updated National Action Plan in the wake of the accident on the Fukushima NPP, 73 measures (94 %) have been completed, while 5 are in progress;
- in early 2019, Kozloduy NPP - New Build Plc filed a request for issuance of an approval order for the selected site;
- on 29.06.2018, the Council of Ministers passed a decision to cancel the decision of March 2012 for suspending any further action on implementing the Belene Project, and assigned the Minister of Energy with the task of renewing the activities for seeking opportunities for the construction of the power plant jointly with a strategic investor.

International reviews and results thereof

The Republic of Bulgaria implements a consistent policy for continuous safety enhancement of nuclear facilities as compared against international standards, sharing of knowledge, experience and good practices, in an atmosphere of openness and maximum transparency. Periodic self-assessment and the accompanying peer reviews are forms of international cooperation, in support of this goal. Bulgaria has been a traditional host of similar forms of cooperation both regarding operating and regulatory practices. Up to 2019, more than 45 peer reviews have been conducted by representatives of the IAEA, EC and WANO in the

field of safe operation of nuclear facilities and the regulatory activity (a full list of these reviews has been provided in Appendix 2). At the same time, a number of Bulgarian experts have taken part in international reviews organised by the IAEA, EC or WANO.

A brief summary provides the results from international reviews conducted over the years 2016-2018.

WANO Corporate Peer Review of the Bulgarian Energy Holding (BEH) and Kozloduy NPP EAD, 31.10÷09.11.2016

The purpose of the Corporate Peer Review (CPR) was to assess the interactions between the Bulgarian Energy Holding Plc and Kozloduy NPP Plc through analysing the underlying concepts, the objectives and tasks formulated, as well as the ways to carry out the related activities and the provision of resources (including staff, financing, technical support, etc.). The review also focused on other aspects of the activities performed at the corporate level related to ensuring nuclear safety.

WANO Peer Review of Units 5 and 6 at Kozloduy NPP, 23.11÷ 08.12.2017

The aim of the review was to assist the power plant and find any non-conformances against relevant standards in the sector, by using the professional experience and knowledge of foreign experts. The team of reviewing experts provided the power plant with facts and evidence to help further improve the production activity at the next stage of the partnership with WANO. The other aim of the peer review was to identify strengths and exchange experience between the review team and the plant personnel.

ARTEMIS Mission to Bulgaria - IAEA Integrated Review Service for Radioactive Waste and Spent Fuel Management, Decommissioning, and Remediation, 10-20 June 2018

The aim of the ARTEMIS peer review service was to provide independent expert opinion and advice on the management of radioactive waste and spent nuclear fuel, the management of residues resulting from uranium production, environmental recovery and decommissioning, based on the IAEA safety standards and technical guidelines, as well as international best practices.

The specific purpose of the review was to verify existing national arrangements against the applicable IAEA safety standards and international best practices.

IAEA Pre-SALTO Mission to Kozloduy NPP, Unit 6, 19 – 27.06.2018

An important peer review regarding the licensing process was the IAEA mission to assess aspects of safety on KNPP Unit 6 in long-term operation. This is a relatively new comprehensive review of the IAEA cpncerning key factors and the nuclear plant's willingness to operate the available capacities beyond the design lifetime period.

During the pre-SALTO mission on KNPP Unit 6, the IAEA team of experts reviewed the finalised activities, activities under way and the planned ones for long-term operation (LTO), including those related to ageing management of Unit 6 structures, systems and components important to safety.

European topical peer review: "Ageing management of nuclear power plants and research reactors"

The national report of the Republic of Bulgaria regarding the participation in the topical peer review entitled "NPP Ageing Management Review" was prepared pursuant to the requirements for conduct of topical peer reviews in compliance with Article 8d (3) of Chapter 2a (Peer Reviews and Reporting) of Council Directive 2014/87/Euratom and the ENSREG Plan for participation of the interested countries. In 2014, the Council of the European Union approved Directive 2014/87/EURATOM which amends Directive 2009/71/Euratom establishing the common framework for the nuclear safety of nuclear installations. The updated and

supplemented Nuclear Safety Directive introduces a European topical peer review system, which will entered into force in 2017. Topical peer reviews (TPRs) are held every 6 years. The purpose of these reviews is to provide the EU member states with a mechanism to check topics of strategic importance for nuclear safety, to share experience and to define measures for improving of nuclear safety. The performance of TPRs is based on the experience gained during the 2011-2012 European nuclear reactor stress tests. The National Report was prepared by the NRA on the basis of a self-assessment conducted by the licensee - Kozloduy NPP. The report was prepared taking into account the requirements developed by WENRA and the technical specification adopted by ENSREG at the end of December 2016. The report contains a description of both the regulatory activity and the activities of the licensee concerning the ageing management processes of nuclear unit structures, systems and components such as: reactor pressure vessel, electrical cables, concealed pipework and concrete structures in the containment.

In 12-19 May 2018, in Luxembourg, the First Topical Peer Review Workshop was organised by the European Commission. During the event, Bulgaria presented the results from self-assessment, responses and comments on the national report.

In October 2018, ENSREG issued a summary report from the first TPR, as well as a report on the country-specific results.

Implementation of the principles of the Vienna Declaration on Nuclear Safety, adopted of 9 February 2015

The Republic of Bulgaria participated in the diplomatic conference for amendments to the Convention on Nuclear Safety held on 9 February, 2015, at the IAEA in Vienna. The Bulgarian delegation supported the adoption of the Vienna Declaration on Nuclear Safety as part of the efforts of the international community to enhance nuclear safety in the wake of the Fukushima accident.

The national policy, statutory and regulatory framework in the field of use of nuclear power conforms to the EU legislation, the IAEA safety standards and safety guidelines, and the best international practices. The Republic of Bulgaria is a party to the Convention on Nuclear Safety, the Convention on Early Notification of a Nuclear Accident, the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, the Convention on the Physical Protection of Nuclear Material, and the Additional Protocol to the Nuclear Safeguards Agreement. The Agreement between EURATOM and non-member countries of the European Union for the early exchange of information in the event of a radiological emergency (ECURIE) was signed in 2003 and ratified by law in 2005. Since 2007, Bulgaria has been a full member of the EU. The national legislation has been harmonised with the European one and Bulgaria has been applying the recognised European good practices. The requirements have been introduced of the Council Directive 2009/71/Euratom establishing a Community framework for nuclear safety of nuclear installations, and of the Council Directive 2014/87/Euratom dated 8 July 2014.

In this context, it is the paramount duty of the government to develop and implement adequate legislation in this area. Adopted in 2002, amended and supplemented in 2010, the Safe Use of Nuclear Energy Act (SUNEA) and the regulations thereto, consider and implement in the national legislation the international conventions and treaties, to which the Republic of Bulgaria is a party, as well as the legislation of the European Union, and standards and the safety guides of the IAEA. Following the SUNEA amendments and supplements, a thorough revision was undertaken of all relevant regulations, some of which were also amended and supplemented while others were re-issued. The NRA has been fulfilling a programme for review and update of secondary legislation.

Also, the Updated National Action Plan is currently implemented, in the wake of the Fukushima accident and pursuant to the IAEA Action Plan on Nuclear Safety.

The conduct of periodic safety reviews (PSRs) is a regulatory requirement and forms the basis for issuance of an operating licence to a nuclear facility. As a result of the PSRs performed on units 5 and 6, and the additionally conducted stress tests, a number of significant modifications have been made to the existing design of the units, and some new systems have been put in place to prevent the occurrence of severe accidents or mitigate the consequences thereof.

The developed severe accident management guidelines (SAMGs) result in considerably enhanced protection of the reactor coolant system pressure boundary and the containment boundary, so as to mitigate the consequences of severe accidents, and bring the reactor installation under control.

In the main body of the report, the texts in articles 6, 14, 17 and 19 describe the respective requirements, technical criteria and standards, the design improvements made and UNAP measures performed that reflect the implementation of the three principles of the Vienna Declaration on Nuclear Safety, of 9 February 2015, within the national statutory framework and the secondary legislation on the application of SUNEA.

In its regulatory practice and policy in the field of safe use of nuclear energy, the Republic of Bulgaria adheres to the CNS objectives and the principles of the Vienna Declaration on Nuclear Safety.

Article 6 contains additional information on the missions conducted.

Future challenges

In the short-term, Bulgaria faces the following more significant challenges:

- Implementation of the UNAP;
- Renewal of Unit 6 licence for operation in 2019;
- Transition to operation using advanced nuclear fuel cycle (advanced nuclear fuel TBCA -12);
- Licensing of a new nuclear power unit.

C. REVIEW OF CNS ARTICLES 6 THROUGH 19

Article 6 Existing nuclear installations

Each Contracting Party shall take the appropriate steps to ensure that the safety of nuclear installations existing at the time the Convention entered into force for that Contracting Party is reviewed as soon as possible. When necessary in the context of this Convention, the Contracting Party shall ensure that all reasonably practicable improvements are made as a matter of urgency to upgrade the safety of the nuclear installation. If such upgrading cannot be achieved, plans should be implemented to shut down the nuclear installation as soon as practically possible. The timing of the shut-down may take into account the whole energy context and possible alternatives as well as the social, environmental and economic impact.

Brief information about the nuclear facilities in Bulgaria

The Bulgarian nuclear energy programme was launched in 1974 with the commissioning of Unit 1 of the Kozloduy Nuclear Power Plant (KNPP). The Bulgarian nuclear facilities are concentrated at the KNPP site where six power units have been built. Units 1-4 with reactor type WWER-440, model B-230 (units 1 and 2), and enhanced model B-230 (units 3 and 4), were shut down in 2002 and 2006, respectively, in conformity with commitments undertaken by the Republic of Bulgaria during its accession to the EU. Table 1 provides detailed information on the nuclear facilities current status.

Table 1. List of the nuclear facilities in Bulgaria

KNPP				
Item No.	Nuclear power unit/ Facility	Commissioning date	Permanent shutdown	Status
1	Unit 1	1974	2002	Decommissioning
2	Unit 2	1975	2002	Decommissioning
3	Unit 3	1980	2006	Decommissioning
4	Unit 4	1982	2006	Decommissioning
5	Unit 5	1987		licence for operation to 2027
6	Unit 6	1991		licence for operation to 2019
7	Unit 7			Site Selection Permit, 2013
8	WSF	1990		licence for operation to 2024
9	DSFSF	2016		licence for operation to 2026
Belene NPP				
1	Unit 1			Site approval, 2006
2	Unit 2			Site approval, 2006

Nuclear facilities in operation

The remaining two Units 5 and 6 with the WWER-1000/B320 reactor type, were put into operation in 1987 and 1991, respectively. In November 2017, Unit 5 had its licence for operation renewed for ten years (to 2027). The licence for operation of Unit 6 is valid to October 2019, and

the licensee - Kozloduy NPP, has filed an application for licence renewal. The strategic objective of Kozloduy NPP is to safely extend the operating lifetime of both units beyond their design life.

Facilities for SNF safe storage

There are two storage facilities for spent nuclear fuel at the Kozloduy NPP site - a pool type SNF interim storage facility for WWER-440 and WWER-1000 SNF assemblies (WSF), and a dry spent fuel storage facility for WWER-440 assemblies (DSFSF). The WSF has been operated in accordance with the operating licence issued by the NRA in 2014 with a validity term of 10 years (to 2024).

In November 2011, the NRA issued a commissioning permit for the DSFSF where the first six casks are placed for long-term storage of SNF from WWER-440 reactors. In January 2016, a licence for operation with a 10-year validity was issued for the facility (to 2026). As at the middle of 2019, there are 15 SNF casks placed for interim storage in the DSFSF.

Kozloduy NPP is the licence-holder for both spent fuel storage facilities.

Review of the issues important to safety

Issues important to safety

The solving of a number of issues important to safety is included in the Kozloduy NPP safety improvement programmes, the National Action Plan in the wake of the Fukushima accident, the Long-Term Operation Programme for Units 5 and 6, and the Integrated Programme for implementing measures for continuous safety enhancement of the units. Among the more significant issues important to safety are:

- transition to advanced nuclear fuel cycle (TVSA -12 nuclear fuel) while the reactor installation is operating at thermal power uprate to 104% of the rated power;
- replacement of equipment the operational life of which will expire in the frame of the extended operational life of the power unit;
- implementation of the major actions in the National Action Plan related with the Fukushima NPP accident, such as:
  - implementing a new Emergency Response Management Centre outside the KNPP site;
  - installing measuring channels to monitor and evaluate the concentration of water vapour and oxygen within the containment space;
  - installing an additional pipeline to the spent fuel storage pool cooling system as an external source back-up;
  - study the possibility for direct water supply to the reactor core from an external source;
  - implement a direct water supply circuit to SG from external sources.
- implement engineering solutions for corium containment in case of a severe accident;
- update the PSA level 1, for operation at full power, low power and with shutdown reactors of Units 5 and 6, also expanding the PSA scope to include consideration of possible internal and external hazards characteristic of the KNPP site, including the mutual impact of the units;
- PTS analyses of a set of leaks at the primary circuit and transients with loss of residual energy removal mode for the operational states as defined in the PSA for a shutdown reactor of Unit 5 or 6.

Events reported to the NRA from 2016 to 2018

Over the past three-year reporting period no operating events important to safety have been registered as per the International Nuclear Events Reporting Scale (INES) employed at KNPP. The total number of events reported for units 5 and 6 is 10: all of them have been rated 0 level as per INES. The use of the results from operating events assessment and analysis, as well as the corrective actions are elements of the operating experience feedback system and they are described in article 19(7) of the current document. ***Appendix 1*** contains a list of the events reported.

Programmes and measures planned for the continuous safety enhancement

Currently, Kozloduy NPP is implementing on Unit 5 an Integrated Programme of measures for safety enhancement in the period 2017-2027. The measures listed in the Programme ensue from the following documents:

- Comprehensive Programme for the implementation of the measures identified after the periodic safety review of Unit 5;
- Kozloduy NPP Units 5 and 6 Lifetime Extension Project Management Plan for Stage 2;
- Program for implementation of measures included in the Updated National Action Plan resulting from the stress tests conducted on the nuclear facilities at Kozloduy NPP;
- Programme for implementation of measures to bring KNPP units 5 and 6 in compliance with the provisions of the 2016 Regulation on ensuring the safety of nuclear power plants;

The Integrated Programme is developed in compliance with article 90 para 3 section 3 of the Regulation on ensuring the safety of Nuclear Power Plants. In accordance with article 90 para 3 of this Regulation, a summary assessment was performed on the basis of individual safety factors and connections among them. All positive and negative findings have been considered and their cumulative effect on safety has been determined by identifying practically achievable improvements, taking into account the whole lifetime of Kozloduy NPP Unit 5.

A similar Integrated Programme was developed also for Unit 6 for the period 2019-2029. The objective of the programme is to ensure effective control in the implementation of and reporting on the measures scheduled for 2019-2029 to maintain and enhance the safety of Unit 6, in compliance with the regulatory requirements and the operational experience. The Programme forms part of the document package to the application for licence renewal of Unit 6, submitted to the NRA on 18.09.2018.

The Integrated Programme comprises of suitable measures and activities for safety improvement in the following areas:

- NPP design;
- current state of SSCs important to safety;
- ageing management;
- deterministic safety analyses.

Lifetime extension of Units 5 and 6

The energy strategy of Bulgaria to 2020 lays the priority on implementing of the Programme of Kozloduy NPP Unit 5 and 6 Preparation for Lifetime Extension (PLEX) following the expiry of their 30-year design life.

The primary requirements to be satisfied in order to continue the operation of units 5 and 6 once their design operational lifetime has expired, are as follows:

- evaluate the residual lifetime of the systems, structures and components (SSCs) which will remain in operation, and the SSCs that have to be replaced with new ones;
- provide a justification for the new operating lifetime;
- develop and implement a programme for preparation of the respective unit for operational life extension.

In view of this, a Strategy was developed for extending the units' operational lifetime, and for each unit it envisages:

- implementation of a comprehensive study and residual lifetime evaluation of the equipment in accordance with a methodology approved in advance by the NRA, and compiling a list of the equipment subject to review;
- updating of the safety assessments and setting the scope of the measures and activities aimed at preparing the units for long-term operation.

In view of implementing in practice the Strategy, a project was launched for Service Lifetime Extension of Kozloduy NPP Units 5&6 (PLEX Project). It was delivered in two major stages:

- Stage 1: Comprehensive assessment and residual lifetime evaluation of the equipment and facilities of Kozloduy NPP units 5 and 6
- Stage 2: Implementation of the Programmes for Units 5 and 6 Preparation for Lifetime Extension (2014 – 2016 for Unit 5, and 2016 – 2018 for Unit 6).

The comprehensive assessment performed during Stage 1 of the project resulted in recommendations and specifying of action items. The project Stage 2 includes implementation of engineering and organisational measures to ensure the lifetime of structures, systems and components (SSCs) that envisage as follows:

- replacement of components whose lifetime has expired;
- additional analyses and justification of the residual lifetime of non-replaceable components;
- amending the SSCs' maintenance, repair and operation procedures in view of their long-term operation.

The measures for operating licence renewal of units 5 and 6 are covered in the preparatory Programmes for lifetime extension of the units developed by KNPP and agreed by the NRA. The activities for equipment replacement or comprehensive assessment are integrated in the annual outage schedules for each of the units.

Unit 5 Lifetime Extension Project

Regarding unit 5 a total of 261 measures have been envisaged and included in the lifetime extension project management, of which:

- 143 measures in the areas Mechanical Equipment, Electrical Equipment and I&C, and Civil Structures are included in the Programme for Preparation for Lifetime Extension of KNPP Unit 5. These are safety related measures, subject to monitoring by the NRA and serving for justification of the unit lifetime extension;
- 97 short-term measures that do not affect the unit 5 operating lifetime and are not subject to monitoring by the NRA;
- 21 measures related to safety and envisaged for implementation in the next licensing period.

The major part of the measures have been performed under a contract with a Consortium comprising of CJSC Rusatom Service, OJSC Concern Rosenergoatom and Électricité de France (EDF).

All the assessment activities planned have been delivered to scope and schedule. After submitting all the necessary documents and results of the implementation of the two stages of the PLEX Project of Unit 5 as well as the results of the Periodic Safety Review of the unit, on 3 November, 2017 the NRA renewed the operating license of Unit 5 for a new 10-year period.

Unit 6 Lifetime Extension Project

Regarding Unit 6, a total of 226 measures have been envisaged and included in the lifetime extension project management plan, of which:

- 120 measures in the areas Mechanical Equipment, Electrical Equipment and I&C, and Civil Structures are included in the Programme for Preparation for Lifetime Extension of KNPP Unit 6. These are safety related measures, subject to monitoring by the NRA and serving for justification of the operating lifetime extension;
- 81 short-term measures that do not affect the unit's operating lifetime and are thus not subject to monitoring by the NRA;
- 25 measures related to safety and envisaged for implementation in the next licensing period.

To carry out the basic part of the measures involving analyses, calculations, time-limited ageing analyses for estimating the residual life of major and auxiliary equipment of the unit 6 reactor plant, Kozloduy NPP had placed a contract with the Consortium of Rusatom Service - Risk Engineering, the scope of which also covers measures related to the assessment of the containment, the reactor building (RB), and the diesel generator station (DGS).

Kozloduy NPP Unit 6 operating licence expires in October 2019. In this connection, Unit 6 operating licence renewal application was submitted in September 2018 at the Bulgarian NRA. It comprises of a document package in compliance with the requirements of the Regulation on the Procedure for Issuing Licences and Permits for Safe Use of Nuclear Energy. As the implementation of the PLEX Strategy and the PLEX Programme is a provision of the effective operating licence for unit 6 intended to prove the safety on the unit after the expiry of its design lifetime, the reports with the results of the completed Comprehensive assessment and evaluation of the residual life of the equipment are attached to the application for renewal of the unit's licence for operation. A new revision of the Safety Analysis Report of Unit 6 was attached to the application incorporating the results and the conclusions from the performed analyses and investigations confirming the operational capability of the unit in the new licensing period. A basic document that demonstrates the compliance of the design with the latest requirements of national normative documents and internationally accepted safety standards is the Summary Report from the Periodic Safety Review (PSR-2018) presented with the application for renewal of the operating licence of Unit 6.

Periodic safety review of Unit 6

In order to demonstrate the compliance of the unit with the current safety requirements, Kozloduy NPP has carried out a Periodic Safety Review, which is a systematic reassessment of all safety factors considered in the design and the operation of the power unit. The PSR has to demonstrate the availability of all prerequisites for safe operation of the power unit in the next validity period of 10 years of the renewed licence. The periodic safety review of unit 6 ended with the issuance of a Summary Report assessing the results of the PSR, and a comprehensive Programme of measures resulting from this PSR.

To date, the results of the ongoing regulatory review of the submitted documents show that no non-conformances with significant safety impact assessments have been identified as a result of the assessment of compliance with the normative and regulatory requirements for nuclear

safety and radiation protection, the recommendations of the International Safety Agency Atomic Energy Agency (IAEA) and the updated safety reference levels of the Western European Nuclear Regulators Association (WENRA). Regardless of this, Kozloduy NPP has identified some safety improvement measures stemming from the PSR, mainly related to updating the Safety Analysis Reports (SAR) and other technical documentation as well as improving performance characteristics.

National Action Plan of the Republic of Bulgaria in the wake of the Fukushima NPP accident

In response to the requirement of the EC Council of 2011, and the subsequent joint initiative of ENSREG (European Nuclear Regulators' Group) and the European Commission (EC) for comprehensive and timely implementation of the measures ensuing from the stress tests conducted, KNPP together with the NRA developed the National Action Plan (NAP) for the Republic of Bulgaria, in the wake of the Fukushima NPP accident. The Plan included a total of 63 measures and activities, the greater share of which were completed by the end of 2014. In view of implementing the NAP, KNPP prepared a Programme for Implementation of the Recommendations Ensuing from the Stress Tests Conducted.

In December 2014, the countries effecting the European stress tests developed Updated National Action Plans (UNAP), which reflected the occurring changes, the current status and progress of the measures planned. The NRA prepared and published the UNAP with the complementary Section IV "Update to the National Action Plan". In late December 2018, the UNAP was updated again and one more measure was added which makes their total number 78. The new measure included concerns the preparation of an emergency procedure for response actions of the emergency worker teams in case of events occurring simultaneously on different facilities at the Kozloduy NPP site.

The measures included in the UNAP can be allocated into four main groups:

- measures to improve the plant resistance to earthquake;
- measures to prevent and mitigate the consequences of floods;
- measures to improve stability in case of a loss of ultimate heat sink;
- measures for improving the capabilities for severe accident management.

As at the end of 2018, of a total number of 78 measures, 71 (91%) have been completed, while 5 are in progress. The latter have been included in the Integrated programme for Unit 5. (More detailed information on the measures and updated dates of their completion is provided in Article 14 (1)).

An electronic copy of UNAP is available on the NRA web page http://www.bnra.bg/en/nuclear-facilitie/stress-tests/kozloduy/unacpbgdecember2018en.pdf

The NRA monitors the UNAP implementation by analysing the quarterly reports issued by KNPP. The performance of the measures is also supervised during the performance of different types of inspections related to the NRA oversight activities.

International review missions (IAEA, WANO, EC)

Kozloduy NPP is continuously striving to enhance operational safety at the plant and use the experience of other NPPs regarding the best international practices in nuclear energy. To this effect, in 2016-2018, Kozloduy NPP hosted the following international missions and peer reviews:

WANO Corporate Peer Review of the Bulgarian Energy Holding (BEH) and Kozloduy NPP Plc, 31.10÷09.11.2016

The purpose of the Corporate Peer Review (CPR) was to assess the interactions between

the Bulgarian Energy Holding Plc and Kozloduy NPP Plc through analysing the underlying concepts, the objectives and tasks formulated, as well as the ways to carry out the related activities and the provision of resources (including staff, financing, technical support, etc.). The review also focused on other aspects of the activities performed at the corporate level related to ensuring nuclear safety.

In the framework of the Corporate Peer Review a team of highly qualified WANO experts reviewed the status of the following seven corporate review areas (performance objectives) at BEH EAD and Kozloduy NPP:

- corporate Leadership;
- corporate Governance;
- corporate Oversight and Monitoring;
- corporate Independent Oversight;
- corporate Support and Performance;
- corporate Human Resources;
- corporate Communications.

It was noted that the BEH provides long-term support to Kozloduy NPP Plc. When planning and financially securing the activities, a bottom-up approach is applied, based on the needs identified and graded by the plant. The review team noted that the safety-related investments proposed by the plant were successfully funded at the corporate level. Also, the Kozloduy NPP management is satisfied with the financial support of the corporation.

WANO Peer Review of Units 5 and 6 at Kozloduy NPP, 23.11÷ 08.12.2017

The aim of the review was to assist Kozloduy NPP in finding any non-conformances against relevant standards in the sector, by using the professional experience and knowledge of the foreign experts. The team of reviewing experts provided the power plant with facts and evidence to help further improve the production activity at the next stage of the partnership with WANO. The other aim of the peer review was to identify good practices and share experience between the review team and the plant personnel.

Within the Peer Review, a team of WANO experts reviewed the performance of Kozloduy NPP with respect to two fundamental, six functional and ten complex performance objectives, as well as the implementation of WANO recommendations listed in the Significant Operating Experience Report (SOER), broken down by review areas as follows:

- Organisation and Administration;
- Operation;
- Maintenance;
- Engineering Support;
- Radiation Protection;
- Performance Improvement;
- SOER;
- Chemistry;
- Training and Qualification;
- Fire Protection;
- Emergency Preparedness.

In parallel with the peer review there was a pilot crew performance observation of the main control room crews trained at the full-scope simulator for reactor type WWER-1000.

It was concluded that the a great number of the activities and practices at Kozloduy NPP are performed very well, which contributes to the efficient operation of the plant. It is obvious from the review of all WANO performance indicators that Kozloduy NPP has achieved substantial results and most are in the top quartile worldwide.

Kozloduy NPP was found by the review team in a good technical and material condition. The team recognised that the plant organisation and most of the work processes are well established and function effectively.

ARTEMIS Mission to Bulgaria - IAEA Integrated Review Service for Radioactive Waste (RAW) and Spent Fuel (SF) Management, Decommissioning, and Remediation, 10-20 June 2018

The aim of the ARTEMIS peer review service was to provide independent expert opinion and advice on the management of radioactive waste and spent nuclear fuel, the management of residues resulting from uranium mining, environmental remediation and decommissioning, based on the IAEA safety standards and technical guidance, as well as international good practices.

The specific purpose of the review was to verify existing national requirements to apply IAEA safety standards and international best practices.

An interdepartamental working group was set up involving participants from the Ministry of Energy, the Nuclear Regulatory Agency, the State Enterprise “Radioactive Waste”, Kozloduy NPP, the Ministry of Healthcare and the Ministry of Environment and Water who self-assessed their activities in terms of preparing for the ARTEMIS mission.

The peer review was performed by an international team of experts and experience in the field of SF and RAW management, also coordinators from IAEA and observers from the European Commission and Lithuania. The review covered the following areas:

- Concepts, plans and engineering solutions for SF and RAW management;
- SF and RAW inventory;
- Financial assessments and funding of SF and RAW management;
- Safety Analysis;
- Adequate capacity building and knowledge preservation for the SF and RAW management.

The ARTEMIS team noted that there is a sound basis in Bulgaria for safe and responsible management of RAW and SF, and further improvements can be successfully made to it. The ARTEMIS team recognised that a well-developed system of RAW categorisation is in use and this categorisation system supports waste handling and operations and further defines the endpoints for all RAW management routes. On the basis of the examples provided, the ARTEMIS team concluded that the process for safety verification of facilities follows in a comprehensive way the guidance specified in the IAEA general safety requirements and safety standards.

SALTO mission to Units 5 and 6 of the Kozloduy Nuclear Power Plant

To confirm the KNPP preparedness for lifetime extension of units 5 and 6, Bulgaria initiated the conduct of an IAEA SALTO (Safety Aspects of Long Term Operation) review mission. In November 2015, the first preparatory mission was held with IAEA representatives and the scope and organisation of the mission were defined:

- a Pre-SALTO mission on unit 5 in the time period 26 July – 03 August, 2016;
- a Pre-SALTO mission on unit 6 in 2018;

- a SALTO mission in 2020;
- a follow-up SALTO mission on units 5 and 6 – dates to be defined.

Pre-SALTO Mission to Kozloduy NPP, Unit 6, 19 – 27.06.2018

One of the important peer reviews in the renewal process of the licence for operation of Unit 6 at Kozloduy NPP was the IAEA mission assessing safety aspects of the power unit for its long-term operation. This is a relatively new IAEA comprehensive review covering key factors and the preparedness of the nuclear plant to operate the existing capacities beyond their design lifetime dates.

During the pre-SALTO mission on KNPP Unit 6, the IAEA team of experts reviewed the finalised activities, the activities under way and the planned ones for long-term operation (LTO), including those related to ageing management of Unit 6 structures, systems and components important to safety.

The review areas were as follows:

- Area A – Organisation and functions, current licensing basis, configuration and modification management;
- Area B - Scoping and screening and plant programmes relevant to LTO;
- Area C – Ageing management review, review of ageing management programmes and revalidation of time limited ageing analyses (TLAAs) for mechanical components;
- Area D – Ageing management review, review of ageing management programmes and revalidation of time limited ageing analyses for electrical and I&C components;
- Area E – Ageing management review, review of ageing management programmes and revalidation of time limited ageing analyses for civil structures;

The IAEA team of experts reviewed the progress in the field of ageing management and preparation for long-term operation. The team recognised that a good progress has been made.

European topical peer review: "Ageing management of nuclear power plants and research reactors"

In 2014, the Council of the European Union approved Directive 2014/87/EURATOM which amends Directive 2009/71/Euratom establishing the community framework for the nuclear safety of nuclear installations. The updated and supplemented Nuclear Safety Directive introduces a European topical peer review system, which entered into force in 2017. Topical peer reviews (TPRs) are to be held every 6 years. The purpose of these reviews is to provide the member states of the European Union with a mechanism to check topics of strategic importance for nuclear safety, to share experience and to define measures for improving of nuclear safety. The European Nuclear Safety Regulators Group (ENSREG) made a decision for the topic of the first peer review to be ageing management in nuclear power plants.

The TPR process comprises three phases: National self-assessment, peer review, and follow-up activities. The Council of Ministers approved a National Assessment Report of the Republic of Bulgaria for participation in the European TPR. The report was prepared by the NRA on the grounds of a self-assessment performed by the licensee - Kozloduy NPP, taking into consideration the ENSREG Technical Specification. The report contains a description of both the regulatory activity and the activities of the licensee concerning the ageing management processes of the KNPP nuclear units' structures, systems and components.

From 12.05 to 19.05.2018 a workshop was held in Luxembourg to discuss the TPR national reports. The following EU member-countries took part in this workshop: Belgium, Bulgaria, Czech Republic, Finland, France, Germany, Hungary, Italy, the Netherlands, Poland, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom. In addition, there were

representatives of Norway, Switzerland and Ukraine. The discussion covered both the general ageing management programmes at nuclear power plants and research reactors, and the following specific topics: electrical cables, concealed pipework, reactor pressure vessel, concrete structures and the containment. Representatives of Kozloduy NPP participated on behalf of Bulgaria. They presented the general AMP programme and the AMP programmes for individual SSCs. On the final day of the workshop, the results from the discussions were summarised as well as country-specific good practices, areas for improvement and challenges.

In late October 2018, the ENSREG report was issued with the results of the first topical peer review conducted on "Ageing management of nuclear power plants and research reactors". The report is publicly accessible at the ENSREG web-site. The main conclusion of the peer review is that Ageing Management Programmes for Nuclear Power Plants exist in all countries, and that regulation of the Ageing Management Programmes is in line with the IAEA safety standards and WENRA safety reference levels on ageing management. The review did not identify any major deficiencies in European approaches to regulate and implement ageing management programmes at nuclear power plants. A separate report, also available on the ENSREG web-site, identifies country-specific good practices and areas for improvement. Overall, Bulgaria meets the expected level - it has good practices in some areas, and areas for improvement in others.

In conformity with the ENSREG decision of March 2019, preparations started for development of a National Action Plan that considers the ENSREG report summarising the results of the first topical peer review on "Ageing management of nuclear power plants and research reactors", and the country-specific results stated in the report.

Construction of new nuclear capacities

Construction of a new nuclear unit at the Kozloduy NPP site

The procedure for a new nuclear unit construction on the Kozloduy NPP site was launched by a decision adopted on 11 April 2012 by the Council of Ministers (CM), whereby a permission in principle was granted as to the construction of a new nuclear facility in the KNPP site area. In pursuance of the CM's decision, a feasibility study and an environmental impact assessment for the new nuclear unit were performed.

Upon the application submitted by Kozloduy NPP - New Builds Plc, the NRA issued a permit for siting of the nuclear installation (site selection) in August 2013.

In June 2015, a request was filed by Kozloduy NPP - New Builds Plc for issuance of an approval of the selected site, complete with relevant technical and administrative documents confirming compliance with the existing regulations. In 2016, an independent expert review of the nuclear facility Preliminary Safety Analysis Report (PSAR) was commissioned and completed. PSAR contains studies - in terms of nuclear safety and radiation protection, of all factors related to the site selection for the future nuclear facility. The results from the expert review generally confirmed the absence of exclusion factors for safe operation and the possibility to deploy a new nuclear facility on the site. In late 2016, Kozloduy NPP - New Builds Plc submitted to the NRA a new revision of the Preliminary Safety Analysis Report for the nuclear facility. The revision addressed and incorporated the gaps found during the expert review of PSAR. In March 2017, the NRA issued a positive opinion on the new revision of the report, and this finalised the review of documentation for site approval within the NRA.

In April 2019, the Supreme Administrative Court confirmed the positive decision on EIA of the Minister of Environment and Water, which is a precondition needed for the NRA Chair to issue a site approval order. This allowed Kozloduy NPP - New Builds Plc to file a new application for site approval that is currently subject to a regulatory review and assessment.

Belene NPP Project

The project to build Belene NPP in North Bulgaria (the "Belene" site lies 4 km away from the town of Belene and 11 km away from the town of Svishtov) comprises two nuclear power units of 1000 MW each, as per generation 3, A92 design of pressurised water reactors – the most commonly used nuclear reactors in the world. This is an evolutionary design that uses the best of decades of accumulated experience in the design and operation of light-water reactors and combines it with state-of-the-art engineering solutions and unique innovations.

In 2004, the Council of Ministers of the Republic of Bulgaria made a decision in principle for building Belene NPP. In 2005 the building site was defined as one of national importance. A decision was made to construct on the the Belene site an NPP with maximum installed capacity of 2000 MWe, based on an evolutionary design using approved engineering solutions with pressurised water reactors.

On 29.03.2012, the Council of Ministers adopted a decision cancelling the previous one for construction of an NPP on the Belene site. The cancellation decision was made due to the inability at that time to structure the project in a way that guarantees its economic viability in the context of the global financial and economic crisis characterising the period.

On 29.06.2018, the Council of Ministers passed another decision to cancel the decision of March 2012 for suspending any further action on implementing the Belene Project, and assigned the Minister of Energy with the task of renewing the activities for seeking opportunities for the construction of the power plant jointly with a strategic investor. This government decision was in pursuance of the decision made on 07.06.2018 by the Bulgarian National Assembly to recommence the action for searching opportunities to build Belene NPP. In this connection it should be assumed that the government has renewed its political commitment to build Belene NPP, and that at present the legal and factual obstacles to continue implementing the project have been removed.

Since during the period preceding the project suspension a number of licensing activities were performed in compliance with the provisions of the Safe Use of Nuclear Energy Act and the regulations for its implementation, it is important to clarify how the procedure for licensing by the NRA will be resumed.

The NRA position regarding the licensing procedure conducted as per the SUNEA is that the acts issued and entered into force in connection with the implementation of the licensing process retain their legal effect and the licensee - the National Electric Company Plc (NEK) can continue drawing rights from them. Examples of these acts are the order for site approval, and the design permit issued by the NRA. The next stage of the licensing procedure - issuance of an order for the technical design approval, has not been officially finalised yet, although a large scope of work has already been completed relating to this phase.

The Belene NPP project was submitted to the NRA together with the Interim Safety Analysis Report (ISAR) in 2008. The documents review procedure for issuance of an order by the Chairman of the Nuclear Regulatory Agency for approval of the prepared technical design (TD) of Belene NPP (Units 1 and 2) in connection with the requirements of Art. 40 of the Regulation on the Procedure for Issuing Licences and Permits for Safe Use of Nuclear Energy, began on the basis of a written application filed by NEK Plc in April 2008. In the period 2008 - 2012, the NRA reviewed and evaluated the materials received in accordance with the approved schedule, and outsourced expert assessments to specialised consulting organisations and obtained them completed:

- assessment of the Interim Safety Analysis Report (ISAR) performed by RISKAUDIT IRSN/GRS International;
- assessment of selected design solutions in the TD, performed by the engineering company EnproConsult Ltd.

In connection with harmonising the approach to safety, the Belene NPP design was also subject to analysis by the International Atomic Energy Agency. The IAEA has conducted two review missions and issued respective reports on the Probabilistic Safety Assessment of Belene NPP, and the Additional Safety Assessment (stress tests) ensuing from the Fukushima NPP accident.

In the event of a practical renewal of the project implementation activities, the licensing process should continue from the TD approval phase for the facility, taking into account the activities carried out so far. It has to be noted that since 2012 a number of amendments have been made to our nuclear national legislation. For instance, amendments were made and adopted to the SUNEA, the Regulation on Ensuring the Safety of Nuclear Power Plants and a new Regulation on Radiation Protection has been issued. These reflect the stricter safety requirements in the wake of the Fukushima accident provided in the IAEA standards; the directives approved on the basis of the Euroatom Treaty; and the documents of the Western European Nuclear Regulators Association.

The NRA will continue its activities on the approval of the Technical Design for Belene NPP, once after NEK Plc has demonstrated that the TD and the ISAR are compliant with the normative documents issued since 2012. It is also necessary for NEK Plc to present an action plan to address the recommendations and comments ensuing from the stress tests performed on the Belene NPP technical design and from the IAEA mission reviewing the results from stress tests. As a result of the assessment for compliance with the current normative acts and standards, as well as the additional measures taken as a result of the stress tests performed, updates of the TD and the ISAR should be undertaken, if necessary, to take them into account.

During the time period in questions, there were also a number of organisational and other changes made within the applying organisation. This necessitates that document be submitted to the management and organisational structure of NEK Plc including those related to the implementation of project activities.

Considering the decision of the Council of Ministers from 29 June 2018 it can be assumed that the government intentions concern the incorporation of a new project company, the capital of which should include participation of NEK Plc and the future strategic investor. On 11 March 2019, NEK Plc initiated a procedure for selection of a strategic investor for the Belene NPP project. The procedure is expected to be completed within a year.

The new company will be the successor to NEK Plc in terms of the actions performed on the Belene NPP project and will thus be able to use the rights as per the licensing acts issued so far. The legislation allows a legal successor to intervene in place of the current holder in the pending licensing procedures. The legal successor should have competent staff as well as sufficient financial, technical and material resources to carry out the activity, which should be evaluated by the regulatory authority.

In summary, until the suspension of the Belene NPP project, the NRA had issued a site selection permit, an order for approval of the Belene site, and permits for design development. Upon an eventual project resuming, the licensing process should continue from the technical design approval phase of the facility. Further licensing acts can be issued to the current holder of administrative acts, issued as per SUNEA, or to its legal successor.

Nuclear facilities shut down for decommissioning

This category of nuclear facilities include the Kozloduy NPP units 1 to 4 with reactors type WWER-440/B-230. With a decree of the Council of Ministers, dated 20.12.2008, concerning units 1-2, and another decree of 19.12.2012 concerning units 3 - 4, these units were declared facilities for management of radioactive waste (RAW) and were transferred to the State Enterprise Radioactive Waste (SE RAW). The spent nuclear fuel has been removed from the reactor ponds and transported to the wet storage facility (WSF).

In November 2014 and July 2016, the Nuclear Regulatory Agency issued to SE RAW licences for decommissioning of units 1 and 2, and units 3 and 4, respectively. In accordance with the units' decommissioning licensing conditions, SE RAW implements management of historical radioactive waste.

Statement on the status of the nuclear facilities

The actions undertaken and planned by the Republic of Bulgaria are in conformity with the requirements of Article 6 of the Convention.

A large-scope Modernisation Programme has been completed on units 5 and 6, which resolved internationally recognised problems of reactor type WWER-1000. Activities have been completed for comprehensive ageing management review and residual lifetime assessment of equipment, and as per the programme for extension of their operating lifetime in conformity with the applicable regulatory requirements and international operating experience. A periodic safety review of units 5 and 6 has been performed. The licence for operation of Unit 5 has been renewed, while renewal of the licence for operation of Unit 6 is under way.

Article 7 Legislative and regulatory basis

1. Each Contracting Party shall establish and maintain a legislative and regulatory framework to govern the safety of nuclear installations.

2. The legislative and regulatory framework shall provide for:

i) the establishment of applicable national nuclear safety requirements and regulations;

ii) a system of licensing with regard to nuclear installations and the prohibition of the operation of a nuclear installation without a licence;

iii) a system of regulatory inspection and assessment of nuclear installations to ascertain compliance with applicable regulations and the terms of licences;

iv) the enforcement of applicable regulations and of the terms of licences, including suspension, modification or revocation.

Article 7 (1) Establishing and maintaining a legislative and regulatory framework

Safe Use of Nuclear Energy Act

The fundamental Act in the field of safety of nuclear installations is the Safe Use of Nuclear Energy Act (SUNEA). SUNEA regulates the public relations related to the state regulation of the safe use of nuclear energy and ionising radiation and the safe management of radioactive waste and spent nuclear fuel. The state regulation is effected by the NRA Chairman who is an independent specialised authority of the executive power and has the competence as specified in the Act. The fully revised Safe Use of Nuclear Energy Act was adopted in 2002 and it conforms to current trends in nuclear legislation including the legislative practices in the EU countries in the area in question. In 2010, the SUNEA was amended and supplemented, taking into account the experience gained in law enforcement, the adoption of new EU directives on nuclear safety and radiation protection and the changes in the Convention on the Physical Protection of Nuclear Material. The SUNEA was amended during the period considered to align it with Council Directive 2013/59/ Euratom of 5 December 2013 laying down basic safety standards for the protection against the dangers arising from exposure to ionising radiation and repeal Directive 89/618 / Euratom, 90/641/ Euratom, 96/29 / Euratom, 97/43 / Euratom and 2003/122 / Euratom (Directive 2013/59 / Euratom).

Related national legislation

According to the SUNEA, in addition to the NRA Chairman, other authorities also carry out specialised control over the facilities and activities associated with the use of nuclear energy and ionising radiation. In this respect, the law explicitly mentions as specialised authorities the Ministers of Healthcare, Environment and Water, Interior, Defence, Agriculture and Food, Transport, Information Technologies and Communications, Education and Science, Youth and Sports, and the Chairman of the State Agency for National Security, all of whom shall exercise control as per the authority they have been granted. Such authority is granted mainly through the following laws:

- Law on Environmental Preservation;
- Energy Act;
- Law on Spatial Planning;
- Health Act;
- Disaster Protection Act;
- Law of the Ministry of Interior.

International conventions and treaties

The Republic of Bulgaria is a Party to the Convention on Nuclear Safety, the Convention on Early Notification of a Nuclear Accident, the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, the Convention on the Physical Protection of Nuclear Material, and the Additional Protocol to the Nuclear Safeguards Agreement to the Treaty on the Non-Proliferation of Nuclear Weapons.

The Agreement between EURATOM and non-member States of the European Union on the participation of the latter in the Community arrangements for the early exchange of information in the event of a radiological emergency (ECURIE) was signed by Bulgaria in 2003 and ratified by law in 2005. In pursuance of the Agreement, the NRA Chairman is designated as the central authority and contact point under the Agreement.

Since 2007, Bulgaria has been a full member of the EU. The national legislation has been harmonised with the European one and Bulgaria has been applying the European good practices. The requirements of Council Directive 2009/71/Euratom on establishing a Community framework for the nuclear safety of nuclear installations have been introduced and the requirements of Council Directive 2014/87/Euratom of 8 July 2014 are being introduced.

The Republic of Bulgaria participated in the diplomatic conference for amendments to the Convention on Nuclear Safety held on 9 February 2015 at the IAEA in Vienna. Bulgaria supported the adoption of the Vienna Declaration on Nuclear Safety as part of the efforts of the international community to enhance nuclear safety in the wake of the Fukushima NPP accident.

Article 7 (2) (i) National safety requirements and regulations

Secondary legislation acts

The SUNEA article 5, (17) provides that the NRA shall develop and submit to the Council of Ministers (CM) for approval any secondary legislation normative documents associated with the law enforcement. The drafts of regulations and the annexes thereto are published on the NRA web page and the portal for public consultations of the CM.

In conformity with the national legal requirements, the NRA policy statement confirms that “the NRA will update the normative requirements in accordance with the development of international standards and the EU legislation, and will develop regulatory guides and directions in areas where this is necessary”. In pursuance of this policy, the NRA keeps a programme for review and update of the secondary legislation documents.

In the period 2016-2018, 4 regulations were amended and supplemented, 3 new regulations and one new Tariff were issued:

- Regulation on Ensuring the Safety of Nuclear Power Plants;
- Regulation on the Implementation of Safeguards under the Nuclear Non-Proliferation Treaty;
- Regulation on Radiation Protection;
- Regulation on the Terms and Procedure for Obtaining of Vocational Qualification and on the Procedure for Issuing Licences for Specialised Training and of Individual licEnces for Use of Nuclear Power;
- Regulation on the Issuance of Licences and Permits for the Safe Use of Nuclear Energy;
- Regulation on the Terms and Procedure for Notification of the Nuclear Regulatory Agency about Events in Nuclear Facilities and Sites with Sources of Ionising Radiation;

- Regulation on the Procedure for Payment of Fees under the Act on Safe Use of Nuclear Energy;
- Tariff for Fees Collected by the Nuclear Regulatory Agency under the Safe Use of Nuclear Energy Act.

The preparation of draft normative acts has considered the changes made to international conventions and agreements, the new legislation of the European Union, the new or modified documents of the IAEA, as well as the experience accrued from the practical implementation of the acts and regulations.

Guides issued by the regulatory body

The basic requirements on nuclear safety, radiation protection and physical protection of nuclear facilities are set out in the SUNEA and the regulations on its application that specify more detailed requirements. If needed, the regulations envisage issuance of regulatory guides with instructions on their application. The regulatory guides are not mandatory in nature and the criteria set out in the guides are not necessarily binding. The NRA has developed 20 regulatory guides, 13 of which concern the safety of nuclear facilities.

In the period 2016-2018, four new regulatory guidelines were developed and adopted:

- Conduct of periodic safety review of nuclear power plants;
- Application of the requirements for the safe transport of radioactive materials;
- Ageing management of structures, systems and components of nuclear power plants;
- Criteria for the authorisation and control of radioactive releases and for environmental monitoring.

In order to ensure broad distribution and easy access to the regulatory guides, they are published in electronic format on the NRA web site http://www.NRA.bg/bg/documents/legislation/manuals. Guides are distributed to all stakeholder organisations with a cover letter.

Activities for harmonisation of nuclear safety requirements

Being a member of the West European Nuclear Regulators Association (WENRA), the NRA has participated with its representatives in the two working groups – the Reactor Harmonisation Working Group, and the Working Group on Waste and Decommissioning. In the Regulation on the Safety of Nuclear Power Plants, published in 2016, due consideration has been given to the WENRA safety goals for new NPP designs, and the updated (in the wake of the Fukushima accident) reference levels for safety harmonisation of NPPs in operation, as well as the latest IAEA safety standards in this field. The Regulation introduces the requirements of the Council Directive 2014/87/Euratom of 8 July 2014 amending the Directive 2009/71/Euratom establishing the common framework for the nuclear safety of nuclear installations.

Article 7 (2) (ii) System of Licensing

The SUNEA establishes a licensing regime to ensure the safety of facilities and activities. The licensing process is effected under the conditions of transparency and equality.

The SUNEA defines the scope of activities, facilities and materials subject to licensing. A license is issued to operate a nuclear facility (a power unit of a nuclear power plant, facility for spent fuel management, facility for radioactive waste management, research reactor), and also for its decommissioning. The maximum term of the licence validity is 10 years. Thus, the operating organisation can plan long-term activities and allocate more resources to safety improvements. Licence renewal is based on periodic safety reviews. The Act places very precise and clear requirements to the operator in respect of the conditions and criteria to be met in order

to obtain a licence, by which the subjective decision-making by the regulatory authority is avoided to the greatest degree possible.

For given single-time activities, the Act envisages permit issuance for the following:

- determining the location of a nuclear facility;
- design of a nuclear facility;
- construction of a nuclear facility;
- commissioning of a nuclear facility;
- making changes, leading to modification of:
- structures, systems and equipment related to nuclear safety and radiation protection;
- limits and conditions for the operation of a nuclear facility on the basis of which the licence for operation or decommissioning has been issued;
- internal rules for the activity, including procedures, programmes, technical specifications and other documents attached to the operating licence or to the decommissioning licence;
- transport of nuclear material;
- deals with nuclear facilities and nuclear materials;
- import and export of nuclear material;
- transit of nuclear material.

The licence or permit, the change thereof, or the refusal of the NRA Chairman to issue the respective document are subject of appeal to the respective administrative court in accordance with the Administrative Procedure Code.

The conditions and procedure for issuance of licences and permits are defined in the Regulation on the Order for Issuance of Licences and Permits for the Safe Use of Nuclear Energy. According to this regulation, the licence or permit applicant has to submit documents confirming compliance with the requirements of nuclear safety and radiation protection, defined mainly in the regulations on the application of the SUNEA.

Public participation in the regulatory process is provided by the Law on Normative Acts, which requires publication of all bills at least one month prior to their adoption, as well as by the Access to Public Information Act. In addition, the Law on Environmental Protection requires public consultation on the results of the environmental impact assessment report for a nuclear facility.

Article 7 (2) (iii) System of regulatory inspection and assessment

Regulatory inspections

The Safe Use of Nuclear Energy Act assigns to the NRA Chairman the responsibility to carry out regulatory control over the nuclear safety and radiation protection in the use of nuclear energy and ionising radiation and in the radioactive waste and spent fuel management. This control includes:

- preventive control by issuing licences and permits for activities and individual capability licences;
- on-going supervision of the implementation of the terms of licences and permits for activities, and individual capability licences;

- follow-up monitoring on the implementation of recommendations and prescriptions given by the control bodies.

In fulfilment of control powers, the NRA Chairman:

- performs periodic and extraordinary inspections through authorised officials;
- informs other specialised control authorities to take action within their competence range;
- alerts the prosecuting authorities upon evidence of any crime performed;
- amends or revokes issued licences or permits, or individual capability licences;
- imposes mandatory administrative measures and administrative sanctions as provided by the Act.

The NRA Chairman is entitled to request from individuals: information about their activities; the necessary documents in respect to the regulatory oversight, and, if necessary, request the assistance of specialised control bodies.

The overall objective of the regulatory inspections and application of mandatory measures is to ensure implementation by the operator of all activities in a safe manner and in accordance with the requirements, rules and regulations on nuclear safety and radiation protection. In pursuance of this objective, the NRA annual plan includes the areas of regulatory control identified by the SUNEA and the conditions of the currently effective licences and permits. The inspection activities are planned by taking into account the operational states of nuclear facilities, the results from previous inspections, and planned modifications, in such a way as to ensure coordination with the activities planned by the operators. Financing of the inspection activities is secured within the NRA budget framework.

The NRA is trying to apply in its activities a non-prescriptive approach, therefore, of particular importance are the systematic contacts with licensees and permit-holders (in the case of KNPP - daily contacts), in which issues are discussed in an open dialogue. The aim is to assist licensees and permit-holders in implementing the requirements of the Act and sublegislative normative documents so that the planned measures shall be acceptable to both parties. Mandatory administrative measures and sanctions provided by the Act are imposed only if all other possibilities have been unsuccessful. Discussions take place on a routine basis both at the KNPP site, and the NRA headquarters, at the initiative of either of the two parties.

The NRA Chairman authorises certain officials of the administration of the Agency (inspectors) to carry out control under the SUNEA, in accordance with their powers of authority. These inspectors have the right to:

- freely access the controlled persons and sites, at any time, to check the status of nuclear safety, radiation protection and the technical condition of the nuclear facilities and the ionising radiation sources;
- require from the respective officials the necessary data, information, explanations, other operational information, including on measurements and tests in order to clarify the technical conditions and the operational status of the facility, staff qualification, and any other information related to ensuring the nuclear safety and radiation protection;
- issue acts for administrative violations in terms of this Act;
- make proposals to the NRA Chairman for modification, suspension, termination or revocation of the permits, licences or individual capability licences issued;
- issue mandatory improvement notices for ensuring the nuclear safety and radiation protection.

The inspection results are recorded in an inspection report (report of findings), to which the evidence collected, explanations and results of observations, measuring and/or testing are attached. The improvement notices given by the inspectors implementing their authorities as per this Act are obligatory. The results of inspection and control activities of NRA and the specialised control authorities are published in the NRA annual report, which is submitted to the Council of Ministers, state authorities, non-governmental organisations and the public.

Review and assessment of safety

The NRA carries out safety review and assessment both in the process of issuing licences or permits, and periodically, during the implementation of the activity. The process of review and assessment of documents supporting applications for issuance of licences / permits can be summarised in the following principal steps:

- receipt and registration of the application and its supporting documentation;
- determining a programme and a team of experts to review and evaluate the documentation and, in some cases, specifying of methodological instructions for the task;
- review and assess the applications and respective attachments for compliance with the requirements in force, and, where appropriate, to the relevant documents of the IAEA or other regulatory authorities. If necessary, the applicant is required to submit additional information for the assessment;
- the results of expert evaluation are summarised and documented, and on the basis of the conclusions a proposal is made to issue a permit or a motivated refusal;
- the final decision on the issuance of a permit or a motivated refusal lies within the responsibility of the NRA Chairman.

In cases where the documents contain information, the assessment of which requires special knowledge, the NRA Chairman may award contracts for additional review and assessment of these documents to be done by external consultants. The experts from the respective departments engaged prepare the TOR for the expertise and participate in its approval procedure.

When a non-compliance with the safety requirements is identified in the documentation submitted, detailed comments are sent to the applicant for their incorporation. In such cases, it is a well established practice to organise meetings with representatives of the applicant in order to discuss and clarify questions and comments.

The ongoing inspection and assessment of the adherence to the requirements for nuclear safety and radiation protection is carried out through review and assessment of licensee's reports on operating parameters, or operating events, and through *in-situ* inspections for compliance with the requirements for safe operation.

Analysis and evaluation of operational events

The requirements for providing information by the licensee or the permit-holder to the NRA, including requirements for mandatory notification of the Agency in case of an event, incident or accident are defined by a Regulation. The Regulation specifies the cases of notifying the regulatory body if the nuclear safety and radiation protection requirements have been violated. The regulation also defines the sequence and time-limits for notifying the regulatory body, the methods for events evaluation and analysis, and the reports' structure and contents.

For each event, a written report shall be submitted within 30 days of its occurrence. All operational event reports are reviewed and evaluated by the NRA inspectors, as for that purpose a special working group has been established. When necessary, additional information is

requested or additional analysis and expertise are conducted in order to clarify the root causes of the specific event. If events important to safety have occurred, NRA inspectors take part in the commissions for analysis and assessment.

Article 7 (2) (iv) Enforcement of applicable regulations

To prevent and discontinue administrative violations and to prevent and remedy their consequences, the NRA Chairman imposes sanctions (fines and penalty payments) and mandatory administrative measures. The SUNEA provides different amounts of sanctions, depending on the type of offence. The establishment of the violations, the issuance, the appeal and the execution of the penal decrees shall be carried out in accordance with the procedure established by the Law on Administrative Offences and Sanctions.

Compulsory administrative measures are imposed for violations of the requirements for nuclear safety and radiation protection, physical protection and emergency preparedness, in which there is an immediate danger for an accident to occur. Mandatory administrative measures that may be imposed in these cases are:

- suspension or restriction of the activity for which a permit or licence has been issued;
- suspension of individual capability licences;
- an order for the examination, inspection or testing of an installation, facility, product, their parts, systems or components; modification of established limits and operating conditions;
- modifications to designs and structures relevant to nuclear safety;
- supplementing or modifying curricula and courses and conducting additional training, including testing of staff knowledge and skills.

Mandatory administrative measures are imposed through an order of the NRA Chairman, based on a protocol of findings of NRA inspectors. The order imposing mandatory measures shall determine appropriate time for their implementation. The order for imposing mandatory administrative measures may be appealed before the respective Administrative Court under provisions of the Administrative Procedural Code. An appeal does not suspend execution, unless the court has ruled otherwise.

Any violation of the conditions of the permit or licence is considered an administrative offence for which the person who committed the offence receives a fine or penalty payment in an amount determined by the SUNEA. Any breach or violation of permit or license conditions as per the SUNEA may give sufficient grounds for revocation of the licence or permit. Revocation of a permit or licence shall be made by a decision of the NRA Chairman, which determines the terms and conditions in which the person may apply for a new permit or licence for the same activity.

The NRA resorts to mandatory administrative measures and issue of penal orders solely when all other possibilities have been ineffective. The regulator policy correctness is confirmed by the small number of penal orders issued or administrative sanctions imposed.

Article 8 Regulatory body

1. Each Contracting Party shall establish or designate a regulatory body entrusted with the implementation of the legislative and regulatory framework referred to in Article 7, and provided with adequate authority, competence and financial and human resources to fulfil its assigned responsibilities.

2. Each Contracting Party shall take the appropriate steps to ensure an effective separation between the functions of the regulatory body and those of any other body or organisation concerned with the promotion or utilization of nuclear energy.

Article 8 (1) Establishment of the regulatory body

Foundation

In 1957 Bulgaria ratified the Statute of the IAEA and became one of the co-founders of the international organisation. In 1957 was established a Committee for the Peaceful Use of Atomic Energy (CPUAE), the mandate of which was to monitor and promote the R&D activities in the use of nuclear energy After commissioning of the first two units of Kozloduy NPP in 1975, the Committee was given also control functions. In 1980, a Decree on State Control of Nuclear Safety was published and assigned to the CPUAE. In 1985, the first *Act on the Use of Nuclear Energy for Peaceful Purposes* was adopted. The Act created a Committee on the Use of Atomic Energy for Peaceful Purposes (CUAEPP) and determined in detail the functions and the tasks of the organisation, and an Inspectorate on the Safe Use of Atomic Energy was also established.

The Act was amended several times until 2002 when it was fully repealed by the new Safe Use of Nuclear Energy Act. The SUNEA is consistent with the current trends in the field of nuclear law, including the legislative practice of the EU countries in this area. In developing the Act, the recommendations of the IAEA experts reviewing the draft were considered. By this Act, the Committee was transformed into NRA - a politically and financially independent regulatory authority.

Legal basis and status of the regulatory body

The status and responsibilities of the NRA are set by the Safe Use of Nuclear Energy Act. The state regulation of the safe use of nuclear energy and ionising radiation, and the safe management of radioactive waste and spent nuclear fuel is effected by the Chairman of the Nuclear Regulatory Agency. The NRA is an independent specialised body of the executive power.

The NRA Chairman is approved by the Council of Ministers and appointed by the Prime Minister for a 5-year mandate and may be appointed for one more term of office. In exercising their power, the Chairman is assisted by two deputy-chairs, who are approved by the Council of Ministers and appointed by the Prime Minister, upon a proposal of the NRA Chairman.

Mission and objectives

The regulatory functions performed by the NRA in the public interest, determine the organisation's mission, namely: “Protection of the individuals, public, future generations and environment from the harmful effects of ionising radiation”. To achieve its mission the NRA is guided by the internationally accepted principles of nuclear safety and radiation protection and constantly strives to improve its effectiveness and efficiency through implementation of internationally recognised regulatory best practices.

In accordance with the objectives, plans, priorities and expected problems in the long term, the NRA develops a Strategic Plan for its activity which is submitted to the Government and

published on the NRA website. It is the basis for generating the annual plans, which define the scope and the objectives of NRA activities for the respective year. The Strategic Plan is periodically updated as a result of a change in priorities and goals of the organisation or if the risk analysis outcome needs to be considered.

For the implementation of the main tasks facing the organisation, the NRA management has adopted and periodically updates its Management Policy Statement which identifies priorities, and expectations to staff.

Authorities and responsibilities

Under the SUNEA, the NRA Chair shall have the following authorities and responsibilities:

- manage and represent the Agency;
- issue, amend, supplement, renew, suspend and revoke licences and permits for the safe conduct of activities under the SUNEA;
- supervise compliance with the requirements and standards for safe use of nuclear energy and ionising radiation, radioactive waste management and spent nuclear fuel and the conditions of the licences and permits;
- issue, terminate and withdraw registration certificates and individual licences for carrying out activities in accordance with the SUNEA;
- impose compulsory administrative measures and administrative penalties as provided by the SUNEA;
- contract expert reviews, studies and research, related to nuclear safety and radiation protection, in respect of the use of nuclear energy and ionising radiation, and management of radioactive waste and spent nuclear fuel;
- interact with the executive authorities, which have been granted regulatory and supervisory functions in respect of the use of nuclear energy and ionising radiation, and propose to the Council of Ministers measures to coordinate these activities;
- carry out the international cooperation of the Republic of Bulgaria in regards of the safe use of nuclear energy and ionising radiation, and of the management of radioactive waste and spent nuclear fuel;
- provide the public, legal persons or state authorities with objective information on the state of nuclear safety and radiation protection;
- submit annual reports to the Council of Ministers on the state of nuclear safety and radiation protection concerning the use of nuclear energy and ionising radiation, and in the management of radioactive waste and spent nuclear fuel, as well as the activity of the NRA;
- organise and coordinate the preparation of, and submit to the Council of Ministers, the reports under the Convention on Nuclear Safety and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management;
- organise and coordinate the implementation of the Bulgarian obligations under the Agreement between the Republic of Bulgaria and the International Atomic Energy Agency for the application of the safeguards, in connection with the NPT and the Additional Protocol;
- perform the functions of a central authority and contact point for emergency notification and assistance under the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in Case of a Nuclear Accident or Radiological Emergency;

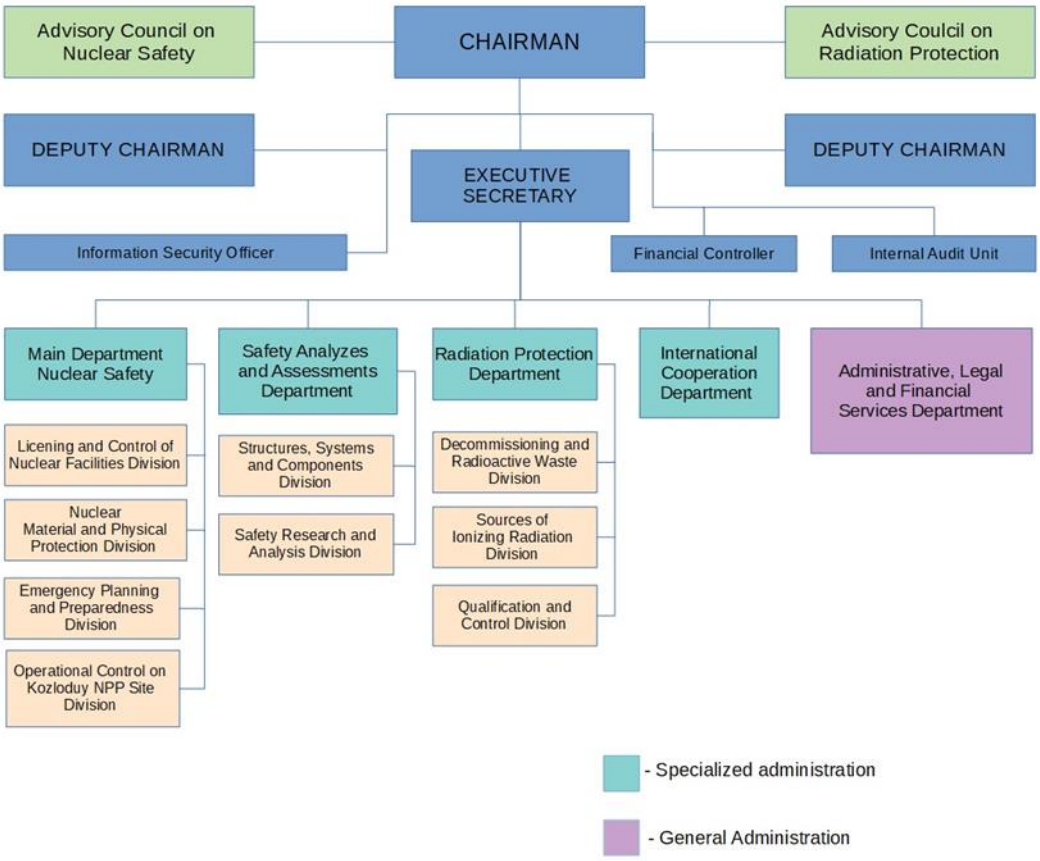
- act as the competent authority, point of contact, and coordinator under the Convention on the Physical Protection of Nuclear Material;
- develop and propose for adoption to the Council of Ministers the regulations on the implementation of the SUNEA.

The SUNEA identifies as essential functions of the NRA the licensing activities, implementation of regulatory control, safety review and analysis, development of regulatory requirements, maintaining emergency preparedness and international co-operation of Bulgaria in the area of its competence. In addition, the Act states that the NRA Chair may have other specific authorities, when conferred upon him by normative statements.

Organisational structure

According to the SUNEA, the NRA Chair is assisted by an administration organised in a Nuclear Regulatory Agency which is a legal person, funded by the state budget and has its headquarters in Sofia. The structure, operation and organisation of work of the Agency and its human resources are determined in the NRA Rules of Procedure, adopted by the Council of Ministers upon proposal of the NRA Chair.

The NRA structure is consistent with the Administration Act; the latter sets out uniform requirements to the structure of the administrations in the country that support the governing bodies and takes due account of all the fields of activity of the regulator in conformity with the powers vested to the NRA Chair by the national legislation. The NRA Administration is headed by an Executive Secretary. The NRA employees are divided into general and specialised administration. The General Administration provides technical support to the activities of the Specialised Administration and carries out administrative services to citizens and legal entities. The Specialised Administration is organised into four Directorates and assists the Chair in carrying out his regulatory and supervisory functions related to nuclear facilities, sources of ionising radiation, nuclear material, radioactive waste, emergency preparedness and international cooperation and includes a regional office at the Kozloduy NPP site. The NRA organisational structure is shown on the figure herein.



Development and maintenance of human resources

The responsibilities of the NRA staff members to the public determine the higher demands on their qualifications and experience, which are accurately and clearly defined for each particular position. Almost all employees of the Agency hold a higher education degree (Masters' Degree) and have long-term professional experience in the field of regulation, design, construction and operation of nuclear facilities and sites with SIR.

According to the Rules of Procedure, the NRA has 114 statutory positions, and by the end of 2018 there were 94 actual employees. Ninety-two percent of all employees of the NRA are university graduates, and the average professional experience of the specialised administration officers exceeds 20 years.

The NRA has a staff training and qualification system in accordance with national and international standards. Specialised training is held to maintain and improve the qualifications of the employees, including the acquisition of additional professional knowledge and skills for quality performance of their official duties. It is based on the requirements of the systematic approach to training - an internationally recognised methodology. The specialised training is carried out in accordance with the approved "Annual NRA Specialised Employee Training Plan".

As a result, the Agency has continued its policy of employing young people, the greater number of whom join the regulator straight from the university. For each newly recruited employee an individual training programme is developed on the basis of his/her job description and analysis of the necessary competences and skills including theoretical training, practical training and coaching.

Financial resources

The Act on the Safe Use of Nuclear Energy creates preconditions for the financial independence of the regulatory authority. The activities of the NRA are financed by the state budget and from the revenues from fees collected under the ASUNE. The NRA Chairman is a budget authorizer by delegation and draws up its own budget in accordance with the Act on Public Finances. As a result, there has been stability in the financing of the Authority in recent years.

Quality management system

The NRA implements an Integrated Management System (IMS) based on the requirements of the IAEA GSR Part 1 - Governmental, Legal and Regulatory Framework for Safety, 2010 and GS-R-3 - Management System for Facilities and Activities, 2006.

The management system brings together all the interconnected elements of the organisation - structure, resources, processes (working practices) and culture of the organisation, which interact to help carry out the policy and achieve the goals of the NRA in an efficient and effective way.

The processes required to implement the policy and achieve the NRA goals are defined and documented. The hierarchy, consistency and interaction of processes and activities within the organisation are defined to ensure comprehensive control and consistency in the decision-making process.

The IMS processes are structured in three groups:

- ***management processes*** - are aimed at leading and managing the organisation, controlling the main and supporting processes, and the effectiveness and efficiency of the management system, e.g. Policy, strategy and planning; Risk Management; Evaluation of the functioning of the IMS and improvement;
- ***main processes*** - they are of strategic importance, they accomplish the NRA mission and are critical for the achievement of the set goals, e.g. Nuclear safety control; Control of safety at work with SIR; Development of regulatory requirements;
- ***support processes*** - create the conditions for carrying out the basic processes and provide technical administrative support activities, e.g. Financial management and control; Human resource management; Management of products and services by an external provider.

The management system is described in documents structured in three levels.

Level 1 documents are strategic and formulate the mission, policy and goals, present the organisational structure, powers and responsibilities of the managers, the functions of the administrative units, contain an overview of the management system and include: policy statement; management system manual; strategic plans; orders defining the functions and number of administrative units.

Level 2 documents (procedures, instructions, guides, plans, programmes, etc.) are aimed at achieving the goals of the strategic documents. They regulate the implementation of processes, define responsibilities and lines of communication, providing administrative guidance to managers at different levels; give detailed instructions to the administration for performing a specific activity; plan the implementation of activities.

Level 3 documents are records that register the results of process execution.

The effectiveness of the IMS is monitored and measured to assess the degree of adequacy of the defined processes of the objectives set and to identify opportunities for improvement. For

this purpose, internal audit, self-assessment, management review are used, non-conformances are identified and managed, and corrective actions - taken.

Openness and transparency

Public opinion is sensitive to the use of nuclear energy and the problems related to the radioactive waste management. In terms of this, the open dialogue with all the stakeholders, the transparency of our activities and decisions, and ensuring public access to information appear as the key issues for efficient regulatory activity. The NRA webpage provides plenty of and varying information on nuclear safety and radiation protection, as well as the activities of the NRA. Access is free to the public registers of issued licences and permits for nuclear facilities and ionising radiation sources, licences for specialised training and individual licences to implement activities with SIR or work on nuclear facilities.

At www.bnra.bg all Annual Reports of the NRA since 2003 have been published, also all National Reports of the Republic of Bulgaria under the Convention on Nuclear Safety, the Reports under the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. The publications include also the reports on implementing the country's obligations as per the IAEA Codes, and the European Directives in the area of radiation protection.

The NRA regularly updates the public information as regards all events on nuclear facilities. It is one of the tasks of the organisation to guarantee timely information to the media about everything happening in the area of nuclear safety and radiation protection. Improving the communication between the professional language of the specialists and the language of the public on such important topics is a challenge.

External technical support

The NRA organisational and management structure has a separate Directorate for Safety Analyses and Assessments, which is part of the specialised administration. This Directorate works in close cooperation with the rest of the specialised directorates, thus ensuring that experts of the required competence participate in the process of review and assessment. In order to improve the internal expertise in different technical areas, analyses are awarded to external organisations in accordance with the Public Procurement Act (PPA). The NRA is fully responsible for the regulatory decion-making, and has provided human and financial resources to secure the effective performance of the technical support system through:

- full time experts within the regulatory authority, who are competent and capable to perform regulatory reviews and assessments;
- full time experts that are trained and capable to evaluate reports on contracts, awarded to external organisations;
- availability, within the NRA and at the TSOs, of necessary assessment tools and computer codes to carry out the assessments;
- sufficient financial resources to pay for the contracts;
- access of the NRA staff to new developments in science and technology;
- continuous improvement of staff expertise, through training and education programmes, as well as participation in international research and exchange programmes, etc.

Advisory Councils

Pursuant to Article 9, Paragraph 1 of the SUNEA, two advisory councils are established in support of the NRA Chair:

- Advisory Council on Nuclear Safety;

- Advisory Council on Radiation Protection.

The Advisory Councils have adopted rules for their work, and their meetings are chaired by the NRA Chair or by an authorised representative. The Advisory Councils support the NRA Chair by giving advice on the scientific aspects of nuclear safety and radiation protection. Their opinion is only advisory in nature, while the full responsibility for the regulatory decisions rests with the NRA. The main functions and tasks of the Advisory Councils are to:

- make proposals in the process of establishing NRA priorities;
- discuss and give opinions on existing regulations and new drafts;
- discuss and give advice on programmes and projects to improve the safety of nuclear facilities and sites with SIR;
- propose implementation of investigations, research and other activities in connection with the safe use of nuclear energy and SIR;
- assist the NRA Chair in the preparation of national reports under the international conventions and treaties;
- assist the dissemination and exchange of information and expetise, including international one among the specialists in a particular area;
- review and give advice on the quality of the reports from contracted expert reviews or research studies;
- carry out other activities as requested by the NRA Chair.

Pursuant to the provisions of Article 9 of SUNEA, the advisory councils staff is appointed by an order of the NRA Chair. The advisory councils include prominent Bulgarian scientists and experts in the field of nuclear energy and ionising radiation, management of radioactive waste and spent nuclear fuel. The members of the Advisory Councils have extensive academic, research, or operational experience in various aspects of nuclear safety and radiation protection, nationally and internationally.

Article 8 (2) Status quo of the regulatory body

Place of the regulatory body in the governmental structure

In terms of Article 4 of the SUNEA, and Article 19, Paragraph 4 of the Law on Administration, the Chair of the Nuclear Regulatory Agency is considered an executive authority. As such, it annually submits to the Council of Ministers a report on the status of nuclear safety and radiation protection in the use of nuclear energy and ionising radiation, and radioactive waste and spent fuel management, as well as the activities of the Agency (responsibility according to Article 5, item 10 of the SUNEA).

As an independent regulatory body within the system of the executive power, the NRA Chair reports directly to the Prime Minister. In addition, the NRA Chair shall inform the National Assembly on matters of nuclear safety and radiation protection, and take part in meetings of the Parliament and the Parliamentary Commissions, when invited to do so.

Article 9 Liability of the licensee

Each Contracting Party shall ensure that prime responsibility for the safety of a nuclear installation rests with the holder of the relevant licence and shall take the appropriate steps to ensure that each such licence holder meets its responsibility.

Formulation in the legislation assigning the prime responsibility for safety to the licence holder

The full responsibility of the licensee to ensure the safety of nuclear installations is regulated by the Safe Use of Nuclear Energy Act, the Regulation on Providing the Safety of NPPs, and the Regulation on the Procedure for Issuing Licences and Permits for Safe Use of Nuclear Energy. The other regulations on the implementation of SUNEA define the responsibilities in specific areas: management of radioactive waste and spent fuel, emergency planning and preparedness, physical protection, NRA notification for events in nuclear installations or with SIR.

The fundamental principles specified by the Safe Use of Nuclear Energy Act, state that nuclear energy and ionising radiation shall be used in accordance with the requirements and principles of nuclear safety and radiation protection, to ensure the protection of human life, health and living conditions of present and future generations, environment and valuables from the harmful effects of ionising radiation. The principle that when using nuclear energy 'the responsibility for ensuring nuclear safety and radiation protection, lies in full with the persons responsible for the facilities and the activities, and may not be transferred to other persons' was introduced.

According to the Regulation on Providing the Safety of NPP: 'The operating organisation bears the full responsibility of ensuring safety, including when other entities implement activities or provide services to the NPP, as well as in relation to the activities of the specialised regulatory authorities, in the field of nuclear energy and ionising radiation'. The same Regulation requires the operating organisations to establish organisational structure for the safe and reliable operation, with clearly defined responsibilities, powers and lines of interaction of the staff, who carry out safety related activities. The changes in the organisational structure that is important to safety shall be justified in advance, systematically planned, and evaluated after their implementation.

In the Regulation on the Procedure for Issuing Licences and Permits for Safe Use of Nuclear Energy the general conditions for the implementation of the main activity of the licensee are included. Each licence issued for nuclear facility operation, determines the type and scope of activity, the main requirements for its implementation, the obligations to maintain adequate financial, human and other resources and specific requirements that must be provided in respect of:

- nuclear safety, radiation protection, physical protection, quality assurance, emergency preparedness, management of radioactive waste and spent fuel, notification of regulatory body about deviations and accidents;
- providing information to the regulator about: the operations, including fulfilment of licence conditions; the procedure for notification in case of change of the circumstances in which the license was issued;
- the obligations of the licensee in connection with the regulatory control, carried out by the NRA, the applicable legislation, interfaces with other permits or licences; etc.

For issuing a permit or a licence, the applicant has to demonstrate that it has adequate organisational structure to maintain high level of safety; a developed system for high level of safety culture and as well as ensured compliance of facilities and declared activities with the rules and regulations on nuclear safety and radiation protection. Any amendment to the Rules of Organisation and Operation of the licensee is subject to authorisation by the NRA.

Description of the principal means by which the licensee is fully responsible for safety

In order to achieve full compliance with the set legal requirements, a distribution of the responsibilities of the licensee was made through the management and organisational structure and internal organisational documents of Kozloduy NPP. The Rules for the Organisation and Operation of Kozloduy NPP, specifies the principles for the overall company organisational structure; management bodies, levels of management and their functions; responsibilities and tasks of different structural units; and lines of interaction. The responsibilities of personnel are defined by job descriptions for each job position, while those for the operating personnel are also included in job instructions. The procedure for making changes to the administrative and organisational structure of the company is specified by the instruction 'Management of organisational changes in Kozloduy NPP'. The instruction defines the criteria for assessing the impact of changes on safety, responsibility for planning, execution and analysis of the consequences of the amendments made.

The internal control and coordination to ensure safety in the company as a top priority, compliance with regulatory requirements and licence conditions is provided by the Safety and Quality Directorate, the functions, tasks and responsibilities of which are described in Article 10, Safety Management section.

Responsibilities and financial obligations of the licensee to manage radioactive waste and spent fuel, the activities of decommissioning and liability for nuclear damage are described in Article 11 (1).

Description of the mechanism by which the regulatory authority shall ensure that the licence holder is fully responsible for safety

This is achieved through the established licensing regime related to the issuance of licences and permits for the safe use of nuclear energy, as well as the modification and renewal of these licences and permits. Authorisations are subject to activities related to the implementation of modifications to SSC important to safety and internal rules for conducting the activity.

In case of changes to internal documents, it shall be demonstrated that the regulatory and legal requirements have been met, and that the changes comply with the procedure for introducing of changes adopted by the plant. If substantial changes have been made to internal rules for performing the activity, the regulatory body issues separate permits. The relevant amendments shall be enforced only after these procedures have been completed.

When changes important to safety are being made to the organisational structure, before issuing a permit for modification, the NRA shall check and verify that those changes have been justified in advance, whether they comply with the statutory requirements, and whether they have been planned and systematically assessed, as per the internal documents established for the purpose.

In accordance with the Safe Use of Nuclear Energy Act, the NRA supervises nuclear safety, physical protection and radiation protection in the use of nuclear energy, ionising radiation and the management of radioactive waste and spent fuel, and that control is performed by:

- preventive supervision when issuing licences and permits for activities under this Act;

- on-going supervision on the implementation of the conditions of the licences and permits issued;
- follow-up control on the implementation of certain recommendations or prescriptions for improvement.

Description of the mechanisms for maintaining a transparent and open public communication by the licence holder

The Kozloduy NPP maintains open and transparent communication with the general public, including the population of the region around the nuclear power plant, non-governmental organisations, scientific circles, the younger generation, professional partners and more. A number of well-established mechanisms are used in the communication process, which include:

- maintenance of a website with separate headings: About the Plant; Current Information; Generation; Safety; Information Centre, etc.;
- maintaining media relations: press releases with up-to-date information on Kozloduy NPP activity; news conferences and briefings; preparation and distribution of print and information publications, including ones targeted at children;
- issuing annual reports in Bulgarian and English, presenting the overall activity of Kozloduy NPP;
- group or individual visits of citizens and students;
- organising Doors Open Days;
- arranging of meetings, workshops, round-tables, public discussions with partners from the country and abroad, and representatives of NGOs, the media and the public;
- holding public opinion polls on the level of public acceptability of the nuclear power plant activities;
- informing citizens about deviations, incidents and accidents in the nuclear facilities by the mass media and the Internet site of the plant, according to the NRA requirements.

Description of the mechanism which provides the necessary resources (technical, human, financial) and powers of the licence holder to effectively manage emergencies on site and to mitigate their consequences

The organisational structure of Kozloduy has established a separate department - Emergency Preparedness (EP), which is a unit within the Safety Division at the Safety and Quality Directorate (see Article 10 - Safety Management). The EP department is responsible for maintaining, updating periodically and reviewing the internal emergency plan of Kozloduy NPP; providing and maintaining emergency and technical equipment, automated information systems, and communication tools in ERC; emergency teams and their training; emergency kits; develops and conducts emergency drills and exercises. Maintains lists and inventories of available facilities and equipment at the plant site and the list of emergency workers. Coordinates and interacts with the other authorities of the scheme for emergency response on site - National Fire Safety and Protection of Population Regional Directorate-Kozloduy NPP, Kozloduy NPP Police Department, Occupational Medical Centre (OMC) and Transport Department (for more information see Article 16).

The assessment of the adequacy of the available organisational measures, technical means and human resources at the site of Kozloduy NPP for action and management of severe accidents is accomplished in practice by periodically conducting drills, emergency exercises, general national and full-scale emergency exercises. A comprehensive assessment is made by conducting emergency exercises and drills of:

- the adequacy of the regulated requirements for the established emergency organisation of the actions included in the emergency plan;
- adequacy of management and executive staff;
- adequacy of the technical means on site including coping with accidents related to simultaneous occurrences with fuel melt-down at various facilities on-site;
- sufficiency of emergency stocks - mobile equipment, radiation instruments, batteries, cables, oils and diesel fuel.

Emergency drills are held annually for mastering the plan and two general emergency drills on site; a full-scale emergency drill is conducted every 5 years with the participation of the executive authorities. Funds to maintain emergency preparedness and measures for improvement after conducted exercises are included in the Programme to Maintain and Improve Safety, and those of investment character in the Investment Programme. The two programmes are part of the Business plan of the company and Kozloduy NPP management team applies a single policy to management of resources, to all processes and activities with main priority to ensure safety.

In 2017 was prepared a Procedure for action of the emergency teams in case of simultaneously occurring events at various nuclear facilities on Kozloduy NPP site, including the organisational measures for the actions of the emergency teams of the plant, the available mobile equipment located on the site and in the PAZ, the logistics provisioning - batteries, cables, oils and diesel fuel in case of an emergency related to simultaneous events together with fuel meltdown at different facilities on-site.

In 2017, a general emergency drill was conducted on "Operation of emergency teams with simultaneous events occurring at different nuclear facilities at Kozloduy NPP site", and an assessment of the adequacy of the emergency teams and the technical facilities at the site to deal with simultaneous core melting events was carried out. The overall assessment is that the current organisational measures and engineered features in the KNPP Emergency Response Plan are sufficient for management of simultaneous occurrences with core melt-down at the various facilities on-site.

As a result of the assessment of the adequacy of the management, executive staff and emergency teams, the Procedure for Organisation and On-call Performance to Ensure the Emergency Planning of Kozloduy NPP was updated. Each unit of the emergency response organisation has at least five employees involved, which fulfils the requirement for rotation of teams in the event of a prolonged, severe accident or core melt accident at various on-site nuclear facilities.

Article 10 Priority to safety

Each Contracting Party shall take the appropriate steps to ensure that all organisations engaged in activities directly related to nuclear installations shall establish policies that give due priority to nuclear safety.

Overview of the measures and regulatory requirements regarding policies and programmes of the licensee to ensure priority of safety with regards to activities for design, construction and operation of nuclear installations

One of the fundamental principles specified by the Safe Use of Nuclear Energy Act, states that nuclear energy and ionising radiation shall be used in accordance with the requirements and principles of nuclear safety and radiation protection, to ensure the protection of human life, health and living conditions of present and future generations, environment and assets from the harmful effects of ionising radiation. Regarding the use of nuclear energy, nuclear safety and radiation protection take priority over all other aspects of this activity.

The Regulation on Providing the Safety of Nuclear Power Plants requires the operating organisation to adopt a document - Safety policy, which gives the highest priority to safety over all other activities, and assumes a clear commitment to continuously improve safety, and encourages staff to adopt a critical attitude towards the operations they do, to support and encourage thinking and behaviour leading to high level of safety culture. The staff and contractors who perform activities that have an impact on safety shall be made familiar with the safety policy.

Safety policy sets out clearly stated safety goals and intentions that can be easily controlled and tracked by the management. Instructions shall be developed for the implementation of the Policy and control of activities that have an impact on safety. The policy should require continuous improvement of nuclear safety by means of:

- continuous process of safety reassessment, taking into account operating experience, research and safety analyses and the achievements of science and technology;
- timely implementation of practically possible improvements;
- use in a timely manner important new information related to the safety of the nuclear plant.

The licensee shall develop and apply a safety monitoring system including systematic self-evaluation at all levels of the operating organisation. Monitoring should include staff behaviour and their attitude towards safety, violations of OLCs, operational procedures, regulatory requirements and the conditions of operating licences. Appropriate safety indicators are developed and used that allow management personnel to identify and respond to weaknesses and inconsistencies in safety management. As a result from the monitoring and the safety performance indicators review, corrective measures are identified and implemented under monitoring and assessment.

Measures taken by licensees to implement regulatory requirements for priority of safety (like those of the previous item or other examples such as good practices and achievements in safety culture)

Kozloduy NPP

Licensee's policies giving priority to safety during implementation of the activities

Kozloduy NPP's long-term intentions, regarding the company management, are declared in the Policy Statement of the Kozloduy NPP Management and the Management Policy of the

Company. Management priorities are developed and justified with specific objectives and principles in the respective policies of Kozloduy NPP: safety management policy, environmental management policy, occupational health and safety management policy, security management policy, quality management policy, business and finance management policy, training and qualification of the personnel management policy, fire safety management policy, human resources management policy.

The Safety Management Policy places the highest priority on nuclear safety and radiation protection, under stable operation of the nuclear facilities, throughout their operating lifetime, as per the regulatory requirements and issued licences. The Plant Management commits to maintain and develop the system for monitoring and assessment of safety, using highly qualified, trained and well motivated personnel, to maintain and continually enhance safety culture.

Programmes for safety culture enhancement (discussion of measures for safety culture enhancement)

Safety culture (SC) maintenance and enhancement is subject to systematic long-term approach applied at Kozloduy NPP. This approach involves periodically assessing the status of the SC, planning its promotion activities annually, engaging all staff to actively participate in these activities, and creating a responsible attitude. The high level of SC is achieved through the development of the value system, the personal example of managers and the contribution of each staff member.

In order to ensure a systematic approach and support the efforts, the Company has approved "Safety Rules. Developing and maintaining values that foster a positive safety culture at Kozloduy NPP Plc", and a Methodology: Self-assessment of the safety culture at Kozloduy NPP Plc. A Guide for Continuous Improvement of Safety Culture was developed. Organisation and implementation of the activities is performed by the Safety Culture Committee, that functions in support of the Safety and Quality Director.

Medium-term safety culture goals are set in the SC improvement programmes, immediately after the SC self-assessment. Every year, a plan for the work of the Safety Culture Committee, which sets out short-term goals with implementation deadlines within the calendar year, is developed and approved.

The status of implementation of the measures to maintain and promote the SC is reviewed at meetings of the Safety Culture Committee. In addition to implementing SC plans and programmes, items discussed at these meetings include: current information or safety culture issues, operational experience information - internal and external (if related to SC), good practices, benchmarking information, etc.

Safety culture activities are reported in an annual report that is included in the annual report of the plant on the state of nuclear safety and radiation protection and the review by the management of the management system, and the report is also sent for information to the Nuclear Regulatory Agency.

Management of safety

Methodological guidance, coordination and control to ensure and maintain safety of Kozloduy NPP is realised through the Safety and Quality (S&Q) Directorate, that is directly subordinated to the KNPP's Chief Executive Officer. The Directorate, by two divisions - Safety and Quality, carries out control and monitoring in the following areas of safety: nuclear safety, safe management of SF and RAW, radiation protection, fire safety, technical surveillance, emergency planning and preparedness, industrial safety, environmental and onsite radiation monitoring, licensing process in the field of using nuclear energy and nuclear material. The Directorate performs the following main tasks:

- develops the policy for safety management, and keeps it updated; organises and takes part in developing and updating of internal guiding and working documents, training programmes and materials in the fields of monitoring;
- ensures in-house supervision in the safety areas and issues mandatory improvement notices;
- analyses and assesses the general status of safety and prepares periodically reports, develops measures to maintain and enhance safety and safety culture;
- organises the entire process of obtaining permits and licences, required as per the SUNEA, supervises their implementation and reports on it to NRA.
- administers the activity of the Safety and Quality Council, Safety Culture Committee and ALARA Council;
- controls and reports the implementation of: Programme for maintenance and improvement of safety at Kozloduy NPP EAD; Integrated Programme to Implement Security Enhancement at Unit 5 for the period 2017-2027; Integrated Programme to Implement Security Enhancement at Unit 6 for the period 2018-2028; Comprehensive programmes for the implementation of the periodic safety review of Units 5 and 6; Programme for Implementation of Measures for compliance of Units 5 and 6 of Kozloduy Nuclear Power Plant with the safety requirements of the Regulation on the Safety of Nuclear Power Plants, adopted by Decree of the Council of Ministers No 245 of 21.09.2016, Programme of Corrective Measures for Enhancement of the safety culture; Comprehensive programme for RAW management; The measures of the NPP in the National Action Plan after the Fukushima NPP accident; Emergency Plan of Kozloduy NPP; Programme for Radiation Monitoring of the Environment; Site Monitoring Programme etc.

NRA receives monthly reports on the safety status of Kozloduy NPP, six-month and annual reports on the implementation of safety measures.

Measures for safety monitoring and self assessment

The routine control on the implementation of the safety principles, as exercised by the Safety and Quality Directorate, provides opportunities to detect the early signs of safety decline and the need for improvements, by analysing the root causes for the deficiencies and taking appropriate corrective action The internal inspections and reviews focus on the following:

- Quality Inspections and review of management;
- Adequacy and observance of the work procedures;
- Safety Culture;
- Reliability of the systems important to safety;
- Protection of personnel and the environment.

A system of indicators is being used by the Kozloduy NPP, which is considered part of the management tools for supervision and management. Their determination considers the activity specificities, the experience gained in the system development, and the experience of other nuclear power plants. For each indicator the limit and target values are determined (planned), which are the basis for performance assessment. The system of indicators is built as an open pyramidal system of five levels. Only qualitative assessment of the degree of implementation is carried out for levels one to four. In the tasks implementation, the bottom parameters of the pyramid are reached, which are measurable and have quantitative values and evaluation criteria - specific indicators. A report and analysis on the indicators of the system is undertaken quarterly and annually. These reports are reviewed and accepted at specialised technical council meetings. Regarding indicators that deviate from the set targets, the corrective actions are implemented.

Operating Experience Council meetings are held periodically reviewing the internal and external experience to determine the corrective improvement measures applicable to Kozloduy Nuclear Power Plant.

Independent safety assessments

Besides the NRA, the following state bodies, within their responsibilities for government regulation, carry out preventive, ongoing and follow-up control and safety assessments at Kozloduy NPP.

- The Ministry of Health through the National Centre of Radiobiology and Radiation Protection in the fields of health protection of workers and the public and ensuring radiation protection in the use of nuclear energy;
- The Ministry of Environment and Water, through the Regional Inspectorate on Environment and Water, in the field of environmental monitoring and the impact assessment of the nuclear energy;
- The Ministry of Interior through the Regional Directorate Fire Safety and Civil Protection in the fields of protection of the population and national economy in case of disasters and accidents ensuring fire safety at the sites of Kozloduy NPP.
- The Executive Agency General Labour Inspectorate through the Regional Directorate Labour Inspection in the field of providing of industrial safety;
- The State Agency for National Security in relation to the protection of strategic sites and activities and specialised control in accordance with SUNEA.

Periodically, Kozloduy NPP hosts international peer reviews for independent safety assessments. List of peer reviews conducted in the Republic of Bulgaria is presented in **Appendix 2**. Information on the international missions and reviews carried out during the period considered is provided in Article 6.

Safety culture improvement measures

One approach to developing SC is conducting a review and assessment of its level. Kozloduy NPP periodically conducts self-assessment of the SC, which includes several stages:

- preparation and planning of self-assessment - resources, activities, deadlines, responsibilities;
- collecting data using qualitative and quantitative methods - interviews, surveys, document reviews, observations and focus groups;
- compilation and analysis of collected data;
- determination of strengths and areas for improvement requiring additional work;
- preparation of a Programme of Corrective Actions for Safety Culture Enhancement.

According to the methodology applied, a complete self-assessment of the safety culture is carried out once every three years, and in part - by separate methods or for separate structural units - over a shorter period. The third self-assessment was carried out, which, according to the trends and requirements of the international and national documents on interrelation and interaction between safety and security, is a combined self-assessment of the safety culture and the safety culture at Kozloduy NPP. Analysis of the information identifies several areas of interest in which there are both good performance practices outlined and weaknesses registered, related to: provision of sufficient and competent staff, storage and transfer of knowledge, efficiency and organisation of work, conditions and psychological climate in the workplaces, underestimation of the risk at work and efficiency and optimisation of the documents used. For improvement of performance in the areas with deficiencies a Corrective Actions Programme will be developed.

Activities designed to enhance SC are not limited to those set out in the Self-Assessment Programmes. The activity of the SC Council includes implementation of ongoing projects and tasks, and discussion of emerging issues related to SC and human activity. The members of the Council participate in the development and updating of training materials, training of staff, focus groups and teams for interviews with the personnel at their workplaces.

Practice has been developed to improve performance in a number of areas related to safety culture, operational experience, human factor and human performance, staff motivation, risk assessment, etc. A number of meetings have been held with Cernavoda NPP, Romania and Paks NPP, Hungary. These meetings are appreciated as beneficial, open and contributing to better work results and improved safety.

Process-oriented management system

An integrated management system (IMS) has been established at Kozloduy NPP, based on a process approach, and it is consistent with the requirements of the IAEA GS-R-3 Safety Standard, The Management System for Facilities and Activities 2006 and the NRA Guideline: The Management System for Facilities and Activities. the IMS incorporates all management aspects and provides for coordination in implementing the requirements for safety, health and safety at work, environment, quality and economy in such a way as to place safety as an overriding priority (for more information see Article 13 of the Report).

Kozloduy NPP - New Builds Plc

Kozloduy NPP - New Builds is a sole-owned joint-stock company, whose main objective is the organisation and management of the overall process of feasibility study, design, construction and commissioning of new generation nuclear power plants at the Kozloduy NPP site.

In the Kozloduy NPP - New Builds Management Policy Statement, the management sets its priorities in pursuit of the main objective: ensuring the highest level of safety; effectiveness, efficiency and cost-effectiveness in the management of the activities and qualified, competent and motivated staff. In the policy implementation, the Management commits to develop the system of values and safety culture. In order to achieve the main objective, the management is committed to the implementation, maintenance and continuous improvement of a Management System suitable for the Company's activities.

The company is the holder of a permit to determine the location of a nuclear facility (site selection) and has submitted the required documents to the request for approval of the selected site.

Regulatory process for monitoring and oversight of the measures of the Licensee to ensure priority of safety

Safety management is a key topic in the scope of topical inspections of the NRA in the Management System field. Inspection is focused on:

- safety policy, including safety priority, commitment of senior management to maintaining a high level of safety, providing resources;
- assessments of the impact of structural and organisational changes on safety;
- self-assessment results through indicators;
- available experience and knowledge of the senior management, focus on safety issues, graded risk assessment approach, motivating of staff;
- safety activities - planning, risk assessment, optimal test and maintenance intervals, questioning attitude to work;
- monitoring of performance of activities and internal evaluations.

In all the areas of inspection oversight safety culture is monitored. A proactive approach is used to identify weaknesses and negative tendencies in the organisation and in the behaviour of the staff, which, if no action is taken, may lead to inconsistencies in the established practice of the licensee with the regulatory requirements and the conditions of the issued licences and permits.

Means used by the regulatory body to prioritise safety in its own activities

According to SUNEA, regarding the use of nuclear energy, nuclear safety and radiation protection have priority over all other aspects of this activity.

The Policy Statement of the NRA management defines that nuclear safety and radiation protection take priority over all other aspects of this activity. Their assurance is only possible with the strict adherence to the fundamentals of the Safe Use of Nuclear Energy Act, the European legislation and the relevant IAEA standards.

The authorisation regime imposed by the SUNEA is one of the guarantees for observing the requirement for priority of safety in all regulatory activities and decisions. The working practices established by the NRA quality management system, follow strictly the SUNEA provisions and the Regulations on the application of the Act.

Another mechanism for ensuring the priority of safety is the independence of the regulatory body. It is secured by the following elements: provision of budget and resources; qualification and training of the employees; assuring non-interference in the work of the regulator; implementation of international cooperation; use of independent analyses and expertise related to nuclear safety and radiation protection; prescribing remedial measures and imposing mandatory administrative measures; conduct of regulatory inspections.

Article 11 Financial and human resources

1. Each Contracting Party shall take the appropriate steps to ensure that adequate financial resources are available to support the safety of each nuclear installation throughout its life.

2. Each Contracting Party shall take the appropriate steps to ensure that sufficient numbers of qualified staff with appropriate education, training and retraining are available for all safety related activities in or for each nuclear installation, throughout its life.

Article 11 (1) Financial resources

Mechanism for providing financial resources to ensure the safety of the nuclear installation, throughout its life

The requirements for the operator to have sufficient financial, technical and material resources and organisational structure to maintain a high level of safety over the operating life of the nuclear installation and in the radioactive waste and spent fuel management, as well as during its decommissioning, are set in SUNEA, the Energy Act and the special regulations to these acts. These requirements are incorporated in the licences for the operation of nuclear facilities, according to SUNEA and in the license for electricity generation, according to the Energy Act.

Principles for financing of activities to improve safety at Kozloduy NPP throughout its life

A guiding document, whereby the Kozloduy NPP states its strategic and business goals through specific actions and measures is the Business Programme of the Company. The Business Programme is developed for a five-year period and integrates the implementation of all measures related to the Production Programme of the plant, the Nuclear Fuel Management Programme, the Programme on Nuclear Facilities Safety Maintenance and Enhancement, the Investment and the Maintenance Programmes.

The main principles in the planning and financing of the activities aimed at improving the safety of the nuclear facilities are as follows:

- paramount importance in providing financial resources for the safety management;
- sufficiency of the resources provided;
- timeliness in providing the necessary resources;
- adequacy of the organisational structure and the financial-economic relations, that guarantee the implementation of the commitments to ensure the safety.

A system for planning, budgeting, preparation, approval, implementation and oversight of the activities on maintaining and enhancement of safety is in place, and it guarantees that the funds that are projected and spent on these activities are adequate in terms of amount and are provided in a timely manner.

The implementation of the Business Programme is subject to regulatory review of the Energy and Water Regulatory Commission (EWRC), and the implementation of the Programme for Safety Maintenance and Enhancement, and the investment projects, related to safety are monitored also by the NRA.

Principles for providing funding for decommissioning, spent fuel and radioactive waste management, during the industrial operation of the nuclear installations

The provision of funding for decommissioning, spent fuel and radioactive waste management, during the industrial operation of the nuclear installations is in consistence with the relevant legislation and the national policy as defined in the Strategy for Spent Nuclear Fuel and Radioactive Waste Management. According to the Strategy, the NPP expenses related to SNF management, including transport, storage and reprocessing, as well as the expenses for RAW management activities, are recognised currently as expenses for the licensed activity that make the cost price of the electrical energy. In the event when the transportation of the spent nuclear fuel for storage and reprocessing cannot be implemented, costs for provisions for future obligation for SNF transportation are accrued for the respective year. These sums are deposited in a special deposit account and are spent solely for the SNF management in the following years.

State policy on the financing of the safe RAW management and nuclear facilities decommissioning activities

In accordance with the SUNEA requirements, the State Enterprise Radioactive Waste (SERAW) was established, with the object of activity - radioactive waste management, construction and operation of facilities for radioactive waste management, and decommissioning of nuclear facilities.

Two funds were set up with the Minister of Energy, and they are operated with the purpose of implementing the state policy on safe management of radioactive waste, including their disposal, the activity and the support of SE RAW, and the activities on decommissioning of nuclear facilities, namely:

- Radioactive Waste Fund (RAW Fund); and
- Decommissioning of Nuclear Facilities Fund (DNF Fund).

The funds are assigned resources, established in accordance with SUNEA and governed by managing boards. The procedure for assessment, collection, spending and control of funds as well as the amount of due contributions to the two funds are stipulated in the regulations adopted by the Council of Ministers. The revenues to the RAW Fund are collected from the contributions from the entities that, as a result of their activities generate radioactive waste, subject to transferring, and resources from the state budget, whereas the accumulated funds are spent expressly on the operation and support of SE RAW. The revenues to the DNF Fund are collected from contributions from entities operating nuclear facilities, money from the state budget, etc. The funds accumulated are used solely to finance projects and activities on decommissioning.

The underlying principles that are followed to ensure the financing of the two funds during the industrial operation of nuclear facilities are:

- predictability and consistency in the provision of funds;
- sufficiency of funds and adequate availability in case of justified necessity in order to prevent transferring an excessive burden to the future generations;
- transparency in the financial management of the funds, while ensuring that these funds will not be diverted unduly for other purposes;
- purposefulness and efficiency in spending.

Statement on the adequacy of financial provisions

Kozloduy NPP

In order to satisfy the statutory requirements related to the performance of the licensed activity, Kozloduy NPP applies a single Business and Finance Management Policy to all processes and activities, with the main priority to ensure safety.

Funding of the measures under the Programme on Nuclear Facilities Safety Maintenance and Enhancement, is ensured with priority, the costs being integrated into the Annual Plan and the long-term Business Programme. The costs are covered by revenues from electricity sales.

The Investment Programme includes several large-scale strategic tasks:

- units 5 and 6 lifetime extension;
- implementing measures to enhance Units 5 and 6 safety over the period of long-term operation, ensuing from the implementation of the Units 5 and 6 Lifetime Extension Project - Stage 2;
- reactor thermal power uprate up to 104%;
- licensing provisions and measures resulting from the operating experience, conducted reviews or regulatory requirements related to safety;
- implementation of the measures under the National Action Plan of the Republic of Bulgaria arising from the stress tests.

Investment activities of total value of BGN 258 million were implemented over the period 2016-2018 (EUR 132 million). An investment programme of total value of BGN 800 million is planned for the period 2019-2023 (EUR 409 million), and it is foreseen that the projects will be funded entirely with the company's own means.

Kozloduy NPP Plc achieved good financial results and all the necessary measures related to safety maintenance and enhancement are implemented in their full scope.

RAW Fund and DNF Fund

According to SUNEA and the Regulation on the Procedure for Determination, Collection, Spending and Control of the Resources and on the Amount of Due Payments to the Radioactive Waste Fund and the Decommissioning of Nuclear Facilities Fund, the monthly instalments to each Fund are determined by a methodology for the assessment of the waste management costs, including the waste disposal, and also a methodology based on the assessment costs for the decommissioning of nuclear facilities relative to the overall lifetime of the facility.

At present, the instalments of Kozloduy NPP payable to the two funds, as the holder of licences for the operation of nuclear facilities, amount to 10.5% of the revenues from electricity sales, thus ensuring that sufficient amount of financial resources shall be accrued to provide for the future decommissioning activities regarding the nuclear facilities, and for RAW and SNF management.

Since the setting up of the two funds in 1999, until the end of 2018 Kozloduy NPP EAD has paid an amount of BGN 1,980 million (EUR 1,012 million).

The activities related to decommissioning of nuclear facilities are funded also by resources from the Kozloduy International Decommissioning Support Fund (KIDSF) (for the shut down units 1-4) through the European Bank for Reconstruction and Development (EBRD).

The revenues and expenses of the two funds since their setting up until the end of 2018, as well as a forecast of the revenues and expenses until 2021, are presented in ***Table 1***:

year	DNF Fund		RAW Fund	
	Revenues	Expenses	Revenues	Expenses
1999-2014	1,379,764,555.13	47,652,901.25	376,574,981.90	257,601,644.50
2015	62,070,645.50	4,043,382.55	25,000,549.67	32,882,313.41
2016	60,426,971.41	8,742,558.00	24,298,335.74	26,229,717.31
2017	67,242,389.46	17,533,600.00	26,947,409.94	20,474,664.95
2018	81,357,117.64	19,218,582.00	32,554,146.00	23,319,989.95
2019	75,827,000.00	18,592,700.00	30,331,000.00	21,282,000.00
2020	76,922,000.00	18,892,700.00	30,769,000.00	21,282,000.00
2021	78,234,000.00	18,892,700.00	31,294,000.00	21,282,000.00

Table 1

Financial provisions assessment process

Periodically, at least once every five years, the estimated expenses of both RAW and DNF funds are re-assessed, including the costs of managing spent nuclear fuel, that remains on site after the final discontinuation of the units operation. If necessary, the contributions of the nuclear facilities' operator may change in a way to guarantee that after shutting down the last nuclear reactor there will be sufficient financial resources accumulated for the implementation of the planned activities.

According to the legislation in force, when the implementation of the decommissioning project turns out to be more expensive than the cost estimates approved by the Board of the DNF fund, the required additional costs are born by the entity that last operated the nuclear facility.

Taking into account the balance of the financial resources accrued in the two funds as at 31.12.2018 (BGN 1,557 million in the DNF Fund, and BGN 128 million in the RAW Fund), during the long-term operation of Units 5 and 6 for another 30 years, and at their increased thermal power up to 104%, over BGN 5 billion nominal value (without discounting and without revenues from the management of the accrued funds) will be accumulated in the funds by the year 2051.

In pursuance of the Regulation on Safety During Decommissioning of Nuclear Facilities, a preliminary Concept on Kozloduy NPP Units 5 and 6 Decommissioning was developed in 2018, with continuous dismantling, involving a stage of safe storage of the equipment in the controlled area. The estimate costs for the units decommissioning amount to approximately EUR 1,800 million nominal value (without escalation and discounting of expenses), and are assessed on the basis of an alternative assessment on the decommissioning costs for 1 MW(e), which is based on the comparative analyses of the IAEA and the Organisation for Economic Cooperation and Development, and the existing world practices in this area. The final decision on the selection of an option for the long-term management of SNF and HLRAW will have a considerable impact on the amount of the total decommissioning costs.

The operational objectives, priorities and activities for the coming year are reviewed on an annual basis, and the five-year business programme is updated with the same periodicity, in order to minimise the risks of liquidity problems of the company and to identify the future needs of financial resources, to ensure the operational and the investment activities.

Description of measures to ensure the necessary financial resources in case of a radiological hazard event

As a party to the Vienna Convention on Civil Liability for Nuclear Damage, the Republic of Bulgaria has designated the persons that are operators of a nuclear installation, under the Convention, as well as the type and provisions of the financial guarantee covering nuclear damage liability of the operator.

Kozloduy NPP Plc has a statutory obligation to sign and maintain a property insurance for the sites/facilities whereby it performs the licensed activity, and a General Civil Liability insurance covering the nuclear damage responsibility, as defined by the Safe Use of Nuclear Energy Act, the Energy Act and the Regulation on Licensing of the Activities in Energy. The liability of the operator for damage caused by any nuclear accident is defined by SUNEA, and is limited to BGN 96 million.

As an operator of nuclear facilities, Kozloduy NPP Plc has the obligation to maintain a permanent financial guarantee, covering the nuclear damage responsibility, and in pursuance of this requirement the company has concluded a contract for General Civil Liability insurance with the Bulgarian National Insurance Nuclear Pool.

According to the Energy Act, the Energy and Water Regulatory Committee, which is an independent regulator, oversees on a regular basis the compliance of the performance of the licensed activity with the licence conditions, including the performance of the obligations to obtain insurance and performance of the obligations for financial collateral of the insurances. According to the Regulation on Licensing of the Activities in Energy, the licence determines the specific risks covered and the amount of the insurance coverage which the licence-holder is obliged to maintain while performing the licensed activity. The licence-holders are obliged to submit to the committee, on an annual basis, within the deadlines set by the licence, information on the concluded insurance contracts, as well as evidence for the insurance validity.

The Disaster Protection Act has arranged options for financing the activities for recovery after a disaster/accident. The Act has established an Interdepartmental Commission for Recovery and Assistance, headed by the Minister of Interior. The support and recovery in case of a natural disaster/accident includes providing urgent and restoration support to the victims and carrying out urgent restoration works. The urgent aid is organised, ensured and provided by the mayors of the municipalities. The Act provides for a procedure for allocation of funds for contingency and/or urgent expenses in the part for prevention, control and overcoming the consequences of disasters/accidents. The resources are available to finance the rescue and emergency works, urgent recovery works, preventive and other activities.

Article 11 (2) Human resources

Arrangements and regulatory requirements concerning staffing, qualification, training and retraining of staff

SUNEA requires that each licence-holder has a sufficient number of qualified and licensed personnel with the appropriate level of education and training for the implementation of all activities under the licence, being obliged to provide training for the staff, oversight and qualification enhancement. Activities in the nuclear facilities and with ionising radiation sources that have an impact on safety may be performed only by professionally qualified personnel holding an individual licence. The specific job positions with such functions are specified in the licences for the operation of nuclear facilities. The individual licences are issued by the Chair of the NRA for entities performing activities related to ensuring and/or control of nuclear safety and radiation protection in nuclear facilities, and full-scope simulator instructors. For the other staff, professionally engaged in nuclear facilities specialised initial and continuing training is held at an organisation that holds a Licence to deliver specialised training as per SUNEA provisions.

The Regulation on Ensuring the Safety of Nuclear Power Plants stipulates that the operating organisation shall identify and allocate the required resources (staff, infrastructure, working conditions, information and knowledge, suppliers, material and financial resources) within its management system, to perform all the activities; to define the requirements on the staff qualification at all levels and ensure training to achieve the required level of qualification; to determine, provide, maintain and periodically reassess the infrastructure and working conditions, required for the performance of the activities in a safe way in compliance with the requirements. The adequacy of the staff and their qualifications have to be analysed and validated in a systematic manner, and any changes in the staff numbers, which could be significant for safety, have to be justified in advance, to be planned and evaluated after the performance. The operating organisation has to define the requirements regarding the qualification of the staff at all levels and to provide the required training. It also has to analyse and identify the training needs and the objectives of the training programmes, to ensure oversight of the training sessions and an evaluation of the training programmes. The preparation and training of staff has to ensure sufficient knowledge on the design basis, the characteristics and behaviour of the SSCs, safety analyses, design and operational documents of the power unit in all operational states and emergency conditions. The operating experience should be used in the training of the personnel involved in activities that have an impact on safety. The operational staff in the MCR have to pass a full-scope simulator training every year, while the operating crews have to undergo periodic emergency drills. The maintenance personnel have to be trained on mock-ups or real components to improve their professional skills and reduce the duration of activities, prior to the implementation of maintenance works with radiological hazard.

The Regulation on the Terms and Procedure for Obtaining Vocational Qualification and on the Procedure for Issuing Licences for Specialised Training and Individual Licences for Work Activities involving Nuclear Power stipulates the general requirements to the personnel recruitment and qualification system, the terms and procedure for acquiring vocational qualifications, for provision of specialised initial and continuing training, for knowledge test and acquiring individual licences to perform activities on nuclear facilities. The Regulation stipulates the procedure for issuance of a Licence to perform specialised training, the obligations and responsibilities of the licence holders.

In accordance with the regulatory requirements, the IAEA Safety Guide NS-G-2.8: Recruitment, Qualification and Training of Personnel for Nuclear Power, Kozloduy NPP implements personnel recruitment and qualification procedures that involve:

- carrying out of professional recruitment;
- medical and psycho-physiological examinations;
- ensuring of specialised initial and continuing training;
- maintaining a high level of safety culture;
- initial and periodic knowledge test;
- control on the adherence to the requirements for specialised training and vocational qualification.

The professional recruitment follows the requirements of the job descriptions that in all cases include education and qualification related requirements, professional experience required for the given position, the minimum of knowledge and skills to perform the respective activity, the individual licence needed (if any) for the position.

Kozloduy NPP holds a Licence for Conducting of Specialised Training on Activities in Nuclear Facilities and with Ionising Radiation Sources. This activity is carried out through the Personnel and Training Centre Division. The training centre has a full-scope simulator (FSS-1000).

The staff who perform activities on nuclear facilities and with ionising radiation sources are obliged to maintain and enhance their own knowledge and to improve their skills. The training process starts from the moment of signing of the employment contract between the employee and the Kozloduy NPP, and continues until the end of employment. Before admission to unassisted work performance, newly recruited workers and professionals need to complete an initial training to acquire knowledge and skills related to the operation and maintenance of specific SSCs, instructions, technologies and operating procedures, specific requirements regarding nuclear safety and radiation protection, and also to establish relationships, ensuring high safety culture. Knowledge and skills, obtained after the initial training are maintained, further developed and built upon through continuing training - periodic and extraordinary, to carry out specific or rarely recurring tasks.

Methods used for the competence requirements and training needs analysis for all safety related activities

In terms of qualification requirements, Kozloduy NPP staff are allocated into 4 groups (A, B, C, D) in accordance with the performed functions and the relation of these functions to nuclear safety, radiation protection, and the operated SSCs. The safety related job positions are allocated in the first two groups, where Group A is the operating personnel (job positions with functions that ensure and/or control nuclear safety and radiation protection).

The input data to plan training and develop the training programmes are the results of the performed specialised training needs analysis. Different analytical methods are used, including job and tasks analysis, competence analysis, and analysis using a combined methodology. The training needs analysis is performed on the basis of:

- the requirements for taking a certain job position, the key functions and duties, rights and responsibilities as described in the job descriptions;
- the requirements defined in the applicable international and national regulatory documents;
- data and requirements regarding the manner of implementing the activities, described in the internal rules, procedures and instructions;
- rules and requirements in terms of nuclear safety, radiation protection, and occupational safety of the personnel performing works in the controlled area, etc.
- internal and international operating experience;
- implemented and forthcoming modifications in the nuclear facility or related to sources of ionising radiation.

Kozloduy NPP performs an assessment of the staff individual job performance. The objective is assessing the performance of the duties and developing personal competence; identifying the development needs for each employee and improving his/her professional competence; improving professional relationships including those between managers and subordinates, and improving the teamwork; creating conditions for implementing fair and transparent procedures for professional and career development.

Arrangements for initial and continuing training of operating staff, including simulator training

The initial specialised training of the operating staff in the MCR and the staff performing functions that have an impact on nuclear safety and radiation protection is carried out by applying a systematic approach. The scope and duration of the training is determined in the training programmes for initial specialised training developed for each specific position. The total duration of training for the staff in the MCR varies from 40 days to 18 months, and for the rest of the operating positions it is 60 days, depending on the specific job position and the functions pertaining to it. The training at the full-scope simulator (FSS) is mandatory for the

personnel taking positions in the MCR. The initial FSS training, depending on the job position, lasts from 10 days to 2 months, while the annual continuing training takes from 5 to 10 days. Upon completion of the initial specialised training internal exams are conducted by an examination committee within the company to validate the acquired knowledge and skills. The staff are admitted to unassisted work after successfully passing an exam before a qualification examination committee and obtaining an Individual Licence (certificate of competency) with a 5-year term of validity.

The continuing training of the operating staff with functions that have an impact on nuclear safety and radiation protection is held on the basis of individual training programmes. The subject-matter includes topics that are dealt with in the initial training programme courses, topics on modifications to SSCs, regulatory and internal documents, topics resulting from the operating experience feedback, etc. The training is conducted as an off-the-job training only.

The scope and duration of the initial training for the other personnel are specified in the standard training programmes developed for each specific position, and the individual training programmes developed on their basis. The duration of the training varies from 2.5 to 3 months, depending on the specific position. Upon completion of the specialised training internal exams are conducted by a examination committee within the company to validate the acquired knowledge and skills. The staff is admitted to unassisted work after successfully passing internal exams and shadowing for the specific work place. The continuing training of this staff is arranged and conducted according to schedules and requests for conducting training. It can be either on-the-job training or off-the-job training.

Capabilities of the Kozloduy NPP simulator to accurately reflect processes, systems and components and the scope of the simulated processes

The requirements for establishing and maintaining the compliance of the full-scope simulator with the reference unit are provided in the Regulation on the Terms and Procedures for Obtaining Vocational Qualification. The particular technical requirements to the simulator, as an engineering tool, are based on the US national standard for NPP simulators, designed for training and evaluation of operators - ANSI/ANS-3.5-2009.

The scope and quality of the simulation models at the full-scope simulator for Units 5 and 6 (FSS-1000) ensure its full-featured functioning as a training aid for initial and continuing training and for evaluation of the main functions of the operating staff. The human-machine interface is a replica of the main control room of Unit 6, while the simulation model supports capabilities to operate in all modes - normal operation, transients, and design basis accidents. This creates the conditions needed for the operators to perform the same actions and follow the same procedures for control of the processes and systems as on the reference unit.

The technical features of the FSS-1000 allow for the facility to be used also as an engineering tool for validation of symptom-based emergency operating procedures, testing of design modifications, testing of technical solutions, testing of operations instructions and procedures, and analysis of operating events.

At the end of each year, an annual plan is developed for activities to be implemented during the next calendar period related to the maintaining of the FSS-1000 in conformity with the reference unit. The plan includes an analysis of the planned changes and modifications on the unit, associated with the FSS-1000 configuration, a description of the necessary activities and terms, dates and responsible persons for their completion.

Arrangements for training of maintenance and technical support staff

The arrangements for training of the maintenance and technical support staff are similar to the activities, described in the section Arrangements and Regulatory Requirements concerning staffing, qualification, training and retraining of staff in nuclear facilities. The specialised

training is conducted as an off-the-job and on-the-job training, and depending on the type of the activity and the features of the workplace it is carried out as:

- theoretical training - lectures, seminars and interactive computer based training;
- practical training in working conditions;
- practical training in workshops, laboratories, on mock-ups, computers, and radiometric, dosimetric and spectrometric equipment and other hardware and software.

The forms of training are applied in a mixed manner, to ensure proper learning and the acquisition of relevant skills and habits. Kozloduy NPP has facilities for training of maintenance personnel, equipped with appropriate mock-ups and hardware and software. Before the implementation of complex maintenance operations or operations with increased dose rates, trial activities are carried out on mock-ups in order to familiarise the maintenance personnel with the implementation of the maintenance work. Prior to the implementation of significant modifications, and in case of necessity, extraordinary pre-job briefings are conducted to acquaint the personnel with the task, and after the modification implementation, the personnel is debriefed on the analysis of the maintenance activity performed.

The contracts with suppliers comprise a provision for providing training related to the maintenance and repair of the supplied equipment.

Improvements to the training programmes as a result of the safety analyses, operating experience, development of training methodologies and practices, etc.

An analysis of the specialised training efficiency is conducted each year, and it is the basis for planning, taking corrective actions and improving all activities, associated with the training process. The training efficiency assessment is a joint activity of the training centre and the plant organisational units. The training efficiency is evaluated on the grounds of data analysis from various sources:

- feedback or inquiry forms filled in by trainees, lecturers, managers;
- results of the training;
- reflecting the modifications to SSCs, operations procedures, operating experience, etc., in the training.

The results of the training efficiency analysis serve as a basis for assessment of the needs of: personnel training; training programmes development, improvement and updating; organising and holding of initial, continuing or extraordinary training; development, improvement and keeping up-to-date of training materials and aids.

Methods for assessment of staff adequacy

The total number of the required staff, as per positions and plant organisational units is specified in the Kozloduy NPP payroll. The staffing numbers needed for the Kozloduy NPP operations are calculated as per the technical specifications requirements, and taking into consideration the uninterrupted production cycle.

Annual reviews are performed on the current payroll, any deviations are analysed and the necessity for its optimisation is assessed. The analysis is performed in order to accommodate the plant organisational structure with the functional distribution of responsibilities among the organisational units.

The composition of the operational shift is defined and structured in a manner to manage and control the whole process. The timetable for the work of operating staff is determined for one calendar year and is approved by the CEO. The work schedule is organised in five shifts in a way that the 24-hour duration of the working day is covered by 3 shifts of 8 hours each. To provide time for operators training and recovery (paid annual holidays, leave due to temporary

disability), in addition to the five operators required by the shift schedule, two more are provided for in the payroll for each work place.

Policy and principles governing the use of contracted personnel to support or supplement the licence holder's proper staff

Pursuant to the licence conditions for the operation of the nuclear facilities, Kozloduy NPP has implemented and maintains a system for assigning, management and oversight of activities and services of contractors, while bearing the responsibility for their performance. Part of the activities that have a significant impact and affect directly nuclear safety may not be assigned to contractors' personnel, in accordance with the regulatory requirements.

The requirements towards the contractors' activity and their staff qualification are specified in the terms of reference (ToR) for awarding contracts, and in the terms and conditions of the signed contracts. The contractors' personnel that perform works on-site should have the appropriate qualification group, as per the relevant regulatory documents, the activity's specifics, and the rules adopted at Kozloduy NPP. In case of performing specific activities, there are additional requirements for specific qualification and competence of the contractor's personnel.

Kozloduy NPP oversees the implementation of the activities by the contractors through on-site inspections, reporting of the inspection results, control over the resolving of non-conformances found, and carrying out of quality audits of contractors.

Methods used to assess the qualification and training of contractor's personnel

The operating organisation specifies the responsibilities and the requirements regarding the required specific qualification and competence of the contractor's personnel, as early as the selection stage, as well as within the contract scope. The contractors are required to demonstrate that their personnel are of adequate number and qualification to perform the activity. A system for assessment of the attached evidence of qualifications and competence of the contractor at the tender stage and at the stage of contract agreement is set up.

One of the requirements is an existing/certified Quality Management System of the contractor, and, in certain cases, a Quality Assurance Programme and/or a Quality Control Plan submitted by the contractor. The Programme and/or the Plan are subject to approval by the Kozloduy NPP before providing the contractor with access to the site. Before being admitted to work, it is mandatory for the contractors' staff to take a training course on 'Introduction to KNPP', either by attending the training in person, or electronically, and the workers performing activities in the controlled area take an additional training course on 'Radiation Protection - contractors'. Both trainings end with a knowledge test and evaluation.

Description of the national provision of and demand for experts in nuclear science and technology

The system of nuclear staff training and qualification in the Republic of Bulgaria follows a multistage approach and includes:

- secondary vocational education;
- higher education for obtaining the relevant educational-qualification degree (BA or MA) in natural sciences and engineering, and the educational and research doctor's degree;
- initial and continuing specialised training to obtain an individual licence to work at a nuclear power plant, taking a specific position (further vocational qualification in licensed specialised training centres).

The higher education degrees in nuclear technology and nuclear science in the Republic of Bulgaria are obtained in the following professional fields: physics, chemistry, power engineering and chemical technologies, in five accredited higher schools.

Currently, the total number of people employed in the nuclear power sector is around 6,500 workers and employees. The majority of them (around 3,689 (about 57%) according to data as of the end of 2018) are directly involved in the maintenance and operation of Kozloduy NPP, 20% of the staff are part of companies, providing repair and maintenance of industry equipment, approximately 10% are employed in science, education and engineering activities. More than 50% of the staff have master's degree, while 8 % of the them hold scientific research degrees (for Kozloduy NPP the employees holding a master's degree represent 72% of all higher education employees, and about 1% hold a PhD). The average age of the workers in the energy sector is about 50, and for Kozloduy NPP the major part is in the range of 41-60 years.

Methods used for the analysis of competence, availability and adequacy of additional staff for severe accident management, including hired personnel or staff from other nuclear installations

The assessment of the sufficiency of the available human resources and their competence for action and severe accident management at the site of Kozloduy NPP is accomplished in practice by periodically conducting exercises, emergency drills, general national and full-scale emergency exercises. After each exercise and drill an analysis and a report are prepared containing identified actions for improvement. An independent assessment of the general emergency exercises is given by an expert committee which includes experts from the Nuclear Regulatory Agency, Ministry of Interior, Ministry of Economy, Bulgarian Energy Holding, etc. The identified weaknesses are reflected in amendments to the emergency plan, emergency procedures, SBEOPs and SAMGs.

As a result of the stress tests performed, and the conclusions drawn from the subsequent emergency exercises at Kozloduy NPP, an assessment was made of the sufficiency of the management and field personnel, and of the plant emergency teams, in case of simultaneous events involving fuel melt in various on-site nuclear facilities. The Procedure for Organisation and On-call Performance to Ensure the Emergency Planning of Kozloduy NPP was updated, and the total number of emergency personnel was increased to achieve exchangeability of the teams in case of a severe accident at all facilities.

Kozloduy NPP is a member of the WANO Regional Crisis Centre in Moscow, set up following the Fukushima NPP accident. The Centre envisages provision of additional, expert on-line support in case of a severe accident at Kozloduy NPP. The Crisis Centre has an approved work plan that includes joint exercises with the Member States.

Regulatory review and control activities

The NRA undertakes review and assessment of the documents submitted by the applicant to support the licence application for specialised training in compliance with the provisions of SUNEA and the Regulation on the Terms and Procedures for Obtaining Vocational Qualification.

Under the licence conditions, the NRA periodically receives information on the performed specialised training and maintains a public register of the individual licences issued for work on nuclear facilities and with sources of ionising radiation.

The NRA's Inspection Programme includes the "Operating Experience Feedback" area, which provides framework for the NRA inspectors to perform reviews on the activity of the licence-holders and the individuals which are issued individual licences (certificates of competency). During the inspections prior to a unit start-up following an annual outage, the NRA verifies the availability of the MCR staff and their qualification.

Article 12 Human Factors

Every Contracting Party shall take the appropriate steps to ensure that the capabilities and limitations of human performance are taken into account throughout the lifetime of a nuclear installation.

Overview of the arrangements and regulatory requirements to take into account human and organisational factors related to nuclear installations safety

The Regulation on Ensuring the Safety of Nuclear Power Plants sets out requirements to take into account human and organisational factors in the design and operation of the nuclear installation.

The design has to be human-error-tolerant as far as practicable, providing for hardware and software means to prevent human errors or to limit the consequences thereof. To that end, the control and monitoring devices, and the presenting of the information should be such as to allow the operating staff to control and monitor the normal operation; to easily evaluate the general condition of the power plant under normal operation, anticipated operational occurrences and accident conditions; to control the reactor condition and the condition of all SSCs, to identify changes important to safety; to verify the execution of the foreseen automatic actions. The changes in the normal operation conditions which could affect safety should be accompanied by audible and visual signalisation in the main control room (MCR). The safety systems should be designed so that they prevent operator's action which could compromise their automatic actuation and efficiency in accident conditions; provide the operating staff with information on the monitoring of the automatic actions effect; provide constant automatic diagnostics of their operability.

The design should provide for sufficient and reliable communication between the main control room and the supplementary control room, the local control rooms and the emergency response centre. The working areas and conditions should be designed so that to take into account the ergonomics principles and allow reliable and efficient task performance.

The operational status of the nuclear power plant and any changes to it should be controlled and monitored by licensed and qualified operating personnel. When operating the nuclear power plant, there are at least two control room operators holding licences issued by the NRA Chairman in the MCR. The personnel is provided with the necessary resources and conditions for implementation of the activities in a safe manner. The operating staff operates the NPP in accordance with written procedures and instructions, that have to be clearly identifiable, discernible in accordance with their purpose, and easily accessible. The staff actions to diagnose the state in accident conditions, for restoration or compensation of impaired safety functions, and for prevention or mitigation of core damage consequences, should be defined in Symptom-Based Emergency Operating Procedures (SBEOP), and Severe Accident Management Guidelines (SAMG).

When assessing safety, the human factors and human-machine interface should be taken into account, in all normal operation modes, anticipated operational occurrences and accident conditions. The scope of PSA should also cover the human error analysis in all operating conditions and accident conditions.

During the operation of the nuclear power plant, constant monitoring should be applied, covering observation of the staff behaviour and their attitude towards safety and violations of OLCs, operations procedures, regulatory requirements and the conditions of operating licences. Systematic self-assessment at all levels of the operating organisation is a part of the monitoring. Appropriate safe performance indicators are developed and used for the purposes of the self-

assessment, allowing the management personnel to identify and respond to weaknesses and inconsistencies in safety management.

A programme for collection, analysis and documenting of internal and external operating experience, as well as operating events at the NPP, has been developed and is systematically implemented. Assessment of operating experience is used to detect hidden defects related to safety, potential preconditions and possible trends for the deteriorated performance of the activities that have an impact on safety, or decrease of safety margins. The NPP staff are required to report departures from normal operation and are encouraged to report near misses important to safety. The information ensuing from operating experience is disseminated to the relevant staff, shared with all interested national and international organisations, and is used in the training of staff performing activities that have an impact on safety.

The Regulation on the Conditions and Procedure for Notification of the Nuclear Regulatory Agency about Events in Nuclear Facilities, Sites and in Activities with Sources of Ionising Radiation and during Transport of Radioactive Material requires that the analysis of the human-induced events contains the causes and circumstances whereby issues related to the human behaviour arose, that contributed to the occurrence and evolution of the event. The analysis is used to identify the areas of human errors which can be connected with the instructions, training, communications, human-machine interface, management or oversight, and to plan corrective actions.

Consideration of human factor in the design of nuclear installations and subsequent modifications (Also, refer to Article 18(3) of the Report)

The requirement that the design of Kozloduy NPP Units 5 and 6 should be human-error-tolerant is implemented through:

- automatic actuation of protections and interlocks, or safety systems in the event when operating actions or changes in equipment state result in changes to the operating parameters exceeding the operational limits, or levels of safety system actuation;
- the design of safety systems provides for non-interference of the operator in their operation;
- data on the parameters and means for their control, in normal operation and in emergency conditions, are localised and concentrated through appropriate location of the control and monitoring tools in the MCR;
- the MCR data on the parameters and the positions of the actuators is sufficient to detect failures and to assess the effects of the operators' actions.

The following diagnostic systems are in place for additional control of the technological equipment parameters, providing information to perform early diagnostics, accurate monitoring of occurred processes and supporting the decision-making process to assist operators:

- primary loose part monitoring system;
- primary leak monitoring system;
- primary to secondary leak control system based on the ^{16}N reference nuclide in the main steam pipelines;
- primary fatigue monitoring system;
- post-accident monitoring system (PAMS);
- safety parameter display system (SPDS);
- containment hydrogen measuring system;
- reactor coolant monitoring system in accident state;

- seismic monitoring system at the site;
- aggregate bearings condition monitoring system;
- containment leak detection system;
- automated information system for off-site radiation monitoring;
- on-line primary water chemistry monitoring system;
- on-line primary coolant activity monitoring system;
- MCP vibration monitoring system;
- closed-circuit television monitoring system for the controlled area equipment;
- system for large-scale temperature monitoring of RPV.

The design of Units 5 and 6 provides for loud speaker communication between the MCR, local control panels and units and on-site compartments. Digital telecommunication systems is in place, which comprises the network of local connectivity telephone exchanges for the operating work places at Units 5 and 6, and a separate network of telephone exchanges to ensure communications all over the site and ensuring connectivity with all communication systems of Kozloduy NPP, as well as the intercity and international telephone network. The MCR work places are provided with telephones of both telephone exchange networks. The DECT system for communication between the operations personnel, plant management and telephone exchange has been put into operation. This system provides freedom of connection similar to the one provided by mobile phones. A wireless communication cellular network was established for communication and permanent contact with the plant management, operating and maintenance personnel, as well as emergency and on-call personnel. A satellite communication system is also in place, designed to ensure alternative communication channels between the units MCR and the ERC in the event of emergencies and disasters. A TETRA system is also in use, ensuring communication and notification to the personnel at Kozloduy NPP site, in the controlled areas of Units 5 and 6, as well as the towns and villages within the 30-km Urgent Protective Action Planning Zone.

The following activities were performed in the past three years to improve the working environment of Units 5 and 6 operators while observing the ergonomics principles:

- reconstructions and repairs of the rooms for the operating personnel outside the MCR (operating personnel in the Turbine Hall, station shift supervisor);
- replacement of local control rooms panels for the ventilation systems equipment;
- operative panels of circulation pump stations;
- local control boards for the water chemical treatment systems;
- a project for replacement of operative panels in the Auxiliary Building (AB-3) is being implemented, parallel with the replacement of the control systems in AB-3.

A number of measures were introduced to prevent errors by the personnel. The Units 5 and 6 equipment is well distinguished from the common plant equipment with clear and unique designations of each item of equipment. The doors of all process rooms on-site are labelled following the internal integrated requirements. A colour-coded labelling is in place, which is used for labelling the rooms, power supply cabinets and switchgear cabinets, as follows: process designation is written on green background (for Unit 5), red background (for Unit 6), or blue background (for common plant equipment). This colour coding is also applied to the work order system to avoid making errors by maintenance crews.

In terms of documentation, the same rules for unique and clear identification numbers are applied so that they are easily recognised by the operators. A colour coding of normal operations

procedures, emergency operating procedures, alarms response procedures, symptom-based emergency operating procedures and SAMG is applied in the Main Control Room.

The human factor is taken into consideration also in subsequent design modifications, taking measures to ensure staff training and acquainting with the modifications made.

Methods and programmes of the licence holder for analysis, prevention, detection and correction of human errors in operation and maintenance of nuclear installations

Methodologies for analysis of causes for human error (the ASSET and the HPES) are used in Kozloduy NPP. During the analysis of events all the aspects related to human and organisational factors are reviewed, deficiencies are identified that might be related for instance with ergonomics and human-machine interface, written instructions, training programmes, using tools to prevent errors, other organisational deficiencies, such as erroneously identified or missing expectations, responsibilities and duties. Relevant corrective actions are outlined.

The requirements for operative interactions, between the operating and the management staff, and separate organisational units in Kozloduy NPP are established. The rules for keeping the operating documentation are identified.

Every power unit has a Chief Operations Process Engineer who does not work in shifts, and who is responsible for the overall unit condition and proper unit operations. All important planned switch-overs, trials, start-up and shutdown operations, are performed under his/her knowledge.

Self-assessment of managerial and organisational issues by the operator

Within the self-assessment indicators system for effective management of Kozloduy NPP a number of functional indicators are monitored, aimed at identification of the human performance and organisational issues, such as:

- fitness for duty of the operators;
- observance of the requirements of the established standards, policies, procedures and rules;
- industrial safety accident rate;
- improvement of human performance;
- enhancement of safety culture;
- use of the operating experience feedback;
- improvement of the independent assessment process;
- efficiency of fire safety programmes;
- efficiency of radiation protection programmes.

In relation to maintaining a high level of personnel motivation, workers and employees are provided with the possibility to assess the working environment conditions established by the employer. Survey of the motivation of a representative sampling of at least 15% of the staff is made on an annual basis. The survey measures the staff attitude towards 24 factors of the working environment, which are indicators for the staff motivation. An important aspect of the survey is the opportunity for the personnel to voice their opinions and proposals by responding to an open question in the inquiry form: "According to your opinion, what should be changed so that Kozloduy NPP Plc becomes an even more attractive place to work?" The feedback from the personnel to the management is a self-assessment through the assessment of the employees on the policies, the management and leadership skills of the managers, on the organisation of work and the quality of the working environment. In order to provide a two-way feedback, the analyses of the conducted surveys are published in the internal information system. Corrective measures are developed if there is a need to enhance the motivation.

Arrangements for operating experience feedback in relation to human factors and organisational issues

One of the objectives of using operating experience is the improvement of human performance and elimination of organisational weaknesses. This is achieved through analysis of operating events, related to human and organisational factors, and determining the corrective actions to remove them, aiming at:

- improving the training programmes for the staff through updating the existing training materials, creating new ones and updating the training periodicity;
- improving the methods and techniques for reducing human errors - through additional trainings and briefings; strengthening the expectations for using written instructions and procedures; updating written procedures and instructions; introducing additional technical and administrative barriers to minimise the probability of errors;
- improving the ergonomics and the human-machine interface through implementing design modifications;
- introducing the applicable operating experience in the simulator training classes at the full-scope simulator FSS-1000;
- integrating the operating experience in the annual continuing training of the staff through selected internal and external events related to human and organisational factors, basic conclusions and lessons learnt;
- motivating the personnel in terms of reporting and using the operating experience through meetings with the personnel, Intranet communications, posters.

In order to improve the efficiency of operating experience feedback related to human errors and organisational issues, Kozloduy NPP has introduced the WANO coding system as an addition to the existing tools. This system was developed to facilitate the comparability of messages on events and determining the problematic areas within WANO, and it increases the possibility for studying the trends in the established causes. The WANO coding system was designed to clearly and consistently state the causes of the events, consequences thereof, damaged or affected systems and components, involved personnel, work they perform, overall plant condition at the beginning of the event. The data for Kozloduy NPP Plc for the period from 2016 to 2018 show that the share of human errors and organisational issues is about and over 50%, which is comparable to the good practices worldwide.

For analysis of human performance and organisational factors, the low level events and near misses system is also used,which provides for two categories (codes) to report events related to human performance/behaviour and organisational factors. In addition to that, to evaluate the level of reporting low level events and near-misses related to human and organisational factors the indicator "Ratio between the LLE and NM related to human and organisational factors and the total number of LLE and NM" ("Relative portion of LLE and NM") is monitored. Work is ongoing (including expanding the scope of the organised trainings) with the staff regarding the need for reporting of LLE and NM, clarification of the declared no-blame policy for inadvertent human errors.

With the purpose of optimising the process of periodic review and assessment (classification, coding and reporting to the management) of non-conformances (including low level events and near misses), recorded as "Comments" in the Organisation of Operational Activity Information System, 4 levels of review and assessment of non-conformances were introduced in 2017:

- first level - daily review of all newly recorded comments for initial assessment of their potential impact on safety and/or production; reporting of comments related to safety and/or production at the morning operations briefing;

- second level - daily classification and coding of comments, recorded during the past 24 hours;
- third level - incorporating the comments classified as level 2 during the review and assessment as low level events or near misses for the past month into the monthly Report on the activities for analysing occurrences and operating experience at EP-2, and reporting to EP-2 Chief Engineer with the purpose of discussing and undertaking additional actions, as needed;
- fourth level - second review of the comments recorded during the previous month and classified as low level event for additional analysis and near miss, to assess possible change in their status (new information when reporting the performed work or issues that occurred during their elimination). This review may result in a change in their classification and/or coding - it is documented in a separate item in the monthly Report on the activities for analysing events and operating experience at EP-2. It is reported to EP-2 Chief Engineer with the purpose of discussing and undertaking additional actions, as needed. It is performed in the month following the reporting period.

Regulatory review and control activities

The human factors management is subject to regulatory review and control in the following areas:

- performing assessments of the modifications in SSCs as regards the human-machine interface;
- planning and implementing activities related to maintenance and repair as regards work load and the established working conditions;
- periodic analysis of the safety performance indicators, related to human factor;
- analysis of operational occurrences related to human error, breached or non-fulfilled operating procedures, organisational issues.

The regulatory control process includes assessment of the effectiveness of the interaction between different organisational units, effectiveness of the management decisions and possible effects on safety due to organisational changes.

Article 13 Quality Assurance

Every Contracting Party shall take the appropriate steps to ensure that quality assurance programmes are established and implemented with a view to providing confidence that specified requirements for all activities important to nuclear safety are satisfied throughout the operational lifetime of the nuclear facility.

Provisions and regulatory requirements

According to SUNEA, entities that perform activities related to the use of nuclear energy are obliged to establish and maintain an effective management system (MS) for the activities, which gives priority to safety and ensures high safety culture, as well as to maintain high level of quality of the activities they perform.

In connection with the implementation of the latest safety requirements and standards at the European and global level with regard to operating and newly constructed nuclear power plant, a new Regulation on Ensuring the Safety of Nuclear Power Plants has been in place as of 2016.

The regulation requires that the operating organisation develops, applies, assesses and continually improves the management system whose main objectives are to ensure and enhance the safety of the nuclear power plant, as well as to promote and support a high safety culture of the staff.

The management system combines all elements of management so that the requirements to protect human health and environment, and to ensure physical protection and quality as well as the financial aspects of the activities of the operating organisation, are not regarded separately from the safety requirements, to prevent potential negative impact on safety. The management system incorporates the required control over processes and activities performed by contractors, with account taken of the complete responsibility of the operating organisation to ensure safety.

The implementation of the management system applies to all stages of the life cycle of the nuclear power plant, as well as for the overall duration of the activities under normal operation, transients and accident modes.

Kozloduy NPP Management System

Status with regard to the development and implementation of an integrated management system

Kozloduy NPP's management applies a management system (MS), integrating all the requirements for nuclear power plant activities, to achieve safe, efficient and environmentally friendly electricity generation, under long-term operation conditions, of guaranteed quality and security of supplies, in compliance with the priorities to ensure the highest levels of safety, efficient and competitive power generation, licensed, competent and motivated staff as well as financial stability.

The Kozloduy NPP management system integrates all management aspects and ensures concordance in the implementation of the requirements regarding safety, health and safety at work, environment, security, quality, and business activity of the company, so that safety is guaranteed top priority. The Management System for Facilities and Activities was developed, in compliance with the IAEA standard GS-R-3, and it was introduced in 2012.

The management system effectiveness is assessed through internal audits, reviews by the regulatory body and during reviews conducted by international organisations. In 2018 the management system was assessed also within the periodic safety review of Unit 6 (PSR-2018),

Safety factor 11 Organisation, management system, and safety culture. The complex programme for implementation of the measures ensuing from the Unit 6 Periodic Safety Review comprises measures for transition to the IAEA standard GSR Part 2 Leadership and Management for Safety.

Main elements of the management system

The long-term intentions of Kozloduy NPP management are set in the Management Policy of Kozloduy NPP and the Management Policy Statement on the Company management.

In strategic terms, the goal is long-term operation of the nuclear power units with guaranteed safe and reliable operation, in compliance with the licences issued by the regulatory bodies. In pursuance of the set goal policies have been developed that are appropriate for the Company's activity and in compliance with Kozloduy NPP management policy. The management assigns paramount priority to safety and declares its commitment to its maintaining and constant improvement in the Safety Management Policy, together with the stated priorities in the management policies on: environment; health and safety at work; security; quality; finance and business; staff training and qualification; fire safety; human resources. The declared policies contain specific objectives in these areas, identify the approach and applied principles for their achievement, The Policies and the Policy Statement are communicated to the entire personnel. They are reviewed on a regular basis to confirm their up-to-date status and applicability when reviewing the Management System.

Based in the policies, strategies and priority business goals, the management develops a five-year Business Programme. The report on the business programme implementation comprises an analysis of the results of the company's activity for the reporting period, identifies the risks and the problem areas and is used in the process of decision making, including undertaking actions for improvement. The reported results of the assessment of business programme implementation form part of the input for the review of management system. More information on the Business Programme is provided in the texts under Article 11(1).

The Management System covers 28 processes (3 management, 4 core and 21 supporting ones), which comprise all the activities related to: business and operative planning; management of material, financial, human resources and knowledge; safety management (nuclear safety and radiation protection, industrial safety and emergency preparedness, environment and security); operating experience; operations; design control; maintenance and repairs; nuclear fuel cycle management; purchase and supply of products/services; RAW management; organisational changes management; measurement, evaluation and improvement of the management system. The required resources, criteria and methods of functioning, management, monitoring and measurement are provided for all processes, with defined functions of a responsible person, a coordinator and a leader. A graded approach is applied to the activities and the results thereof (product, service) for each process, which allows to focus the resources and attention on the activities and equipment important to safety.

The requirements to the external organisation are defined in a way to ensure that:

- the activities they perform are in compliance with Kozloduy NPP policy for maintaining a high level of safety, continuous enhancement of safety culture, as well as observing the requirements of the applicable regulations;
- there is a well established organisation, clear allocation of responsibilities within the external organisation (EO), as well as between the EO and Kozloduy NPP;
- the external organisations have appropriate equipment in a good working condition, special tools and personal protective equipment necessary for work performance;
- the activities are performed by qualified and certified personnel having the required experience;

- the requirements, standards and rules for nuclear safety, radiation protection, physical protection, industrial and fire safety, and environmental management, which are in place at Kozloduy NPP are observed during the performance of the activities.

Continuous monitoring and evaluation of the performed activities, periodical reviews and independent assessments of all processes, as well as self-assessment on behalf of the managers at all managerial levels, are the major mechanisms for early detection of unfavourable trends, timely response in the event or identified non-conformances, as well as for identification of opportunities for safety enhancement and MS improvement .

Once a year Kozloduy NPP senior management perform a review of the MS, whereby they assess the functioning, adequacy, effectiveness of the MS and its capability to achieve the set goals, and identify measure for improvement.

Each measure is integrated in a MS improvement programme which covers specific tasks, the required resources and responsibilities for their performance.

Licensee audit programme

The internal audits of the management system are carried out in accordance with approved five-year and annual schedules, ensuring the assessment of each process of the management system. The internal audits are included in the annual activity plans of the organisational units. When planning, the following is taken into account:

- management's priorities in the Company management;
- implementation of the five-year plan for conducting audits;
- significance of the audited process/activity;
- specific requirements of relevant normative acts and standards related to the periodicity for conducting audits in certain areas;
- requirements related to conducting audits of management systems of accredited (certified) licensed organisational units acting within the framework of the management system;
- changes that were made to normative acts and standards relevant to Kozloduy NPP EAD;
- changes to the requirements of the management system in place;
- changes to the organisational structure;
- conclusions and results of previous audits and inspections (recurring non-conformances);
- results of inspections by supervisory bodies, conducted missions/peer reviews;
- operating events;
- status of Kozloduy NPP effective management self-assessment activities performance indicators.

Audits of vendors and suppliers

The responsibilities and the order for performing purchasing activities related to request, selection of supplier, signing contracts, carrying out supplies, receiving, testing, and storing the product, are well defined at Kozloduy NPP.

The requirements for purchasing are defined mainly on the grounds of the significance of the purchased product/service to safety, health, environment, physical protection, and business activity, with safety having the highest priority. The requirements are incorporated in the

contract documentation, and their implementation is overseen pursuant to the specified order for managing the work of external organisations under signed contracts.

The oversight exercised over the suppliers is determined depending on the type of the product, its impact on safety and the requirements of the management system, and it may involve:

- performance of audits of the manufacturer's or vendor's management system (quality management system) on behalf of Kozloduy NPP;
- inspection of the materials, designed for complex and important items (it could be performed by the manufacturing organisation or in the supplier's warehouses, together with its specialised quality control bodies);
- dedicated receiving inspection, which could be performed at the manufacturing organisation/supplier's warehouses, together with its dedicated quality control bodies.

Kozloduy NPP - New Build Plc Management System

Status with regard to the development and implementation of an integrated management system

In compliance with the requirements of the SUNEA and the Regulation on Ensuring the Safety of Nuclear Power Plants, Kozloduy NPP - New Build Plc applies and maintains a Management System developed in consistence with the requirements of the IAEA Safety Standard GS-R-3 Management System for Facilities and Activities.

The system is based on a process approach and comprises all the activities which are relevant to the current stage of the nuclear facility life cycle - site selection. As the new nuclear unit project advances the MS will be added to and further developed.

A review of the management system guide was carried out at the beginning of 2018, with the assistance of a certified consultant, in relation to the application of the IAEA standard GSR Part 2 Leadership and Management for Safety.

Main elements of the management system

Kozloduy NPP - New Build Plc management adopted a Policy Statement on the management policy, which describes the main goal an dthe priorities for its achievement. In order to realise the main goal, the management is committed to the introducing, maintaining and continuous improvement of the management system, as relevant for the Company's activity. The management Policy Statement on the management policy is in compliance with Kozloduy NPP Plc policies, as a single owner of the capital of the Company. The Policy Statement is distributed, clarified and brought to the knowledge of all stakeholder, incl. employees.

The management system of Kozloduy NPP - New Build Plc provides for integration of the requirements for safety, health, environment, security, quality and business with ensured utmost priority of safety through identification of eight processes - two management, one core and five supporting processes. The management system is described in a Manual. Apart from the Manual, 52 documents were developed and approved to suport the management of the processes. These documents are distributed hierarchically at three levels depending on their function and area of application. The first level documents describe the management system, mission, vision, strategies, policies, objectives, organisational structure, authorities and responsibilities of the management staff in decision making. The second level documents describe the processes and responsibilities that are implemented to achieve the set goals and objectives, as well as the staff responsibilities during their implementation. The third level documents describe specific details and/or methods and responsibilities for the implementation of specific work activities and tasks.

The requirements towards the activities and results thereof for each of the processes are prioritised with the purpose of focusing the attention and resources towards the activities/results of greater importance to safety, which leads to reduction of the total costs.

The signed contracts are implemented according to the requirements contained in the relevant provisions of the Terms of Reference and the contracts, for ensuring compliance with the existing regulations at Kozloduy NPP -New Build Plc for providing a good quality product, with the highest priority given to safety. A regular control of the activities performed by the contractors as described in the Quality Assurance Programmes,which are an integral part of the signed contract, is carried out. The control over the activity of the suppliers is implemented through defining criteria ensuring the fulfilment of the principles related to safety culture and the requirements of the Management System.

Audit programmes of the Licence Holder

The performance of internal audits is included in the Annual Plan for the Activities of Kozloduy NPP- New Build Plc. The internal audits are used to verify and evaluate the functioning and efficacy of the MS, as well as the compliance with the requirements of the normative documents and international standards relevant to the activity.

Regulatory review and control

NRA carries out preventive control in the process of issuing licences and permits. This includes review of the documents describing the management system of the operating organisation.

Verification of the practical implementation of the management system is carried out during the inspections on the implementation of the issued licence and permit conditions. One of the topical areas for control in the NRA Inspections Programme is the Management System.

During the period 2016-2018 the practical implementation of Kozloduy NPP management system was verified in the following areas: management of activities during receiving inspection; management of controlled documents; management of the Maintenance and Repair process; organisation and conducting of internal audits.

Article 14 Safety assessment and review

Article 14 (1) Safety assessment

Overview of arrangements and regulatory requirements for comprehensive and consistent safety assessments

The Safe Use of Nuclear Energy Act (SUNEA) requires from the Licensees to perform assessment of nuclear safety and radiation protection of the nuclear facilities and the sources of ionising radiation and to undertake actions and measures for their enhancement, taking into account the internal and international operating experience, and scientific achievements in this area. The scope of the assessment shall verify the established measures to prevent accidents and mitigate their consequences, the protective physical barriers and administrative procedures, the disruption of which would result in significant damage to personnel and the population caused by the impact of ionising radiation.

A license to operate a nuclear facility is issued or renewed on the basis of an assessment of nuclear safety, radiation protection and the actual condition of the nuclear facility. The period of validity of the licence issued or renewed is limited to 10 years. Subject to authorisation are the activities on the site selection, design, construction and commissioning of a nuclear facility, as well as changes in structures, systems and components (SSCs), internal rules, operating limits and conditions of the facility. Licences shall be issued for the operation and decommissioning of a nuclear facility.

The requirements for issuance, amendment, renewal termination and revocation of licences and permits are defined in the Regulation on the Order for Issuance of Licences and Permits for the Safe Use of Nuclear Energy. At the individual stages of the licensing process for nuclear installations, the submission of a preliminary, interim and final safety analysis report (SAR) is required as follows:

- preliminary SAR - for approval of a selected site;
- interim SAR - for approval of a technical design of a nuclear facility;
- final SAR - for issuance of an operating licence.

The minimum scope of the SAR for a nuclear facility is set out in Annex 1 to the Regulation.

To issue a permit for carrying out modifications leading to changes in SSCs important to safety, operational limits and conditions and internal rules for the activity of the nuclear facility, the provisions of the regulation require also submission of an impact assessment of all interconnected changes as well as of the amended parts and sections of the SAR.

The renewal of an operating licence of a nuclear facility requires submission of a justification for the new licence term, a periodic SAR and a draft of an integrated programme for implementation of safety enhancement measures in accordance with the provisions of the Regulation on Ensuring the Safety of Nuclear Power Plants.

The Regulation on Ensuring the Safety of Nuclear Power Plants, adopted at the end of 2016, sets out the basic rules for nuclear safety and radiation protection, the organisational measures and the technical requirements for ensuring safety at different stages of the life cycle of a modern nuclear power plant. The Regulation sets out conceptually new safety requirements for modern NPPs based on the safety objectives published by WENRA of the design of new NPPs and the IAEA safety standards updated in the wake of the Fukushima accident and WENRA reference levels for safety harmonisation. Introduced are also the requirements of the Council Directive 2014/87/EURATOM of 8 July 2014 amending the Directive 2009/71/Euratom establishing the community framework for the nuclear safety of nuclear installations.

In the process of review and evaluation during issuing licences and permits the NRA's Regulatory Guides Performing Periodic Safety Review of Nuclear Power Plants, Performing Deterministic Safety Assessments, Developing Probabilistic Safety Analyses and Use of Probabilistic Safety Analyses to Assist the Safety Management of Nuclear Power Plants are also used.

Safety assessments in the framework of the licensing process and safety analysis reports for the different stages in the operating lifetime of nuclear installations (e.g. site selection, design, construction, operation);

According to the requirements of the Regulation on Ensuring the Safety of Nuclear Power Plants, the safety assessment is a systematic process that is carried out during the site selection, design review, construction, commissioning, operation, design modifications and/or operating conditions, conducting PSR and long term operation beyond the design life.

Studies and surveys of factors of natural and man-made origin are carried out in order to evaluate the characteristics of potential sites for the location of the NPP and the selection of the preferred site. These studies and surveys shall identify all external events of natural and anthropogenic origin related to the selected site and the area around it. The regulatory requirements for the scope, activities and documentation of the results from the studies and evaluation of the site for deployment of a new NPP are set out in the part of the report referred to in Article 17 (1).

Information on the studies and assessments of the existing site of Kozloduy NPP carried out, as well as the reassessments made (including reassessments of assumptions used in external hazard identification) in determining the location of a site for a new nuclear built adjacent to the existing NPP, are provided in parts of the report referred to in Articles 17 (1) and 17 (3).

The design safety assessment aims to confirm that the impacts and the loads on the SSCs as a result of external events, internal events and realistic combinations of events are taken into account in the design basis and the defence-in-depth is implemented, in accordance with the provisions of the Regulation on Ensuring the Safety of Nuclear Power Plants. The design limits shall include technical and radiological criteria for assessing the integrity of the barriers and the performance of the determined safety functions. The final list of events and accidents taken into account in the design shall cover the scenarios leading to limit loads on the SSCs with the least margin to meet the acceptability criteria for the results of the deterministic event and accident analysis. The events and accidents taken into account in the design shall be categorised according to their frequency of occurrence and their consequences, demonstrating that the most frequently occurring events lead to minimal consequences.

The SSCs important to safety and their functional characteristics have to be designed with a reasonable margin in relation to the specified boundary loads resulting from design basis events and accidents. Information on the requirements for the reliability, classification, redundancy of SSCs and their independence at the levels of the defence-in-depth is provided in the part of the report referred to in Article 18.

The design basis, the safety assessment and the technical and organisational measures ensuring the implementation of the defence-in-depth concept shall be documented in a preliminary, interim and final safety analysis reports related to the authorisation process under the SUNEA.

According to the Regulation on Ensuring the Safety of Nuclear Power Plants, the results of the deterministic safety analysis are documented in the SAR, which confirms the design basis of the NPP for the specific site and location. Analyses shall be performed for the reactor installation and the SNF pool for each specific unit both for normal operation and emergency conditions.

The operating organisation (utility) shall maintain the safety analysis report updated in accordance with the changed made to the SSCs important to safety, the assessments and analyses

carried out and the current safety requirements. The report shall be updated in due time and when there is new information on the safety assessment, including one regarding the site and NPP siting area characteristics. The computer programmes and analytical methods used in safety analysis shall be verified and validated and the uncertainties of the results shall be quantified.

For the purposes of licensing analyses in the SAR, the initiating events for analysis in operational and emergency modes shall be categorised according to the expected frequency of incurrence and consequences, into the following categories:

- steady-states and transients during normal operation;
- anticipated operational occurrences;
- accidents without nuclear fuel melting;
- accidents with nuclear fuel melting.

Within the scope of the SAR, external event analyses are required and performed in order to confirm the effectiveness and sufficiency of the design solutions and the means of site protection, to provide the concept of NPP protection, performance of safety functions by the SSC, to prevent the occurrence and development of station equipment accidents.

Carrying out a PSA - levels 1 and 2 is required in connection with the implementation of an integrated approach in the process of NPP safety assessment. The probabilistic safety analyses are used to systematically identify all factors that significantly contribute to the safety and radiation risk to the population and the environment. Implementation of PSA Level 3 can be required by a decision of the NRA Chairman.

The Safety Analysis Reports of Units 5 and 6 at Kozloduy NPP have been developed in compliance with the requirements of the national regulatory framework, IAEA safety standards taking into consideration the applicable good practices in leading countries. To fulfil the requirement to keep the SAR updated, Kozloduy NPP have introduced internal rules for this activity and have established a structural unit responsible for the periodic and annual update of SAR as well as coordination of the changes and amendments after agreement with the NRA.

In the period after the 7th National CNS Report, the SAR of Units 5 and 6 were updated in connection with the implemented changes in the SSC, the operating limits and conditions resulting from the implementation of the activities and projects related to the units, as follows:

- completed measures under the National Action Plan resulting from the stress tests conducted on the nuclear facilities at Kozloduy NPP;
- project for power uprate of the units**;**
- commissioning of a new type of nuclear fuel;
- project management plan for the plant life extension project of the units**;**
- implementation of safety enhancement measures as a result of the implemented PSR of the units.

Periodic safety assessments using deterministic and probabilistic methods of analysis, if applicable, and performed with the relevant standards and practices

The requirements to the performance of periodic safety review are specified in the Regulation on Ensuring the Safety of Nuclear Power Plants. The operating organisation shall periodically review all safety aspects of the units and the NPP as a whole in order to determine its compliance with the licensing basis, with the current safety requirements and safety standards and with the internationally recognised good practices. The purpose of the PSR is to identify non-conformances and deviations, to assess their importance for safety and to identify remedial measures. A PSR of a nuclear unit is conducted at least once every 10 years and the period until the next PSR is reported. The requirements for the scope of the PSR are set out in the Regulation

and they shall include at least the following safety factors:

1. Characteristics of the site;
2. NPP design;
3. Current state of SSCs important to safety;
4. Qualification of SSCs;
5. Ageing management;
6. Deterministic Safety Analysis;
7. Probabilistic Safety Analysis;
8. Analysis of internal and external events and hazards;
9. Safe operation indicators and operating experience assessment;
10. Effectiveness of the feedback from foreign experience and scientific research;
11. Organisation, management system and safety culture;
12. Operating procedures and emergency procedures;
13. Human factor;
14. Emergency planning;
15. Interaction of nuclear facilities at one site;
16. Radiation impact on personnel, population and the environment.

According to the Regulation, the review of factor 15 surveys the following aspects:

- the interactions between nuclear facilities at one site in the event of an accident with one or more of the facilities that may affect the implementation of recovery activities;
- provision of technical facilities at the site of the nuclear facilities, as well as personnel to carry out recovery operations and bring the affected facilities to a controlled safe state;
- the practical feasibility of the actions foreseen in the emergency procedures and severe accident management guides affecting one or more nuclear fuel facilities;
- the availability of on-site stockpiles of solutions and fuels to ensure the autonomy of nuclear facilities with respect to external supplies for a minimum period of 72 hours.

The regulation requires the PSR to be implemented according to an up-to-date, systematic and documented methodology, which defines the scope, approach and activities for conducting the PSR. The overall safety assessment of the PSR carried out shall be made on the basis of the results of the review of all factors, taking into account the dependencies between them. The conclusions of the assessments shall determine the compliance with the applicable safety standards and requirements.

The PSR shall assess the consequences of the cumulative ageing effects, modifications and requalification of SSCs, operating experience, current safety standards and R&D achievements, changed characteristics of the NPP site, and organisational and managerial problems. On the basis of the results and conclusions of the PSR, practically feasible measures and improvements to the SSCs should be defined and implemented to enhance the current level of safety arising from the current safety requirements and standards.

During the period 2014-2016, Kozloduy NPP Plc completed the PSR of Unit 5 in accordance with the recommendations of the IAEA Safety Manual SSG-25 Periodic Safety Review of Nuclear Power Plants. The results from the implementation of the following activities were taken into account in the implementation of the PSR:

- the previous PSR of the units performed in 2008;
- completed measures under the National Action Plan resulting from the stress tests conducted on the nuclear facilities at Kozloduy NPP;
- OSART, SALTO and WANO missions carried out;
- Comprehensive Assessment and Residual Lifetime Evaluation of the Equipment and Facilities of Kozloduy NPP Units 5 and 6;
- on-site studies in connection with the construction of a new unit.

An Integrated Programme with Measures for Improving the Safety of Unit 5 has been prepared, which has been agreed with the NRA and its implementation is included as a condition for the unit's operating licence renewal in 2017. The integrated programme combines activities and measures to improve safety contained in the following programmes:

- a comprehensive programme of safety enhancement measures identified as a result of the PSR;
- the programme for implementation of measures for lifetime extension;
- practically feasible safety enhancement measures arising from the introduction of the new Nuclear Safety Improvement Regulation;
- programme for implementation of measures included in the Updated National Action Plan resulting from the stress tests conducted;
- a schedule for implementation of additional analyses and evaluations of safety.

In the period 2017-2018, a PSR of unit 6 was implemented in accordance with the provisions of the new Regulation on Ensuring the Safety of Nuclear Power Plants and the NRA Regulatory Guide Performing a Periodic Safety Review of Nuclear Power Plants, No. PP - 18/2016. The results of the PSR, together with the elaborated Comprehensive Programme for Safety Enhancement of Unit 6, are under review by the NRA as part of the process for renewal of the unit's operating licence.

The conclusions of the PSRs completed for Units 5 and 6 confirm the relevance of the methods and approaches for conducting deterministic analyses, the validation status and the applicability of specialised computer programmes, and the consideration of generally accepted good practices. There are deterministic analyses that take into account the current state of the units in operation at uprated power with fuel assemblies type TBCA and TBCA-12. Kozloduy NPP has a set of SBEOP and SAMG, covering the states of operation at full power, low power with shut-down and pressurised reactor, and also depressurised reactor. The SAMG also cover states and conditions involving accidents in the SNF pool and accidents in the refuelling pool with shut-down unit. As a significant safety measure planned resulting from the PSR carried out at Units 5 and 6, we can mention the need to update PSA - levels 1 and 2 of the units to take into account all changes and all external events specific to the site of Kozloduy NPP.

Overview of safety assessments performed and the main results for existing nuclear installations including summary of significant results (for each of the nuclear facilities, not just their type and generation)

Implementation of the measures from the Updated National Action Plan in the wake of the Fukushima NPP accident

In December 2018, a new version of the Updated National Action Plan (UNAP) was published following the accident at Fukushima NPP, prepared as a result of the Kozloduy NPP stress tests. The UNAP reflects the status of implementation of the measures so far - 73 measures were implemented out of a total of 78 measures. For the remaining 5 measures under

implementation, an update of the implementation deadline is proposed, with detailed justification for each implementation phase. These measures concern:

- construction of KNPP off-site Emergency Response Centre (ERC);
- install measuring channels to monitor and evaluate the concentration of water vapour and oxygen within the containment space;
- install an additional pipeline to the spent fuel storage pool cooling system as an external source back-up;
- study the possibility for direct water supply to the reactor core from an external source;
- implement a direct water supply circuit to SG from external sources.

The main reasons for updating the deadlines (until 2020-2021) are related to:

- duration of the procedures for obtaining permits for design, construction and implementation of external connections in the process of implementation of investment projects outside the Kozloduy NPP site;
- performing specific analyses and studies for the VVER-1000 reactor NPP design, sharing scientific knowledge and discussing different options with countries operating WWER-1000 reactors;
- specific features of the rules for conducting procurement procedures, etc.

The remaining measures for Unit 5 are included in the Integrated Programme for Implementation of Safety Improvement Measures and Kozloduy NPP periodically reports to the NRA on the status of implementation of this programme. The same approach will be applied for Unit 6 when the operating licence is renewed in 2019.

Power uprate of Units 5 and 6

In 2012, Kozloduy NPP initiated a project for thermal power uprate of Units 5 and 6 up to 104% of the nominal power, which includes major and approved modifications of the main equipment to handle the load, and of the systems for monitoring, control and protection of processes during electricity generation. Reporting and design documentation was submitted to the NRA to prove the safety of the units during operation at uprated thermal power levels. As a result of the review, regulatory requirements were put in place to conduct additional engineering analyses and assessments, to draw up a programme with the procedure for implementation of changes in systems, components, operational documents and to draw up a programme for graded testing in the process of the thermal power uprate to a level of 104% of the nominal value.

The project implementation activities are implemented according to the adopted concept in the following separate stages:

- Stage 1 - Development of project documentation and justifications for safe operation;
- Stage 2 - Preparation of licensing procedure for implementation of the resulting changes and modernisations;
- Stage 3 - Implementation of the modernisation of the SSC;
- Stage 4 - Conducting complex tests to confirm the success of the changes and upgrades of the SSC;
- Stage 5 - Processing of the results from the complex tests;
- Step 6 - Modifications of equipment in the conventional part - modernisation of the turbine generator;
- Stage 7 - Operation at uprated power.

In 2018, Kozloduy NPP completed the project for the thermal power uprate of Unit 6 to 104%. The successful implementation of the changes and upgrades of the unit was confirmed by the results of phased complex tests at nominal power and in the process of increasing the power up to 104%, in accordance with the terms of the NRA permit issued in 2016.

A project for increasing the thermal power of Unit 5 is underway. The renewed licence for operation of the unit includes the conditions that the plant must fulfil for the gradual transition to operation at uprated power up to 104% of the nominal one. The required changes in the design of Unit 5 for the gradual carrying out of the complex tests at nominal and uprated power have been implemented in accordance with the complex test programme approved by the regulator. The implementation of the project for the thermal power uprate of Unit 5 to 104% will be completed after approval by the NRA of the assessment of the fulfilment of the criteria for the success of the conducted tests and approval by the regulator for transition of the unit to continuous operation at uprated power level.

Introduction of a new type of nuclear fuel in Units 5 and 6

In 2015 and 2016, the NRA received applications for the issuance of permits for the gradual transition to operation with modified nuclear fuel of the type TBCA-12 for Unit 6 and Unit 5 of Kozloduy NPP, respectively. The use of a new type of fuel aims to improve the efficiency and safety of the fuel cycle when operating at uprated power, as well as to reduce the number of SNF assemblies.

Pursuant to the provisions of the Regulation on Ensuring the Safety of Nuclear Power Plants, the use of a new type of nuclear fuel is considered to be a modification which substantially modifies the configuration of the NPP and must be preceded by a detailed and thorough assessment of the impact of the changes on the safety of the unit. The NRA reviewed and evaluated the technical documentation of the new type of fuel and the safety justifications fulfilled for operating conditions at uprated power to 104%. As a result, additional requirements were imposed and after their implementation, the NRA issued authorisations for the use of the new type of nuclear fuel in 2016 for Unit 6 and in 2017 for Unit 5.

Units 5 and 6 lifetime extension

In order to continue operation beyond the design life, the Regulation on Ensuring the Safety of Nuclear Power Plants requires the operating organisation to develop and implement a long-term operation programme that shall include:

- preliminary conditions, including licensing basis, implemented measures for enhancement and verification of the level of safety, and existing operating programmes;
- identification of SSCs to be covered by the programme;
- categorisation of SSCs in respect of ageing and degradation processes and selection of a strategy for extension of their design life if necessary;
- conducting new safety analyses based on time-limited assumptions and initial conditions;
- plan for preparation of the Long Term Operation.

In connection with the expiry of the 30-year design life of Unit 5, in 2017, and Unit 6, in 2021, Kozloduy NPP has developed a strategy for the extension of the unit's life and fulfilled the planned activities in the following two stages:

- Stage I: Comprehensive assessment and residual lifetime evaluation of the equipment and facilities of Kozloduy NPP units 5 and 6 (2012-2014)
- Stage II: Implementation of the Programme for preparation of Unit 5 for LTO 2014-2017) Preparation for Lifetime Extension (2014-2017) and Programme for preparation of Unit 6 for LTO (2016-2019).

Stage I of the strategy to extend the life of the units has been completed, with a comprehensive examination of the current condition of the equipment. Reports were prepared on the results of specific studies and assessment of the operating lifetime according to the developed for this purpose procedures. The survey resulted in recommendations and formulated concrete measures for the implementation of Stage II.

As a result of the implementation of the Stage I activities of the Strategy, Programmes have been developed and implemented for the preparation of Units 5 and 6 for the extension of the operational life according to certain schedules, where the measures for the implementation at the Stage II of the Strategy were planned.

Within the scope of the measures of the Programmes for the preparation of the units for LTO, analyses, calculations and quantitative estimates were made for the residual life of the equipment and the civil structures of the units.

In Phase II of the PLEX projects of Units 5 and 6, a revalidation of the design analyses and strength calculations of the equipment of the units was carried out taking into account the current state of the equipment, the estimates for the ageing and degradation of the SSCs, using modern verified software products.

The measures and activities resulting from the implementation of Stages I and II are included in the Project Management Plan for the Kozloduy NPP EAD Units 5 and 6 Lifetime Extension Project (PLEX).

The measures and activities for Unit 5 from the PLEX Project Management Plan are included in the Integrated Programme to Implement Safety Enhancement at Unit 5 under the transitional conditions of the renewed licence of the Unit.

The conclusions and assessments of the technical condition and residual life of the SSCs for the extended life of Units 5 and 6 were taken into account when conducting the PSR of the Units.

Regulatory review and control activities

The examinations and evaluations of the submitted documents are related to the application of the permit and the licensing regime for Kozloduy NPP Units 5 and 6 and are related to the following activities carried out by the licensee:

- carrying out modifications of SSCs important to safety;
- changes in the operational limits and conditions on the basis for which the operating licence has been issued;
- changes in the internal rules in order to perform works, procedures and programmes applied to plant operating licences;
- reporting the implementation of the issued permits and licences;
- annual update of the SAR, which includes changes and amendments from the previous year;
- justifications and measures to ensure the safety of the extended service life of Units 5 and 6;
- Completing PSR of Units 5 and 6 and renewal of the operating licences.

Regulatory Activities Regarding the Periodic Safety Review (PSR)

In connection with the renewal of the operating licences of Unit 5 and 6, in 2013, the NRA developed and adopted Position on the conduct of a periodic safety review for long term operation of Units 5 and 6 at Kozloduy NPP in the light of Fukushima NPP accident. The position underlines the necessity to reconsider the site-specific external hazards, the concept for continuous enhancement of safety including the implementation of measures for severe accidents

management. The NRA's position specifies the regulatory framework and provides guidance to the Kozloduy NPP on the form and the content of the methodological and reporting documents from the periodic safety review.

The NRA reviews the submitted documentation from the separate PSR stages and provides its opinion on their compliance with the normative requirements, IAEA safety standards, the NRA guidance and the updated WENRA reference levels. The regulatory review of the documents submitted for unit 6 will use the results from the independent expert assessment of selected aspects of the PSR assigned by the NRA in 2018. The expertise is to verify the completeness and correctness of this review the following safety factors:

- Site characteristics considered in the design and, where appropriate, their reassessment using updated methods and data;
- Current state of SSCs important to safety;
- Qualification of SSCs;
- Ageing management;
- Deterministic Safety Analysis;
- Analysis of internal and external events and hazards;
- Effectiveness of the feedback from foreign experience and scientific research;
- Operating procedures and emergency procedures;
- Human factor;
- Emergency Planning;
- Interaction of nuclear facilities at one site;
- Radiation impact on personnel, population and the environment.

Regulatory activities related to Units 5 and 6 lifetime extension

The regulatory activity related to the long term operation of Units 5 and 6 at Kozloduy NPP follows the implementation stages of the PLEX project with the measures planned.

The reports submitted under the first stage - the completed comprehensive assessment of the actual state of the SSCs and the residual life were thoroughly reviewed and evaluated by NRA experts. In addition, an independent external expert evaluation was performed by a technical support organisation on selected aspects of the specific surveys carried out. As a result of the performed assessment, recommendations for additional studies in compliance with the methodology for the conduct of integrated assessment were given.

With regard to the programmes for the preparation of the units for LTO submitted at the second stage, independent expertise in specific areas has been fulfilled, given the thematic complexity of the measures of these programmes and the need to confirm the updated safety assessments and the planned preparation activities for the long-term operation.

The status of implementation of the measures and activities of the PLEX Project Management Plan for Units 5 and 6 of Kozloduy NPP Plc is monitored by the NRA within the scope of the Integrated Programme for Implementation of Safety Enhancement Measures. Replacement of obsolete equipment and equipment with expired life is carried out in accordance with the authorisation regime.

Regulatory activities related to the implementation of the measures of the Updated National Action Plan of the Republic of Bulgaria

The UNAP measures to increase the resistance of Units 5 and 6 against external hazards are implemented with separate NRA permits issued after a regulatory review. After completion

of all measures of the action plan, Kozloduy NPP has to prepare and submit to the NRA a final report on the implementation of the whole plan.

Regulatory activities related to the power uprate of Units 5 and 6

By the end of 2016, the modifications and upgrades of Unit 6 related to the transition to operation at uprated thermal power were completed. The changes in the SSCs of Unit 6 in relation to the implementation of the project for power uprate of the unit were implemented with NRA permits issued on the basis of a review and assessment of the compliance with the design requirements of the SSCs and the safety justifications. According to the conditions of the permit, in 2018 the results of the phased complex tests at nominal power and in the process of increasing the power up to 104% were presented. The NRA review concluded with a positive result.

The changes in the SSCs of Unit 5 in connection with the implementation of the power uprate project are under way and are monitored by the NRA in accordance with the transitional conditions of the renewed operating licence.

Regulatory activities related to the introduction of a new type of nuclear fuel

In the course of the procedure for issuing a permit for the commissioning of a new type of nuclear fuel at Unit 6, the NRA assigned an independent examination of the amended sections of the SAR of the unit and performed verification analyses for selected design emergency modes taking into account the new type of fuel. The results of the regulatory review of the expertise documents and the verification calculations confirmed the safety rationale and were used in the decision-making process for the authorisation of the commissioning of the new fuel. In 2016, the NRA issued a permit for a gradual transition to the operation with fuel TBCA-12 at Unit 6, following the fulfilment of the instructions for elimination of the gaps found during the document review. In the same year, the NRA modified the unit's operating licence to take account of the new type of fuel. Currently this transition to TVSA-12 is ongoing on unit 6 and by 2019-2020 homogeneous core loading with the new fuel type is expected to be accomplished.

Similar activities were performed so as to obtain an authorisation from the NRA to load the same TVSA fuel on Unit 5 in May 2017. The licence for operation of Unit 5 was renewed in November 2017 and it considers the possibility to operate with the old and the new type of fuel. Pursuant to the transitional conditions of the renewed operating licence, the completed permits for making changes to the unit and the deadlines for their implementation shall continue to be valid within the renewed licence. At present, Unit 5 operates with the old TVSA fuel type.

Article 14 (2) Verification of safety

Overview of arrangements and regulatory requirements for safety review

In accordance with the requirements of the Regulation on Ensuring the Safety of Nuclear Power Plants, the operating organisation shall develop and implement programmes for maintenance, testing, supervision and inspection of SSCs important to safety, which ensure the fulfilment of the design requirements for the operability, reliability and functionality of the SSCs throughout the whole life of the NPP.

Maintenance programmes shall cover activities to control degradation processes, failure prevention, restoration of the operability and reliability of SSCs, and to take into account the results of the ageing management programme.

The operating organisation shall develop, implement, evaluate and improve an ageing management programme. The programme shall cover the SSCs important to safety, as well as the activities required to maintain their operability and reliability. The measures and activities for the maintenance of SSCs should be determined on the basis of the established ageing mechanisms and the consequences of ageing for specific SSCs.

The Ageing Management Programme shall take into account all the factors of influence (radiation embrittlement, thermal ageing, fatigue, corrosion, etc.) on the specific SSCs and

compare the level of degradation of the SSCs with that envisaged in the NPP design. The ageing management programme shall be evaluated and updated as a minimum at the time of conducting a periodic safety review.

The results of the implementation of the periodic inspection, surveillance and testing programmes shall certify the fulfilment of the requirements for the SSCs important to safety or identify the need for corrective measures or recovery activities. The scope and frequency of the maintenance, tests, surveillance, and inspections of SSCs shall be determined using a systematic approach based on:

- their importance to safety;
- their intrinsic reliability;
- their tendency for degradation;
- operating experience, the results of the SSCs monitoring and other applicable experience.

Maintenance, testing, surveillance and inspection activities shall be performed under a validated and approved working procedure, and the results of these activities shall be logged, stored and analysed in order to detect deterioration trends in a timely manner for the SSCs characteristics and to timely apply any corrective actions.

Maintenance programmes shall be periodically reviewed in the light of operating experience and proposals for changes in the programmes. Proposed changes to the maintenance programmes are evaluated for compliance with applicable requirements, impact on SSC characteristics and NPP safety.

After each operating event that has compromised safety functions or the functional integrity of a component or system, relevant remedial actions and verification of the safety functions shall be performed.

In 2018, the NRA guideline on the Management of Ageing of Nuclear Structures, Systems and Components of Nuclear Power Plants No. PP-20/2018 was put into effect, reflecting the recommendations of the IAEA Safety Manual NS-G-2.12 Ageing Management for Nuclear Power Plants, shared experience of the IAEA Safety Report SRS 82 Ageing Management for Nuclear Power Plants: International Generic Ageing Lessons Learned (IGALL) and updated WENRA reference levels for existing nuclear power plants.

Main elements of the programmes for continuous safety review (in-service inspection, surveillance, functional tests of the systems, etc.)

As a result of the periodic safety review of Unit 5 in 2018, a new revision of the Equipment Surveillance Programme was put in force at Kozloduy NPP and external operating experience was also taken into account. The Programme stipulates the activities for ensuring the reliability of the SSCs and for checking the compliance of the units with the design operating limits and conditions, as well as timely detection of deteriorated characteristics of the SSCs, which could lead to disruption of the equipment’s performance during the implementation of the safety functions or to a failure. The programme covers the organisational and procedural aspects of the following methods of supervision:

- control and diagnostics of the technical state of the SSCs;
- periodic functional tests;
- metrological verification of the operability of the measuring instruments; calibration of sensors and instruments;
- tests to re-certify the systems important to safety;

- inspections and checkups on the condition of the equipment subject to technical supervision;
- tests after maintenance or repair;
- post-modifications surveillance programmes for implementation of modifications important to safety;
- maintenance and repair activities;
- ageing management.

The activities related to the diagnostics of the condition of the SSCs are performed on the basis of approved monitoring methods, according to the developed and implemented procedures.

In order to confirm the correspondence between the actual and design characteristics and the equipment readiness for start-up, tests shall be carried out periodically on a schedule, before the start of the unit and if necessary.

The periodic functional tests shall comply with the principle of simulating conditions as close as possible to the actual conditions under which automatic safety systems are expected to be activated automatically.

In order to regulate the organisation and the procedure for performing metrological control of the measuring instruments and measuring systems, a Quality Procedure was developed and implemented in Kozloduy NPP entitled Metrological Control of Measuring Instruments at Kozloduy NPP Plc. The scope and methods of calibration and metrological checks of measuring instruments and measuring channels are described in the respective methodologies. The scope and sequence of verification of the technical condition of the measuring instruments and measuring systems related to the systems important to safety are established by procedures. The procedures determine the content, order and methodology for performing the necessary verification activities, the analysis of the condition of the equipment and the requirements for formulation of the results.

Inspections and checks of the condition of the equipment shall be carried out by means of visual inspections, non-destructive testing of the metal, corrosion control, pneumatic and hydraulic tests and, if necessary, examination of material samples. Guiding documents are technical certification procedures that serve to describe the scope and criteria for certification of equipment or part of a process system in order to demonstrate compliance with the requirements of the applicable regulations and standards.

After an outage, complex functional tests of the individual equipment and systems are carried out in advance, and the results are documented to confirm the fulfilment of the maintenance objectives and the requirements for the component (system) before putting them back into operation.

After implementation of design changes, functional tests of the newly installed equipment or of the modified system are carried out, if necessary. Specific functional test programmes are being developed in this regard. The programmes have two objectives - to check the compliance of the implementation with the requirements of the project and to determine on the basis of the accumulated experience the optimal scope and period of supervision. After one year fuel cycle of operation, an analysis of the performance results of the new equipment is carried out in order to determine the most favourable operating conditions.

Maintenance and repair include a complex of operations to restore the equipment operability and /or the lifetime of the equipment or parts of it and shall be carried out:

- under an established schedule - long-term schedule for maintenance of SSCs, as well as specific (detailed) schedules;
- in case of deterioration of the technical condition;

- in case of negative trends and recommendations based on periodic analyses and as per information on applicable operating experience (internal and external);
- in case of failures and violations.

Elements of the Ageing Management Programme

Ageing Management (AM) of the nuclear power plant means ensuring the fulfilment of the necessary safety functions by the designated SSCs during the lifetime of the nuclear power plant (including long-term operation beyond the design life), taking into account the changes occurring after a certain time and a certain number of duty cycles.

Effective AM throughout the lifetime of the SSCs requires a systematic approach to ageing management based on a thorough understanding of ageing (the mechanisms of degradation and the resulting ageing effects).

Kozloduy NPP implements an Ageing Management Programme aimed at systematising the range of activities for prevention, detection, control, monitoring and mitigation of the effects of ageing on SSCs. These activities ensure the safety, reliability and availability of systems and equipment within the scope of ageing management by:

- clearly defined functional relationships (interconnectivity) of the ageing management programme with other existing plant programmes relevant to ageing management;
- distribution of the functions and responsibilities of the plant officials, defining the terms and conditions for coordination and interaction between the respective structural units, ensuring the implementation of the specified activities;
- a description of how documenting of the activities (archiving, recording) under the ageing management programme is performed in order to ensure traceability.

The programme covers the activities of all structural units of Kozloduy NPP Plc related to the ageing management of equipment important to safety of Units 5 and 6, included in the following programmes:

- Technical servicing and maintenance programme;
- Surveillance programme;
- Operation programme;
- Water chemistry control programme;
- Equipment qualification programme;
- Component-specific ageing management programmes.

The main ageing management activities include:

- Determining the scope of SSCs for ageing management by applying the Methodology for Defining the Scope and Selection of Structures, Systems and Components for the Purpose of Ageing Management, based on the following criteria:
  - Criterion 1 – SSCs important to safety that will retain their functional characteristics under postulated initiating events, in order to preserve the coolant circuit integrity, the capacity to shut down the reactor and maintain it in a safe shutdown state, and the capability to prevent or mitigate any accident consequences;
  - Criterion 2 - SSCs that are non-safety related, the failure of which may interfere with the performance of the intended safety functions by safety systems, by functional or physical impact, or those whose failure results in postulated PSAs;
  - Criterion 3 – SSCs not related to safety which have to ensure that functions continue to be performed in the course of operation with ensured protection against cold

embrittlement, emergency protection actuation failure, and in case of a total blackout;

- Criterion 4 – SSCs not related to safety which have to ensure that functions continue to be performed in the course of operation in conformity with the requirements of fire safety and environmental protection qualification;
- Criterion 5 - SSCs common for the units or part of BOP, required for the sustainable electricity generation, as well as those selected on the basis of the accumulated operating experience.

- Accumulation of knowledge related to ageing. Identification of potential degradation mechanisms and ageing effects;
- Preventive actions to control and minimise degradation due to ageing;
- Determination of effects of ageing;
- Monitoring and trending of ageing effects;
- Mitigating ageing effects;
- Acceptance criteria;
- Corrective actions;
- Operating experience feedback and feedback from research and development activity;
- Quality Management.

All ageing management activities are performed according to approved procedures and programmes.

Arrangements for internal review by the licensee of safety related issues to be submitted to the regulatory body

Consideration of issues and solving of issues related to the safety of Kozloduy NPP shall be subject to review and discussion by a wide range of specialists. This is arranged through Expert Committees with established status and rights. Depending on the scope of the issues under review, the following types of expert committees are established:

- Safety and Quality Committee - on Kozloduy NPP plant general issues related to safety and quality during operation, maintenance and reconstruction, fuel cycle and radioactive waste management, maintaining emergency preparedness;
- Safety Committee on issues related to the programmes for plant shutdown and start-up, functional tests, design modifications, documents related to safety important systems, event analyses, corrective and preventive actions, quality assurance system;
- Safety Culture Committee - on safety culture related issues (refer to Article 10).
- ALARA Application Committee (refer to Article 10);
- Operating Experience Feedback Committee (refer to Article 19);
- Expert Technical Committee - on issues related to technical or process proposals and developments for design modifications of the equipment and systems in a special field.

Regulatory review and control activities

The conditions of the Units 5 and 6 operating licences establish that Kozloduy NPP shall submit for review to the NRA within not less than 15 days prior to plant shut down for outage and refuelling the following documents:

- programme for in-service inspection of the base metal, built-up surfaces and welded joints of the equipment and pipelines;
- maintenance schedules and programmes;
- report on new reactor core performance and analysis of the compliance with the accepted criteria.

The procedure for start-up following the plant outage, is also determined by the provisions of the operating licence conditions. According to the operating licence, within 7 days prior to the start-up of the unit, Kozloduy NPP shall notify the NRA. In this relation an order is issued by the NRA Chairman to set up a Committee to check the unit preparedness for start-up and operation, in accordance with an approved programme including at least the following areas:

- state of the core and the unit at the time of the inspection;
- implementation of measures to increase the unit safety, functional tests and changes in the operating documentation;
- implementation of the planned and additional maintenance works, as well as testing justifying the systems operability;
- in-service inspection of the equipment and pipelines carried out during the planned annual outage;
- monitoring of the facilities of high risk important to nuclear safety (pressure vessels and pipelines and lifting equipment);
- metrological certification;
- radiation protection during outage, generated RAW and preparedness of the radiation monitoring systems;
- primary and secondary water chemistry and corrosion examination;
- analysis of operational events, implementation of the approved corrective measures;
- fulfilment of the licensing conditions and staffing with qualified and licenced personnel;
- conditions of systems, workplace operating documentation and housekeeping.

In compliance with the licence conditions, the Licensee may start-up the unit following refuelling only after the NRA inspectors give a positive assessment on the implementation of the conditions for safe start-up and power operation of the unit, approved by an order of the NRA Chairman.

Within one month after notification to the NRA Chairman of the unit start-up after refuelling, the licensee shall submit for review and assessment a summary report on:

- results from the implemented programme for in-service inspection of the base metal, built-up surfaces and welded joints of equipment and pipelines;
- results from loaded fuel integrity test;
- results from the comparison of fuel performance and the unit operational data;
- fuel lifetime;
- the residual life of the reactor pressure vessel (including critical temperature increase - Tk) and the equipment of the unit of which the residual life is estimated;
- results from the test programme implementation;
- results from the reactor vessel neutron flux monitoring programme implementation;
- results from the unit start-up programme implementation.

When the plant is operated at power, the NRA permanent on-site inspectors, supervise the implementation of the periodic tests of the safety systems, planned outage activities and remedying defects and failures of SSCs important to safety.

Article 15 Radiation Protection

Each Contracting Party shall take the appropriate steps to ensure that in all operational states the radiation exposure to the workers and the public caused by a nuclear installation shall be kept as low as reasonably achievable and that no individual shall be exposed to radiation doses which exceed prescribed national dose limits.

Regulatory requirements for radiation protection at nuclear installations

The regulatory requirements for radiation protection at nuclear facilities are set out in the SUNEA, the Regulation on Radiation Protection (RRP), the Regulation for Ensuring the Safety of Nuclear Power Plants.

In the use of nuclear energy and ionising radiation and in the management of radioactive waste and spent fuel, ionising radiation exposure of personnel and the public shall be maintained at the lowest reasonably achievable level.

The radiation protection regulation was adopted in 2018 and has been developed in accordance with Euratom Directive 59/2013. It defines:

- the general principles, requirements and measures for radiation protection;
- basic and derived dose limits for external and internal radiation;
- limits for radiation control and protection planning purposes;
- rules and limits for release of materials from regulatory control.

The effective dose limit for each occupationally exposed person is 20 mSv for a period of one year. In addition to the effective dose limit, the following equivalent dose limits should be observed:

- the equivalent dose limit for the eye lens is 20 mSv for a period of one year, or 100 mSv total dose for any five consecutive years, provided that the maximum dose does not exceed 50 mSv for one single year;
- the equivalent dose limit for the skin is 500 mSv for a period of one year, averaged over every 1 cm2 of the skin surface, irrespective of the area of the exposed surface;
- the limit of equivalent dose for the limbs is 500 mSv for a period of one year.

For the activities related to the operation of nuclear power plants, research nuclear installations, facilities for radioactive waste management and spent nuclear fuel, as well as for the transport of radioactive substances, the specific safety requirements set out in the relevant regulations apply.

According to the Regulation for Ensuring the Safety of Nuclear Power Plants, the basic requirements and criteria for providing radiation protection are as follows:

- in all operating states of the nuclear facilities on the NPP site, the annual individual effective dose resulting from external and imternal exposure of the public caused by the impact of all nuclear facilities on the site, shall be maintained as low as possible and shall not exceed 0,15 mSv.

To ensure radiation protection, the NPP design shall identify all real and potential sources of ionising radiation and shall provide measures for ensuring the necessary technical and administrative control over their use.

Provisions shall be made in the design for an automated system for radiation monitoring at the workplace and at the NPP site, and a system for radiation monitoring in the precautionary

action zone and the surveillance zone. These systems shall ensure the collection and processing of information on the radiation conditions, on the effectiveness of protective barriers, on the radionuclide activity, and information necessary to predict changes in the radiation conditions in all operational states and accident conditions.

The equipment of the automated system for radiation monitoring shall enable the implementation of:

- process radiation montoring;
- radiation dosimetry control;
- radiation control of NPP premises and the site;
- radiation monitoring and prevention of spreading of radioactive contamination.

The laboratory methods and technical means of the system for radiation monitoring shall ensure measurement of the human induced radionuclides content in soil, water, deposits, vegetation, water flora and fauna, and agricultural products

The range and scope of radiation monitoring are coordinated with the competent state authorities - NRA, Ministry of Health (MoH) and Ministry of Environment and Water (MOEW). The control of radiation parameters of the environment and of agricultural production within the boundaries of the precautionary action zone and the surveillance zone, including the assessment of the radiation exposure of the population inhabiting these zones, is carried out by both the licensees and the state bodies for specialised control.

Regulatory requirements for licensee's processes for dose optimisation and implementation of the ALARA principle

In accordance with the ALARA principle, radiation dose limits (dose quotas) for personnel and the general public have been introduced in the Regulation on Radiation Protection (RRP) and security factors for the planning of external and internal radiation protection. The dose quotas of the various nuclear facilities shall be justified in the course of the licensing process.

The values which are set in the RRP shall include:

- secondary (derivative) exposure limits for external and internal exposure of personnel and the general public, including the equivalent dose rate limits and the limits of the annual intake of radionuclides into the body by inhalation and ingestion;
- limits for the purposes of radiation control and protection planning (control limits) in the case of external and internal exposure of persons from the personnel and the population, which include: average annual air volumetric activity limits in the working compartments for radioactive noble gases for the personnel; surface radioactive contamination limits; limits on the average annual flux density of ionising particles (electrons, photons, neutrons) in case of external exposure of personnel (body, eye lens and skin); average annual air volumetric activity limits for radioactive noble gases and aerosols for atmospheric air; average annual volumetric activity of radionuclides for drinking water.

The RRP defines the requirements for radiation protection of occupationally exposed persons:

- preliminary risk assessment and optimisation of protection;
- classification of workplaces and zoning;
- categorisation of occupationally exposed persons;
- radiation monitoring of the work environment, including individual monitoring;

- medical monitoring of personnel.

Organisation of the radiation protection at nuclear installations

Kozloduy NPP implements a programme for radiation protection of the personnel and the population, which includes:

- preliminary risk assessment and optimisation of protection;
- classification of workplaces and zoning;
- categorisation of professionally exposed persons;
- radiation monitoring of the work environment, including individual monitoring;
- rules for conduct in the radiation controlled area;
- rules for access to the radiation controlled area;
- informing the personnel about radiation risks;
- medical monitoring of the personnel.

Based on the limit values specified in the RRP, Kozloduy NPP have introduced:

- dose limits for occupationally exposed persons;
- reference levels for operationally measurable radiation parameters, with a view to timely identifying deviations and taking corrective actions.

Implementation of radiation protection programmes at Kozloduy NPP

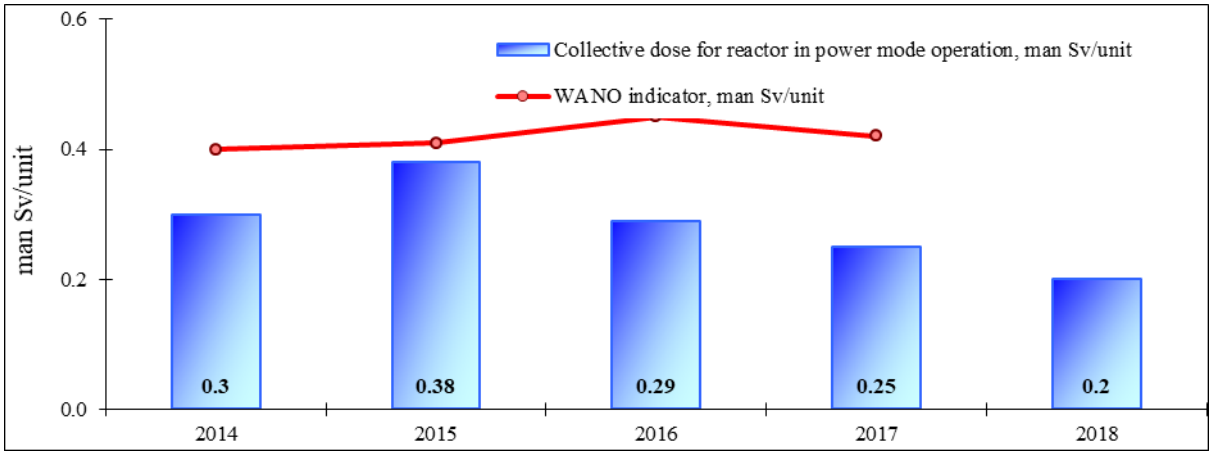
Dose exposure monitoring

Independent control of the occupational exposure is carried out by an Inspection Authority of type C - Personal Dosimetry Monitoring Centre, accredited by the Executive Agency Bulgarian Accreditation Service according to BDS EN ISO/IEC 17020.

The table presents data on the occupational exposure at Kozloduy NPP (Units 5, 6 and SFSF) over the last five years.

№	Indicator	2014	2015	2016	2017	2018
1	Collective effective dose, manSv	0.60	0.75	0.58	0.50	0.41
2	Share of the internal exposure in the occupational exposure, %	0.22	0.14	0.18	0	0
3	Exceedance of the annual limit for occupational exposure (RRP)	0	0	0	0	0
4	Average individual effective dose of monitored persons, mSv	0.24	0.30	0.23	0.19	0.17
5	Maximum effective dose, mSv	9.08	8.21	7.29	6.94	6.45

The collective effective dose in 2018 for the Kozloduy NPP normalised to the number of reactors in operation (WWER-1000) is 0.20 manSv/unit. For the last five years, the collective dose has been commensurate with or below the average of the WANO indicator for PWR type reactors (shown in the figure).



For the last five years at Kozloduy NPP, the maximum individual effective dose has maintained its downward trend starting in 2015, ranging from 6 to 9 mSv per year and has not exceedrd the annual dose limit of 12 mSv established at the plant.

Conditions for release of radioactive substances into the environment, operational control measures and main results

The basic principles, norms and rules to be followed in the release of radioactive substances into the environment resulting from licenced or authorised practices are set out in the SUNEA, the Regulation on Radiation Protection and the Regulation on the Safety of Nuclear Power Plants.

The SUNEA does not provide for the issuance of a separate permit for the release of gaseous and liquid radioactive substances into the environment. Radioactive releases from nuclear facilities shall be evaluated when considering the technical design of the facility and shall be authorised with operating licences as an integral part of the operating limits and conditions for the nuclear facilities.

Liquid and gaseous radioactive releases to the environment

Liquid releases:

The dose limit of the individual effective dose from liquid discharges accepted for the plant site is 50 μ Sv/y. Based on this dose limit, the limit values and reference levels for the activity released into the environment by liquid discharges have been established. These limits are also included in the technical specifications of Kozloduy NPP units, which contain the limits and conditions for safe operation.

When monitoring the liquid discharges into the environment, limits have been established on two parameters - total activity released for a certain period of time and volumetric activity registered at the time of wastewater drainage.

The table indicates the limits and reference levels for the total waste water activity of the production process for all facilities on site (including Units 1-4).

Indicator	Quarterly reference level	Quarterly limit	Annual reference level	Annual limit
Total activity (without tritium), GBq	37	185	148	740
Tritium, TBq	6.5	46.2	25.9	185

The reference levels are set at around 20% of the limit values. In order to prevent high activity releases for a short time, quarterly limit values have also been set for liquid releases in addition to the annual limit values.

The following limits and reference levels have been set for the monitoring of the waste water activity, which are controlled operatively in the drainage process:

- volumetric activity limit (without tritium) of process water - 1850 Bq/l and corresponding reference level 370 Bq/l;
- limit of the volume activity of water from washrooms, toilets and baths located in the radiation controlled area - 11 Bq/l.

Gaseous releases

For the gaseous radioactive discharges, annual limit values are set for individual components so that, when they are reached, the limit of an individual effective dose per capita is not exceeded - 50 μSv/a. The limit values thus obtained are for all facilities at the plant site (including Units 1-4). In addition, a distribution was made between the individual ventilation stacks (VSs) based on operating experience.

The values of the annual limits for the gaseous discharges from the Kozloduy NPP site are given in the table below:

Emission components	**VS-1 Units 1,2**	**VS-2 Units 3,4**	**VS-5 Unit 5**	**VS-6 Unit 6**	**0VS AB-3**	**VS - SFSF**	**NPP - Total**
RNG, TBq	100	100	1400	1400	700		**5600**
^{131}I, GBq	3	3	13.5	13.5	5		**65**
Aerosols, GBq	3	3	12	12	5	3	**50**
^{3}H, TBq	10	10	60	60	60		**250**
^{14}C, GBq	1000	1000	9000	9000	9000		**38000**

As the actual discharges are much lower than the limit values set, the main driving force behind the control of gaseous discharges is the early identification of negative trends in the operation of the units and the optimisation of the radiation protection of the population. For this purpose, the 24-hour reference levels presented in the table below have been additionally introduced:

Emission components	**VS-5 Unit 5**	**VS-6 Unit 6**	**0VS AB-3**	**VS - SFSF**	**NPP - Total**
RNG, TBq	3.8	3.8	2		15
^{131}I, MBq	38	38	14		178
Aerosols, MBq	33	33	14	7	137

The day-to-day reference levels are constantly monitored with automated control systems.

In addition, a detailed assessment of the radionuclide composition and the activity contained in the discharges is periodically made on the basis of samples obtained by means of continuous sample taking. This periodic radiation monitoring is intended to provide data on the most realistic assessment of the dose exposure of the population and to provide information to the public on the releases from the plant to the environment.

Results from the periodic monitoring of liquid and gaseous releases to the environment

Gaseous releases

The table presents the results of the monitoring of the gaseous releases through the ventilation stacks of Units 5 and 6 and the SFSF for the period 2014-2018. The values indicated for radioactive noble gases (RNG) and aerosols represent sums of values obtained for the individual radionuclides in the respective group. The list of controlled radionuclides is in accordance with European Commission Recommendation 2004/2/Euratom.

Component	RNG, TBq		^{131}I, MBq		Aerosols, MBq		^{*14}C, GBq		^{*3}H, GBq	
Year	SFSF	EP-2	SFSF	EP-2	SFSF	EP-2	SFSF	EP-2	SFSF	EP-2
2014	0	0.553	0	1.33	0	14.1	0	655	0	486
2015	0	0.690	0	2.36	0	11.2	0	631	0	513
2016	0	0.888	0	2.29	0	3.48	0	671	0	506
2017	0	1.68	0	29.4	0	6.68	0	570	0	523
2018	0	0.912	0	8.40	0.37	89.90	0	537	0	427

** Values are for a total of ^{14}C and ^{3}H (organic and inorganic forms).*

Liquid releases:

The activity released into the environment by liquid discharges during the operation of Units 5 and 6 is indicated in the table below. The waste water from the spent fuel storage facility (average 15 m^3 per month) is treated in the auxiliary building of Units 3 and 4. There are no direct discharges from the SFSF. The total activity is formed as the sum of the activities of the individual radionuclides. The list of reference radionuclides is in accordance with European Commission Recommendation, 2004/2/Euratom.

Year	Total activity, MBq (without H-3)	H-3, TBq
2014	364	17.7
2015	137	21.2
2016	107	22.9
2017	155	22.2
2018	203	23.0

During the period 2014-2018, the released radioactive substances with gaseous and liquid releases from Kozloduy NPP are below 1% of the determined limits. Tritium activity in the liquid releases is about 14% of the annual limit.

The total dose exposure of the population in the 30 km zone around Kozloduy NPP due to radioactive emissions into the environment is:

Year	Maximum Individual Effective Dose, [Sv/a]		
	Airborne	**Liquid***	**Total**
2014	$1.46.10^{-6}$	$3.34.10^{-6}$	$\mathbf{4.80.10^{-6}}$
2015	$1.25.10^{-6}$	$4.08.10^{-6}$	$\mathbf{5.33.10^{-6}}$
2016	$1.29.10^{-6}$	$4.37.10^{-6}$	$\mathbf{5.66.10^{-6}}$
2017	$0.74.10^{-6}$	$4.14.10^{-6}$	$\mathbf{4.88.10^{-6}}$
2018	$1.17.10^{-6}$	$4.29.10^{-6}$	$\mathbf{5.46.10^{-6}}$

* - for a representative member of the population

For calculating the additional public dose exposure due to radioactive discharges from the plant to the environment, verified and validated modelling codes for evaluation, based on the CREAM methodology adopted by the European Union (EU) and adapted to the geographical and hydrological specifics of the Kozloduy NPP area are applied.

Processes and steps taken to ensure that staff are exposed to radiation as low as reasonably achievable for all maintenance and repair activities

In recent years, Kozloduy NPP maintains levels of radiation exposure of personnel and population comparable to the best world practices and constantly makes efforts to optimize radiation protection.

The main directions in which efforts are being made to improve the level of radiation safety at the plant are:

- administrative management of dose exposure optimisation measures;
- better integration of radiation protection measures into the generation process, along with other safety measures at work;
- focusing efforts on radiation risk assessment and identifying appropriate protection measures;
- conducting training and coaching sessions to raise worker awareness;
- detailed exposure planning during outage;
- reducing radiation exposure in the period between outages;
- improvement of the dosimetric permit-to-work system and the dosimetric monitoring system;
- informational and methodological provision of activities with increased radiation risk;
- preparation of reports on and analyses of the activities performed;
- feedback from operating experience.
- evaluation of the effectiveness of the measures implemented.

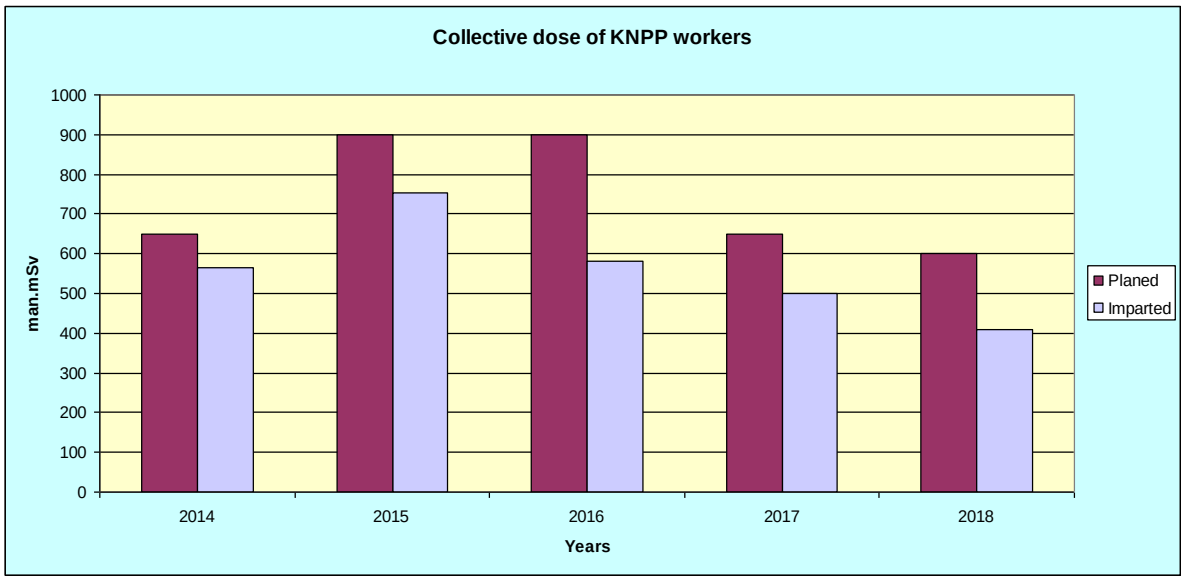
Of primary importance in the optimisation of the radiation protection system at Kozloduy NPP are the administrative regulation and exposure planning. The main approaches that are applied in the planning and administrative regulation of personnel exposure are:

- setting dose limits for the annual individual dose exposure of the personnel;
- determining reference levels for the content of radioactive substances in the air in the premises of the radiation controlled area, for surface contamination and the dose rate in

them so that the expected individual effective dose of personnel is kept as low as possible;

- assessment of radiation risk also for certain maintenance operations;
- individual and collective dose exposure planning for the outage periods;
- maintaining the dose level of the population as low as possible by establishing reference levels for liquid and gaseous radioactive releases to the environment.

The results of the planned and received collective dose exposure of personnel from the plant in recent years are presented in the figure below:



Environmental monitoring and key results

The environmental radiological monitoring at Kozloduy NPP Plc fully complies with the national and European normative requirements in this field and corresponds to the experience and good practice in the countries having developed nuclear energy. The range and scope of the performed monitoring complies with the requirements of Art. 35 of the Euratom Treaty and Recommendation 2000/473 / Euratom. The results of the monitoring are verified by independent studies of the control by the supervisory authorities in the country - NCRRP/MoH and EEA / MOEW. The departmental radio-ecological monitoring since 2012 is accredited by BAS № 154 LI under BSS according to BSS EN ISO / IEC 17025.

Automated and laboratory control of radiation parameters is carried out in the Bulgarian section of 30 km surveillance zone and comparative measurements in benchmark points up to 100 km. There is an automated system for radiation monitoring of the settlements within the 30 km surveillance zone with 13 local measuring stations, information from which is transmitted to the national radiological monitoring network in accordance with the law on environmental protection. At public places in these settlements there are stationary instruments for visualization of the radiation gamma background.

There are 36 monitoring points in total around Kozloduy, where measurement and sampling for the content of man-made radionuclide activity is carried out. The airborne radioactivity, atmospheric deposits, vegetation, soil and radiation gamma background are monitored on a regular basis. Outside these points, samples of water, bottom sediments, milk, fish and agricultural production grown in the area are analysed. Attention is paid to drinking water sources and the Danube river, along which there are several sampling points. Methods such as gamma spectrometry, alpha spectrometry, total alpha and beta activity low-background radiometry, liquid scintillation spectrometry for the determination of tritium, carbon-14 and

strontium, and others, are used. A specialised mobile laboratory is used for radiation surveillance and field measurements. More than 2.200 samples from different environmental specimen are tested annually: air, water, soil, vegetation, milk, fish, crops, etc., with the total number of laboratory tests exceeding 4000. There are over 1200 measurements of radiation gamma background performed at the monitored posts and monitoring routes with portable dosimetry devices and stationary located thermoluminescent dosimeters.

The quality assurance of the of the analyses is carried out by means of analyses of blank, duplicate and labelled samples, control tests of the equipment and regular participation in international laboratory comparisons and competency tests.

The results of the radio-ecological monitoring carried out are reported periodically to the competent authorities in the country - NRA, MOEW and NCRRP / MoH. Monthly newsletters with radiation status data are sent to the mayors of the neighbouring municipalities - Kozloduy, Mizia and Oryahovo. Real-time public access to the data from the automated radiation monitoring system in settlements of 30 km zone is provided.

Regulatory control

NRA

The issued operating licences of all Kozloduy NPP units include specific requirements regarding the provision of radiation protection, radiation monitoring and the periodicity and type of the reporting to the NRA on the results of the this monitoring. Monthly reports on the gaseous and liquid releases at the Kozloduy NPP site, annual reports on the results of the personnel dose exposure control and annual reports on environmental radiation monitoring, including an assessment of the radiation exposure of the population from the releases shall be submitted to NRA.

The NRA exercises regulatory oversight of the radiation protection at Kozloduy NPP based on site inspections and analysis and evaluation of submitted by Kozloduy NPP documentation verifying compliance with issued licences. The periodic monitoring of the radiation protection status performed by the NRA inspectors includes analysis and evaluation of the information submitted to the NRA for compliance with the regulatory and licensing requirements for radiation protection. The results of regulatory control are published in the NRA's annual reports.

A “Procedure for independent regulatory control of the radioactive releases from Kozloduy NPP” has been developed at the NRA. The procedure describes the scope and organisation of the monitoring, the programme and timetable for sampling and analysis, the responsibilities of individual participants, the requirements for reporting the results. The sampling programme defined by the NRA includes at least 5% of the number of the samples taken at Kozloduy NPP, depending on their type. The procedure stipulates the regulatory control of the NRA by assigning the analysis of the samples to an independent laboratory. The NRA also has its own aerosol sampler situated at the Kozloduy NPP site.

In the period 2014-2018, the Institute for Nuclear Research and Nuclear Energy (INRNE) analysed more than 90 samples of radioactive releases from Kozloduy NPP searching for gamma radionuclides, transuranic elements, ^{90}Sr, ^{3}H and ^{14}C. The data from the sample analyses protocols submitted to the NRA show good compliance with the results of the Kozloduy NPP.

MOEW

Ministry of Environment and Water through the Executive Environmental Agency and its regional structures, performs extra departmental monitoring of the environmental radiation status in 30 km area around Kozloduy NPP.

The radiological environmental monitoring is performed in two ways:

- through an automated on-line monitoring system;

- through a laboratory-analytical system for off-line monitoring.

Continuous and periodic monitoring is performed on the following radiological parameters:

- radiation gamma background;
- atmospheric radioactivity;
- content of technogenic radionuclides in the arable land from points in the monitored area;
- radiological indicators in surface waters within the 30 km zone and discharge waters from the plant;
- content of technogenic radionuclides in sediments from the Danube river.

The Executive Environmental Agency (EEA) administers the National Automated System for Continuous Control of the Radiation Gamma Background. The system consists of 27 local monitoring stations located throughout the country, the greater concentration of stations is in the 100 km zone around Kozloduy NPP.

The users of the operational information from the automated system are the Ministry of Interior - General Directorate Fire Safety and Protection of the Population and the Nuclear Regulatory Agency - Emergency Centre. Eight automatic stations from the off-site dosimetric control of Kozloduy NPP located within a radius of 1.8 km from the plant are integrated into the system. The system is integrated into the European Radiological Data Exchange Platform (EURDEP). Under normal conditions, data is sent to EURDEP once a day and, in the case of increased values, every hour.

The EEA also administers an Automated Radiation Monitoring System for Water of the Danube River in the area of Kozloduy NPP. The system consists of two local monitoring stations, installed at the Kozloduy port, before the plant and the port of Oryahovo, after the cooling water discharge canal of the plant. The stations carry out continuous sample taking from the river and perform automatic analysis for the content of a range of emitting radionuclides. The system did not report elevated levels of technogenic radionuclides such as cesium-137 and iodine-131.

The real-time radiometric measurements, sample taking and laboratory-analytical activity in the area of Kozloduy NPP are carried out by the Regional Radiation Measurement Laboratories in Vratsa and Montana at the EEA. Periodic monitoring is performed of: atmospheric aerosols, uncultivated soils, discharge waters from the plant, surface waters and sediments from the Danube river and other water bodies in the area. The data obtained from the measurements show no influence of the operation of the nuclear power plant on the environmental components.

The results of the radiological monitoring carried out are published in the EEA's periodicals - daily and quarterly bulletins and the National Report on the Status and Protection of the Environment.

Ministry of Health - National Centre of Radiobiology and Radiation Protection

The Ministry of Health through the National Center for Radiobiology and Radiation Protection (NCRRP) carries out independent state health and radiation control of the factors of work and living environment that can lead to the exposure of persons (personnel and population) from sources of ionizing radiation; assessment of the exposure and radiation risk of the population as a whole or for specific members of the population. The state health and radiation control at the Kozloduy NPP includes:

- preliminary control by coordinating, where necessary of the general and detailed development plans; drawing up a health report, evaluating and issuing statements on the compliance with the health and radiation protection requirements for the personnel and the population in: designing, construction, reconstruction, expansion, commissioning of sites for public use and activities with sources of ionizing radiation;
- systematic control without prior notification in public buildings is carried out by means of on-going control on compliance with the health requirements established by a normative act for the site, as well as for the activities carried out in it; sampling or measurement of the radiation factors of the working environment, carrying out of laboratory analyzes, processing of data and preparation of protocols/reports and in case of irregularities, issuing mandatory prescriptions; verification of compliance pursuant to issued pescriptions. The current control at the Kozloduy NPP PLC is carried out by the State Health and Radiation Control Department at the NCRRP, through the NPP Control Group at the site according to a preliminary approved plan;
- topical inspections on compliance with the requirements for ensuring radiation protection and the status of documentation, assessment of radiation risk and individual doses of the personnel, as well as prescribing measures to reduce staff exposure.

The National Center for Radiobiology and Radiation Protection, through the Department of Radiation Safety and Medical Screening, conducts specialized examinations and studies to evaluate the health status of people working with SIR, including NPP personnel and their suitability to perform specific professional duties in an ionizing radiation environment .

In order to evaluate the annual effective dose and the exposure over the natural background of the population from the Kozloduy NPP activity, the NCRRP performs radiation monitoring of sites from the terrestrial and aquatic ecosystems in the area (3-90 km zone) of the plant. The content of technogenic radionuclides, in particular strontium-90 and cesium-137 in atmospheric deposition, water, sediment sludge, vegetation, soils and food of local origin is determined by performing radiochemical and gamma-spectrometric analyzes.

The estimated annual individual effective dose of the exposure over the natural background of individuals from the population living in the area around the Kozloduy NPP is below 0,010 mSv according to the estimation made on the basis of the radiation monitoring results obtained and is below the dose limit of 0,15 mSv in accordance with the Regulation on ensuring the safety of nuclear power plants.

Article 16 Emergency preparedness

1. Each Contracting Party shall take the appropriate steps to ensure that there are on-site and off-site emergency plans that are routinely tested for nuclear facilities and cover the activities to be carried out in the event of an emergency. For any new nuclear facility, such plans shall be prepared and tested before it commences operation above a low power level agreed by the regulatory body.

2. Each Contracting Party shall take the appropriate steps to ensure that, insofar as they are likely to be affected by a radiological emergency, its own population and the competent authorities of the States in the vicinity of the nuclear facility are provided with appropriate information for emergency planning and response.

3. Contracting Parties which do not have a nuclear facility on their territory, insofar as they are likely to be affected in the event of a radiological emergency at a nuclear facility in the vicinity, shall take the appropriate steps for the preparation and testing of emergency plans for their territory that cover the activities to be carried out in the event of such an emergency.

Article 16 (1) Emergency plans and programmes

Overview of the arrangements and regulatory requirements for on-site and off-site emergency preparedness

The emergency preparedness and response in case of nuclear or radiological event is a part of the general national arrangements for protection in case of disaster. The main legislative and regulatory requirements for the structure and organisation of the emergency preparedness are specified in the Disaster Protection Act (DPA), the Safe Use of Nuclear Energy Act (SUNEA), the Ministry of Interior Act (MIA), the Regulation on emergency planning and emergency preparedness in case of nuclear and radiological emergencies, and the Regulation on radiation protection. DPA is harmonized with SUNEA regarding the requirements for the development of emergency plans, their contents, the necessary human resources, material and technical support and others. SUNEA determines additional specific requirements for emergency preparedness and response to nuclear or radiological emergency.

According to the DPA, the Council of Ministers establishes and implements the state policy to protect the population in disaster, and for this purpose a Council for Reducing the Risk of Disaster and an Interdepartmental Commission for Recovery and Assistance have been established. The Council for Reducing the Risk of Disaster is a permanently acting consulting body which ensures the coordination and cooperation during implementation the state policy in disaster. Its main functions are related to development of National Strategy for Reducing the Risk of Disasters, National Disaster Protection Programme, and National Plan for Disaster Protection, as well as support in development and implementation of Acts and secondary regulatory legislation related to reducing the risk of disaster. In the period 2017-2018 the Council had developed a National Strategy for Reducing the Risk of Disaster 2018-2030 and Guidance for development and preparedness for implementation of plans for protection in case of disaster, which assist the central executive authorities, regional and municipal structures and the respective parts of the Integral Rescue System in developing Plans for Disaster Protection, which consist parts related to nuclear or radiological emergency.

Disaster protection is planned at municipal, regional and national level. The Council for Reducing the Risk of Disaster develops a National Plan for Disaster Protection (NPDP), regional councils for reducing the risk of disaster organise development of Regional Plans for Disaster Protection, and the municipal councils for reducing the risk of disaster develop Municipal Plans for Disaster Protection.

The National Plan for Disaster Protection contains an analysis of the hazards that may occur on the national territory. Specific measures have been developed for each hazard to protect

the population, eliminate the consequences and restore the affected area. To respond to nuclear or radiological emergency, an External Emergency Plan, which represents a part of the NPDP, have been developed at Kozloduy NPP. Plans for disaster protection at regional level have been also developed for each hazard, specific for a given area, and parts of the plans for earthquake, flood, nuclear or radiation accident are obligatory. The executive authorities develop plans for the implementation of their obligations provided in NPDP.

According to SUNEA state bodies and persons engaged in the operation of nuclear facilities are obliged to take measures to prevent incidents and accidents and limit their consequences. Emergency planning measures are established with the emergency plans as follows:

- for protection of the population (off-site emergency plan), which regulates the emergency planning zones and determines actions by the competent authorities to protect people, property and the environment in case of emergency;
- for protection of the personnel of the nuclear facility (on-site emergency plan), which defines the actions of the licensee for accident mitigation and elimination of consequences in accordance with the off-site emergency plan.

In case of an accident, the licensee must:

- immediately inform the population and the mayors of the municipalities within the emergency planning area and competent authorities;
- take action to limit and mitigate the consequences of the accident;
- control and regulate the exposure of persons involved in the reduction and elimination of the accident;
- ensure continuous monitoring of radioactive releases into the environment.

Regulation on emergency planning and emergency preparedness in case of nuclear and radiological emergencies (Emergency regulation) defines:

- terms and conditions for development of emergency plans;
- persons who implement emergency plans and their obligations;
- actions and measures for confinement (localization) and mitigation of consequences of a nuclear or radiological emergency;
- ways of informing the population;
- order to maintain and test emergency preparedness;
- risk categories of sites, facilities and activities and classes of accidents;
- intervention levels as values of projected dose and preventable dose over some time, dose rate and specific activity, when reaching them begins the implementation of protective measures.

Regulation on emergency planning and emergency preparedness in case of a nuclear or a radiological emergency (Emergency regulation) complies with IAEA recommendations in emergency preparedness and response area, included in GS-G-2.1 Arrangements for Preparedness for a Nuclear or Radiological Emergency 2007; EPR-Method(2003) Method for Developing Arrangements for Response to a Nuclear or Radiological Emergency, 2003, etc.

As required by the Emergency regulation, emergency planning zones are defined for Kozloduy NPP, as follows:

- zone for on-site emergency planning – sheltering zone (zone No.1);
- precautionary action zone with a radius of 2 km (zone No. 2);

- urgent protective action zone with a conditional radius of 30 km (zone No. 3).

The Kozloduy NPP Emergency Plan covers zone No. 1, zone No. 2 and zone No. 3 in a part of which Kozloduy NPP informs the population about the Emergency Plan actuation.

A draft for a new Emergency Regulation has been developed, which is expected to become effective in the third quarter of 2019. This draft complies with IAEA requirements included in GSR Part 7 – Preparedness and Response for a Nuclear or Radiological Emergency, 2015.

The Radiation Protection Regulation defines the following:

- basic elements of management in situations with emergency exposure;
- reference levels for exposure of members of the public;
- reference levels for emergency workers in emergency occupational exposure;
- requirements to the off-site emergency plan contents;
- requirements to the scope and contents of the information provided to the public in case of an emergency.

In addition to the above regulations, requirements for emergency preparedness are applied in:

- Regulation № 28 on the terms and conditions for medical assurance and health standards to protect the individuals in the event of a radiological emergency;
- Regulation for the construction, maintenance and use of collective protection equipment;
- Regulation on the terms and conditions for functioning of the national early warning system and notification of executive authorities and the population during disasters and notification of air hazards;
- Regulation for creating, storing, updating, maintenance, delivery and reporting of stocks of personal protective equipment;
- Regulation No.11 on setting requirements to the limits of radioactive contamination of foods in a radiological emergency;
- Regulation on the terms and procedures for notification of Nuclear Regulatory Agency about events in nuclear facilities and sites with sources of ionising radiation and in the transport of radioactive substances.

Key elements of the National Plan for Disaster Protection, including hierarchy of management, roles and responsibilities of the licensee, the regulatory body and other competent authorities

The National Plan for Disaster Protection (NPDP) determines the order of introducing the plan in action; analysis of possible disasters and forecast of their consequences, including nuclear and radiological emergency situations; measures to prevent or reduce the consequences; measures to protect the population; order of request or rendering international assistance; obligations of the executive authorities and the persons responsible for implementation of measures to protect the population; funds and resources provided for liquidation of the consequences; ways of interaction between the executive authorities and procedures for timely notifying in case of disasters. One of the parts of the NPDP (Part III) is Kozloduy NPP Off-site Emergency Plan.

Activities to protect the population in case of disasters are performed by the Unified Rescue System (URS), which consists of basic and additional structures. The basic structures of the URS are Directorate General Fire Safety and Civil Protection at the Ministry of Interior (DGFSCP-MI) and its regional structures, Bulgarian Red Cross and Emergency Care centres.

Additional structures of the URC include: ministries and departments, responsible for implementation of plans for protection in case of disaster, and their regional structures; regional and municipal councils; trade companies and sole traders; medical and health institutions; legal non-profit entities, voluntary formations and armed forces.

The basic structures of the URS are formed throughout the country in accordance with the administrative-territorial division. Additional URS structures provide assistance upon request, according to their plans, and the armed forces – only with the permission of the Minister of Defence. Entities that provide electronic communications assist the Ministry of Interior to implement the communications and the National Emergency Call System using a single European number 112. Coordination of the URS structures is implemented through operational centres of the DGFSCP-MI. When Kozloduy NPP Off-site Emergency Plan is activated, by an order of the Prime Minister, National Headquarters are established to perform analysis and evaluation of the situation, make decisions about application of public protection measures and organise and control actions of ministers, departments, regional governors and mayors of the municipalities who are assigned to provide protection in case of a nuclear and radiological emergency. Coordination of activities in the disaster area is performed by a manager in place who is assigned by an order of the Headquarters manager, who organises and controls implementation of decisions of the National Headquarters.

According to the Disaster Protection Act, NRA is a part of the Unified Rescue System. In case of nuclear or radiological emergency, the NRA Chair participates in the National Headquarters.

NRA Chair performs the functions of a central authority and point of contact for notification of an accident and providing assistance, under the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in Case of a Nuclear Accident or Radiological Emergency.

NRA maintains an emergency response team and carries out training for its members. In case of a nuclear or radiological emergency, the main activity of the emergency team is to process incoming data, make forecasts for the development of the accident, evaluate the consequences for the population and prepare reasoned proposals for National Headquarters in order to apply protective measures. The team training is carried out according to the approved procedure and programmes and includes work with application programmes for forecasting the consequences of nuclear or radiological emergency, notification of IAEA and the EU.

According to the Regulation on emergency planning and emergency preparedness in case of a nuclear and radiological emergency, the licensee prepares preliminary evaluation and classifies the accident, activates on-site emergency plan and informs MI, NRA Chair, Ministry of Energy, corresponding regional centres (RD FSCP-Vratsa and RD FSCP-Montana), and notifies the public in municipalities within zone No. 3 (12-km area of 30-km urgent protective action planning zone) via Local Early Notification and Warning System.

Implementation of emergency preparedness measures by the licensee

Classification of emergency conditions

In the on-site emergency plan emergency conditions are classified in accordance with the Regulation on emergency planning and emergency preparedness in case of a nuclear and radological emergency, and definitions of IAEA published in documents Method-2003 – Method for developing arrangements for response to a nuclear or radiological emergency, TECDOC 955 – Generic assessment procedures for determining protective actions during a reactor accident and GSR Part 7 – Preparedness and response for a nuclear or radiological emergency in respect of the possible consequences and related activities that must be carried out:

- general emergency;
- site area emergency;

- facility emergency;
- alert;
- other emergency situations – emergency organisation and actions are subject to separate emergency plans.

Key elements of the on-site emergency plan of nuclear facilities, including sufficient resources and authorities to effectively manage and mitigate the consequences of an accident

Measures for emergency preparedness of Kozloduy NPP are defined in the On-site Emergency Plan (OEP), which is the main guiding document for action in case of an emergency at the plant. The on-site emergency plan forms part of the package of documents required for a licence. It is mandatory for implementation by all the plant personnel and personnel of organisations located on the site and in the precautionary action zone. The emergency plan is developed based on the project documentation, the additional analyses and assessments of safety, requirements of the national regulations and international recommendations, established common standards and practices in emergency planning and preparedness, nuclear safety and radiation protection.

Subject to review and classification in EP are nuclear and radiation emergencies and events without direct radiological consequences (non-radiation, conventional accidents) that create actual or potential prerequisites for significantly lowering the safety of plant equipment.

Accidents involving the transport of fresh and spent fuel and other events related to the safe operation of Kozloduy NPP (such as low and high waters of the Danube River, pollution of the Danube with oil products, accidents with other sources of ionising radiation and actions related thereto) are the subject of separate emergency plans, instructions and procedures.

Upon the occurrence of an emergency event, the emergency condition is determined by procedures for initial assessment of the initiating event and by periodic assessment of the facilities, based on:

- condition of the reactor systems;
- state of the nuclear fuel in the reactor and spent fuel pools (SFP);
- radiation situation at the plant and in the precautionary action zone;
- condition of spent fuel repositories (SFS and DSFSF);
- plant safety status (various events, natural disasters, human activity etc.).

The Plant Shift Supervisor is the senior operational manager of the shift. He is responsible for organisation and implementation of immediate actions in case of an emergency and first aid to the injured. The responsible officer for the overall management of activities under EP is the Emergency Response Manager (ERM). Until the formation of the emergency teams responsibilities and obligations of ERM are performed by the Plant Shift Supervisor.

The structure of the emergency response authorities includes the following additional services:

- Regional Fire Safety and Civil Protection Service (RFSCPS-Kozloduy);
- Regional Police Station – Kozloduy NPP;
- Occupational Medical Centre;
- Transport Department.

Services have developed their own emergency plans that are jointly implemented and coordinated with the On-site Emergency Plan of Kozloduy NPP.

According to the requirements of the Procedure for Organisation and On-call Performance to Ensure the Emergency Planning of Kozloduy NPP, for each emergency post there shall be ensured sufficient number of trained and qualified personnel obliged to be on duty in accordance with the emergency plan, and in case of a long-term emergency event to be replaceable. At least five trained and qualified individuals are defined for each emergency post.

The EP annexes describe the technical means available at Kozloduy NPP required for control and mitigation of an accident. Additionally, the Procedure for actions of the emergency teams in case of simultaneous occurrences at various nuclear facilities on Kozloduy NPP site describes the available mobile equipment located on the site and in the PAZ, the logistics provisions – accumulator batteries, cables, oils and diesel fuel in case of an emergency related to simultaneous events combined with fuel meltdown at different various facilities on-site.

On the availability of sufficient resources see also Article 9: Description of the mechanism by which the necessary resources are provided (technical, human, financial) and powers of the licensee to effectively manage emergencies on site and mitigate their consequences.

Facilities of the licensee to ensure emergency preparedness

The Emergency Response Centre (ERC) at Kozloduy NPP is designed to ensure the appropriate working conditions for the emergency response team and the emergency personnel working at the ERC. The ERC is established on the site territory and it is equipped with means for communication with the regional and national authorities and workplaces in plant buildings and facilities. Local Early Notification and Warning System and National System for Early Warning and Notification, installed at ERC, are used for notification of the personnel and the population. The external power supply is backed up. There is an independent electrical supply with two diesel generators. It is fitted with an independent filtering-ventilation system with the possibility to operate in three modes (pure ventilation, filtered ventilation and complete isolation mode), and also with air parameters monitoring, independent water and sewage system with reserve service water and a stock of foodstuffs. Radiological control regime is organised in ERC with monitoring assemblies for surface contamination of the emergency personnel and there is an option for decontamination.

The ERC is equipped with technological, radiation and meteorological monitoring; software and hardware means for assessment, forecast and visualization of the conditions. The radiation monitoring of the premises is carried out automatically and with portable devices, including for aerosol content in the air. Individual dose monitoring of the emergency personnel is done by thermoluminescent dosimeters (TLD) and digital display dosimeters. Each working place is provided with the required technical, operational and emergency documentation.

The ERC receives information from the following systems:

- automated emergency plan on-call system;
- Safety Parameters Display System (SPDS) and Post-Accident Monitoring System (PAMS) at Units 5 and 6;
- automated information system for off-site radiation monitoring;
- automatic information system for on-site radiation monitoring;
- automated aerological probing system;
- automated control of gamma background in populated areas of the urgent protective action zone;
- automated monitoring system for the hydraulic dual channel mode for technical water supply of Kozloduy NPP and monitoring of the level of the Danube;
- automated meteorological monitoring system;

- six water stations for monitoring the specific volume activity of liquid discharge and sewage waters.

The data from radiation monitoring system, the meteorological monitoring system (MMS) and the source of discharge are used as input data to software for determining protective measures for the personnel and the public. Data from the mobile laboratory for environmental monitoring are received during an accident. Transmission of data to ERC takes place on-line via Tetra radio channel and GPRS. Monitoring of Kozloduy NPP site is done by off-road vehicles equipped for this purpose. All these data are sent to the NRA Emergency Centre.

KNPP daily receives data from the National Operational Centre of the DGFSCP about any forthcoming extreme weather conditions two days prior to the event from the National Institute of Meteorology and Hydrology and from the Military Air Forces of the Bulgarian army.

The following software products are installed in the ERC:

- software JROSOS and ESTE for calculation of the radiological impact on the environment in a radiological accident, and protection measures for the personnel and the public. These programmes are installed in NRA emergency centre as well;
- Smart Fuel programme to control the location of nuclear fuel in the nuclear power plant;
- Scale programme for calculating the accumulated isotopes and residual heat removal;
- programme to control stressing of the containment cables.

There are ongoing works on building a new off-site ERC, in the town of Kozloduy.

Inventories of available emergency facilities and equipment at the plant site and a list of emergency personnel are attached to the EP of the plant:

- inventory of tactical and technical characteristics of fire equipment and armament in the RFSCPS of Kozloduy NPP;
- list of personnel and equipment for evacuation and emergency recovery work;
- inventory of mobile equipment necessary for safe cooling of the reactors;
- available quantity of diesel fuel.

Drills and exercises, activities of their assessment and main results of performed exercises, including lessons learned

Systematic approach is applied during training in emergency preparedness and response. Emergency personnel at the national level are trained in the Training Centre of the Ministry of Interior. Initial and recurrent training for actions in a nuclear or radiological emergency are conducted in it. Training of Kozloduy NPP personnel is held at the plant Training Centre and in the ERC.

To maintain emergency preparedness and to improve emergency response, the executive authorities, local authorities and entities conduct periodic emergency drills regulated by the Regulation on emergency planning and preparedness in nuclear and radiological emergencies. National emergency drills and exercises are organised and performed:

- every 5 years – a full-scale emergency exercise to implement the National Plan for Disaster Protection;
- annually – drills in mastering the elements of the plan.

In order to cover all activities described in the emergency plans a list was prepared of targets to be achieved during the exercises and drills for a period of five years.

Full-scale emergency exercises involve the executive authorities, the operator and entities included in implementation of Part 3 of the National Plan for Disaster Protection (Off-site

Emergency Plan), as well as local authorities and the population in the areas of emergency planning. The scenario for the conduct of each training event is approved at national level by the Minister of Interior. It describes the objectives, components of the emergency plan, which will be checked/exercised, participants (ministries, administrative structures, population, media, etc.), observers and inspectors of the exercise, and a performance timetable.

Trainings and exercises are performed by a programme, prepared and approved in advance. The assessment of general emergency exercises is given by an expert committee, the composition of which may include representatives of NRA, MI, ME, BEH and others. After each exercise an analysis is prepared and an order determines the measures for addressing the weaknesses and shortcomings noted during the exercises.

The NRA participates in international and national exercises (full-scope, computer-simulated) for actions in various disasters (a nuclear or radiological emergency, flooding, earthquake, terrorist act, etc.). In 2016-2019 time period, the NRA has participated in all exercises of the ConvEx series (organised by IAEA) for international information exchange in case of a nuclear or radiological emergency and in international exercises ECURIE and INEX, organised by the EU.

The NRA emergency centre receives data on-line from the Safety Parameters Display System (SPDS) and Post-Accident Monitoring System (PAMS) at Kozloduy NPP Units 5 and 6. There are technical means for conducting a video link conference and means of communication among NRA, Kozloduy NPP, MI, IAEA and the EU ECURIE system for operating notification in case of emergency situations.

As a member of the WANO Regional Crisis Centre in Moscow, set up following the Fukushima NPP accident, Kozloduy NPP participates in conducted by WANO-MC and WANO-LO drills for testing the notification forms.

In July 2017, a general emergency exercise was conducted to exercise activities of emergency response teams in case of simultaneous events at various nuclear facilities on Kozloduy NPP site. Through the exercise conducted, the existing organisational measures and technical means on the plant site were assessed, such as:

- sufficiency of regulatory requirements for the organisation of actions in the emergency plan and procedures;
- sufficiency of management and executive personnel;
- sufficiency of technical resources on site to deal with simultaneous events involving fuel melting at various nuclear facilities on the site;
- sufficiency of diesel fuel.

The overall evaluation states that the existing organisational measures and technical means of action in the emergency plan of Kozloduy NPP are sufficient.

It has been established that there is a necessity of conducting more frequent trainings and briefings on Kozloduy NPP communication plan to improve the interaction between the plant emergency teams and off-site emergency teams.

In November 2016, a general emergency exercise on the topic Framework Plan for Recovery after an Accident at Kozloduy NPP was conducted for two days. Through the conducted exercise were assessed existing organisational measures, financial insurance and technical means on Kozloduy NPP site for recovery of the plant after an accident. Emergency team from the WANO-MC Regional Crisis Centre participated in the exercise.

In November 2018, a joint general emergency exercise was conducted which involved response forces of the Republic of Bulgaria and plant emergency teams. The exercise was

entitled Terrorist Attack on Kozloduy NPP followed by a Radiation Accident. WANO Regional Crisis Centre participated in the exercise.

The training of the NRA emergency team is conducted in accordance with approved programme and annual schedule. The programme includes basic training of the whole emergency team and specialised part oriented to separate expert positions, and includes a practical training.

Joint exercises between the NRA and Kozloduy NPP are conducted in accordance with an approved annual schedule. In the course of these drills the NRA emergency procedures are implemented, knowledge and skills of the participants are enhanced and the coordination between separate team members and between NRA and Kozloduy NPP teams is improved. Periodic conduct of joint drills leads to improvement of internal rules and procedures both of the operator and the regulatory body.

A national full-scope exercise, Defence-2019, is planned to be conducted in November 2019. The exercise envisages occurrence of a general accident at Kozloduy NPP affecting more than one nuclear facility on site and involving a release of a considerable amount of radioactive material into the environment.

Regulatory activity and control

According to SUNEA, the NRA jointly with the specialised state service for fire safety and civil protection develop regulations on emergency preparedness and response in case of a nuclear and radiological emergency. According to these requirements, the entity operating the nuclear facility develops an on-site emergency plan and provides it for approval to NRA Chair, to specialised state service for fire safety of the population and to Minister of Environment and Waters not later than six months prior to the commissioning. The emergency plan is tested in practice prior to commissioning of the facility and during its operation.

The NRA controls the emergency preparedness of the licensees through annual inspections in accordance with an approved 3-year Inspection Programme. During these inspections (topical inspections) the following is checked:

- emergency plan, emergency instructions and procedures, interaction with local authorities, exchange of information with the regulatory body;
- initial assessment of the accident, an estimate of discharges into the environment, levels of intervention and implementation of protective measures;
- personnel training on the emergency plan, conducting exercises and drills, preparation of exercises, documentation and feedback;
- informing the public, preliminary information, notification and periodic testing of the early notification system.

Article 16 (2). Informing the public and neighbouring countries

Informing of the public in the nuclear facility area about emergency planning and emergency situations issues

According to SUNEA, the NRA provides the public with objective information about the condition of nuclear safety and radiation protection in normal operation, as well as in emergency situations in the country. According to the Regulation on Emergency Planning and Emergency Preparedness in case of a nuclear or radiological emergency, the executive bodies are obliged to notify the public in case of an emergency, within the frames of their competency.

The National Plan for Disaster Protection and the plans for disaster protection of the executive authorities define the requirements and the rules for immediate notification and periodical information of the population, for the whole period from the emergency occurrence until the final elimination of the consequences.

In the event of an accident, the affected population in the urgent protective action zone shall be notified immediately through the early notification system by Kozloduy NPP and shall be periodically informed through the National System for Early Warning and Notification about the accident, its characteristics, planned protective measures and, if applicable, protective measures that must be taken.

The information policy of Kozloduy NPP upon activation of the Emergency Plan aims to provide the public information and transparency regarding the evolution of the emergency, the implemented actions and measures undertaken by Kozloduy NPP to protect the personnel on site and to limit the consequences of the accident. For the purpose, timely and accurate information about the accident and about the forecasts for its future evolution is planned to be provided to the general public through the media and the internet site of the plant. Information and communication with the media is carried out by an Off-site Information Centre (OIC), which is a structure of the emergency team. When activating the emergency plan, OIC is positioned outside the plant site. The centre is equipped with the necessary technical means for providing information to the media and holding press conferences and briefings.

Kozloduy NPP has created an educational video for the municipality population on how to act in case of an accident at the power plant. It was projected in all schools of the town of Kozloduy and was broadcast on local televisions. It is published in electronic format on the power plant web site.

Meetings are carried out annually between the representatives of Kozloduy NPP, responsible for emergency planning, and Kozloduy Municipality management. During these meetings issues are discussed related to the activity and status of the power plant and are of public interest, as well as issues related to preparation for actions in emergency situations. Special attention is paid to public awareness of emergency planning issues through preparation of information materials, booklets, meetings and quizzes with students, meetings with local authorities and population.

Kozloduy NPP has issued booklets related to emergency planning and preparedness. One of the booklets contains description of protective measures and rules for public behaviour in case of increased radioactivity. The booklet is available at the web sites of Kozloduy NPP and DGFSCP-MI.

Informing the competent authorities in neighbouring countries

Informing neighbouring countries is carried out in accordance with the Convention on Early Notification of a Nuclear Accident (by USIE-IAEA), WebECURIE-EU and the signed bilateral agreements with some countries, listed in the next paragraph.

International agreements, including ones with neighbouring countries

The Republic of Bulgaria ratified the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in Case of a Nuclear Accident or Radiological Situation. Under both Conventions NRA performs the functions of a national contact point with the IAEA (USIE-IAEA). The NRA is a contact point also in accordance with the EU requirements (ECURIE-EU).

In 2018, the Republic of Bulgaria became a member of a network for providing assistance in case of a nuclear or radiological emergency, RANET, established by the IAEA. Through this network, countries that ratified the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, can quickly and efficiently request or provide support in case of a nuclear or radiological emergency. This facilitates the mechanism of the Convention and reduces significantly the time for receiving or providing assistance.

The Republic of Bulgaria has signed intergovernmental agreements on cooperation in the field of nuclear safety and the exchange of information in case of an emergency with Greece,

Romania, Turkey and Ukraine. In 2018, Bulgaria signed an intergovernmental agreement with the Republic of Serbia as well.

Agreements for notification and exchange of information in case of a nuclear or radiological emergency have been concluded between the NRA and nuclear regulators of Greece, Macedonia, Romania, Russia and Ukraine.

Kozloduy NPP is a member of the WANO Regional Crisis Centre in Moscow, set up following the Fukushima NPP accident. The centre envisages provision of additional, expert on-line support in case of a severe accident at Kozloduy NPP.

Article 17 Siting

Each Contracting Party shall take the appropriate steps to ensure that appropriate procedures are established and implemented:

i) for evaluating all relevant site-related factors likely to affect the safety of a nuclear installation for its projected lifetime;

ii) for evaluating the likely safety impact of a proposed nuclear installation on individuals, society and the environment;

iii) for re-evaluating as necessary all relevant factors referred to in sub-paragraphs (i) and (ii) so as to ensure the continued safety acceptability of the nuclear installation;

iv) for consulting Contracting Parties in the vicinity of a proposed nuclear installation, insofar as they are likely to be affected by that installation and, upon request providing the necessary information to such Contracting Parties, in order to enable them to evaluate and make their own assessment of the likely safety impact on their own territory of the nuclear installation.

Article 17 (1) Evaluation of relevant site-related factors

Overview of arrangements and regulatory requirements relating to the siting and evaluation of sites of nuclear facilities

The authorisation regime for determining the location of a nuclear facility (siting) is specified by the Safe Use of Nuclear Energy Act. It represents a two stage decision making process – two regulatory decisions are made by the NRA Chair, namely: Issuance of a siting permit – a permit to carry out site selection activities and approval of site selection based on issuance of the relevant administrative document – order for approval of the selected site

Implementing an Environmental Impact Assessment for the facility, including transboundary considerations, is required by the Environmental Protection Act. The same Act specifies the organisation of public discussions of EIA report, in conjunction with the municipal authorities, state and public organisations, the competent authority on environment protection, the general public, and the interested persons and legal entities.

The procedure for granting of a siting permit for a nuclear facility and issuance of a site approval order, is specified by the Regulation on the Procedure for Issuing Licences and Permits for Safe Use of Nuclear Energy. For the issuance of a siting permit, together with the conceptual description of the nuclear facility and the acceptance criteria for the sites, the applicant shall submit Terms of Reference for site pre-feasibility studies, description of the measures to implement the studies, methods for their implementation and for result evaluation.

For approval of the selected site, the applicant shall submit a Preliminary Safety Analysis Report (PSAR), which shall include, apart from other information, comparative analyses of proposed sites in terms of nuclear safety and radiation protection, as well as selection of an option based upon:

- impact of factors - man-induced or of natural origin, on the safety of the facility;
- radiological impact of the nuclear facility on the public and the environment;
- site specific characteristics that are of importance for migration and accumulation of radioactive substances;
- possibilities for implementation of public protection actions in case of an emergency;
- size of the special statute areas and emergency planning zones.

The preliminary report shall include the results of the study of the site characteristics, including:

- geographical, topographical and demographic conditions;
- man-induced factors;
- hydro-meteorological conditions;
- geological, hydro-geological, seismic and engineering-geological conditions;
- site-specific and region-specific characteristics for the purposes of emergency planning, accident management, and physical protection.

The documents necessary to approve the selected site shall also include:

- site monitoring programmes, including: seismic monitoring, regime of groundwater and surface water monitoring, and monitoring of other natural phenomena;
- a programme for additional site studies of the selected site, when the submitted SAR requires them.

When planned to locate the nuclear facility at the site of an already constructed and commissioned nuclear facility, the potential impact on the safety of the proposed new facility and the other nuclear facilities located on the same site will be considered in the preliminary safety analysis report.

For approval of the selected site, it is necessary to demonstrate that all factors which may affect safety have been identified, as well as the applicable requirements and criteria for site selection defined in Regulation on Ensuring the Safety of Nuclear Power Plants, of 2006, are met. The Regulation defines the scope of engineering studies and research of processes, phenomena, and factors of natural and man-induced origin which may affect the safety of the NPP and which should be performed when characterising the site: the characteristics of the tectonic activity; characteristics of the initial ground motion during earthquakes with a frequency of 10^{-2} events per year and frequency of 10^{-4} events per year at the site elevation zero; the potential for slope instability; potential for development of karst, suffosion, and karst-suffosion processes; presence of specific ground layers (biogenic, collapsible, swelling, salted, alluvial, man-induced); zones of water-saturated segregated ground layers liable to liquefaction under seismic effects and limit values for ground acceleration when there is a potential for liquefaction; impact on the safety of the NPP due to increase of the level of underground waters; characteristics of rare phenomenon such as tornado; maximum level of the water and duration of potential flooding due to precipitation, intensive snowmelt, high water level in water basins, ice blockage of the river, avalanche, and landslide; potential for tsunamis or seiches, hurricanes, severe precipitation, icing, thunder-storms, etc.

The Regulation requires to investigate the area for location of a nuclear power plant and site of a nuclear power plant to identify the sources of potential human-induced hazard. All fixed and portable potential sources of explosions including industrial and military sites for production, treatment, storage and transportation of chemical and explosive substances and storages for ammunitions are analysed and the parameters of the effects of the most hazardous explosion are defined. All fixed and portable potential sources of emergency release of chemically active substances, including industrial and military sites where toxic and corrosive substances are processed, used, stored and transported are analysed. In order to identify the sources of potential man-induced hazards, it is required to identify the parameters of their impact and, if possible, probability for achieving them.

For site selection, it is required to determine the effects of the NPP on the public and the environment through:

- study of the atmospheric, hydro-meteorologic, hydro-geologic, and geochemical conditions of radionuclide dispersion, migration, and accumulation of radionuclides as well as the natural radiation background; a forecast for the variation of these conditions throughout the entire period of operation of the NPP is prepared.
- assessment of atmospheric dispersion by taking into account of the light wind, air stagnation, air temperature, ground and attitudinal inversions, atmospheric stability, precipitation, and fog in the area of the NPP;
- determination of the characteristics of the radionuclide migration in the surface water and groundwater and accumulation of radionuclides at the bottom of the relevant water basins taking into account the conditions specified in the Regulation.

The Regulation also specifies the requirements for the evaluation and analysis of the external events and hazards for the site of a nuclear power plant. The evaluation of the external events include:

- identification of all hazardous sources specific to the site and the region for location of a nuclear power plant;
- pre-selection based on the established criteria;
- evaluation of the parameters of the effects of the selected external events;
- analysis of the external events with deterministic and probabilistic methods.

The following groups of natural origin events should be considered in the designs of a nuclear power plant:

- design basis events which include single events of natural origin and combination of cause-related and non-related phenomena and processes;
- extreme events which are identified, evaluated and analysed to define their margins to the occurrence of cliff edge effects.

When designing the concept of protection, it is required to take into account the fact that the event may cause multiple failures in the safety systems and/or their support systems and may simultaneously jeopardize several power units at the same site, site infrastructure, regional infrastructure and external supplies.

Review of assessments carried out and criteria used for assessment of all the factors specific for the site which may affect the safety of the nuclear installation, including multiple unit emergency conditions and a loss of infrastructure and access to the site resulting from an event

When selecting sites for nuclear power plants, the characteristics and the frequency of occurrence of phenomena of natural and man-induced factors are investigated and evaluated, whenever possible. The presence of exclusion criteria and factors is assessed, and, if there are none, the sites are evaluated if they are favourable for siting of nuclear power plants. For consistent application of the defence-in-depth concept in the designs of nuclear installations, the values of impact parameters for the relevant periods of recurrence of external events that could affect safety are defined. Potential consequences of external events, considered in the design basis of nuclear installations are analysed with deterministic methods to verify the selected defence concept. Reasonably achievable measures are planned to prevent consequences of rare phenomena and events, including extreme external events and natural phenomena that could impact simultaneously the whole site.

Kozloduy NPP site and the region have been subject to investigation since 1967, when the site was selected for the construction of the first nuclear power plant in Bulgaria. In the following period, a number of additional analyses and investigations were performed to identify possible natural phenomena and hazards, as well as sources of potential man-induced hazard.

The evaluations methods and their results are documented in the safety analysis reports for the units and are subject of reassessment within the periodic safety review.

As a result of the engineering and geological feasibility studies of the site, the following adverse phenomena have been identified:

- earthquakes;
- loess collapse;
- settlement due to large loads from certain facilities;
- subsidence of moulds;
- filtration of service water and transfer of contaminants to the aquifer horizon;
- liquefaction of structurally unstable soils;
- erosion and flooding of the Marichin Valog tributary valley.

Measures have been taken to limit those processes and prevent their effects applying different methods for bedrock enhancement.

In 1992, re-evaluation of seismic loads was carried out at the site of Kozloduy NPP – Review Level Earthquake (RLE) for the recurrence period of 10,000 years was established for qualified equipment. Based on this reassessment, the following impact parameters were determined:

- SL-2 Design Basis Earthquake free field acceleration (recurrence period of 10,000 years) – 0.2 g;
- SL-1 free field acceleration (recurrence period of 100 years) – 0.1g;
- Enveloping design basis free field response spectrum and the relevant 3D accelerograms with a duration of 61 s.

The methods of seismic hazard probabilistic analysis are based on the Cornel standardized mathematical model and on the McGuire 1976 and Toro&McGuire 1988 software products.

The seismic levels, enveloping design basis free field response spectrum and relevant 3D accelerograms were reviewed and verified by the IAEA expert missions in 1995 and 2000. Following the IAEA recommendation, the free field response spectrum and relevant 3D accelerograms with a duration of 20 s have been determined.

In addition to the geological, engineering geological and seismic-tectonic investigations at the site of Kozloduy NPP and the location area, the meteorological and hydrological conditions were also studied to determine the design basis of the power plant in terms of external hazards, including flooding, temperature, wind loadings, etc. The flooding hazard assessment considers an accident with the hydro-technical facilities on the Danube river forming a maximum water quantity with a recurrence period of 10,000 years. For all phenomena causing floods and flooding, the water amount in the Danube river as well as the maximum flooding level, which is compared to the existing level at the site of Kozloduy NPP and the top of the hydraulic engineering facilities providing for the service water supply to the nuclear power plant were defined. A conclusion was drawn that the site of Kozloduy NPP is not jeopardised by flooding from the Danube River. The maximum river water levels in case of high waters are lower than the level of the crown of facilities and the plant site.

The frequency of occurrence of rare and extreme external impacts, e.g. hurricane, extreme precipitations, air and water temperatures, icing, thunderstorms, dust and sand storms, erosion of the banks of rivers and water basins, and tornado, was also evaluated.

In terms of sources of man-induced hazard in the region of the plant, the analyses and studies based on the distance and probability level screening methods were performed. Applying

these two methods, the man-induced sources in the radius of 30 km surrounding the site of Kozloduy NPP site were identified. The potential impact of the following human-induced hazards was evaluated:

- explosion at the site of Kozloduy NPP and in the stationary and portable sources nearby;
- emergency release of chemically active substances, including from industrial sites where toxic and corrosive substances are processed, used, stored and transported;
- off-site fires including on river and road transport vehicles, etc.

During the "stress tests" of the European nuclear power plants carried out in 2011 following the Fukushima NPP accident, the plant response in general and the effectiveness of the protective measures at extreme external events, affecting all the facilities at the site as a consequence of an earthquake, flooding, and extreme meteorological impacts were evaluated. The available capacity margins of facilities and equipment before occurrence of boundary conditions were also evaluated, and the results were summarised in the Report Section referred to in Article 17(3). In the frames of the National Action Plant of the Republic of Bulgaria resulting from the stress tests, the IAEA Action Plan on Nuclear Safety, and conclusions of the second special meeting on the Convention on Nuclear Safety held in 2012, additional assessments and measures for enhancement of safety under extreme external impacts causing failure of all on-site facilities, deteriorated infrastructure, and loss of access to the site were planned and implemented. Some of the measures are related to:

- analysis of extreme weather conditions using probabilistic methods;
- re-evaluation of the technical provisions and the organisational measures in case of a simultaneous accident with fuel melting in the nuclear facilities at the plant site;
- development of emergency procedure for actions in case of destruction of the hydraulic engineering facilities Zhelezni Vrata 1 and 2;
- update of the on-site and the off-site emergency plans in terms of a simultaneous accident, deteriorated infrastructure and difficult access to the on-site facilities.

In relation to the general governmental decision for construction of a new nuclear unit in the area of Kozloduy NPP, at the end of 2012, an application was submitted to the NRA for issuance of a permit for selection of the location for a nuclear facility (siting) near the site of the existing Kozloduy NPP. In August 2013, the NRA issued a permit for siting of a new nuclear facility to Kozloduy NPP – New Builds Plc, a subsidiary of the operator, Kozloduy NPP. As a result, in the period from 2013 to 2015, a project was performed to study the 4 potential sites located near the operating plant, select the preferred site for the construction of a new nuclear unit, and assess (reassess) its characteristics. Detailed information on the reassessment of the impact parameters of the site-specific factors that may affect safety is given in Article 17(3).

In the frames of the project for selection of a site for location of a new nuclear unit, a consistent review of the whole data base from previous studies of the site was carried out. The existing data were analysed for completeness and compliance with the current regulatory requirements and a Programme for additional studies was developed. The obtained results and existing data were used for comparative assessment of the potential sites. The current national requirements for site selection and relevant IAEA safety standards at the time of the survey were considered in the assessment methodology. The criteria for comparative assessment of the potential sites were grouped according to different factors, such as: seismicity; geotechnics; hazardous weather effects; man-induced effects; dispersion of radionuclides in the atmosphere and hydrosphere; interaction between the new nuclear unit and existing nuclear facilities at the site. According to the recommendation of the NRA, an independent verification of the study results was carried out in order to confirm that an up-to-date methodology was applied, the

uncertainties due to lack of recorded data were reviewed and assessed, and that the documentation was complete and traceable.

In the process of site selection for the construction of a new nuclear power unit in the area of Kozloduy NPP, four potential sites near the existing nuclear power plant were evaluated. The current regulatory requirements regarding the safe use of nuclear energy and the environmental protection, as well as the applicable IAEA standards were used for the assessment and analyses. In addition, for selection of the appropriate site the impact of the existing infrastructure at the site of Kozloduy NPP was also evaluated.

All proposed sites comply with the requirements of the regulations in the area of safe use of nuclear energy. No exclusion factors were identified according to both the requirements of the Regulation on ensuring the safety of nuclear power plants and the criteria in the up-to-date IAEA standards. Site No. 2 was selected as a preferred site. As for the remaining sites, the weaknesses identified during studies may be corrected through suitable engineering solutions.

Review of the design solutions against man-induced external events and natural external events such as fire, explosion, aircraft crash, external flood, extreme weather conditions, and earthquake as well as the impact of secondary natural disasters (tsunami due to earthquakes, mudslides/sediments due to torrential rains)

The layout of reactor buildings at Units 5 and 6 complies with all main requirements to ensure the protection of the personnel, the public and the environment against radiological impact and is in compliance with the generally accepted principles and international practices related to designing of NPPs, and considered in the IAEA documents.

In the period from 2004 to 2006, studies and analyses of the seismic stability of the buildings at reevaluated seismic levels (0,2g for SL-2 and 0.1 g for SL-1) and analyses of the behaviour of safety system equipment in case of earthquakes were also performed. As a result, measures were identified and implemented for the seismic re-qualification and ensuring seismic stability of safety system equipment and civil structures in terms of increased seismic impact.

Based on their design functions, a list of the SSCs required for plant shutdown and maintaining in a safe state in accident and post-accident conditions (safe shutdown list) was prepared. This list includes SSCs important to safety whose failure may compromise a fundamental safety function.

In the period from 2006 to 2007, prestressed concrete containment vessel structure analyses were carried out applying the finite elements method and using data from the on-line monitoring system as well as laboratory testing and studying of the components. The assessment of the containment strength properties was expanded and clarified in 2012 when updating the PSA, Level 2. Assessment of the structural reliability was carried out for all design basis internal and external impacts, taking into account the actual condition of the structure and the pre-stress system. The containment behaviour in severe accident conditions was also analysed determining the limiting bearing capacity for each of the units. The ageing processes were analysed, critical elements were identified, and an ageing management programme was developed. The analysis and the evaluation results demonstrate that the containment of Units 5 and 6 are capable of fulfilling their functions for all design basis external and internal events.

The analysis of design solutions for SSCs conducted during the stress tests in the European NPPs in 2011 following the Fukushima accident proved the sufficient margins of the equipment and facilities to the occurrence of boundary effects. As a result, there is no need for application of additional design solutions for man-induced external events and natural external events, such as fire, explosion, aircraft crash, external flood, extreme weather conditions, and secondary natural disasters (tsunami and mudslides due to torrential rains).

In the period following the Seventh National Report, Programmes for preparation of Units 5 and 6 at Kozloduy NPP for plant lifetime extension were implemented. In the frames of these

programmes the robustness and functional capacities of the main buildings at the site with the projection for 30 years in terms of the listed below characteristics were evaluated and re-evaluated. As a result of the re-evaluation of the containment structures of the two units, the following conclusions were made:

- technical condition - no significant defects concerning the concrete were identified;
- integrity - reinforcement, pre-stressed tendons and concrete of the containment structures withstand the load combination of postulated accident and RLE with a significant margin;
- leak tightness - maximum strain in the linings from a combination of postulated accident and RLE reach up to 64% of the allowable values. Shear stress in the welds between the sheets of lining and in the concrete profiles reach 77% of their calculated bearing capacity. The weakest point in the containment system - these are the welds between the sheet steel and in the concrete profiles are with the calculated bearing capacity margin of up to 23%.

Regulatory review and control activities

In relation to the decision for construction of a new nuclear unit, at the end of 2012 an application was submitted to the NRA for issuance of a permit for siting of a nuclear facility in the close vicinity to the site of existing Kozloduy NPP. As a result of the regulatory review and assessment of the compliance between the data submitted and regulatory requirements, the NRA issued in 2013 a permit to the Kozloduy NPP – New Build for siting of a new nuclear unit. The permit conditions define the main requirements for the works and preliminary studies related to site selection and determination of the impact parameters of processes and phenomena.

Upon completion of the activities related to study, selection, and assessment of the selected site for the construction of a new nuclear unit, in June 2015, Kozloduy NPP – New Build submitted to the NRA an application for issuance of an order for approval of the selected site supported by the following information:

- Preliminary Safety Analysis Report (PSAR);
- report from an independent verification of the results of studies, assessments, and reassessments of the site characteristics;
- documents verifying the compliance with the current regulations and provisions of the permit for siting;
- monitoring programmes;
- decision on the Environmental Impact Assessment Report of the Minister of Environment and Water.

The independent verification of the results of the selected site assessment contracted by Kozloduy NPP– New Build covers the tectonic and neotectonic conditions, seismic hazard analysis, site geodynamic model, and effects of the local geological conditions. This independent verification confirmed that the scope of the performed studies for siting of the new nuclear unit fully complied with the national regulatory requirements and current IAEA standards.

In 2016, the NRA assigned an expert evaluation of the PSAR in the frames of the regulatory review of the presented documents for approval of the selected site of the new nuclear facility in the region of Kozloduy NPP, according to Article 33, para.4 of the Safe Use of Nuclear Energy Act. The expert evaluation reviewed and assessed the completeness of the submitted data for the site characteristics in both the separate parts of the PSAR, and the submitted topical reports. A specific objective of the expert assessments of the validity and up-to-dateness of the information related to the geological, seismic, hydrological, and meteorological characteristics of the site and its surroundings in order to verify the lack of

exclusion factors. The following site specific risks were subject to independent review (man-induced and natural external events):

- geological and engineering geological risks related to weak, collapsible, and dynamically unstable soil layers;
- seismic and seismotectonic risks related to the potential for active faults, surface faults, and specific characteristics of the vibrational seismic movement;
- meteorological risks;
- hydrological risks related to potential flooding of the site, or low water levels challenging the operation of the nuclear facility, future changes of the river bed, etc.;
- combination of extreme external impacts and resulting damages;
- radiological risks related to nuclide migration into the atmosphere and hydrosphere;
- man-induced risks.

For consideration of the comments from the regulatory review of the safety report, including the external expert evaluation, a second revision of the PSAR was prepared and submitted to the NRA and on its basis a decision is to be made for approval of the selected site.

Article 17 (2) Impact of the installation on the population, society, and environment

In accordance with the SUNEA, the proposal for construction of a new nuclear power plant is submitted by the Minister of Energy together with the assessment of nuclear safety, radiation protection and environmental impact. The Minister makes arrangements for public consultations of the proposal, which is attended by state and local authorities, representatives of public organisations and interested physical and legal entities. When the operation of a nuclear power plant might have impact on the population and the environment in the territory of another country, the Minister of Foreign Affairs shall notify the competent authorities of that country and, if requested, provide the information necessary for analysis and assessment of the potential impact of the plant on their territory in terms of public safety and the environmental protection.

The Regulation on ensuring the safety of nuclear power plants requires to conduct the assessment of the radiological consequences in all operating and emergency conditions in the nuclear power plant and, if required, envisage technical and organisational measures to provide for the safety of the public. The consequences of a potential radiological consequence on the public and the environment in the supervised areas in the event of accidents in a nuclear power plant should be defined with the required level of conservatism and taking into consideration the specifics of the designed nuclear installation and the relevant site. The limit of the individual effective dose from internal and external exposure of the public caused by the impact of liquid and gaseous discharges to the environment, in all operational states of all nuclear facilities at the site of a nuclear power plant is defined in the Regulation on ensuring the safety of nuclear power plants.

According to the Regulation on the procedure for issuing licences and permits for safe use of nuclear energy, in order to approve a selected site for construction of a new nuclear unit, along with the other documents, it is required to submit site monitoring programmes - seismic monitoring, underground and surface water monitoring and monitoring of the other natural phenomena. In order to issue a permit for commissioning of a nuclear installation, the regulation requires to submit a programme for monitoring of the radiation parameters at the site of the nuclear installation and an environmental radiation monitoring programme during its operation.

The following monitoring programmes are performed at the site of Kozloduy NPP:

- monitoring of current ground motions - geodesic monitoring of deformation processes;

- seismic monitoring - measurement through diversification systems such as local seismological network; system for seismic monitoring of equipment and structures, seismic monitoring system and alarm system for the operator in the control room;
- monitoring of the regime of ground waters and monitoring the regime of surface waters (hydrology);
- geotechnic monitoring of the ground basis - monitoring of the density and moisture in the mounds of the double canal to the Danube river, contents of long-lived sources of ionising radiation, speed and direction of filtration;
- meteorological monitoring - on-line measurements of the current meteorological regional characteristics through 3 meteorological stations.

In 1999, the EIA Report for Units 5 and 6 at Kozloduy NPP was prepared in compliance with the Environmental Protection Act. The results from the analysis of Kozloduy NPP impact on the public and the environment are included in the updated safety analysis reports.

In accordance with the provisions of the operating licences issued for Units 5 and 6, the licence holder, Kozloduy NPP, is obliged to submit on an annual basis to the NRA information on the condition of nuclear safety and radiation protection, fulfilment of the environment and the working environment radiation monitoring programmes and programme for radiation protection of the personnel.

The intention for construction of a new nuclear unit at the site of Kozloduy NPP falls within the scope of the Environmental Protection Act, which requires the performance of an EIA. The EIA Report on the construction of a new nuclear facility in immediate proximity to Kozloduy NPP was developed, and in it the effects were determined and their significance for the environment and the public were assessed. The unavoidable and lasting effects resulting from the construction, operation, and decommissioning of a new nuclear unit were analysed and compensatory measures were identified. The analysis covers the territory of the Republic of Bulgaria and the Republic of Romania, being an affected country, as well as the recommendations and requirements of the Republic of Austria, which requested and took part in the EIA procedure.

The main conclusion of the EIA Report based on the analyses and assessments conducted in accordance with the normative requirements, is that the implementation of the investment proposal will not have a lasting negative effect on the factors and components of the environment and human health, including biological diversity.

In connection with the requirements for publicity and public participation in the assessment process, a number of consultations with national and international institutions, non-governmental organisations, and physical and legal entities were made. There are five public consultations conducted within the Republic of Bulgaria and three in the Republic of Romania. The demands of the Republic of Austria were also considered.

Thus, at the beginning of 2015, the Minister of Environment and Water made a decision to approve the investment proposal for construction of a new nuclear unit of the latest generation at the site of Kozloduy NPP.

The monitoring programmes for the Kozloduy site after the construction of the new nuclear unit provide for meteorological, hydrological, seismic, geodesic, non-radiological and radiological monitoring. At the design stage of the nuclear facility, there will be final identification of the site monitoring programmes as well as specification of their scope; methods for monitoring of the variables; provision of the necessary resources; archiving, processing, and transmission of information and the manner of its use; reporting of the results to the competent authorities, as well as management of the process and allocation of responsibilities for the implementation.

Article 17 (3) Re-evaluation of site-related factors

Activities for re-evaluation of the factors related to siting and mentioned in Article 17 (1), ensuring continuous acceptability in terms of safety of the nuclear installation and performed in accordance with the relevant standards and practices

Re-evaluation of the factors resulting from the stress tests

In the frames of the performed stress tests at Kozloduy NPP following the Fukushima NPP accident, a comprehensive re-evaluation of the safety margins of Kozloduy NPP was conducted as well as a re-evaluation of the efficiency of preventative actions in extreme situations caused by earthquakes, external flooding, and extreme weather conditions.

The performed seismic reevaluation confirmed the adequacy of the current design basis: maximum horizontal free field acceleration on site = 0.2g for SL-2 Design Basis Earthquake, and maximum horizontal free field acceleration on site = 0.1g for SL-1 earthquake. In the course of the re-evaluation, it was established that the analysis of seismic resistance of the equipment having safety functions in these scenarios was performed and the parameters characterising its fragility curves were determined. The limit values of the seismic accelerations that any nuclear facility on the Kozloduy NPP site is capable of withstanding without the occurrence of a severe fuel damage and radioactive releases into the environment were determined. The summarised evaluation shows that the margin for Units 5 and 6 is 0.13g or 65% of RLE (PGA=0.2g), i.e the units may survive without any fuel damage an earthquake 1.65 times higher than the re-evaluated one. The main results of the performed analysis of the dynamic non-linear behaviour and seismic capacity of the containment structure of Units 5 and 6 are as follows:

- limited damages and cracks in the concrete without loss of integrity - for impacts with PGA = 0.75g;
- loss of integrity due to plastic deformations in the steel lining - for impacts with PGA= 1.7g;
- structure damage due to rupture of the pre-stressed tendons and shear of the reinforced concrete cross section - for impacts with PGA= 1.9g.

The BDB seismic impact analysis proves that in terms of seismicity the SSCs at Kozloduy NPP are capable of providing for plant safety under maximum potential seismic effects for the site.

Based on the re-evaluation of the recurrence frequency and site flooding effects, a new maximum water level was established and its occurrence was re-considered. The potential for ice blocking of the river was studied and the potential for combination of a maximum water level and other unfavourable phenomena was evaluated. The new maximum water level for the site of Kozloduy NPP (32.93 m) was determined based on the maximum water level of the Danube River with recurrence period of once in a period of 10,000 years, accident at the hydroelectric power plants Zhelezni Vrata 1 and 2, and maximum values for rain and wind. A probabilistic analysis with the combination of two events, the natural extreme water levels of low probabilities (from 10^{-5} to 10^{-7}) and rupture of hydroelectric facilities Zhelezni Vrata 1 and 2, was carried out. The predicted water levels are as follows:

- 32.98 m for extreme levels with probability of 10^{-5} (once in 100 000 years) and rupture of the water-power system dams;
- 33.26 m for extreme levels with probability of $p = 10^{-6}$ (once in 1 000 000 years) and rupture of the water-power system dams;
- 33.26 m for extreme levels with probability of $p = 10^{-7}$ (once in 10 000 000 years) and rupture of the water-power system dams.

These results confirm that the hazard of flooding the site of Kozloduy NPP, located at the elevation 35,00 m may be avoided.

The analysis of the resistance to the extreme weather conditions characteristic of the site (extreme wind, tornado, snowfall and icing, extreme temperatures, and extreme rainfalls) considers the condition of the structures and presence of safeguards and organisational measures ensuring house loads power supply and nuclear fuel cooling. The results demonstrate that the plant has the required resistance to extreme weather conditions and the existing procedures and instructions are applicable to the staff actions in extreme situations.

Results of recent activities for site re-evaluation

In the frames of the project for study of the Kozloduy site in order to define the location for the construction of a new nuclear unit, in the period from 2010 to 2015, the following evaluations and studies were carried out:

- engineering-geological studies of the potential sites;
- modelling of radionuclide migration to the subterranean space of the potential sites;
- update of the site seismic hazard;
- definition of the seismic design basis;
- analysis of geophysical fields and current ground motion;
- climatology and local meteorology, dispersion characteristics of the atmosphere;
- hydrology of the Danube River;
- demography and anthropogenic impacts;
- additional engineering-geological and geophysical surveys of the selected site;
- additional evaluation of the protection of Kozloduy site against hazardous meteorological, hydrological, and geological phenomena.

In the frames of the reevaluation works for the Kozloduy site, the regional climate was analysed and the loads resulting from weather effects were determined for different recurrence periods from 5 to 10,000 years. With the loads thus identified, "Analysis of the civil structures on the territory of Kozloduy NPP subject to a combination of extreme weather conditions" was conducted. The behaviour of the structures was analysed, an engineering evaluation was carried out, and their margins for resistance to loads due to weather effects were determined. For the civil structures, which do not have the required capacity, the interaction of the relevant structural element with other SSCs was analysed and, based on that, organisational and engineering measures for reinforcement and mitigation of consequences due to weather effects were identified.

In order to characterise the weather conditions in the area of Kozloduy NPP, systematic data for wide enough area surrounding the site of the nuclear power plant were used. The data from the standard meteorological observations from the archived materials of the meteorological stations in Bulgaria were also used; thus, obtaining the required input for determination of the design basis meteorological characteristics, containing a number of annual values of the parameters as well as information on the peaks for different periods of a various duration. The analyses of the relation between the regional long-term weather characteristics and local parameters clearly confirmed the representativeness of these characteristics for the site. Based on that, a quantitative and probabilistic assessment for a wide range of phenomena was made – with a recurrence period of 100 years (Level 1) and 10,000 years (Level 2).

Typical extreme weather effects that may occur in the area of Kozloduy NPP are extreme snowfall, including snow storms and snowdrifts, extreme rainfall, extremely low and high temperatures, extreme winds, tornado and icing. In order to address extreme external effects with

a recurrence period of more than 10,000 years, which may lead to a loss of basic safety functions, the above events as well as a combination of related - in terms of their origin - extreme effects, e.g. extreme rainfall and hurricanes; extremely low temperatures – high wind – icing were considered.

The level of groundwater at the site of the Kozloduy NPP is monitored on a monthly basis (over 100 drilling wells). The data are submitted for processing, analysis, and storage to the relevant experts on hydro-engineering facilities.

In the frames of the Project for survey and selection of a preferred site for location of a new nuclear unit, additional studies related to engineering-geological studies of the potential sites, modelling the migration of the radionuclides in the subterranean space, definition of the seismic design basis, analysis of geophysical fields and current ground motions, climatology and hydrology were performed. The results of the performed additional studies are also subject to independent verification of the obtained results from the study.

All available data are used for both developmet of the Preliminary report for safety analysis of the new nuclear unit and re-evaluation of the site characteristics in the process of the periodic safety review of Units 5 and 6 at Kozloduy NPP in the period from 2014 to 2018. As a result of the performed periodic safety review, an integrated programme for the implementation of safety enhancement measures was developed for each of the units. As part of these works, it is planned to perform risk assessment of the seismic effects with current brittle curves of SSCs important to safety and take the relevant measures based on the results of this evaluation. It is also planned to take into account and evaluate with probabilistic methods all external hazards and the impact of one unit on the safety of the other unit.

Regulatory review and control activities

The regulatory activities related to the licensing of the selected site for the construction of a new nuclear unit near Kozloduy NPP are given in Article 17(1).

For the existing nuclear facilities at Kozloduy NPP, the regulatory activities for review and control of the re-evaluation of factors related to the site are carried out in the course of the administrative proceedings for renewal of the operating licences. The authorisation regime, established in the SUNEA, provides for the extension of the operating licence of the nuclear facility based on assessment of nuclear safety and radiation protection (periodic safety review). According to the Regulation on ensuring the safety of NPPs, the periodic safety review should include a re-evaluation of the site characteristics considered in the design using up-to-date methods and data. In fulfilment of these provisions in connection with the renewal of the operating licences for Units 5 and 6 at Kozloduy NPP, the NRA made an assessment of the results of the periodic safety reviews in the period from 2017 to 2019. As part of the regulatory review, the NRA commissioned in 2018 the conduct of external independent expert evaluation of selected aspects of the periodic safety review, including consideration of site characteristics which were re-evaluated for the purpose of designing a new power unit. As a result of the regulatory review and the expert evaluation carried out, it will be recommended to perform some additional analyses related to the re-evaluated parameters of the external impacts typical for the site.

Article 17 (4) Consultations with other Contracting Parties likely to be affected by the facility

International agreements

Consultations with other contracting parties likely to be affected by the facility are conducted in accordance with the Environmental Protection Act, Regulation on the environmental impact assessment (EIA), and in compliance with the Convention on the environmental impact assessment a transboundary context to which the Republic of Bulgaria is a party.

In connection with the above said, the Ministry of Environment and Water (MEW) notified the Republic of Romania as an affected party from the implementation of the investment proposal for the construction of a new nuclear unit at the site of Kozloduy NPP. In terms of the letter to the MEW received from Austria with request to provide information about the investment proposal for the construction of a new nuclear unit at the site of Kozloduy NPP, Austria was sent notification and information for the access to the technical specifications of the scope of the EIA, the EIA report, which is available on the website of the MEW and written consultations were undertaken. Three public consultations were held in the Republic of Romania. In the process of the procedure, written consultations were also performed with the Republic of Austria, of which the latter expressed its satisfaction. The results, recommendations and requirements of the interested parties were considered when performing the analyses and evaluation of the impact of the investment proposal for construction of a new nuclear unit at the site of Kozloduy NPP on the environment and human health. Preventive actions to limit the transboundary impact were also planned.

Bilateral agreements with neighbouring countries

There are bilateral Agreements signed between the government of the Republic of Bulgaria and the governments of Romania, Greece, and Turkey on early notification of a nuclear accident and exchange of information about nuclear facilities. Pursuant to these Agreements, the Contracting Parties shall notify each other if they have plans for construction of new nuclear facilities and shall also provide the required technical information about those facilities.

Article 18 Design and construction

Each Contracting Party shall take the appropriate steps to ensure that:

i) the design and construction of a nuclear facility provides for several reliable levels and methods of protection (defence- in-depth) against the release of radioactive materials, with a view to preventing the occurrence of accidents and mitigating their radiological consequences should they occur;

ii) the technologies incorporated in the design and used in the construction of the nuclear facilities shall be proven by experience or qualified by testing or analysis;

iii) the design of a nuclear facility allows for reliable, stable and easily manageable operation, with specific consideration of human factors and the man-machine interface.

Article 18 (1) Application of the defence in depth concept

Overview of the arrangements and regulatory requirements concerning the design and construction of nuclear facilities

The main criteria and rules for nuclear safety and radiation protection of nuclear power plants, as well as organisational measures and technical requirements for ensuring the safety during siting, design, construction, commissioning and operation, are defined in the Regulation on ensuring the safety of nuclear power plants, of 2016. Pursuant to this Regulation, the safety of a nuclear power plant is ensured by implementation of the defence-in-depth concept which is the main tool for prevention and mitigation of the consequences of accidents and is ensured by a suitable combination of:

- effective management system with a clear commitment of the plant management for providing the priority of safety and development of a high level safety culture;
- selection of a suitable site and integration of the conservative design with suitable engineering solutions, which provide for diversity, redundancy and safety margins mainly by using:
  - design, technology and materials of high quality and reliability;
  - systems and design features that control and limit the reactor installation operation;
  - a proper combination of inherent plant features and engineered safety features.
- comprehensive operating procedures and emergency management procedures.

In the design of a nuclear power plant the defence-in-depth concept is applied through providing a number of physical barriers and several levels of protection aimed at providing the protection against the effects of ionising radiation and mitigation of the consequences in the event that the preventive measures have not been successful. The number of the required physical barriers is defined on the basis of the evaluation of the inventories and isotope composition of the radionuclides which could be discharged to the environment, efficiency of the separate barriers, their vulnerability to internal and external impacts, as well as potential consequences in the event of a barrier failure.

The design of a nuclear power plant provides for independent physical barriers for every significant source of ionising radiation. The evaluation of the risks of sources of ionising radiation covers all risks caused by all the nuclear fuel at the site of a nuclear power plant as well as the risks caused by other sources of ionising radiation.

The levels of protection are designed to prevent to a degree practically achievable:

- conditions resulting in compromising the integrity of physical barriers;
- failure of a physical barrier, if there are conditions under the previous bullet;
- failure of a physical barrier as a result of the failure of another physical barrier;
- potential for adverse consequences as a result of errors during operation and maintenance of structures, systems and components (SSCs).

The levels of defence-in-depth are as follows:

- ***Level 1*** - prevention of abnormal operation and failures of the SSC important to safety, which requires conservative provisions taken through the choice of plant site, design, construction, maintenance and operation in compliance with the management system and proven engineering practice;
- ***Level 2*** - detection and control of abnormal operation to prevent development of anticipated operating occurrences in emergency conditions;
- ***Level 3*** - prevention of nuclear fuel damage and releases of radioactive materials off the site and bringing the reactor to a safe state in the event of evolution of anticipated operational occurrences and emergency sequences through the use of inherent safety features and dedicated safety systems and emergency procedures;
- ***Level 4*** - control and management of accidents that occurred at previous defence levels or caused by extreme external events until reaching a stable safe state in order to postpone in time the consequences of severe accidents. The most important task at this level is to provide for the function of confining the radioactive material within the boundaries of the containment structure, thus reducing the radioactive releases to the atmosphere to a level as low as reasonably achievable;
- ***Level 5*** - mitigation of the radiological consequences for the public caused by the radioactive releases as a result of potential emergency conditions.

When implementing the defence-in-depth, independence and efficiency at every level of defence is provided so that the loss or inefficiency of a level of defence will not affect the potential for implementation of the defence at the other levels.

The independence of the SSCs performing safety functions at different level of defence is provided by the simultaneous fulfilment of the following conditions:

- the possibility to perform the required safety functions shall not be affected by the operability or inoperability of the SSCs which are involved in the safety functions at the other levels of defence;
- the possibility to perform the required safety functions shall not be affected by the consequences of the postulated initiating events including external and internal hazards, which require functioning of the relevant SSCs.

The design should provide sufficient efficiency at the first two levels of defence in order to avoid progression into accidents of all failures and departures from normal operation, which is likely to occur throughout the lifetime of a nuclear power plant.

The systems and tools to prevent accidents with fuel meltdown shall be independent of the systems and tools specially designed to perform safety function in postulated severe accident, to a level that will not impede the performance of these functions.

The defence-in-depth concept is applied throughout all lifetime stages of a nuclear power plant. Depending on the performed activities, independent levels of defence are defined, which prevent a single technical, human or organisational error or non-conformance leading to

significant harmful consequences, while the combination of such errors or non-conformances is kept at a very low probability level.

The Regulation on Ensuring the Safety of Nuclear Power Plants specifies the requirements for design basis and safety assessments of a nuclear power plant. The design basis is required to define the necessary features of a nuclear power plant which ensure that the established limits of internal and external exposure to the personnel and the public, as well as the limits of discharges of radioactive materials to the environment are not exceeded in all operational states and design basis accidents.

The Regulation requires the design basis to define the necessary features of a nuclear power plant and its SSCs to perform safety functions to:

- ensure safe operation within the justified limits and operating conditions throughout the operating lifetime;
- confine the potential radiological impact within the boundaries of the site of nuclear power plant so that in all operating conditions and accidents without fuel melting to avoid reaching the intervention criteria for the application of protective measures for the public;
- prevent the progression of accidents and fuel melting in the reactor core and spent fuel storage pool;
- practically eliminate early or large radioactive releases to the environment;
- limit the consequences of potential releases in the event of accidents which could not be practically eliminated, confine the radioactive materials for a long period and maximum delay in time of a potential release.

The NRA developed a new Regulation on Ensuring the Safety of Nuclear Power Plants which became effective in 2016. This regulation replaced the Regulation on Ensuring the Safety of Nuclear Power Plants of 2004. The 2016 Regulation contains conceptually new safety requirements to the modern nuclear power plants. Due consideration has been given to the WENRA safety objectives for the design of new nuclear power plants, the updated (following the Fukushima accident) reference levels for safety harmonisation of nuclear power plants in operation, as well as the latest IAEA safety standards in this field. The Regulation also introduced the requirements of the Council Directive 2014/87/EURATOM, of 8 July 2014, amending the Directive 2009/71/Euratom establishing the common framework for the nuclear safety of nuclear installations.

The draft of the new Regulation on Ensuring the Safety of Nuclear Power Plants also considered the latest revisions of the IAEA standards at the time of its development (2016) referring to:

- design of nuclear installations: SSR-2/1/Rev.1 Safety of Nuclear Power Plants: Design
- construction of nuclear installations; SSG-38 - Construction for Nuclear Installations;
- safety classification of structures, systems and components: SSG-30 - Safety Classification of Structures, Systems and Components in Nuclear Power Plants;
- design of electrical power systems for nuclear power plants: SSG-34 - Design of Electrical Power Systems for Nuclear Power Plants and SSG-39 - Design of Instrumentation and Control Systems for Nuclear Power Plants.

Status with regard to the application of the defence in depth concept for all nuclear installations; ensuring multiple fuel protection levels of the containment primary boundary considering the internal and external events and the impact of the following natural events

The design of Units 5 and 6 at Kozloduy NPP were developed in the early 80s in the former USSR, based on the unified reactor design WWER-1000/B-320. The safety principles and criteria, which the original design is based on, are included in the Design Part “Technical justification of safety" (i.e. safety analysis report). The basic design principles and safety criteria are defined in compliance with the “General Provisions for Ensuring the Safety of Nuclear Power Plants during Design, Construction and Operation” - (ОПБ-88/97) (ПНАЭ Г-01-011-97), Moscow, 1998”.

The main principle incorporated in the design basis is ensuring the protection of the personnel and the public against external and internal exposure and protection of the environment against radioactive material contamination. The conservative approach was applied to the design, which provides for the inherent defence of the reactor installation. The design provides for technical measures and features focused on ensuring safety in the event of a single potential failure of a normal operation equipment, which may be combined with a long lasting hidden failure of another normal operation equipment. Simultaneously with the failure of a normal operation item, a failure of an independent active protection item and of one of the independent active confinement items is considered. The protection and confinement equipment perform their safety functions in all design accident conditions considered, including the so called “maximum possible design basis accident” and they have features sufficient to perform their functions, and triple redundancy, including of the power supply. The primary coolant circuit is located entirely in the containment structure. All penetrations in the containment walls are equipped with confinement devices, designed for separate testing of the penetrations, whose seals are capable of withstanding design basis pressure.

A combination of a sudden rupture of a steam line, loss of off-site power and the simultaneous occurrence of a safe shutdown earthquake (SL-2) is regarded as a "maximum hypothetical design basis accident" in the technical design.

The existing symptom-based emergency operating procedures (SBEOP) for Units 5 and 6 and severe accident management guidelines (SAMG) define the personnel actions for diagnostics of the unit condition, recovery or compensation for the violated safety functions and prevention or mitigation of the core damage consequences.

The used basic design principles and safety criteria, including the application of independence, redundancy and diversity, in general fulfil the main concept of defence in depth, as defined in the IAEA document INSAG-10, Defence in Depth in Nuclear Safety. The results of the safety analysis performed including accident analyses carried out using up-to-date computer programmes show that the reliable levels of protection, including maintaining normal operation, preventing accident development and mitigation of the consequences of design basis accidents are ensured. Moreover, the analyses confirm that the safety is also ensured during beyond design basis accidents without significant core damage, including anticipated transients without SCRAM. Specific components and systems are installed to reduce the consequences of beyond design basis accidents in order to protect the personnel and the public.

With regard to the external initiating events of natural origin - in the process of the stress tests conducted at Kozloduy NPP it was demonstrated that the margin of Units 5 and 6, in terms of earthquake, is 0.13 g or 65% compared to RLE (PGA = 0.2 g), i.e. the power units are capable of withstanding without fuel damage an earthquake 1.65 times stronger than RLE. The equipment important to safety and included in the emergency scenarios is analysed for seismic resistance and their fragility curves are defined. The limit values of the peak ground accelerations which nuclear facilities at the site may withstand without a severe fuel damage and radioactive release to the environment are determined. The analysis and the evaluations of the

margins during the stress tests showed that in terms of seismic hazards the SSCs performing safety functions can withstand a combination of seismic loads of up to 0.26g without loss of their functions and the cliff-edge effects and loss of stability and life may be expected for seismic effects in the range of 0.26 g to 0.33 g.

Therefore, the analysis of the beyond design basis earthquake is conservative enough and ensures that the SSCs at Kozloduy NPP in terms of their seismicity are capable of providing for the plant safety for maximum seismic effects at the site.

Also, for the purposes of stress tests the maximum water level (MWL) of the Danuve River and its duration is defined, and the potential for ice blockage of the Danube is analysed, the potential for a combination of MWL and other hazards is evaluated. The results confirm the non-floodability of the site of Kozloduy NPP.

In the frames of the 2016 periodic safety review at Unit 5 and the 2018 periodic safety review at Unit 6, in the factors for the hazard evaluation external events are postulated and then it was evaluated whether the external event may be internally initiated. In this connection, the cause and effect relationship between the hazard of tornado with frequency of occurrence of 10^{-7} and an internal event of “potential loss of nuclear fuel cooling” is evaluated and categorised as the most severe internal event due to external hazard. All remaining external hazards that are evaluated in all possible combinations of loads with any primary, secondary and cascading effects are not challenging to the plant. A cause and effect relationship between a primary internal event and a subsequent external natural event was not identified.

In compliance with the general layout of Kozloduy NPP, the infrastructure and the buildings of Units 5 and 6 are located on solid loess soil, insusceptible to collapse in the region where no mining works have been performed before. In the construction phase, unstable soils were removed and a waterproofing cover was laid on the loess base, which protects both groundwater sites and serves as a barrier - a level of protection against the spread of radioactive products to groundwater.

The relevant configuration and the pre-designed measures do not characterise the site as jeopardized by mud slides, sediments, torrential rains, and the site distance of about 450 km from the closest Black Sea in fact eliminates the hazard of tsunami. Still, it should be noted that during the performed stress tests at Kozloduy NPP, in 2011, the potential and consequences of high tidal wave of the Danube River in the event of rupture of any hydro-engineering facility, located upstream the Danube River was evaluated. It is proven that for the most unfavourable combination of conditions, the tidal wave will not cause flooding of the site of Kozloduy NPP.

Use of design principles, such as passive safety or the safe failure, automation, physical and functional separation, redundancy and diversity for different types and generations of nuclear installations

The design of SSC important to safety at Units 5 and 6 of Kozloduy NPP uses design solutions based on a passive principle of actuation, safe failure principle and inherent safety features (self-control, thermal inertia and other natural processes). The presence of inherent protection and passive elements of safety systems provides for significant safety margins for a successful shutdown and long-term reactor cooling.

The specific technical solutions applied to the design of safety system are related to the implementation of the basic requirements of the relevant normative documents – multitrain structure (redundancy), physical separation and diversity. The multitrain design enables the safety system to perform its functions despite a potential failure of a train (single failure). Automatic devices are actuated by signals generated following a comparison of several measurements in order to prevent spurious actuation of safety systems in the event of an occasional deviation during measurement. Following the safety system actuation, their operation cannot be interrupted until they have fulfilled their functions related to bringing the units to a

safe state. The trains are physically separated through their location in a separate room and use of separate cable routes. This feature provides for successful operation of the safety system, despite the failure of the trains due to internal events (fire, explosion, high temperature, flood, etc.). The diversity of the physical principles for implementing the safety system functions is applied to the design by using both active (pumps, electric valves) and passive devices (pressurised tanks, check valves), in order to eliminate the potential failure of all safety systems due to a loss of power supply (power supply, working medium, etc.). The combination of redundancy, diversity and physical separation ensures the toughness of safety systems to common cause failures.

There are no physical connections between Kozloduy NPP Units 5 and 6 which are still in operation, and the other nuclear facilities at the plant site, i.e. the spent fuel storage facilities (pool type “wet” spent fuel storage, and dry spent storage facility fuel) - they are physically and functionally separated.

Implementation of design measures or modifications to prevent beyond design basis accidents and mitigate radiological consequences in the event of a severe accident (for the entire nuclear installation including SFP)

As a result of the periodic safety reviews of Units 5 and 6, as well as of the stress tests, a number of significant changes have been made to the existing design of the units. A number of new systems have been implemented to prevent and mitigate the consequences of severe accidents. The more important among the performed changes and implemented new systems are as follows:

- installation of filtered containment venting system;
- installation of additional hydrogen passive recombiners in the containment;
- installation of service plugs made of high temperature resistant material for prevention of early containment bypass in the event of a severe accident at Units 5 and 6 of Kozloduy NPP;
- implementation of alternative SG make-up system energized by 6 kV or 0.4 kV mobile diesel generators (MDG);
- implementation of a direct water supply circuit to SG from an external source (in the process of implementation);
- implementation of power supply scheme to the reliable power supply cabinets from 6 kV mobile diesel generator;
- implementation of a battery charging scheme to the trains of safety system from a 0.4 kV MDG;
- replacement of the the accumulator batteries in the three safety systems trains;
- power supply from an accumulator battery was provided to the valves of emergency gas removal system from the primary circuit and the primary main steam relief valve between the primary circuit and hydro-accumulators, for the purpose of ensuring severe accident management;
- construction of an additional line for direct water supply to the Wet Storage Facility from an external source (diesel fire pumps or a fire truck);
- a project has been launched for hydrogen, oxygen, carbon dioxide and steam concentration monitoring designed to measure hydrogen and carbon dioxide concentration in the containment during and after a beyond design basis (severe) accident;

- modernisation of the monitoring systems qualified for beyond design and severe accident conditions and measuring the parameters within the range of severe accidents using:
  - sensors measuring the temperature at the exit of the reactor core up to 1200ºC and the coolant level in the reactor pressure vessel;
  - sensors with extended measurement range of the radiation situation within the containment, with measuring range 10^9 Bq/m^3÷10^{15} Bq/m^3; 10^{-2}÷106 Gy/h;
  - sensors for reactor vessel temperature measurement in the expected area of the maximum critical thermal flux for severe accident, with measuring range from 500 to 1300ºC.

The data from the measurement trains of these systems are entered in Safety Parameter Display System and Post-accident Monitoring System (PAMS), which are installed in the Main Control Room (MCR), Supplementary control room (SCR) and Emergency Response Centre (ERC). In connection with the installed SG emergency make-up system, in the event of total blackout accidents, measures are taken to provide for additional power supply of the system with power from the three mobile diesel generators envisaged for the two units.

The tests conducted on the new accumulator batteries following the Fukushima NPP accident show that their capacity is sufficient to provide power supply of the required consumers for up to 11 hours.

The implementation of specific measures, where necessary, to preserve the containment physical integrity to prevent continuous external contamination, and especially activities undertaken or planned for dealing with extreme weather conditions, which are not considered in the design basis

The implementation of the above measures (filtered containment venting system, service plugs made of high temperature resistant material for prevention of early containment bypass, passive hydrogen recombiners in the containment, monitoring systems qualified for the conditions of severe accidents, etc.) as well as the developed severe accident management guidelines (SAMGs) have improved to a significant extend the capacity of the containment structure to fulfil the function of “confining of radioactive products” during accident conditions corresponding to a fuel melting accident.

After the accident at the Fukushima NPP, and based on the results of the stress tests at Kozloduy NPP, the National Action Plan of the Republic of Bulgaria included a measure for "Investigation of the possibility for confinement of the core melt in the event of a severe accident”. Within this measure, a number of studies have been carried out on the potentials for localization of the melted core during a severe accident and finding suitable engineering solutions for cooling down of the melted core and prevention of reactor vessel melt-through. In this connection, Kozloduy NPP participates in international projects on the topic together with the Nuclear Research Institute (RIE) Rez, Czech Republic and Joint Research Centre (JRC), Peten, the Netherlands. The potentials for the implementation of both ex-vessel melt retention (ExVR) and In-vessel melt retention (IVR) strategies are considered.

A strategy that has the potential for success is to feed a high-flow rate coolant at the right time in the volume where the melt is located in order to retain it at the place of its generation. The chosen strategy is combined with all other strategies for severe accident management, such as pressure reduction in the core, management of conditions within the containment structure (in particular, hydrogen concentration, protection of the melt distribution and spread out paths), pressure reduction in the second circuit, water supply to the steam generator depending on the specific situation. This set of strategies is included in the Accident Management Guidelines (SAMGs) of Kozloduy Nuclear Power Plant. Following the stress tests and taking into account the lessons learned from the Fukushima accident, additional mobile facilities were installed at

the plant, which are able to provide for and support the processes of heat transfer to the physical volume where the melt has formed.

Measures have also been taken to reduce the potential for reaching the ex-vessel phase during a severe accident. Reactor level control and external temperature monitoring systems for the reactor pressure vessel have been installed, as considered in the existing Severe Accident Management Guides (SAMGs). Activities related to the implementation of additional measures, such as the direct water supply to the reactor core and the installation of measuring trains for monitoring of water vapours and oxygen concentrations in the containment, are under way.

Recent analyses of the confinement structure in the series Analysis of the civil structures with a combination of extreme meteorological phenomena at the site of Kozloduy NPP, Volume 1, General part and Analysis of the main building and diesel generator stations, show that the containment structure can withstand with a large margin various extreme load combinations caused by natural hazards, including those not accounted for in the design basis, sustaining them in any combination of primary, secondary and cascading effects.

Improvements of the design of nuclear power plants as a result of the deterministic and probabilistic safety assessments; review of the major improvements made following the commissioning of nuclear installation

Based on the results of the probabilistic safety analyses (PSA) conducted, suggestions for changes aimed at improving the safety of Units 5 and 6 at Kozloduy NPP were made in the following major areas:

- emergency procedures and training;
- planning of outages and maintenance schedules, as well as organisation and control of maintenance works;
- draft of design and process requirements;
- seismic risk analysis;
- internal and external fire risk analysis.

The main part of the performed modifications required to harmonise the units with the international recommendations for safety and reliability are the result of the implementation of the Units 5 and 6 Modernisation Programme (completed in 2008).

In connection with the implementation of the National Action Plan of the Republic of Bulgaria following the Fukushima NPP accident, Kozloduy NPP has prepared and submitted to the NRA a Programme to implement the recommendations of the stress tests conducted at the nuclear facilities of Kozloduy NPP referring to Article 6 of the National Action Plan of the Republic of Bulgaria in the wake of the Fukushima NPP accident.

Regulatory review and control activities

The licensing regime, as required by the Safe Use of Nuclear Energy Act, is implemented in compliance with the requirements of Regulation on the Procedure for issuing licences and permits for safe use of nuclear energy. The Regulation, apart from the others licences and permits, establishes the process of issuing a permit for design of a new nuclear facility and a permit for construction of a nuclear facility.

The modifications of SSC important to safety are carried out after issuing a permit by the NRA in compliance with the SUNEA and the conditions specified in the Regulation on the procedure for issuing licences and permits for safe use of nuclear energy. The Regulation defines the documents the Applicant should submit for review and evaluation. The follow-up control of the modification made is through inspections.

The process of a regulatory review and evaluation covers the following main activities:

- establish a compliance with the normative requirements of the design basis and operation of safety-related structures, systems and components;
- review and evaluation of documents submitted to the NRA in fulfilment of the regulatory requirements, conditions of the issued licences and permits and made recommendations, as well as other documentation required by the NRA;
- review and evaluation of the external independent expert evaluations, studies and researches performed;
- review and evaluation of all other documents required for making regulatory decisions for safety of the nuclear facilities.

In the course of the evaluation process, if required, and at the discretion of the Chair of the Agency, the following may be performed:

- inspection of the facility site subject to the stated activity;
- involvement of external consultants;
- support of the decision-making process by Consulting Boards at the NRA Chair.

Article 18 (2) Incorporation of proven technologies

Measures and regulatory requirements for the use of technologies proven by experience or qualified by testing or analyses

The regulatory requirements for the use of technologies proven by experience or qualified by tests or analyses are defined in the Regulation on Ensuring the Safety of Nuclear Power Plants. According to the regulation, the design solutions used in the evolutionary designs of the nuclear power plants are validated in the existing NPPs. Where this is not possible, safety is justified by the use of the results of supplementary research programmes or of the experience gained in other relevant applications. Based on the results and lessons learned from the operational experience, safety analysis and studies conducted, an assessment is made of the necessity and benefit of improving the design beyond established practice. When innovative or non-validated design solutions are introduced, compliance with safety requirements is demonstrated by an appropriate supplementary programme for preliminary experimental testing and validation of the relevant features.

All SSCs important to safety are defined and classified by safety classes based on their function and safety relevance. The classification of SSCs is carried out using a structured approach based on a combination of deterministic and probabilistic methods and supplemented by engineering assessment, if appropriate. The SSCs are designed, manufactured, installed, tested, operated and maintained in a manner providing for quality and reliability required for the relevant class.

For each safety class the following are defined:

- the appropriate standards and rules for design, manufacturing, installation and inspection;
- the degree of redundancy, the need for emergency power supply, the qualification for operation in certain harsh environmental conditions;
- the condition of functionality or unavailability of the SSC, which is taken into account in the deterministic safety analysis.

In order to ensure the required reliability, efficiency and independence of SSCs important for safety, the design should use proven in practices or experimentally tested and qualified components.

Measures taken by the licensees to use proven technologies

Kozloduy NPP has a configuration management system established ensuring the compliance between the physical configuration of the existing and the newly installed equipment in accordance with the design documentation.

Every design modification is implemented in compliance with a specific technical solution, regardless of whether hardware or software changes are involved. The specific requirements for the SSC are defined in the technical solution considering the classification and qualification of the SSCs in accordance with the regulatory requirements.

The existing integrated information system for organisation of the operating activities ensures that all phases of planning and implementation of the technical solutions are performed following a detailed and systematic review by the process owners. An assessment on the impact of the planned activities on safety is performed for every design modification.

Consideration of the international experience, engineering researches and receiving inspection performed by the authorised plant subdivisions ensures that the procured and delivered equipment comply with the requirements of the design documentation in terms of quality and reliability and it has been manufactured in accordance with the applicable standards and technologies.

Analysis, testing and experimental methods to qualify new technologies

An analysis of the compliance of the existing programmes for qualification of the equipment of the systems important to safety (SIS), whose failure may compromise specific safety functions, was performed within the periodic safety review (PSR) conducted in the period 2016-2018 at Units 5&6 of Kozloduy NPP.

For all new digital control systems, instrumentation and automation systems commissioned at Units 5 and 6 after the Seventh Review of the National CNS Reports (for example modernisation of the instrumentation and control systems of the Auxiliary Building-3; replacement of panels for visualisation of the hydroaccumulators; modernisation of panels and units for detection of independent radiation monitoring equipment; replacement of cable junction boxes, cables and terminals of qualified equipment installed in LOCA or HELB areas; upgrades of the automated system for water treatment plant (WTP) and the reagent inventories Teleperm XP, etc.), their relevant analyses were performed to prove their qualification - seismic, environmental and electromagnetic interference protection. Compliance tests with the design features including harsh working conditions are carried out (LOCA or HELB) and the results are documented in the relevant certificates, records and/or reports.

Regulatory review and control activities

The documents for analyses, inspections and tests performed are submitted to the NRA by the licensee as part of the documentation for issuing of the relevant permits for the modifications.

The Regulatory review and control of activities are described under Article 18 (1) in accordance with the existing regulations and cover the above aspects.

Article 18 (3) Design for reliable, stable and manageable operation

Overview of measures and regulatory requirements for reliable, stable and easily manageable operation specifically considering the human factor and human-machine interface

The Regulation on Ensuring the Safety of Nuclear Power Plants provides for requirements for process control. For management and control of the normal operation systems and safety systems of every power unit in a nuclear power plant main control room (MCR), supplementary control room (SCR), normal operation control systems, control safety systems and independent

data acquisition and storage equipment. There should be a potential to keep the unit in a safe state or to restore this state if required under all operating conditions and design basis accidents from the MCR. It is required that control and protection systems are designed to automatically trigger the necessary systems, including those for reactor shutdown, to ensure compliance with the design limits for anticipated operational occurrences.

The design of a nuclear power plant should consider human errors as potential initiating events and potential combinations of internal and external events based on realistic assumptions. The probabilistic safety analyses should include analysis of human errors with consideration of the factors that may influence the behaviour of the operational staff for all operational states and accident conditions. More specific normative requirements are the following:

- To take account of human factors, the design provides for:
  - automatic or passive tools for actuation and control of safety systems to the extent that no operator's actions are required within 30 minutes of the occurrence of an initiating event;
  - technical means to prevent human errors and limit their consequences, including in maintenance of the SSCs important to safety.
- The safety assessment considers consistently the human factors and man-machine interface in the design of a nuclear power plant. For this purpose:
  - the actions assigned to the operational staff have been identified to ensure safety, and analyses of operational decision-making tasks have been carried out;
  - control and monitoring equipment is sufficient to enable the operating staff to control and monitor the normal operation; easily evaluate the general condition of the nuclear power plant under normal operation, anticipated operational occurrences and accident conditions; control the reactor condition and the condition of all SSCs, to identify changes important to safety; verify the performance of the planned automatic action.
  - working areas and operating conditions are designed to take into account the ergonomics principles and allow reliable and efficient task performance;
  - the design of a nuclear power plant is human-error-tolerant to the level practically achievable;
  - all operating action to be performed for a short time are automated
  - sufficient and reliable communication is provided between the main control room and supplementary control room, local control panels and emergency response centre.

The layout of the control and operation equipment, and the visualisation of the information in the MCR should enable the operating staff to clearly and quickly determine the state and the behaviour of the power unit, adhere to operational limits and conditions, identify and control the automated actuation and operation of safety systems, as well as the operation of accident management systems.

The specific consideration of the human factor and man-machine interface is discussed in detail in Article 12.

Implementation measures taken by the licensee

All process safety systems and systems important to safety, and measures undertaken to maintain the unit in a safe state and restore this state in all deviations from normal operation are possible to be monitored and controlled from the MCR.

The safety system control, bringing and maintaining the reactor in a subcritical state, providing for heat removal from the primary circuit and SFP and control of the condition of reactor installation state is possible to be performed from the SCR.

After the modernisation of the instrumentation and control system (I&C), a new work station is installed in the SCR to monitor and control the normal operation systems. It enables the personnel to access the full information about the condition of equipment of the normal operation systems. In the unit normal operation modes, the work station functions as an information system.

In situations when the MCR is inaccessible, there is an option for a full control from the SCR not only of the safety systems, but also of the normal operation systems through the “Soft Control” function on the newly installed operator's station. The SCR equipment is physically, electrically and functionally separated from the MCR equipment.

Management and organisational aspects related to human factors are discussed in Article 12.

Regulatory review and control activities

Regulatory review and control activities are described in the text of Article 18 (1) and are carried out in accordance with the current regulations and internal rules (see also Article 7 (2) (iii)).

Article 19 Operation

Each Contracting Party shall take the appropriate steps to ensure that:

i) the initial authorisation to operate a nuclear installation is based upon an appropriate safety analysis and a commissioning program demonstrating that the installation, as constructed, is consistent with design and safety requirements;

ii) operational limits and conditions derived from the safety analysis, tests and operational experience are defined and revised as necessary for identifying safe boundaries for operation;

iii) operation, maintenance, inspection and testing of a nuclear installation are conducted in accordance with approved procedures;

iv) procedures are established for responding to anticipated operational occurrences and to accidents;

v) necessary engineering and technical support in all safety-related fields is available throughout the lifetime of a nuclear installation;

(vi) incidents significant to safety are reported in a timely manner by the holder of the relevant licence to the regulatory body;

(vii) programmes to collect and analyze operating experience are established, the results obtained and the conclusions drawn are acted upon and that existing mechanisms are used to share important experience with international bodies and with other operating organisations and regulatory bodies;

(viii) the generation of radioactive waste resulting from the operation of a nuclear installation is kept to the minimum practicable for the process concerned, both in activity and in volume, and any necessary treatment and storage of spent fuel and waste directly related to the operation and on the same site as that of the nuclear installation take into consideration conditioning and disposal.

Article 19 (1) Initial authorisation

Overview of arrangements and regulatory requirements for the commissioning of a nuclear installation demonstrating that the installation, as constructed, is consistent with design requirements and safety requirements

The Regulation on Ensuring the Safety of Nuclear Power Plants requires that the operating organisation develops Commissioning Program which covers all operational states of the NPP, the activities to be carried out at each stage and the planned duration of each stage. The results of the implementation of the Programme shall demonstrate the compliance of the safety important SSC parameters and the parameters of the NPP's technological processes with the design requirements as well as the conditions of the authorisation issued by the Nuclear Regulatory Agency for commissioning. The Programme ensures the execution of all necessary tests to confirm the compliance of the constructed nuclear power plant with the design requirements are implemented.

NPP commissioning shall be performed in successive stages and a separate programme for each stage shall be developed. The implementation of each successive stage shall be preceded by an evaluation of the results from the previous stage and confirmation that objectives and design requirements have been met. The Regulation on the Procedure for Issuing Licences and Permits for Safe Use of Nuclear Energy specifies the documents, which shall be submitted to the NRA to obtain a commissioning permit for each stage separately.

Conduct of appropriate safety analyses

Safety analyses shall be included in the Interim SAR, which is required for design approval by an Order of the NRA Chair (a licensing stage prior to commissioning). The commissioning

programme shall provide for all necessary tests to confirm the design characteristics of the NPP referred to in the interim SAR. The activities conducted during implementation of the Programme should not lead to operational states and emergency conditions that have not been analysed in the interim safety analysis report.

Commissioning programmes

Each commissioning program is based on the requirements of the SSC technical design, taking into account the results of the performed analyses (in the interim safety analysis report) and additional studies, including scientific, analysis of the accumulated experience of operation, as well as the data for the already proved technologies applied, design solutions and engineering practices.

Each stage of the commissioning programme shall include the purpose, description, safety measures, schedule for the implementation of the activities typical of the stage and a list of the test procedures. The programmes should describe:

- the sequence, timing and logical connections between activities at the stage;
- initial and final status at the respective stage;
- organisation for implementation and required staff;
- preconditions for implementation of the tests;
- requirements on technological preparation and provision of power sources and operation fluids;
- criteria for acceptability and for assessment of their fulfillment;
- the conditions for transition to the next stage.

The stage commissioning programmes provide:

- all the necessary tests to confirm the compliance of the constructed nuclear power plant with the design requirements are implemented;
- performing the tests in a logical and documented sequence;
- defining the "hold points" in the commissioning process;
- training of operating staff and validation of the procedures.

Programmes for verification that installations, as constructed, are consistent with the design and in compliance with safety requirements

Programmes for verification of SSCs are being developed as early as the conceptual design phase. Verification is performed in the harmonization process between the set design system functions and implementation of modifications in order to upgrade design capabilities. Thus the modification is followed most accurately and conservatively to verify whether the newly installed systems are in accordance with the requirements of the design and the imposed new criteria and safety requirements. Combining existing verification programmes and such that involve equipment and modifications made during subsequent stages are described and evaluated on the basis of documents (e.g., preliminary design report, notes on the design stages, research of facilities, documentation of system definition, regulatory documents, design-related procedures or practices). Verification data is documented as part of the safety assessment.

Before initial core loading with nuclear fuel, the following should be completed: SSCs important to safety and required at this stage should be installed, tested and be available; tests to determine the characteristics of the reactor coolant circuit should be carried out; biological shielding effectiveness should be tested; radiation monitoring should be carried out at the premises, the site, the precautionary action and surveillance zones.

Before reaching initial criticality of the reactor installation, functional tests of SSCs important to safety should be carried out, to confirm the fulfillment of design functions envisaged and the compliance with design characteristics. The transition from one power level to another should be performed after successful neutron-physics experiments on the reactor installation and completion of all construction and installation activities.

Following the tests and experiments at each stage of commissioning, reports shall be drawn up containing:

- description of the performed activities;
- analysis of the compliance of the design and actual characteristics of tested equipment;
- description of the defects and failures;
- analysis and conclusions about the causes and acceptability of departures of actual characteristics from the design characteristics and measures to address and eliminate them.

Regulatory review and control activities

The Regulation on the Procedure for Issuing Licences and Permits for Safe Use of Nuclear Energy requires that prior to issuing an authorisation for the performance of a single stage of the commissioning, a committee of NRA inspectors shall examine the site for compliance with the stated data and circumstances and readiness for carrying out the stage. The committee may also include representatives of other specialised control authorities. The following is carried out:

- assessment of the acceptance procedures and criteria;
- review of the implementation of these procedures;
- direct observation of the performance of key tests;
- assessment of tests results;
- confirmation of the integrity of each engineering barrier.

Based on the committee conclusions reflected in the minutes, reports produced by other specialised authorities as well as on the report on the resolved identified deficiencies, the NRA Chairperson issues a permit for the implementation of the respective stage.

Article 19 (2) Operational limits and conditions

Regulatory requirements for the definition of safe boundaries of operation

The Regulation on Ensuring the Safety of Nuclear Power Plants requires the operation of nuclear power plants to be conducted in conformity with the operational limits and conditions, in order to maintain the levels of protection of the physical barriers in a state of stand-by. Operational Limits and Conditions (OLC) shall be defined and justified by the technical design, the safety analyses, and the tests during commissioning. They shall be reviewed periodically and as necessary in order to reflect operational experience, modifications to SSCs important to safety, new safety analyses, and development of science and technology. Modifications of the operating limits and conditions should be justified through analyses of safety margins and independent verification of these analyses.

Operational Limits and Conditions shall cover all normal operation conditions, including, at power operations, sub-critical state of the reactor installation, core refuelling, all the transitional states between these modes of operation or temporary states due to maintenance and tests and shall include at least:

- safety limits;
- actuation parameters of safety systems;

- operational limits and conditions;
- testing, inspection, surveillance and operational control of the SSCs important to safety;
- minimum operational control in respective operating conditions, including qualified and experienced personnel at the main control room;
- operators' actions in case of departures from the operational limits and conditions.

When determining safety margins, a conservative approach should be used, taking into account uncertainties in safety analyses. OLC, collected in one document (Technical Specifications) shall be easily accessible to MCR staff, who shall be well acquainted with them and their technical bases. The management staff of the operating organisation must have a clear understanding of their importance to safety.

Implementation of operational limits and conditions, their documentation, training in them, and their availability to plant personnel directly involved in safety related activities

In the operation of the NPP, a system for continuous monitoring of the limits and conditions for ensuring safety is developed and implemented. Operational control for compliance with the limits and conditions of operation and their documentation is performed by the personnel in observance of the values and limits of the controlled parameters established in the Technical Specification. Administrative control to implement the operational limits and conditions is carried out by managers of the sections that operate the equipment. Observance of operating limits and deviations from normal operating states is discussed at the Chief Engineer's day-to-day operational meetings. In case of affected areas restricted by the operating limits, immediate actions are taken to restore normal operation. All those cases are documented in accordance with the operating procedures and are reported to the NRA. Violations of limits are monitored through monthly self-assessment indicators as well.

Compliance with the operating limits and conditions is an element of the safety culture of staff that is obliged to receive the necessary training in accordance with the methods and programmes for initial and continuing training. When the operational limits and conditions are modified, briefings are held, and additional training, when needed, is carried out. The process of monitoring and the performed self-assessment determine the level of safe execution of activities and document activities related to deviations from specific limits. Monitoring should include staff behaviour and their attitude towards safety, violations of OLCs, operational procedures, regulatory requirements and the conditions of operating licences.

Review and modification of the limits and operating conditions if necessary

The limits and conditions of operation are compiled in a single document - the Technical Specifications for operation. The justification of each limit, deviation range and meaning of the particular boundary is presented in the Safety Analysis Report for each individual unit. The limits and conditions presented in the Technical Specifications are readily available to MCR staff who are well familiarised with them and their technical basics.

In cases when there is a need of a modification in the safe operation limits and conditions, it is assessed as a modification with significant impact on safety. Changes in operational limits and conditions may be required by the implementation of technical modifications SSCs important to safety, by operating experience, by changes in the status of the nuclear facility, or by the analysis of significant operational events. Proposed changes shall be thoroughly analysed for possible consequences, following an approved internal procedure. Changes shall be justified and submitted to the NRA together with a request for authorisation of the amendments to the technical specifications. Certain modifications affecting specific limits and operating conditions are agreed with the Chief Designer of the reactor facility.

Regulatory review and control activities

NRA site inspectors carry out daily control on the performed activities and the adherence to the operational limits and conditions. Changes to OLC are subject to authorisation, which requires their detailed justification. In reviewing the documents, submitted to NRA with requests for authorisation for modifications to SSCs important to safety, one of the cornerstones of the analysis is the impact of the modifications on the existing operational limits and conditions.

Article 19 (3) Procedures for operation, maintenance, inspection and testing

Overview of arrangements and regulatory requirements on procedures for operation, maintenance, inspection and testing

The Regulation on Ensuring the Safety of Nuclear Power Plants requires that operating personnel shall operate the NPP in accordance with written operating instructions and procedures, developed on the basis of design and technical documentation, OLC and commissioning results. Operational instructions and procedures must be clearly identified, distinguishable according to their intended purpose and easily accessible at the MCR and, where appropriate, at other control panels. The level of completeness in them must depend on their intended purpose. Instructions must be clear and concise, as well as verified and validated. Operating procedures shall be prepared before the commissioning stage and operating personnel shall be familiarised and trained in them. The final version of these procedures is based on the results and experience of commissioning.

The operating organisation must develop testing, maintenance and repair, surveillance and inspection programmes to ensure compliance of the important to safety SSCs' operational, reliability and functionality with the design requirements throughout the entire NPP lifetime. These programmes shall take into account the operating limits and conditions and shall be reviewed considering operational experience. The maintenance programmes take into account the results of the ageing management programme and include the replacement of obsolete SSCs or those with expired operational lifetime, re-qualification of SSCs that are important to safety and the implementation of new repair technologies. The implementation of the periodic inspection, surveillance and testing programmes must confirm that SSCs that are important to safety fulfill the requirements for further safe operation or that recovery measures are required.

The control of the condition of the parent metal and the welded joints shall be carried out following specially developed procedures, at intervals the duration of which shall be determined taking into account the finding of any deterioration of the most loaded component before the failure occurs.

Control activities and tests that are not described in the Technical Specifications or operating procedures, shall be implemented using specially developed programmes and procedures, which shall be developed for each particular case.

According to the Regulation on the Procedure for Issuing Licences and Permits for Safe Use of Nuclear Energy a part of the set of documents submitted to the NRA for issuance of an operating licence shall comprise operating procedures, schedules and testing procedures and control of the systems important to safety, including operating procedure for control of the parent metal and welded joints of equipment and pipelines, a schedule for maintenance and repair of the basic equipment and an Ageing Management Programme for the duration of the licence.

Establishing of operational procedures, their implementation, periodic review, modification, approval and documentation

Kozloduy NPP Units 5 and 6 are operated in accordance with written instructions and procedures, developed on the basis of design and technical documentation, operational limits and conditions, results of commissioning tests - initial and after each outage, taking into account modifications made of SSCs and/or the operating conditions.

Operational documentation includes:

- operating procedures for SSCs, describing the composition and design functions of the technological systems, including operating procedures for start up and shutting down for maintenance of equipment and systems, including safety systems, complete procedures for scheduled switchover, for unit start-up and shut down;
- programmes and procedures for testing, maintenance, commissioning, decommissioning;
- procedures to perform various activities - procedures for reporting events, design modifications, operational relationships, practical operations, etc.;
- emergency procedures and instructions, severe accidents management guidelines;

The following requirements shall be complied with when developing, implementing, checking and updating the operating procedures and instructions:

- to cover all aspects and activities ensuring safe operation;
- to comply with the limits and conditions of operation and the requirements of the relevant supervisory authority;
- to be developed by qualified experts in accordance with the quality assurance requirements;
- to be kept up to a clear and understandable level, avoiding ambiguous interpretation;
- to be drawn up in accordance with the objectives of the design and in such a way as to ensure that work is carried out without difficulty in the necessary sequence and without further supervision.

Requirements for controlled documents in terms of format and contents, development methods, identification, coordination, approval, as well as distribution and their maintenance up-to-date are specified by quality procedures. The Documentation Management System ensures the implementation of the latest versions of the documents only. Modified documents shall be enforced into operation by the relevant ordering document.

Availability of the procedures to the relevant staff of the nuclear power plant

The operating instructions and procedures are clearly identified; they are easily accessible in the control rooms as well as in the other operating rooms. The administrative heads determine the scope of the necessary operational documentation and ensure its availability at the relevant working places. Staff shall be familiarised in detail with the contents of the instructions and procedures and the modifications thereto. The programmes and procedures for maintenance, testing, supervision and inspection shall be implemented when carrying out the relevant activities. Check-lists for step-by-step implementation and recording of results are annexed to them.

Involvement of relevant staff in the development of instructions

Operational procedures and maintenance, testing, surveillance and inspection programmes are developed by personnel with the requisite competence and knowledge in an order as specified in a quality procedure. There is a practice in place that the most experienced personnel is to be involved in the process of developing operating or test procedures. Verification and validation of operational documents is done with the participation of the operating personnel.

Incorporation of operational procedures into the management system of the nuclear installation;

Management of documents and records in Kozloduy NPP is performed by the auxiliary process "Management of documents and records" of the integrated management system. The process ensures that staff of all jobs uses the necessary documents for their activities that are

updated, clear, unambiguous, identified, have undergone the respective checks, approved through the established order. The documents are structured in hierarchical levels, determined according to their function and their area of application. Operating procedures occupy the lowest hierarchical level of the working documents which include specific details, methods and responsibilities for the execution of specific tasks by the staff.

Regulatory review and control activities

SUNEA requires a permit to be issued for changes leading to a modification of the internal rules and documents for performing the activities of the licence holder. The operating licences include an annex, which lists the operating programmes and procedures, technical specifications, emergency response procedures, metal control, radiation protection, physical protection, RAW management, radiation monitoring, organisational documents and operations management documents, whose modifications requires the issue of a permit. Permits are issued if the proposed amendments are not contrary to statutory requirements and the conditions of operating licences issued.

During the period under review, inspections were carried out for the practical application of the operating, maintenance and testing procedures in the following areas: organisation and management of controlled documents, management of the "Maintenance and repair process" by the Kozloduy NPP IMS, technical support of the periodic tests of the safety systems. Recommendations have been made for improvement and activities have been undertaken by the licensee to address the recommendations.

Article 19 (4) Procedures for responding to incidents and accidents

Overview of arrangements and regulatory requirements on procedures for responding to anticipated operational occurrences and accidents

The Regulation on Ensuring the Safety of Nuclear Power Plants requires that instructions and procedures are developed to determine the actions of personnel in normal operation, deviations from the limits and operating conditions, anticipated operational occurrences and accidents, that shall provide an adequate level of safety.

Staff actions in emergency situations occurring in all operating states are defined in the emergency procedures and in the Severe Accident Management Guidelines (SAMG).

The emergency procedures cover design basis accidents and scenarios at which significant fuel damage in the core or in the spent fuel pool could be prevented. The emergency procedures must be Symptom-based emergency operating procedures (SBEOP) and compatible with the SAMG. Emergency procedures for design basis accidents should provide guidance for reaching a stable safe state of the NPP, while and emergency scenario procedures that can prevent significant damage to nuclear fuel should provide guidance for recovery or mitigating the lost safety functions and for actions to prevent damage to nuclear fuel in the core area or in the spent fuel storage pool.

SBEOP must include diagnostics of the state regarding optimal recovery in transient modes and emergencies, status monitoring, restoration of safety features as well as conditions for transition to SAMG.

SAMG should mitigate the consequences of severe accidents in the cases when the staff actions, including the measures as defined in the SBEOP were not successful to prevent core damage or fuel damage in the spent fuel pool. SAMGs are based on scenario management strategies identified within the analysis of weaknesses and capabilities of the unit in case of severe accidents and the possible management measures, including for containment protection. In the SAMG, priority shall be given to the operation of the qualified equipment and measuring devices.

The requirements regarding the format, structure and content of SBEOP and SAMG are specified. The requirements regarding using specific data for the unit for which they are being developed are formulated Emergency Procedures shall be verified and validated by a team of independent experts. Procedures must be validated analytically using verified computer programmes and performance models for operator actions efficiency. The implementation of operators' actions shall be validated by means of simulators. Procedures shall be updated regularly, and after each modification they shall be re-validated.

Establishing of symptom based emergency operating procedures

Staff actions to diagnose the state of Kozloduy NPP units in all DBAs and a wide range of BDBAs, and for recovery or compensation of impaired safety functions, are defined in the symptom based emergency operating procedures. SBEOP are developed for unit operation at power, at low power and a sealed reactor, shut-down and depressurized reactor. They are introduced after successful verification, validation and simulator training of the staff.

Each SBEOP set includes:

- diagnostic procedure;
- procedure for operation at total blackout;
- optimal recovery procedures;
- functional recovery procedures based on control of critical safety functions and their degradation;
- procedures, regarding operation with degraded barrier, covering BDBAs.

Introducing SBEOP was preceded by a significant analytical work, justifying the critical safety functions and their degradation, as well as main and alternative operator' actions, incorporated into the procedures. The major projects are:

- International Nuclear Safety Program (INSP) of the U.S. DOE. (1997-2003), with the participation of PNNL-USA, OKB Gidropress, Energoproekt and INRNE-BAS;
- Project for "Identification of critical safety functions and their degradation at Kozloduy NPP Units 5 and 6", (2002);
- "Extension of symptom-based emergency operating procedures for applicability to all conditions determined by technical specifications (low power and shutdown unit) for Units 5 and 6 of Kozloduy NPP" (2011).

According to Kozloduy NPP internal rules, SBEOPs are regularly reviewed and updated. When performing safety analyses and safety assessments, as well as when implementing design modifications related to SBEOP, the respective changes shall be introduced in them.

In addition to SBEOP in order to eliminate disturbances in normal operation and emergency states which do not result in reactor scram activation or safety system activation, emergency procedures are developed.

Establishing of procedures and guidance to prevent severe accidents or mitigate their consequences

Kozloduy NPP has developed Severe Accident Management Guidelines (SAMG), which follow the SBEOP format and, under certain criteria, are implemented with a transition from SBEOP. The guidelines were developed in accordance with the requirements of SRS 32 - Implementation of Accident Management Programmes in Nuclear Power Plants, 2004, following the approach of SRS 48 - Development and Review of Plant Specific Emergency Operating Procedures, 2006.

The process of SAMG implementation in practice includes the development of the guidelines, their verification and validation by an independent team of table-top experts and

follow-up training for operators. Two types of SAMGs are available - one for MCR / SCR (two-column format) and one for the Emergency Response Centre (ERC) (in graphical text form - in the format of flow-charts).

The implementation of SAMG is preceded by extensive research and system analysis of processes as well as the introduced design modifications regarding severe accidents within the framework of a PHARE project. In the end of 2012, SAMGs were enforced in place, corresponding to operation in power, low power and shut down reactor with a tight primary circuit. In 2015, the scope of SAMGs was extended by introducing 5 new guidelines:

- Severe Accident Management Guidelines in Case of a Blackout at a Shutdown Unit;
- Severe Accident Management Guidelines at Depressurised Reactor;
- Severe Accident Management Guidelines in Underwater Refueling Pool at a Shutdown Unit;
- Severe Accident Management Guidelines in Spent Fuel Pool;
- Severe Accident Management Guidelines in the Containment at a Shutdown Unit.

Development of procedures and guidelines for the management of emergency situations on sites with several nuclear installations and/or nuclear facilities

In order to implement the measures of the National Action Plan, following the "stress tests", a procedure for actions of the emergency teams in case of simultaneous occurrences at various nuclear installations and facilities on Kozloduy NPP site was developed, including the organisational measures for the actions of the emergency teams of the plant, the available mobile equipment located on the site and in the PAZ, the logistics provisioning - batteries, cables, oils and diesel fuel in case of an emergency related to simultaneous events together with fuel meltdown at different various facilities on-site. The Procedure is a basic document for the activities of the emergency team at the ERC in case of simultaneous emergency occurrences at various nuclear facilities at the Kozloduy NPP site.

Regulatory review and control activities

The NRA provides methodological guidance and controls the process of developing the SBEOP from the very beginning. All the documents of the licensee related to addressing disruptions of normal operation and accidents are part of the documents on the basis of which an operating licence is issued and are subject to control by the NRA. In all cases where the licensee requests to make changes to the SSC or operational documents, it is assessed whether the change has an impact on the SBEOP or the emergency procedures.

Article 19 (5) Engineering and technical support

Availability of necessary engineering and technical support in all safety related fields for all nuclear installations, under construction, in operation or under decommissioning

The construction, commissioning and operation of the units under the conditions of long-term operation at Kozloduy NPP are carried out with engineering and technical support by Russian and Bulgarian design and construction organisations and scientific institutes as well as by the manufacturers of the equipment. The chief designer of the units is OKB "Gidropress", and the scientific supervisor is SRC "Kurchatovski Institut". The Bulgarian Design Institute "Energoproekt" is a designer of separate systems of the secondary circuit and the balance-of-plant systems.

In the last two decades, in the implementation of the programmes and measures for the modernisation of the nuclear facilities, along with the Russian engineering and technical institutes, the services of consortia of European and American organisations have also been taken advantage of.

Availability of the necessary technical support at the licensee's site and the necessary procedures to secure the most important resources for the nuclear installations

Activities related to engineering and technical support are carried out in two of Kozloduy NPP divisions - "Maintenance" and "Engineering Support". The Engineering Support Division focuses on the activities of management of modernisation and reconstruction of SSCs, safety analyses and assessments, scientifically-applied projects and research, analyses of the results of the periodic tests of safety systems and coordination of activities related to long-term operation. All engineering support activities are performed according to procedures and instructions governing the order, rules, requirements, responsibilities and interactions between internal organisational structures and external contractors.

The engineering and technical maintenance of the repair activities is carried out by the Maintenance Division. In the case of outsourcing, the Division prepares the technical specifications and assignments, performs the technical evaluation of the tender documents, supervises activities during the execution and the acceptance of the maintenance works that are carried out. These activities are regulated by internal instructions and procedures.

The resources needed to maintain the nuclear facilities are planned in the long term within the Company's Business Plan in order to supply the necessary spare parts or new equipment or to choose contractors. Tendering, contracting and supplies are managed by the Commercial division of Kozloduy NPP.

Dependence on consultants and contractors for technical support

The specific activities of scientific support, consultancy assistance and service delivery are carried out by specialised technical organisations and scientific institutes from the Republic of Bulgaria, the Chief Constructor and the Chief Designer of the units. Overhauls of conventional equipment (turbine, electric generator and pump units), maintenance of specific and non-standard equipment and measuring instruments as well as their metrological verification are carried out by specialised external organisations. Contracts were signed with the Chief Designer and the main equipment manufacturers for chief-engineering presence at the site. For the specific equipment, service contracts have also been signed.

Regulatory review and control activities

The licence for operation includes the condition that the licensee submits to the NRA the Business Plan of the Company on annual basis. Thus, regulatory control over the planned engineering and technical maintenance activities in the production, maintenance and investment programmes is carried out, both in the long-term and in the short-term (annual) plan.

"Engineering support", "Maintenance" and "SSC important for safety" are three of the main inspection areas in the NRA's long-term (three year) Inspection Programme. Control and evaluation of the planned engineering and technical maintenance activities is carried out during the inspections regarding the preparedness of the units for start-up after scheduled outages as well as in the implementation of the activities included in the integrated program for improving safety of the units.

Article 19 (6) Reporting of incidents important to safety

Overview of the regulatory requirements to report events significant to safety

The terms and conditions for obligatory notification of NRA for events significant to safety are defined in the Regulation on the Terms and Procedures for Notification of the Nuclear Regulatory Agency for Events at Nuclear Facilities, at Sites and during Activities with Sources of Ionising Radiation and in Transportation of Radioactive Substances. The Regulation classifies the events for which notification to the NRA is required in three categories - deviations, incidents and accidents. It determines the scope of events in each category, the order, timing, and notification mode. The notification format and the content requirements of the information

provided are defined. The Regulation sets out requirements for carrying out the event investigation, which aims to collect and systematise the information necessary for the successful implementation of the analysis and evaluation of the event, identification of its root causes and the implementation of corrective measures to prevent recurrence. According to the Regulation, the significance of the event in terms of nuclear safety and radiation protection is determined by the INES scale, initially by the licensee, with the final assessment carried out by the NRA.

The licensee may also notify the NRA of other events that are not classified in the three categories when they consider that these events are potentially important for the safety of the nuclear installation.

Established reporting criteria and reporting procedures for events that are important to safety, near misses and incidents

Events at the Kozloduy NPP are classified into 3 categories:

Category 1: operational events that are classified in one or more of the NRA reporting categories in accordance with the Regulation on the Terms and Procedures for Notification to the Nuclear Regulatory Agency on Events in Nuclear Facilities, Sites and Activities with Sources of Ionising Radiation and during Transportation of Radioactive substances and cover all safety-relevant events.

Category 2: operational events (failures, defects, errors, disturbances or occurrences) which are not relevant to safety and are not subject to reporting to the NRA, but have consequences for the normal operation and/or operability of the SSC and are relevant to health and safety at work.

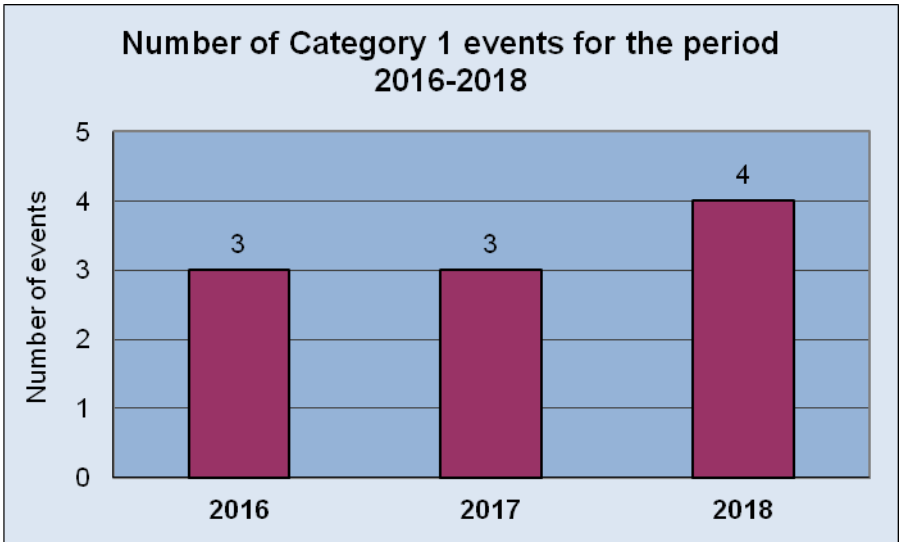
Category 3: low-level events that do not meet the criteria for events in the above two categories. For those events, registration, coding and trend analysis are performed. Near misses are also in this category - improper actions or conditions that do not in themselves lead to events, but in combination with other conditions or actions could lead to events.

The criteria and order for reporting the events of categories 1 and 2 are indicated in the Safety Procedure Manner of Reporting and Analysing of Operating Events at the Kozloduy NPP. For Category 3 events, the criteria and order of reporting and analysis are set out in the Safety Procedure for reporting and analysing low level events and near misses at Kozloduy NPP Plc.

Statistics of reported incidents important to safety for the past three years;

During the period under review for Units 5 and 6 of Kozloduy NPP, there are 10 reported events of 1st category (Annex 1), evaluated as "0" on the INES international scale. Those are distributed in the years as follows:

- 2016 – 3;
- 2017 – 3;
- 2018 – 4.



During the reviewed three-year period (2016-2018), a total of 110 events of categories II and III were analysed, 86 of which were at units 5 and 6.

Documentation and publication of reported events and incidents by the licensee of the regulatory body

Documenting

Kozloduy NPP stores all information on deviations from normal operation, incidents and accidents in a joint electronic database. The information contains a detailed description of the event, the causes, safety consequences, analyses, and corrective measures. Along with the electronic database the detailed information on the event and additional materials used to perform the analysis are stored also on paper throughout the whole operating period of the nuclear installation.

Publication

For any registered incidents and accidents, as well as for deviations from normal operation, natural disasters, industrial accidents and other extraordinary events that are of public interest, Kozloduy NPP distributes press releases to the main electronic media and information agencies; these PRs are also published on the NPP web site and in the internal information network on the same working day. Notification of the World Association of Nuclear Operators (WANO) on registered and analysed events is carried out following the Procedure for the exchange of operational events with WANO.

According to SUNEA and the Regulation of the Conditions and Procedure for Notification of the Nuclear Regulatory Agency about Events in Nuclear Facilities and Sites with Sources of Ionising Radiation and during transportation of radioactive substances the NRA provides information on events at nuclear facilities to the specialised international organisations, state bodies, legal entities and the citizens. The notices on events are published on the Agency website, in Bulgarian and in English. The NRA publishes a summary analysis and a list of the events reported by the licensees in its annual report, which is accessible on the Agency's website as well. Events are also reported in the International Reporting System of Operating Experience (IRS).

Policy for use of INES scale

Pursuant to the Regulation of the Conditions and Procedure for Notification of the Nuclear Regulatory Agency about Events in Nuclear Facilities and Sites with Sources of Ionising Radiation and during transportation of radioactive substances the significance of the event as regards safety and the level of the event are determined by the International Nuclear and Radiological Events Scale INES, initially by the licensee, and the final assessment according to

the same scale is determined by the Chairperson of the NRA. The INES User Manual is used for assessment of the events.

At Kozloduy NPP the algorithm to determine the level on INES is entered into the electronic database for analysis of events. Each record of an event analysis comprises a standard form reflecting the INES assessment and additional information, such as impact on the site and the environment, degradation of defense in depth. The events distribution according to the INES scale is used as one of the main indicators for safe operation of the plant.

Regulatory review and control activities

An Events Analysis Group was set up in the NRA, whose activity is specified in the Procedure for the operation of the Events Analysis Group in nuclear power plants. The Group is convened periodically and carries out independent analyses of the operational events, discusses the corrective actions taken by the licensee and determines the final assessment on the INES scale. If necessary, additional information is required and staff meetings are held. A database for operational events is maintained at the NRA. Events considered to be of interest to other countries are published in the IRS international system.

Regulatory inspections, before unit start-up after annual outage includes the implementation of the corrective measures for events from the previous fuel cycle and during the actual outage. The NRA's Inspection Program includes the "Operational Experience Feedback" area, which governs the reporting sequence for the events, the analyses performed, the corrective measures adopted and their effectiveness. Inspections are also performed should more significant events occur.

Article 19 (7) Operational experience feedback

Regulatory requirements to the licensee to collect analyse and share operational experience

The Regulation on Ensuring the Safety of Nuclear Power Plants requires the licensee to develop and systematically use a program for collection, analysis and documenting of internal and external operational experience, as well as of operational events at the NPP. To identify adequate improvement measures appropriately trained staff should be appointed who need receive adequate support and resources from the NPP management. The assessment of the operational experience shall detect all hidden flaws, potential preconditions and possible trends for the deteriorated performance of the activities that have an impact on safety or result in decrease of safety margins.

Operational events and deviations that are significant to safety, including near misses and low level events, shall be reported and investigated in consistence with the established procedures and criteria. In order to prevent re-occurrences and to counteract undesired trends, timely and appropriate corrective measure should be implemented, and good practices should be reported.

The information ensuing from the operational experience should be disseminated to the relevant staff, to be shared with all interested national and international organisations and to be used in the training of staff performing activities with impact on safety. Periodic reviews of operational experience feedback based on certain indicators or criteria shall be implemented within the process of self-assessment or by an independent team.

The Regulation of the Conditions and Procedure for Notification of the Nuclear Regulatory Agency about Events in Nuclear Facilities and Sites with Sources of Ionising Radiation and during transportation of radioactive substances requires the licensee to perform an operational experience analysis taking into account the operational data, information on deviations, incidents and accidents, including statistical analyses of safety indicators previously agreed with the NRA. Analyses of operational experience (feedback on operating experience) identify trends in the

behaviour of operating staff and of equipment performance and conclusions and recommendations for improvement are made.

Overview of licensee programmes for the feedback of own and others operational experience

Requirements, basic principles, responsibilities and obligations in the use of operational experience at Kozloduy NPP are listed in the procedure "Safety rules. Operating experience feedback system". A structural unit is established - Operating experience and self-assessment indicators OESAI). There is the Operating Committee to review and assess the feasibility of operational experience and the Council on operational experience (COE).

The Committee is a permanently acting body, having its meetings on a monthly basis. The Committee performs a review of the received information on external operational experience, if needed assigns an additional review by specific experts of the power plant; it makes an assessment (screening) of the proposals for corrective measures from external operational experience before they are presented for review and endorsement for implementation by the COE. The Council is a specialised advisory body with the Production Director to assist them in matters related to the improvement and development of the operational feedback system.

The feedback system consists of two main programmes, the Programme for the use of internal (home) operating experience and the Programme for the use of external (industry) operating experience.

Programme for utilization of the internal operating experience

Sources of home operating experience are operating events that occurred at Kozloduy NPP, including low level events and near misses. The main stages in the Programme for internal operating experience feedback include:

- reporting and recording of the event in the information system;
- investigation of the event;
- analysis of causes - definition of direct, indirect and root causes (for events of the first and second category);
- analysis of trends in low-level events and near misses and establishing common causes (program and organisational);
- determining the appropriate corrective actions to prevent recurrence of similar events (for 1st and 2nd category) and reducing the frequency of such events (for the third category);
- implementation and reporting on the corrective measures;
- evaluation of the effectiveness of implemented corrective measures;
- periodic review of the effectiveness of the program, including independent external evaluations (NRA, IAEA, WANO).

The events of the first and second categories are subject to root cause analysis. The events of the third category are subject to screening, classifying, coding, tracking and trend analysis. Category 3 events that are classified as "Low Level Events for Additional Analysis" are analysed in the order of Category II events.

Programme for utilization of the external operating experience

Sources of external operational experience are operational events published in the information networks of WANO and IRS-IAEA, materials from seminars and conferences, and also the established good international practices. The main stages in the Programme for external operating experience feedback include:

- initial examination (screening) of the applicability of the information published in relevant international information networks (WANO, IRS-IAEA);
- review of feasibility of selected information by the Committee for review and evaluation of operating experience (Screening Committee) and identification of relevant corrective measures;
- approval of the correctives measure by the Operating experience council;
- implementation and reporting on the corrective measures;
- evaluation of the effectiveness of corrective measures and of the programme for utilisation of external operating experience.

Evaluation of the effectiveness of the programmes for operational experience feedback is made using a system of indicators.

Procedures to analyse internal and external events

Procedures for the analysis of internal events

As stated in the text of Art. 19 (6) events in Kozloduy NPP are classified into three categories, for each category there are procedures that specify the way for reporting and analysis.

For analysis of events I and II categories the approved ASSET methodology is used and some techniques from the HPES system, as described in the Method for analysis of events and operating experience. The analysis is carried out by a committee set up for each event, which obligatory involves a root cause analysis expert. The deadlines for the analysis, as required, are 25 days for Category 1 events and 45 days for Category 2 events and Category 3 events, respectively, which are classified as “Low Level Events for Additional Analysis”.

Events of category 3 (low-level events and near-misses) are subject to daily review (screening), classification and coding. Keeping up with trends is done monthly and trend analysis on the code categories is done on an annual basis.

Procedures for the analysis of external events

Review (screening) and analysis of external events in Kozloduy NPP is carried out according to the "Procedure for exchange and dissemination of operating experience". The main evaluation criteria for the applicability of external operating experience, which is carried out by the Committee for review and evaluation of operating experience, are:

- Significant Operating Experience Report (SOER), Significant Event Report (SER);
- severe incidents or accidents and damages;
- personnel over-exposure;
- personnel traumatism;
- human error;
- VVER reactors;
- significant operational experience.

Procedures for deriving useful experience and implementing modifications in the nuclear installation or in the programmes for staff simulator or refresh training

Kozloduy NPP has established a system for the use of operational experience, which is documented in the "Procedure for the use and dissemination of operating experience." The procedure is based on the WANO and IAEA guidelines. The review of the external operational experience also includes materials coming from the personnel taking part in missions, seminars and conferences. Corrective measures are aimed at restoring, enhancing or creating new technical and/or administrative barriers in order to prevent significant events and their

recurrence. Information from operating experience (both internal and external) is disseminated among the staff. Significant internal events (I and II category) and operational experience from external events translated into Bulgarian language are published in the internal information system of Kozloduy NPP and are available to all personnel of the plant. Information from internal and external operational experience (basically, information about events) is included in pre-job briefings, in periodic and refresher training programmes and simulator sessions of FSS-1000.

Best practices identified during internal audits and self-assessments of individual structural units are disseminated among the other organisational units for information.

Mechanisms for sharing experience with other operating organisations

Dissemination of operational experience outside Kozloduy NPP is specified by the procedure "Exchange and dissemination of operational experience". The dissemination criteria are in accordance with WANO guidelines: WANO/WPG02 - Operating Experience Program Guideline, и GL 2003-01 - Guidelines for Operating Experience at Nuclear Power Plants.

The major mechanisms to share important experience with other operating organisations are, as follows;

- providing information to WANO Moscow Center on significant events occurring at Kozloduy NPP;
- publication of events occurring at Kozloduy NPP in the IAEA information system - IRS (through the NRA National Coordinator);
- providing information on issues from the WANO Moscow Centre technical queries system;
- presenting information by Power Point presentations, at international seminars and benchmarking meetings with operators operating similar reactors;
- exchange of information, experience, benchmarking through participation in IAEA and WANO missions.

Use of international information databases on operating experience;

Kozloduy NPP has organised access to the information arrays, which store information on shared operational experience from nuclear power plants - WANO database and IAEA - IRS.

The WANO database is accessed by the contact person at the plant through a dedicated VPN channel. More than 10 employees have access to the IAEA IRS database.

Notifications on significant operational experience such as SOER and SER, as well as information on targeted instruction (JIT - Just-in-Time) are translated into Bulgarian and examined shortly after their publication. The newly published information is reviewed and evaluated once a month.

The use of information is governed by the Procedure for Exchange and Dissemination of Operating Experience. The procedure determines the activities for seeking information from external sources, the responsibilities and priorities for the initial processing of the information.

Regulatory review and control of the licensee's programmes and procedures

The operating experience feedback system is subject to periodic regulatory inspections regarding organisation and implementation of activities, instructions and procedures, organisation and practice of utilizing foreign experience, information exchange channels with international organisations (IAEA and WANO), and models of operating experience dissemination among plant personnel and external organisations. The results and efficiency of the system are evaluated. "Operating experience feedback" is an independent inspection area in the NRA Inspection Program.

Every quarter the licensee submits to the NRA information on safety performance indicators. An analysis and report on the safety performance indicators are contained in the Kozloduy NPP self-assessment reports, periodic and annual reports.

Regulatory body programmes on operating experience feedback and the use of existing mechanisms to share important experience with international organisations and other regulatory bodies.

An Events Analysis Group is set up in the NRA, whose activity is specified in the Procedure for the operation of the Events Analysis Group in nuclear power plants. The group convenes periodically and reviews and evaluates events for which it has received information from the IAEA International Operational Experience Reporting System - IRS, WANO, WWER Nuclear Regulators Forum, including information from seminars, training courses, etc.

The Group performs analyses and own INES assessment of all operating events reported by the licensees and of the corrective actions they have taken. For significant operating events that would be of interest to other international organisations or regulators, an event report shall be prepared and published in the IAEA IRS system.

Article 19 (8) Management of spent fuel and radioactive waste on site

On-site storage of spent fuel

At the Kozloduy NPP site, spent nuclear fuel (SNF) is stored underwater in the reactor pools of Units 5 and 6 for a specified period, according to the supplier's requirements, which are reflected in the Technical Specification and Operating Procedures. After the specified period it is transported to the wet type storage facility (WSF). SNF storage requirements include compliance with operating conditions in terms of chemical indicators, activity, tightness of the fuel rods of fuel assemblies and the temperature of the coolant. Control over operating conditions is carried out by the operating staff of Kozloduy NPP. The WSF stores SNF from the shut down units 1-4 (WWER-440)as well as from units 5 and 6 (WWER-1000).

From the WSF, the WWER-440 SNF is sent for processing or storage at the Dry Spent Fuel Storage Facility (DSFSF). The current licence to operate the facility was issued by the NRA in 2016 for a period of 10 years. Each year, according to the approved schedule, containers of WWER-440 SNF are placed there for long-term storage while at the end of 2018 there were 13 CONSTOR 440/84 containers loaded there.

Treatment, conditioning and storage of radioactive waste

Radioactive waste (RAW) activities are carried out in accordance with the Kozloduy NPP Comprehensive Management Program for RAW. Kozloduy NPP collects, sorts, processes and temporarily stores solid RAW. Liquid RAW treatment consists of separate flow collection, chemical correction, settling, pre-treatment (evaporation, filtration) and temporary storage of the concentrate. Operational RAW unprocessed or processed are stored in the designated according to the design areas, without limiting the possible options for their subsequent treatment, exemption from regulatory control or disposal. Activities are carried out in compliance with administrative dose limits and radiation protection programmes.

Since 2005, Kozloduy NPP has adopted an approach aimed to transfer all currently generated RAW to the SE RAW for processing and gradually release the facilities from the historically accumulated RAW. RAW management activities are carried out on the basis of established administrative structures, having clearly defined statute, functions and tasks and clear allocation of rights, obligations and responsibilities of the two licensees on the site - Kozloduy NPP and SE RAW.

Activities to keep the amount of waste generated to a practicable minimum, in terms of activity and volume

In order to minimise the generated RAW, measures of organisational and technical character are envisaged in the following major directions - minimizing the quantities of RAW generated, both at source and secondary RAW; prevention of unreasonable radioactive contamination of clean materials; ensuring interrelation between the generation activities and the subsequent stages of RAW management.

The following activities are implemented at Kozloduy NPP to minimize the generated RAW:

- minimising solid RAW - limiting operational RAW, timely actions to retrieve and sort by physical and radiation indicators;
- minimising liquid RAW - organisational measures related to planning, improvement of procedures, compliance with operational safety culture, training of personnel, analyses of results;
- technical measures - control on the cleaning installations condition, separation of the oil fractions, housekeeping, recycling of boron acid.

Existence of procedures for materials exemption from regulatory control

In accordance with the requirements of the Regulation on radiation protection, activities with sources of ionising radiation that meet the following dose criteria are not regulated under the SUNEA:

- the effective dose expected to be received in one year by any person of the population shall not exceed 10 μSv;
- the effective dose expected to be received in one year by any person in scenarios with a low probability of occurrence shall not exceed 1 mSv.

Radioactive materials originating from licenced practices for which disposal, recycling or reuse is envisaged are subject to SUNEA regulation. Radioactive material shall be exempted from regulation on a case-by-case basis by order of the NRA Chairperson, in case the licensee or permit holder has submitted documents proving the compliance of the material radiation characteristics with the regulatory exemption criteria.

The Regulation on radiation protection requires that the specific activities of the radionuclides contained in the materials are determined by an accredited laboratory or an accredited inspection body.

Materials to be disposed of, recycled or reused shall be unconditionally exempted from regulation, provided that at any time for all radionuclides the sum of the ratios of their specific activities to the unconditional release levels of the respective radionuclides is less than or equal to one. If the specific activities of individual radionuclides are greater than the respective release levels, the material may be conditionally released. To this end, a preliminary justification is required as to the intent, method and area of use of the relevant materials. The NRA assesses compliance with the dose criteria on a case-by-case basis.

Kozloduy NPP prepares procedures for the release of materials on a case-by-case basis, including pre-sorting of materials, preliminary activity assessment, determination of radionuclide composition (including hard-to-measure radionuclides) by an accredited laboratory, validation of the results by an accredited authority. After completion of the procedure, the results are submitted to the NRA with a request for release of the given batch of materials from regulation.

Regulatory review and control activities

The SNF and RAW management at the Kozloduy NPP site is subject to continuous control by the NRA inspectors. In accordance with the Inspection Program and the NRA Inspection Plan, inspections are envisaged and performed in the following areas: radiation protection, management of radioactive waste and the authorised liquid and gaseous discharges during the operation of the NPP, operation, maintenance and repair activities at the WSF and DSFSF, ensuring nuclear safety in activities with containers for SNF storage of CONSTOR 440/84.

In compliance with operating licences, the NRA shall be furnished with periodic information on the RAW reporting data and the status of the temporary storage facilities, the implementation of the personnel radiation protection program and the site environmental radiation monitoring program, the nuclear material reporting data, information on the radioactive gaseous and liquid releases into the environment from the units and the implementation of the Comprehensive RAW Management Program by Kozloduy NPP Plc.

Appendix 1 – List of operating events at Kozloduy NPP reported for the period 2016 – June 2019

Date	Site	Description	INES level
5 January 2016	Units 5	Failure of a safety injection pump during a scheduled testing of a safety system train	0
11 February 2016	Units 5	Taking a train of the sprinkler safety system out of service	0
11 May 2016	Unit 6	Taking out of service a train of the fire detection and alarm and fire suppression systems for maintenance	0
22 February 2017	Units 5	Loss of power supply to a control rod of the Reactor Protection System	0
22 April 2017	Units 5	A control rod of the Reactor Protection System remains in an intermediate position during testing after the outage of Unit 5	0
2 July 2017	Units 5	Trip of the Unit 5 turbine generator	0
28 June 2018	Unit 6	Failure of a diesel generator breaker during a scheduled testing of a safety system train	0
1 November 2018	Unit 6	Taking out of service a pump of the steam generators' emergency feedwater system	0
6 November 2018	Units 5	Taking out of service a pump of the steam generators' emergency feedwater system	0
25 November 2018	Units 5	Coolant leak from a pipe of the reactor coolant purification system	0

Appendix 2 – List of the peer reviews conducted in Bulgaria

1. IAEA Assessment of Safety Significant Events Team (ASSET) Mission, Kozloduy NPP, Units 1-4, November 1990;
2. IAEA Safety Review Mission (SRM), Kozloduy NPP, Units 1-4, June 1991;
3. IAEA Operational Safety Assessment Review Team (OSART) Mission, Kozloduy NPP, Units 5 and 6, July 1991;
4. IAEA Assessment of Safety Significant Events Team Follow-Up Mission (ASSET Follow-up), Kozloduy NPP, Units 1-4, June 1992;
5. IAEA Safety Review Follow-Up Mission (SRM Follow-up), Kozloduy NPP, Units 1-4, April 1993;
6. IAEA Assessment of Safety Significant Events Team Final Mission (ASSET Final), Kozloduy NPP, Units 1-4, September 1993;
7. IAEA Assessment of Safety Significant Events Team (ASSET) Mission, Kozloduy NPP, Units 5-6, November 1994;
8. IAEA Safety Review Mission (SRM) – Modernisation Programme, Kozloduy NPP, Units 5 and 6, June 1995;
9. World Association of Nuclear Operators (WANO) Peer Review – Kozloduy NPP, Units 5 and 6, November 1995;
10. International Physical Protection Advisory Service (IPPAS) Mission, November 1996;
11. IAEA International Regulatory Review Team (IRRT) mission, NRA, November 1997;
12. IAEA Assessment of Safety Significant Events Team (ASSET) Mission, Kozloduy NPP, Units 5-6, November 1997;
13. Mission under the PHARE Programme for review of the activities associated with Probabilistic Safety Analyses, Level 1 (PSA level 1), Kozloduy NPP, Units 5 and 6, November 1998;
14. IAEA Operational Safety Assessment Review Team (OSART) Mission, Kozloduy NPP, Units 1-4, January 1999;
15. IAEA mission on preparation, validation, and verification of emergency procedures, Kozloduy NPP, Units 5 and 6, August 1999;
16. Targeted review by the Western European Nuclear Regulators' Association of the European Commission (WENRA, EC), Kozloduy NPP, Units 1-4, October 1999;
17. IAEA Safety Review Mission (SRM) – Modernisation Programme, Kozloduy NPP, Units 5 and 6, July 2000;
18. IAEA Safety Review Mission (SRM) – Modernisation Programme, Kozloduy NPP, Units 1-4, October 2000;
19. IAEA Operational Safety Assessment Review Team Follow-Up Mission (OSART Follow-Up), Kozloduy NPP, units 1-4, January 2001;
20. IAEA International Physical Protection Advisory Service Follow-Up Mission (IPPAS Follow-up), February 2002;

21. IAEA Safety Review Follow-Up Mission (SRM Follow-up) - Modernisation Programme, Kozloduy NPP, Units 3-4, October 2000;
22. IAEA International Regulatory Review Team (IRRT) mission, NRA, June 2003;
23. World Association of Nuclear Operators (WANO) Peer Review – Kozloduy NPP, Units 3-4, November 2003;
24. European Commission Atomic Questions Group (EC AQG) Peer Review – Kozloduy NPP, Units 3-4, November 2003.
25. IAEA Safety Review Follow-Up Mission (SRM) - Modernisation Programme, Kozloduy NPP, Units 5-6, 2008;
26. World Association of Nuclear Operators (WANO) Peer Review – Kozloduy NPP, Units 5-6, June 2009;
27. World Association of Nuclear Operators (WANO) Follow-Up Mission – Technical Support – Kozloduy NPP, Units 5 and 6, November-December 2011;
28. World Association of Nuclear Operators (WANO) Peer Review – Technical Support and Preparation for an OSART Mission – Kozloduy NPP, Units 5 and 6, February-March 2012;
29. IAEA Operational Safety Assessment Review Team (OSART) Mission, Kozloduy NPP, Units 5-6, November 2012;
30. IAEA International Regulatory Review Team (IRRT) Mission, NRA, April 2013;
31. IAEA mission on probabilistic safety analysis (IPSART), Kozloduy NPP, Units 5 and 6, June 2013.
32. World Association of Nuclear Operators (WANO) Peer Review – Kozloduy NPP, Units 5-6, December 2013;
33. IAEA Operational Safety Assessment Review Team Follow-Up Mission (OSART Follow-up), Kozloduy NPP, Units 5 and 6, June 2014;
34. World Association of Nuclear Operators (WANO) Follow-Up Mission – Kozloduy NPP, Units 5-6, June 2015;
35. World Association of Nuclear Operators (WANO) Peer Review for Technical Support – Kozloduy NPP, Units 5-6, March 2016;
36. IAEA International Regulatory Review Team (IRRT) Follow-Up Mission, NRA, April 2016;
37. IAEA Pre-SALTO Peer Review to Kozloduy NPP, Unit 5, 26 July – 3 August 2016;
38. WANO Corporate Peer Review (CPR) to Kozloduy NPP and BEH EAD, 31 October – 9 November 2016;
39. World Association of Nuclear Operators (WANO) Technical Support Mission on: Trend analysis in all plant operations areas – Conduct of Operations, Maintenance and Repair, Engineering Support, Monitoring and Analysis, Kozloduy NPP, 3-6 April 2017;
40. IAEA Pre-SALTO Mission to Kozloduy NPP, Unit 6, 19 – 27 June 2018;
41. World Association of Nuclear Operators (WANO) Peer Review to Kozloduy NPP, Units 5 and 6, 24 November – 8 December 2017;
42. IAEA Integrated Review Service for Radioactive Waste and Spent Fuel Management, Decommissioning, and Remediation (ARTEMIS) Mission to Bulgaria, 10-20 June 2018;

43. Member Support Mission: “Use of Instructions for Routine Maintenance Works,” WANO, Kozloduy NPP, 9-11 July 2018;

44. Member Support Mission: “Deterministic Assessment Methods,” WANO, Kozloduy NPP, 5-7 November 2018;

45. First thematic peer review: “NPP Ageing Management Review” pursuant to the requirements for conduct of thematic peer reviews in compliance with Article 8d(3) of Chapter 2a (Peer Reviews and Reporting) of Council Directive 2014/87/Euratom and the ENSREG Plan for participation of the interested countries, completed in November 2018 with the issue of a report.

46. Member Support Mission: “Operator Training Approaches,” WANO, Kozloduy NPP, 3-6 December 2018;

List of Abbreviations

NPP	Nuclear Power Plant
UNAP	Updates National Action Plan
EP	Emergency Plan
NRA	Nuclear Regulatory Agency
BAS	Bulgarian Academy of Sciences
BEH	Bulgarian Energy Holding
SFP	Spent Fuel Pool
BPS	Bank Pumping Station
MCR	Main Control Room
PSA	Probabilistic Safety Analysis
WWER	Water-Water Energy Reactor
CONTR	Contractor
VS	Ventilation Stacks
WC	Water Chemistry
PSS	Plant Shift Supervisor
FSCPGD	Fire Safety and Civil Protection General Directorate
DG	Diesel generator
DGS	Diesel Generator Station
NPT	Non-Proliferation Treaty
SE RAW	State Enterprise Radioactive Waste
EC	European Commission
EU	European Union
URS	Unified Rescue System
SUNEA	Safe Use of Nuclear Energy Act
LPZ	Long-Term Protective Action Zone
DPA	Disaster Protection Act
MIA	Ministry of Interior Act
UPZ	Urgent Protective Action Planning Zone
EPA	Environmental Preservation Act
PAZ	Precautionary Action Zone
EEA	Executive Environment Agency
IMS	Integrated Management System
INRNE	Institute for Nuclear Researches and Nuclear Energy
SIR	Sources of Ionising Radiation
EWRC	Energy and Water Regulatory Commission
SC	Safety Culture
RCA	Radiation Controlled Area
SSC	Structures, Systems, and Components
CPPNM	Convention on the Physical Protection of Nuclear Material
CNS	Convention on Nuclear Safety
IAEA	International Atomic Energy Agency
MWL	Maximum water level

MI	Ministry of Interior
ME	Ministry of Energy
MH	Ministry of Health
KIDSF	Kozloduy International Decommissioning Support Fund
MEW	Ministry of Environment and Water
CM	Council of Ministers
NIMH	National Institute of Meteorology and Hydrology
NAP	National Action Plan
NDPP	National Disaster Protection Plan
NCRRP	National Centre of Radiobiology and Radiation Protection
SAR	Safety Analysis Report
EIA	Environmental Impact Assessment
QA	Quality Assurance
SNF	Spent Nuclear Fuel
SG	Steam Generator
PIE	Postulated Initiating Events
MP	Modernisation Programme
DCM	Full-Scope Simulator
PSAR	Preliminary Safety Analysis Report
PSR	Periodic Safety Review
PLE	Long term operation
RAW	Radioactive wastes
ERM	Emergency Response Manager
RP	Radiation Protection
RB	Reactor Building
SCR	Supplementary control room
SAMG	Severe Accident Management Guidelines
SS	Safety System
SIS	System important to safety
SBEOP	Symptom Based Emergency Operating Procedure
OMC	Occupational Medical Centre
MS	Management system
QMS	Quality Management System
TLD	Thermoluminescent Dosimeter
RPCMA	Rules of Procedure of the Council of Ministers and its Administration
ICA	Inside Containment Area
WSF	Spent Fuel Storage Facility
DSFSF	Dry Spent Fuel Storage Facility
ERC	Emergency Response Centre
NS	Nuclear Safety
NF	Nuclear Fuel
NF	Nuclear Facility
NPP	Nuclear Power Plant
ALARA	As Low As Reasonably Achievable