SEVENTH NATIONAL REPORT

OF THE REPUBLIC OF BULGARIA

UNDER THE

CONVENTION ON NUCLEAR SAFETY

Sofia, 2016

CONTENTS

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 six previous meetings for national reports review, as well as in the two extraordinary meetings in 2009 and 2013, and presented its national report at each meeting, respectively. In accordance with the rules adopted for the review process, answers are promptly provided to any questions raised to the national reports. 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.bnra.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 in terms of high technology and production efficiency, competitive prices and maintaining a high level of nuclear safety and radiation protection. Ensuring the safety of nuclear facilities is a national policy of the development of nuclear energy in the Republic of Bulgaria. In this context, the paramount duty of government is the development and implementation of adequate legislation in this area. Adopted in 2002, the Act on the Safe Use of Nuclear Energy (ASUNE), amended and supplemented in 2010, 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 share (of about 32%) of nuclear energy in the electricity generation. Active effort is made towards extending the lifetime of Kozloduy NPP units 5 and 6, and opportunities for new build are being considered.

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. The Bulgarian nuclear facilities are concentrated at the Kozloduy NPP site where six power units have been built.

- ***Facilities in operation*** – Kozloduy NPP units 5 and 6 with reactor type WWER-1000, model B-320, commissioned in 1987 and 1991, respectively. Their design lifetime expires in 2017 for unit 5 and in 2021 for unit 6. The plans envisage plant lifetime extension. In accordance with the lifetime extension strategy, that foresees two stages in implementation of the planned activities, currently are conducted analysis in the second stage which indicate the potentiality for lifetime extension with 30 years.

- ***Facilities in the process of decommissioning*** - units 1-4 with reactor type WWER-440, model B-230 (units 1 and 2), and enhanced model B-230 (units 3 and 4), shut down in 2002 and 2006, respectively, in conformity with commitments undertaken by the Republic of Bulgaria during its accession to the 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 units were declared facilities for management of radioactive waste (RAW) and together with the required movable and immovable property were transferred to the State Enterprise for Radioactive Waste State (SE RAW). In 2014, the

Nuclear Regulatory Agency issued decommissioning licences for units 1 and 2, while units 3 and 4, as at the time of preparing the National Report, hold operating licences as *facilities for radioactive waste management, subject to decommissioning*. For these reasons, units 1-4 are already subject to reporting in terms of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.

- ***Facilities planned for construction on the site of Kozloduy NPP*** – 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. To launch an investment intent, a project management organisation was established, namely Kozloduy NPP - New Build plc. In August 2013, the NRA issued a site selection permit for the new nuclear unit. At the time of preparation of the National Report, the following activities have been completed: *A Feasibility Study to Justify the Construction of a New Nuclear Unit at the Kozloduy NPP Site; Survey and Selection of the Preferred Site for the Construction of a New Nuclear Power Unit; a Preliminary Safety Analysis Report (PSAR), and an Environmental Impact Assessment Report (EIA-R)*. By the time of developing the National Report, a procedure is under way for appealing the decision on EIA before the Supreme Administrative Court. In June 2015, Kozloduy NPP applied for approval of the preferred site.

Other nuclear facilities in operation on-site of Kozloduy NPP include a pool type spent nuclear fuel (SNF) interim storage facility for WWER-440 and WWER-1000 SNF assemblies, and a dry spent fuel storage facility for WWER-440 assemblies.

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 carry out the state regulation and control. The responsibilities and duties are clearly defined and allocated among the respective authorities as follows:

- *Nuclear Regulatory Agency (NRA)* – implements the State regulation on the safe use of nuclear energy and ionizing radiation and on the safety of radioactive waste management 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 regulatory requirements;
- *Ministry of Energy* (ME) - carries out the state policy on energy development and implementation of the 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 Healthcare (MH)* - implements the state policy of protecting public health and establishes mandatory health regulations, requirements and rules on all matters of hygiene, radiation protection and epidemiology. Through its specialised units, the Ministry carries out specific functions in the field of healthcare while using nuclear energy and ionising radiation. Such specialised units are the National Centre of Radiobiology and Radiation Protection (NCRRP), as well as the Radiation Monitoring departments at the Regional Healthcare Inspectorates.
- The *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 Environmental Impact Assessments.

- The *Ministry of Interior (MI)* ensures the security of nuclear facilities and related sites, identified as particularly important in terms of physical protection. The Ministry, through the General Directorate for Fire Safety and Civil Defence, coordinates the activities for protecting of the population 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 ASUNE provides that the coordination among the different authorities is within the responsibilities of the NRA Chairman.

Content and structure of the Report

The current Seventh 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 licence-holder of nuclear facilities. This report describes the State developments following the sixth meeting, and provides information on the progress of the major activities and the implementation of the measures for safety enhancement of the nuclear facilities. The report discusses in detail the safety assessments and analyses completed during the reporting period, the methodologies used, the results obtained and the major conclusions. Special attention is given to the safety improvement measures completed on the nuclear power units in operation, the programmes undertaken for plant lifetime extension, the Updated National Action Plan measures implementation, and the resolution of safety significant issues presented in the previous 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 seventh Convention review held in October 2015. Section B, Summary, presents briefly 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 implementation of the measures in the wake of the lessons learned from the Fukushima NPP accident. Section C provides information on the Convention implementation, adopting the article-by-article approach for review, while the reporting on articles 17 and 18 meets the new requirements identified at the organisational meeting.

The Seventh 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.

The following appendices have been attached to the report:

Annex 1: List of operating events reported over the period 2013-2016.
Annex 2: List of secondary legislation for implementation of the ASUNE
Annex 3: List of the peer reviews conducted in Bulgaria
Annex 4: List of systems and tools of the licensee to ensure emergency preparedness

B. SUMMARY

The current seventh National Report of the Republic of Bulgaria under the Convention on Nuclear Safety describes the State developments following the sixth review meeting, and provides information on the progress of the key activities and the implementation of the measures for safety enhancement of the nuclear facilities. The seventh 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. Nuclear energy remains the key factor of the national energy balance with a share of about 32% in the electricity generation. The Kozloduy NPP units 5 and 6 with reactor type WWER-1000, model B-320, are in operation. Their design lifetime expires in 2017 for unit 5, and in 2021 for unit 6. The plans envisage operational lifetime extension for the both units. 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. The design company Kozloduy NPP - New Build plc was established. In August 2013, the NRA issued a site selection permit for the new nuclear unit. Possibilities for construction of a new nuclear unit are being considered.

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

Review and amendment of relevant secondary legislation

Once the amendments to ASUNE became effective in 2010, a review was performed of all the regulations on the implementation of the Act, and some of them were amended and supplemented, while others were issued as new regulations.

Over the years 2014-2016, three regulations were amended and supplemented while another two were issued as new ones:

- *Regulation on the Conditions and the Order of Gaining Professional Qualification and the Order of Issuance of a Licence for a Specialised Training and Individual Licences for the Usage of Nuclear Power;*
- *Regulation on the Procedure for Issuing Licences and Permits for Safe use of Nuclear Energy;*
- *Regulation on the Conditions and Manner of Implementing Transport of Radioactive Substances;*
- *Regulation on the Terms and Procedure for Transfer of Radioactive Waste to the Radioactive Waste State Enterprise (a new one);*
- *Regulation on Providing Physical Protection of Nuclear Facilities, Nuclear Material, and Radioactive Substances (a new one).*

Drafts for four regulations have been developed:

- *Regulation on Ensuring the Safety of Nuclear Power Plants (a new one);*
- *Regulation on the Rules, Norms and Technical Requirements for the Arrangement and Safe Operation, and the Conditions for Exercising Control on High-risk Facilities Important to Nuclear Safety (a new one);*

- *Regulation on the Terms and Conditions of Defining Special-Status Zones around Nuclear Facilities.*
- *Regulation on Ensuring the Safety in Decommissioning of Nuclear Facilities (a new one).*

The draft for a new *Regulation on Ensuring the Safety of Nuclear Power Plants* introduces conceptually new requirements for safety of modern NPPs. Due consideration has been given to the WENRA safety goals for new NPP designs, and the updated after the Fukushima NPP accident reference levels for safety harmonisation of NPPs in operation, as well as the latest IAEA safety standards in this field. The draft of this Regulation introduces the provisions of the Council Directive 2014/87/EURATOM, of 8 July 2014, establishing a Community framework for the nuclear safety of nuclear installations. Due consideration has also been given to the latest revisions of IAEA standards regarding: site selection for nuclear facilities, design, construction, commissioning and operation.

In 2015, a draft was prepared of the guideline for *Periodic Safety Review (PSR) of Nuclear Power Plants*. The document specifies the instructions for applying regulatory requirements to the process of PSR conduct, and the scope of the individual safety factors.

Issues important to safety

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:

Lifetime Extension of Kozloduy NPP Units 5 and 6

The project for *Lifetime Extension of Kozloduy NPP Units 5 and 6 (PLEX Project)* consists of two major stages:

- *Stage 1:* Comprehensive Assessment and Residual Lifetime Evaluation of the Equipment and Facilities of Kozloduy NPP Units 5 and 6 (2012-2014)*;*
- *Stage 2:* Implementation of the Programme for Preparation of Unit 5 for Service Lifetime Extension, *(2014-2017) and the* Programme for Preparation of Unit 6 for Service Lifetime Extension *(2016-2019).*

The Stage 1 activities have been completed for both units over the time period 2012-2014. The preliminary results from the residual lifetime evaluation of irreplaceable components show that operation is practicable for at least the next 20-year period. As a result of the comprehensive assessment, specific technical and organisational measures are identified for the second stage lifetime extension preparatory programmes that foresee the following:

- replacement of components that have reached the end of their service lifetime;
- further analyses and justifications of the residual lifetime of irreplaceable components;
- amending the components maintenance, repair and operation procedures in view of their long-term operation.

The actions from the second stage are under implementation at the present moment. The further analysis and justifications of the residual lifetime of irreplaceable components indicate the potential for lifetime extension with 30 years.

Periodic safety review of units 5 and 6

For the licence renewal of units 5 and 6 (in 2017 and 2019, respectively), Kozloduy NPP undertakes *Periodic Safety Review* (PSR) for service lifetime extension. To this effect, in 2014, a

set of methodological documents was prepared and agreed with the NRA to regulate the PSR conduct process. Currently, the actual review of safety factors and the results global assessment is under way. Within the PSR a conformity analysis is performed of the existing programmes for qualification of equipment and systems important to safety, the failure of which may lead to failure of certain safety functions. The reports from the safety review performed are expected to be submitted to the NRA by the end of 2016.

The units 5 and 6 safety assessment and analysis will include update of the Level 1 PSA, taking into account all the design changes made since 2010, and all external events specific for the plant site.

The delivery of the two projects - *Plant Lifetime Extension* and *Periodic Safety Review*, is a precondition for the operating licence renewal of each of the two Kozloduy NPP units.

Thermal power uprate to 104%

In 2015 were licensed the major part of the modifications to SSCs on unit 6, related to the transition to operation at higher thermal power (104%). In 2016, the modifications and comprehensive tests are under implementation. The positive outcomes from the functional tests, as well as from the safety analysis report are preconditions for transition to operation at a higher thermal power rate. It is expected that the implementation of the *Programme for Thermal Power Uprate of Unit 6* will be completed by the end of 2016. At unit 5 the functional tests will be completed by the end of 2018.

Transition to enhanced nuclear fuel cycle on unit 6

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 TBCA-12. A review process is under way on the submitted documentation about the fuel assemblies and safety assessment for normal operation conditions with thermal power uprate to 104%Nnom and emergency conditions.

Implementation of the Updated National Action Plan after the Fukushima NPP accident

The NRA controls the implementation of the Updated National Action Plan through the Kozloduy NPP quarterly progress reports on the 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 2016, of a total of 77 measures 58 (75 %) have been completed and 19 are in progress.

Approval of the site selected for the construction of a new nuclear unit

A decision of the Council of Ministers, dated 2012, provided an approval in principle for the construction of a new nuclear unit on the site of Kozloduy NPP. In August 2013, the NRA issued a permit for site selection to the project management company *Kozloduy NPP-New Build plc* In the time period following the sixth National Report issuance, social and economical analyses were carried out on the necessity of constructing a new nuclear unit; an environmental impact assessment (EIA) was prepared; and studies and analyses were performed for the precise siting in the vicinity of the current Kozloduy NPP. The results from the studies for site re-evaluation are included in the preliminary SAR, and they have been verified by a team of independent experts. The NRA has undertaken a review and assessment of the Preliminary SAR submitted. The regulator's decision on the site selected is expected to be made by the end of 2016.

Safety significant issues addressed in the previous CNS review

The sixth review of CNS reported on the progress made in implementing the measures planned in the fifth 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 (rapporteur's report). This report reviews the performance of these measures, and their status is described in detail, as appropriate, in the body text of the individual articles, namely:

- the measures arising from the Kozloduy NPP Units 5 and 6 Periodic Safety Review in 2009 have been completed;
- SAMGs have been put in place for a shutdown and depressurised reactor, and the spent fuel pools, and the programme for preparing of SAMG for units 5 and 6 has been implemented (articles 14, 19);
- the review has been completed of the secondary legislation after the amendments to the ASUNE of 2010 (article 7);
- a full-scope national emergency exercise was conducted in November 2014, in cooperation with the IAEA (articles 9, 16);
- a Pre-SALTO review mission on unit 5 has been scheduled to take place in the period from 26 July through 03 August 2016 (article 6);
- additional hydrogen recombiners have been installed on units 5 and 6, in order to ensure the recombination of hydrogen generated in case of a severe accident (article 18);
- designs have been developed for installation of a system for volumetric measurement of the concentration of gases and steam in the containments of units 5 and 6 under severe accident conditions; the projects have been scheduled for implementation in 2018 (article 18);
- a survey has been completed on the possibility of using the existing stand-by and emergency feedwater system of units 3 and 4 as a redundant alternative system for units 5 and 6;
- a study is in progress on the possibilities of localisation of core melt under severe accident conditions (articles 6, 14);
- evaluation has been made of the liquid RAW generated under severe accident conditions and of the adequacy of the measures available for preventing their release to the environment (article 6);
- the licensing process is ongoing for site approval for the new nuclear unit (articles 14, 17);
- the operator has been performing the NRA approved activities and programmes for extending the lifetime of units 5 and 6, and renewal of their licences in 2017 and 2019 (articles 6, 14);
- the operator has been implementing the activities scheduled in the project for thermal power uprate of units 5 and 6 (article 14);
- the NRA action plan resulting from the IRRS mission in 2013 has been implemented; a follow-up mission was conducted in April 2016; (article 8);
- the periodic safety review for lifetime extension of unit 5 is under way (article 14);
- an OSART follow-up mission was held in 2014 (article 6).

International inspections 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. Over the years 1990 – 2016, more than 35 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 is provided in Annex 3). 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 is provided on the results from international reviews conducted over the years 2014-2016, and the plans for the coming three-year period.

OSART follow-up mission in 2014

An OSART follow-up mission was conducted in July 2014. The OSART mission team in November-December 2012 submitted three recommendations and eight suggestions for further improvement of operational safety. By the time of the follow-up mission, 73% of the problems were fully resolved, while for the remaining 27% satisfactory progress was demonstrated. The review team concluded that the plant management had had a considerable benefit from the OSART mission, while for the implementation of corrective measures it had used the IAEA safety standards and benchmarking activities with other NPPs. Some of the corrective measures are of a larger scope than envisaged in the OSART mission recommendations and suggestions. The plant readiness and motivation to discuss new ideas for safety enhancement are obvious, and they are an explicit indicator of the potential for further improvement of the operating safety of Kozloduy NPP.

WANO follow-up mission in 2015

A WANO follow-up Peer Review of Kozloduy NPP was conducted in June 2015. The main review in November - December in 2013 identified 6 good practices and 2 strengths, as well as 14 areas for improvement. The follow-up peer review assessed the effectiveness of the corrective actions developed and the progress made in the areas for improvement. The progress in 9 of the areas was graded level A – problem resolved. The remaining 5 areas for improvement were graded level B – a considerable scope of work has been completed. The WANO team highly evaluated the work performed by the plant after the initial review and the NPP personnel who demonstrated professionalism and openness during the review mission period.

Second workshop of ENSREG for peer review of the progress on the Updated National Action Plan

In April 2015, a second workshop was held in Brussels for peer review of the progress on the implementation of the measures of the Updated National Action Plans. The review concluded that the Bulgarian National Action Plan embraced in a systematic way all the elements envisaged by ENSREG and described the status of each of the measures. Considerable progress was demonstrated during the workshop and it was confirmed that, overall, the plan had been implemented to schedule. Several good practices were identified.

Follow-up IRRS mission in 2016

The IAEA follow-up mission was conducted in the period 12-18 April 2016, to review the implementation of the recommendations issued by the major IRRS mission in 2013 for review of regulatory activities in Bulgaria (Full Scope Integrated Regulatory Review Service). The review covered the NRA, the Ministry of Healthcare, and the National Centre of Radiobiology and Radiation Protection (NCRRP) at the Ministry of Healthcare in terms of their responsibilities for the radiation protection of patients, personnel and public.

According to the Follow-up IRRS mission report, 13 out of 15 recommendations and 31 out of 34 suggestions made from the IRRS mission in 2013 have been incorporated and are considered completed. Two new suggestions have been added.

The general conclusion of the mission is that the Nuclear Regulatory Agency has made a considerable progress on the implementation of the recommendations of 2013, and has demonstrated serious commitment for implementing the IAEA standards.

WANO technical support mission in 2016

In March 2016, Kozloduy NPP hosted a technical support mission (TSM) of WANO–MC on Best Practices of Pre (Post)-Job Briefing for Maintenance Activities. The WANO experts performed walkdowns, observations and interviews at the nuclear power plant. The mission ended with a preliminary report presented to the plant management.

The following international reviews have been scheduled for the coming three-year period:

SALTO review missions for units 5 and 6

In the context of activities for lifetime extension of units 5 and 6, Kozloduy NPP has initiated the conduct of IAEA SALTO 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 – 04 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.

A WANO Corporate Peer Review in 2016

From 31 October through 9 November 2016, Kozloduy NPP will host a WANO Corporate Peer Review. The review will cover the following areas: leadership, management, control and surveillance, independent surveillance, support and work performance in the corporation, human resources in the corporation and communications in the corporation.

The objective of the review is to check the interaction of the Bulgarian Energy Holding corporation with the personnel of the nuclear power plant as per the document "*Performance Objectives and Criteria*", *March 2013, PO&C 2013-1*.

The reports from the OSART and IRRS peer reviews are uploaded respectively on the web pages of Kozloduy NPP and the NRA.

Lessons learned from the Fukushima NPP accident and the measures undertaken

As a result of the stress tests performed and the lessons learned from the accident at the Fukushima NPP, a number of measures have been implemented to enhance the nuclear facilities resistance to extreme external impacts, prevention of severe accidents and mitigation of the consequences thereof.

To ensure the safe condition of nuclear facilities during disasters affecting the entire site and the surrounding infrastructure, measures have been completed to evaluate the potential damage on the regional road infrastructure in case of extreme off-site impacts (SSE or flooding). The reliability has been assessed of the transport routes ensuring access of machinery, supplies and personnel to the NPP. Routes have been identified for the on-site movement of emergency equipment, as well as alternative routes for transport of supplies and emergency response teams. Implementation is under way of the UNAcP measure for constructing a Remote Emergency Centre on the territory of the town of Kozloduy.

Additional measures ensuring enhanced resistance of the plant to off-site flooding have been performed:

- An emergency response procedure has been developed for a potential dam wall collapse of “Zhelezni Vrata 1" or “Zhelezni Vrata 2" Hydroelectric Power Stations;
- The protection functions of the dyke in the area of Kozloduy lowlands have been improved;
- Measures have been undertaken to protect the equipment at BPS-2 and BPS-3 in the event of off-site flooding with maximum water level;
- Implementation is nearly complete of a project to prevent the water penetration to the plant sewage network while flooding the lowlands;

At the end of 2015 was completed the analysis of extreme weather conditions on Kozloduy NPP site using probabilistic methods as per the IAEA methodology. Within the scope of this measure, the bearing capability was assessed of the civil structures on-site of the plant. The assessment results showed that no additional engineering measures were necessary to support SSCs important to safety.

The reassessment, performed within the stress tests, of the safety margins in events with loss of safety functions leading to severe accidents, demonstrated good resistance of the facilities and adequate time margins for undertaking of protective actions. To ensure additional safety margins, the following measures have been implemented:

- supplied two new 0.4 kV mobile DGs in addition to the mobile 6 kV DG available on the plant site;
- scheme for recharging of anyone battery per unit of the safety systems by a mobile 6 kV DG;
- scheme for recharging of anyone battery of unit 5 by a mobile 0.4 kV DG via a new 0,4 kV power supply bus; at unit 6 this measure will be completed during the outage in 2016;
- scheme to power anyone reliable power supply bus 6 kV at unit 5 by mobile 6 kV DG. At unit 6 this measure will be completed during the outage in 2016.
- power supply scheme for the spent fuel pools feed water systems by a mobile 0.4 kV DG;
- power supply scheme for the primary circuit feed water system in shutdown (cold) state and reactor low pressure in the event of a failure of the emergency DGs, by a mobile 6 kV DG or mobile 0.4 kV DG;
- power supply scheme for the SGs make up system in the event of a failure of the emergency DGs, by a mobile 6 kV DG or mobile 0.4 kV DG;
- additional feed water pipeline from a mobile device to the spent fuel pools;
- under implementation is a design for alternative feed water supply to the SGs from a mobile device.

In 2014, the analysis was completed of the processes during severe accident with shutdown and open reactor and in the spent fuel storage fuel pool. On the grounds of this, the scope of SAMG was expanded with five new guidelines, and in 2015, the programme for developing and introducing of SAMGs for units 5 and 6 was completed.

Estimates of the volume of radioactive effluents generated in case of a severe accident, and the adequacy of the existing design tools and volumes, and available measures to prevent their discharge to the environment under severe accident conditions demonstrate that the design configuration ensures their retaining within the containment in the initial phase of a severe accident. Regarding the actions in the interim and late phases of the accident, the volume of tanks available on-site for storage and reprocessing of radioactive liquids are sufficient.

The investigation on the possibilities of using the units 3 and 4 SGs Complementary Emergency Feedwater System (CEFS) as an auxiliary alternative system for residual heat removal from units

5 and 6 showed that the CEFS performance features are insufficient and the system will not have any significant contribution in case of an accident on units 5 and 6.

On the grounds of the stress tests performed, and the conclusions drawn from the subsequent emergency drills, and in implementation of the NAcP measures, reassessment was performed of the Kozloduy NPP On-site Emergency Plan, emergency procedures and the arrangements in place for plant response actions in case of simultaneous events involving fuel melt in various nuclear facilities on-site. The *Procedure on Organisation and On-call Performance to Ensure the Emergency Planning of Kozloduy NPP* has been updated. The emergency response team numbers have been increased to provide for replacement of the emergency response teams in case of a severe accident involving all the facilities. The adequacy of technical means available on-site for dealing with simultaneous events with fuel melt down has been assessed. Under development is a *Procedure on Action of the Emergency Response Teams in Case of Simultaneous Events at Different Facilities On-site.*

In November 2014, a national full-scope exercise was conducted entitled "Defence 2014 - A severe accident at Kozloduy NPP- accident management and mitigation of consequences". The overall conclusion is that the current response organisational measures and technical means in the *Kozloduy NPP On-site Emergency Plan* are sufficient for management of simultaneous events with fuel melt down at various facilities on-site. Specific actions have been identified for improvement of the management bodies' activity and the response teams of the Unified Rescue System (URS), and they will be included in current update of the *Off-site Emergency Plan* for Kozloduy NPP.

Implementation of the principles of the Vienna Declaration on Nuclear Safety, adopted on 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 NPP accident.

The national policy, legal and regulatory framework in the field of the use of nuclear power complies with the EU legislation, the IAEA 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 States 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 European good practices. Transposition was effected of the provisions of the Council Directive 2009/71/EURATOM for establishing a Community framework for nuclear safety of nuclear installations, and now are being effected the provisions of the Council Directive 2014/87/EURATOM from 8 July 2014.

In this context, the paramount duty of government is the development and implementation of adequate legislation in this area. Adopted in 2002, amended and supplemented in 2010, the *Act on the Safe Use of Nuclear Energy (ASUNE)* 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 EU legislation and standards and the safety guides of the IAEA. Following the ASUNE 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 performing a programme for review and update of the secondary legislation. For instance, the amendments to the draft new *Regulation on Ensuring the Safety of Nuclear Power Plants*, described in the section entitled: *Review of the Secondary Legislation* in summary.

Activities are currently under way for ageing management review and residual lifetime evaluation of the SSCs, and preparation of a programme for extension of their operating lifetime in conformity with the applicable regulatory requirements and the international operating experience. Also, the *Updated National Action Plan (UNAcP)* is currently implemented, in the wake of the Fukushima NPP 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 primary circuit and containment boundaries, so as to mitigate the consequences of severe accidents, and bring the reactor installation under control.

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

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.

Future challenges

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

- Implementation of the UNAcP;
- Implementation of the Programme for Preparation of Unit 5 for Operating Lifetime Extension (2014-2017) and the Programme for Preparation of Unit 6 for Operating Lifetime Extension (2016-2019);
- Periodic Safety Review of Units 5 and 6 in view of their operating lifetime extension;
- Extending of the operating lifetime of unit 5 and renewal of its operating licence in 2017;
- Thermal power uprate of Units 5 and 6;
- Transition to enhanced nuclear fuel cycle (advanced nuclear fuel, TBCA -12 type);
- Licensing of a new build.

C. Reporting Article By Article

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. The Bulgarian nuclear facilities are concentrated at the Kozloduy NPP 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 the commitments undertaken by the Republic of Bulgaria during its accession to the EU.

Nuclear facilities in operation

Units 5 and 6 of the WWER-1000/V320 reactor type were put into operation in 1987 and 1991, respectively. In 2009, Kozloduy NPP obtained renewed licences valid until November 2017 for unit 5, and October 2019 for unit 6. The strategic objective of the licensee is the safe extension of the operating lifetime of both units, whose design operating lifetime will expire in 2017 for unit 5 and 2021 for unit 6. Kozloduy NPP plans envisage operating lifetime extension for the both units.

Facilities related to the SNF safe storage

Other nuclear facilities in operation on-site of Kozloduy NPP include a pool type spent nuclear fuel interim storage facility for WWER-440 and WWER-1000 SNF assemblies, and a dry spent fuel storage facility (DSF) for WWER-440 assemblies. The SSF has been operated in accordance with the operating licence issued by the NRA in 2014 with a validity term of 10 years.

In November 2011, the NRA issued a commissioning permit for the DSF where the first six casks have been loaded for long-term storage. Since January 2016, a 10-year validity operating licence has been issued for the facility. Kozloduy NPP is the licence-holder for both spent fuel storage facilities.

Review of the issues important to safety

Issues important to safety

The implementation of the safety upgrading programmes for the Kozloduy NPP, and of the *National Action Plan* following the Fukushima NPP accident, is aimed at resolving a number of issues important to the plant safety, the more significant of which include as follows:

- A justification of the safe operation of Units 5 and 6 in relation with the plans for transition to enhanced nuclear fuel cycle (advanced nuclear fuel, TBCA -12 type), and thermal power uprate to 104 %;

- Comprehensive assessment of the actual condition and residual lifetime evaluation of the equipment and facilities at units 5 and 6 in view of extending their operating lifetime;
- Implementation of major actions of the National Action Plan in relation to the Fukushima NPP accident, such as:
  - Power supply scheme for the spent fuel pool cooling and feed water systems by a mobile diesel generator;
  - Construction of a Remote Emergency Centre outside the Kozloduy NPP;
  - Installed additional hydrogen recombiners within the containment;
  - Study the possibilities for corium retention in case of a severe accident;
  - Evaluation of the volume and measures for preventing the release of liquid RAW effluents generated in case of a severe accident;
  - Implemented a technical solution for preventing the early containment bypass in case of a severe accident;
  - Power supply schemes for recharging anyone battery per unit of the safety systems by a mobile DG;
  - Assessment of the possible damages under extreme external impacts on the regional road infrastructure surrounding the plant.
- Update of PSA level 1, for operation at full power, low power and with shutdown reactors of units 5 and 6, also expanding its scope to include consideration of possible internal and external hazards characteristic of the Kozloduy NPP site, including the mutual impact among the units;
- PTS analyses of the set leaks at the primary circuit and transients with loss of residual energy removal mode for the PSA defined operating conditions for a shutdown reactor at units 5 and 6.

Events reported to the NRA from 2013 to June 2016

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 Kozloduy NPP. A total of 21 events have been reported for units 5 and 6, and one for the DSF, all of which have been rated level 0 as per INES. The use of the results from operating events assessment and analysis, as well as the corrective actions, as elements of the operating experience feedback system are described in article 19 (7) of the current document. Annex 1 contains a list of the events reported.

Programmes and measures planned for the continuous safety enhancement

Kozloduy NPP implements programmes for continuous improvement of safety envisaging measures resulting from the following:

- National Action Plan for harmonisation of the safety of reactors in the WENRA member-countries;
- National Action Plan ensuing from the conducted stress tests in the wake of the Fukushima NPP accident;
- Licensing conditions and prescriptions of the Bulgarian NRA;
- Recommendations of international missions and reviews.

All the measures have been compiled in a general *Programme for Maintaining and Enhancing of Safety of Kozloduy NPP*, which is subject to updating in the beginning of each calendar year in compliance with current regulatory requirements, international requirements and operating experience.

Kozloduy NPP stress tests

Over the July-October period in 2011, stress tests were performed on the nuclear facilities located on-site of Kozloduy NPP. A Summary Report on the stress tests conducted was submitted to the NRA on 28.10.2011. In late December 2011, the NRA forwarded to the EC the *National Report of the Republic of Bulgaria on the Stress Tests at Kozloduy NPP*.

In connection with the results from the stress tests conducted at Kozloduy NPP, a *Programme for Implementation of the Recommendations Ensuing from the Stress Tests* is under way.

Peer review

Following the submission of the *National Report of the Republic of Bulgaria on the Stress Tests at Kozloduy NPP,* in late 2011, ENSREG initiated in the beginning of 2012 a series of peer reviews to cover all national reports.

National action plan for the Republic of Bulgaria

In response to the requirement of the EC Council of June 2012, and the subsequent joint initiative of ENSREG (European Nuclear Regulators' Group) and the EC for comprehensive and timely implementation of the measures ensuing from the stress tests conducted, Kozloduy NPP together with the NRA developed the *National Action Plan 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 NAcP, Kozloduy NPP prepared a *Programme for Implementation of the Recommendations Ensuing from the Stress Tests Conducted.*

In January 2014, the NRA updated the NAcP and issued a new revision thereof, where in the complementary Section IV, reports were provided on 10 new measures.

In December 2014, the countries fulfilling the European stress tests developed *Updated National Action Plans* (UNAcP), which reflected the occurring changes, the current status and progress of the measures planned. The NRA prepared and published the UNAcP with the complementary Section IV "Update to the National Action Plan", with the number of measures totalling 77. An electronic copy of this Plan is available on the NRA web page (http://www.bnra.bg/bg/facilities/stress-tests/Kozloduy /NAcP-bg-2015-bg.pdf).

In April 2015, a second ENSREG workshop was held in Brussels for peer review of the progress on the implementation of the measures of the Updated National Action Plans. The review concluded that the *Updated Bulgarian National Action Plan* embraced in a systematic way all the elements envisaged by ENSREG and described the status of each of the measures. Considerable progress was demonstrated during the workshop which confirmed that overall the plan had been implemented to schedule. Several good practices were identified.

The NRA monitors the UNAcP implementation through analysing the quarterly reports submitted by Kozloduy NPP. The performance of the measures is also supervised during the performance of different types of inspections related to the NRA oversight activities.

The implementation of UNAcP measures has been ongoing in the current year 2016. At the beginning of 2016, out of a total number of 77 measures 58 (75 %) have been completed, while 19 are in progress.

WANO mission

From 22 November through 6 December 2013, Kozloduy NPP hosted a WANO Peer Review mission. The review areas were: organisation and administration, operation, maintenance, technical support, operating experience, radiation protection, chemistry, training and qualification, fire safety and emergency planning and preparedness. A review was also performed on the corrective actions from the WANO Significant Operating Experience Reports, SOERs, ranging from SOER 1998-1 to SOER 2013-1. The review was performed by a team of 23 experts from 7 countries. The review formulated 6 good practices and 2 strengths. The number of areas for improvement was 14.

A WANO follow-up peer review of Kozloduy NPP was conducted from 22 to 26 June 2015. The purpose of the follow-up review was to assess the effectiveness of the corrective measures developed and estimate the level of problem solving (areas for improvement), as reflected in the official final report of the main peer review.

The WANO team highly evaluated the work performed up to the time of the review by the plant and the NPP personnel who demonstrated professionalism and openness during the review mission period.

OSART mission

From 26 November to 13 December 2012, an IAEA OSART Mission was conducted on units 5 and 6 at Kozloduy NPP. The IAEA experts performed a thorough review of the operating safety indicators, on the basis of the IAEA safety standards. The review areas were organisation, administration, and management, operation, maintenance, technical support, operating experience feedback, radiation protection, chemistry, fire safety, and emergency planning and preparedness.

The mission team appreciated the determination of the management and personnel to enhance plant operational safety and reliability, and acknowledged the systematic approach to implement measures to achieve and maintain high safety standards. The peer review issued recommendations and suggestions for the areas where Kozloduy NPP performance can be improved. Good practices were also identified to be disseminated for information to the countries operating nuclear power plants.

The follow-up OSART mission at Kozloduy NPP was held from 23 to 26 June 2014. The review team assessed the actions taken to analyse and resolve the problems identified during the primary mission. The follow-up mission concluded that all the suggestions and recommendations made had the status of “resolved” or “satisfactory progress” made.

Plant Lifetime Extension

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).

The primary requirements to be satisfied in order to continue the operation of units 5 and 6 are as follows:

- Evaluate the residual lifetime of the systems, structures and components (SSCs) which will remain in operation, and the SSCs required to be replaced with new ones;
- Provide a justification for the new operating lifetime;
- Develop and implement a programme for preparation of the respective unit for operational lifetime extension.

To satisfy these requirements a project was launched entitled *Service Lifetime Extension of Kozloduy NPP Units 5 and 6 (*PLEX Project*)*, to be delivered in two major stages:

- Stage 1: Comprehensive assessment (ageing management review) and residual lifetime evaluation of the equipment and facilities of Kozloduy NPP units 5 and 6 (2012-2014);
- Stage 2: Implementation of the Programmes for Units 5 and 6 preparation for lifetime extension (2014 – 2017 for Unit 5, and 2016 – 2019 for Unit 6).

Stage 1 has been completed for both units. The activities were delivered in the years 2012-2014 by JSC Concern Rosenergoatom and Electricite de France, against a contract awarded for: Comprehensive Assessment and Residual Lifetime Evaluation of the Equipment and Facilities of Kozloduy NPP Units 5 and 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 that have reached the end of their service lifetime;
- further analyses and justifications of the residual lifetime of irreplaceable components;
- amending the components maintenance, repair and operation procedures in view of their long-term operation.

The measures for the operating licences renewal of units 5 and 6 are covered by the programmes for preparation of the units for lifetime extension developed by Kozloduy NPP and agreed by the NRA. The activities for equipment replacement or comprehensive assessment are integrated in the annual outage schedules for each of the power units. The plant business programme for 2014-2019 has envisaged the corresponding financial resources to ensure the project delivery as a priority one for the company.

Unit 5 Lifetime Extension Project

Regarding unit 5, a total of 264 measures have been envisaged and included in the Project Management Plan for lifetime extension, of which:

- 145 measures in the areas of Mechanical Equipment, Electrical Equipment and I&C, and Civil Structures are included in the Programme for Preparation for Lifetime Extension of Kozloduy NPP Unit 5. These are safety related measures, subject to control by the NRA and serve for justification of the unit lifetime extension. Their implementation was launched in 2014 and will be complete after the unit 5 outage in 2016;
- 97 short-term measures that do not affect the unit 5 operating lifetime and are not subject to supervision by the NRA;
- 22 measures related to safety and envisaged for implementation in the next licensing period.

The measures for time limited ageing analyses and residual lifetime assessment of major and auxiliary equipment of the unit 5 reactor equipment are delivered within the scope of a contract placed with a Consortium comprising: CJSC Rusatom Service, OJSC Concern Rosenergoatom and JSC Electricite de France (EDF) with the subject of: Development of a Feasibility Justification for Kozloduy NPP Unit 5 Lifetime Extension to 60 Years: Analyses, Calculations and Quantitative Assessment of the Residual Lifetime of SSCs. The same contract contains measures related to the assessment of the containment, the reactor building (RB), the diesel generator station (DGS) and electrical channels between the DGS and RB, as well as assessment of underground trunk pipelines and spray ponds.

It envisages the development of 252 deliverables including methodologies, programmes, calculations and conclusions. The assessment was accomplished according to a SSCs Assessment Plan during the 2015 Annual Outage and the Inter Outage Period through 56 programmes.

All the assessment activities planned have been delivered to scope and schedule. The results from the activities accomplished have been described in certificates and reports on the works completed. The final close-out reports are expected to be issued in September 2016.

Unit 6 Lifetime Extension Project

Regarding unit 6, a total of 226 measures have been envisaged and included in the Project Management Plan for lifetime extension, of which:

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

To carry out part of the measures involving analyses, calculations, time-limited ageing analyses for estimating the residual lifetime of major and auxiliary equipment of the unit 6 reactor plant, Kozloduy NPP has 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).

SALTO review missions for units 5 and 6

To confirm the Kozloduy NPP preparedness for lifetime extension of units 5 and 6, Bulgaria has initiated the conduct of an IAEA SALTO review mission. In November 2015, the first preparatory mission was held with IAEA representatives and the scope and organisation of the mission were defined:

- Pre-SALTO mission on unit 5 in the time period 26 July – 03 August 2016;
- Pre-SALTO mission on unit 6 in 2018;
- SALTO mission in 2020;
- Follow-up SALTO mission on units 5 and 6 – dates to be defined.

Nuclear facilities shut down for decommissioning

This category of nuclear facilities includes the Kozloduy NPP units 1 to 4. 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 Radioactive Waste State Enterprise (SE RAW). The spent nuclear fuel has been removed from the reactor ponds and transported to the wet storage facility (WSF).

In November 2014, the NRA issued a licence to SE RAW for the decommissioning of units 1 and 2. As per the decommissioning licence for units 1-2, and the licence for operation of units 3-4 as a RAW management facility, SE RAW effects management of the legacy waste backlog, preparations for the decommissioning of units 3-4 including dismantling part of the radiologically non contaminated equipment.

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 recognized problems with reactor type WWER-1000. Activities are currently under way for ageing management review and residual lifetime evaluation of the SSCs, and preparation of programmes for extension of their operating lifetime in conformity with the applicable regulatory requirements and the international operating experience. Implementation is continuing of the *National Action Plan in the Wake of the Fukushima NPP Accident*, as a result of the European stress tests conducted, and in conformity with the IAEA Nuclear Safety Action Plan.

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

Act on the Safe Use of Nuclear Energy

The fundamental Act in the field of safety of nuclear installations is the *Act on the Safe Use of Nuclear Energy (ASUNE).* ASUNE 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 *Act on the Safe Use of Nuclear Energy* was adopted in 2002. It conforms to current trends in nuclear legislation including the legislative practices in the EU countries in the area in question. In 2010, the ASUNE 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 Physical Protection of Nuclear Material.

Related national legislation

According to the ASUNE, 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 Transport and Communications, Education and Science, Youth and Science, 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.

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 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. Transposition was effected of the provisions of the Council Directive 2009/71/EURATOM for establishing a Community framework for nuclear safety of nuclear installations and currently under transposition are the provisions of the Council Directive 2014/87/EURATOM of 8 July 2014.

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 accident, in Japan.

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

Secondary regulatory legislation

The ASUNE article 5 (17) provides that the NRA shall develop and submit to the Council of Ministers (CM) for approval any secondary regulatory legislation 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. A list of secondary legislation on the application of ASUNE is provided in Annex 2.

In conformity with the national legal requirements, the NRA policy statement confirms that "the NRA will update the legal 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 regulatory legislation.

Over the years 2014-2016, three regulations have been amended and supplemented while another two have been issued as new ones:

- Regulation on the Conditions and the Order of Gaining Professional Qualification and the Order of Issuance of a Licence for a Specialised Training and Individual Licences for the Usage of Nuclear Power;
- Regulation on the Procedure for Issuing Licences and Permits for Safe Use of Nuclear Energy;
- Regulation on the Conditions and Manner of Implementing Transport of Radioactive Substances;

- Regulation on the Terms and Procedure for Transfer of Radioactive Waste to the Radioactive Waste State Enterprise (a new one);
- Regulation on Providing Physical Protection of Nuclear Facilities, Nuclear Material, and Radioactive Substances (a new one).

The regulatory document drafts preparation has considered the changes made to international conventions and agreements, the new legislation of the European Union, and the new or modified documents of the IAEA, as well as the experience accrued from the practical implementation of the Act and regulations

Drafts for three new regulations have been prepared:

- *Regulation on Ensuring the Safety of Nuclear Power Plants, updated;*
- *Regulation on the Rules, Norms and Technical Requirements for the Arrangement and Safe Operation, and the Conditions for Exercising Control on High-risk Facilities Important to Nuclear Safety, a new regulation;*
- *Regulation for the Terms and Conditions of Defining Special-Status Zones around Nuclear Facilities.*

The draft for a new Regulation on Ensuring the Safety of Nuclear Power Plants introduces conceptually new requirements for the safety of modern NPPs. 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 draft of this Regulation introduces the provisions of the Council Directive 2014/87/EURATOM, of 8 July 2014, establishing a Community framework for the nuclear safety of nuclear installations. Due consideration has also been given to the latest revisions of IAEA standards regarding: Design of Nuclear Installations SSR-2/1/Rev.1; Construction of Nuclear Installations SSG-38; Safety Classification of Structures, Systems and Components in Nuclear Power Plants SSG-30; Design of Electrical Power Systems and Instrumentation and Control Systems for NPPs SSG-34 and SSG-39.

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 ASUNE 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 seventeen regulatory guides, ten of which concern the safety of nuclear facilities.

In 2015, a draft was prepared of the guideline for *Periodic Safety Review (PSR) of Nuclear Power Plants*. The document specifies the instructions for applying regulatory requirements to the process of PSR conduct, and the scope of the individual safety factors.

In order to ensure broad distribution and easy access to the regulatory guides, they are published in electronic format on the NRA web site www.bnra.bg. 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 course of updating the secondary regulatory legislation, a draft has been developed for a new revision of the Regulation on Ensuring the Safety of Nuclear Power Plants. The draft considers the WENRA safety goals for new plants, and the revised reference levels for existing reactors safety harmonisation, updated following the accident in the Japanese Fukushima NPP. The draft for a new Regulation is currently being approved by ministries and other state authorities. The next step is to submit it to the CM.

Article 7 (2) (ii) System of Licensing

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

The ASUNE defines the scope of activities, facilities and materials subject to licensing. A licence is issued to operate a nuclear facility (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 as follows:

- siting of a nuclear facility, design, construction, and commissioning;
- 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;
  - the limits and conditions for safe operation on the basis of which the operating licence has been issued;
  - internal rules for the activity, including procedures, programmes, technical specifications attached to the operating licence;
- transport of nuclear material;
- business transactions with nuclear facilities;
- import and export of nuclear material;
- transiting of nuclear material.

The licence or permit, the change thereof, or the refusal of the NRA Chairman to issue the respective document is subject of appeal in the Supreme Administrative Court.

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 ASUNE.

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 Act on the Safe Use of Nuclear Energy 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 regulatory control by issuing licences and permits for activities under the Act and for issuing individual employment licences;
- Current regulatory control over the implementation of the conditions of licences and permits and individual employment licences as issued under the ASUNE;
- Confirmatory control to verify compliance with the recommendations or directives issued by the control authorities.

In executing of the controlling powers, the NRA Chairman shall:

- Conduct planned and reactive inspections through authorised officials;
- Notify other specialised control authorities to undertake actions within their competence range;
- Notify the prosecuting authorities upon evidence of any criminal offence being committed;
- Amend or revoke the issued licences or permits, or individual employment licences;
- Imposes administrative enforcement measures and administrative penalties as provided under the ASUNE.

The NRA Chairman is entitled to require provision of information or documentation from persons related to their relevant activities and, if necessary, to request assistance from specialised control bodies.

The overall objective of the regulatory inspections and application of enforcement 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 inspection plan includes the areas of regulatory control identified by the ASUNE and the conditions of the currently effective licences and permits. The inspection activities are planned by taking into account the operating 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 Kozloduy NPP - 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 the secondary regulatory legislation so that the planned measures shall be acceptable to both parties. Enforcement 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 Kozloduy NPP 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 ASUNE provisions, in accordance with their powers of authority. These inspectors have the right to:

- Free access to the regulated licensees and sites, at any time, to inspect nuclear safety, radiation protection and the technical condition of the nuclear facilities and the ionising radiation sources;
- Require from the competent officers any data, reports, explanations, operational and other information, including measurements and tests in order to clarify the technical status and the operating conditions of the facility, including staff qualification, and any other information related to ensuring the nuclear safety and radiation protection;
- Issue written statements on administrative infractions under this Act;
- Propose to the NRA Chairman for amendment, suspension, termination or revocation of permits, licences or individual employment licences issued;
- Issue mandatory written directives for ensuring of nuclear safety and radiation protection.

The inspection results are recorded in an inspection report (report of findings), to which the evidences 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 the 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 currently during the implementation of the activity. The process of review and assessment of documents supporting the application for issuance of a licence/permit can be summarised in the following principal steps:

- Receipt and registration of the application and its supporting documentation;
- Specifying a programme and a team of experts to review and evaluate the documentation and, in some cases, specifying the methodological instructions for the task;
- Revision and assessment of the application and the supporting documents for compliance with the requirements in force, and, where appropriate, to the applicable documents of the IAEA or other regulatory authorities. If necessary, the applicant is required to submit additional information for the purpose of assessment;
- The results of expert evaluation are summarised and documented, and on the basis of the conclusions a proposal is made to the NRA Chairman either 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 contract external consultants for additional review and assessment. The experts from the respective departments engaged prepare the ToR for the expertise and participate in its adoption procedure.

When a non-compliance with the safety requirements is identified in the submitted documentation, detailed comments are sent to the applicant for their incorporation. In such cases,

there is a practice to organise meetings with representatives of the applicant in order to discuss and clarify questions and comments.

The current review and assessment of the compliance with the requirements for nuclear safety and radiation protection is carried out through review and assessment of licensee reports on operating parameters, and operating events, and through on site 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 to 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 or radiation protection requirements have been violated. The regulation also defines the sequence and time-limits for notifying the regulatory body, the methodology 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 events 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. In case of events important to safety, NRA inspectors participate in the event investigation teams.

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

To prevent and discontinue administrative violations and to prevent and mitigate their consequences, the NRA Chairman imposes sanctions (property sanctions and fines) and administrative enforcement measures. The ASUNE provides different amounts for the sanctions, depending on the type of violation. The ascertainment of violations, issuance, appeal and enforcement of penalty decrees are made in the order specified by the Law on Administrative Violations 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. Enforcement administrative measures that may be imposed in these cases are:

- Termination or limitation of the activity for which a permit or licence has been originally issued;
- Suspension of the individual employment licence;
- Order issued to the licensee to carry out expertises, inspections or tests, modification of established operating limits and conditions; modifications of design and structures; review and modification of training programmes and courses and conducting of additional training, including verification of personnel knowledge and skills.

Enforcement administrative measures are imposed through an order of the NRA Chairman, based on a report of findings of NRA inspectors. The order imposing enforcement measures shall determine appropriate time for their implementation. Any order for imposing enforcement administrative measures shall be appealed before the Supreme Administrative Court under the provisions of the Administrative Procedure Code. Any appeal shall not suspend execution, unless the court has ruled otherwise.

Any violation of the conditions of a permit or licence is considered an administrative violation for which the person who committed the violation receives a fine or property sanction in an

amount determined by the ASUNE. Any non-compliance with or violation of a permit or licence conditions as per the ASUNE 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 applies the envisaged in ASUNE enforcement administrative measures and issues penalty decrees solely when all other possibilities have been ineffective. The regulator policy effectiveness is confirmed by the small number of penalty decrees issued and enforcement administrative measures 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 organization 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 organization. In 1957 was established a Committee for the Peaceful Use of Atomic Energy, 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 1985 was adopted the first *Act on the Use of Nuclear Energy for Peaceful Purposes*. The Act created a Committee for the Use of Nuclear Energy for Peaceful Purposes and determined in detail the functions and the tasks of the organization, establishing also an Inspectorate on the Safe Use of Nuclear Energy.

The Act was amended several times until 2002 when it was fully repealed by the new *Act on the Safe Use of Nuclear Energy (ASUNE)* The ASUNE 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 Nuclear Regulatory Agency (NRA), which is a politically and financially independent regulatory authority.

Legal basis and status of the regulatory body

The statute and responsibilities of the Nuclear Regulatory Agency are set by the *Act on the Safe Use of Nuclear Energy*. The state regulation of the safe use of nuclear energy and ionizing 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 specialized body of the executive power. The NRA Chairman is designated by a decision of the Council of Ministers and appointed by the Prime Minister for 5 years mandate and may be appointed for one more term of office. In exercising his powers, the Chairman is assisted by two deputy-chairmen, who are designated by a decision of the Council of Ministers and appointed by the Prime Minister, upon a motion by the NRA Chairman.

Mission and objectives

The regulatory functions carried out by the NRA in the public interest, determine the organization's mission, namely: “Protection of the individuals, public, future generations and environment from the harmful effects of ionizing 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 recognized regulatory best practices.

In accordance with the objectives, plans, priorities and expected challenges 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 organization or if the risk analysis outcome needs to be considered.

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

Authorities and Responsibilities

Under the ASUNE, the NRA Chairman 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 ASUNE;
- Supervise compliance with the requirements and standards for safe use of nuclear energy and ionizing radiation, radioactive waste management and spent nuclear fuel and the conditions of the licences and permits issued;
- Issue and revoke individual licences for employment at nuclear facilities or with sources of ionizing radiation;
- Undertake enforcement measures and impose administrative penalties as provided by the ASUNE;
- Assign external expertise, studies and research related to nuclear safety and radiation protection, in respect of the use of nuclear energy and ionizing radiation, and in management of radioactive waste and spent nuclear fuel;
- Interact with the other competent authorities, which have been granted regulatory and control functions in respect of the use of nuclear energy and ionizing radiation, and propose to the Council of Ministers measures to coordinate such activities;
- Carry out the international cooperation on behalf of the Republic of Bulgaria in regards of the safe use of nuclear energy and ionizing radiation, and the safety management of radioactive waste and spent nuclear fuel;
- Provide the public, legal entities and state authorities with objective information on nuclear safety and radiation protection;
- Submit annually 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 in the management of radioactive waste and spent nuclear fuel, as well as the activities of the NRA;
- Organize 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;
- Organize and coordinate the implementation of the obligations under the Agreement between the Republic of Bulgaria and the International Atomic Energy Agency in implementation of the NPT of Nuclear Weapons, as well as the Additional Protocol to the Agreement;
- Perform the functions of a competent authority and a 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;

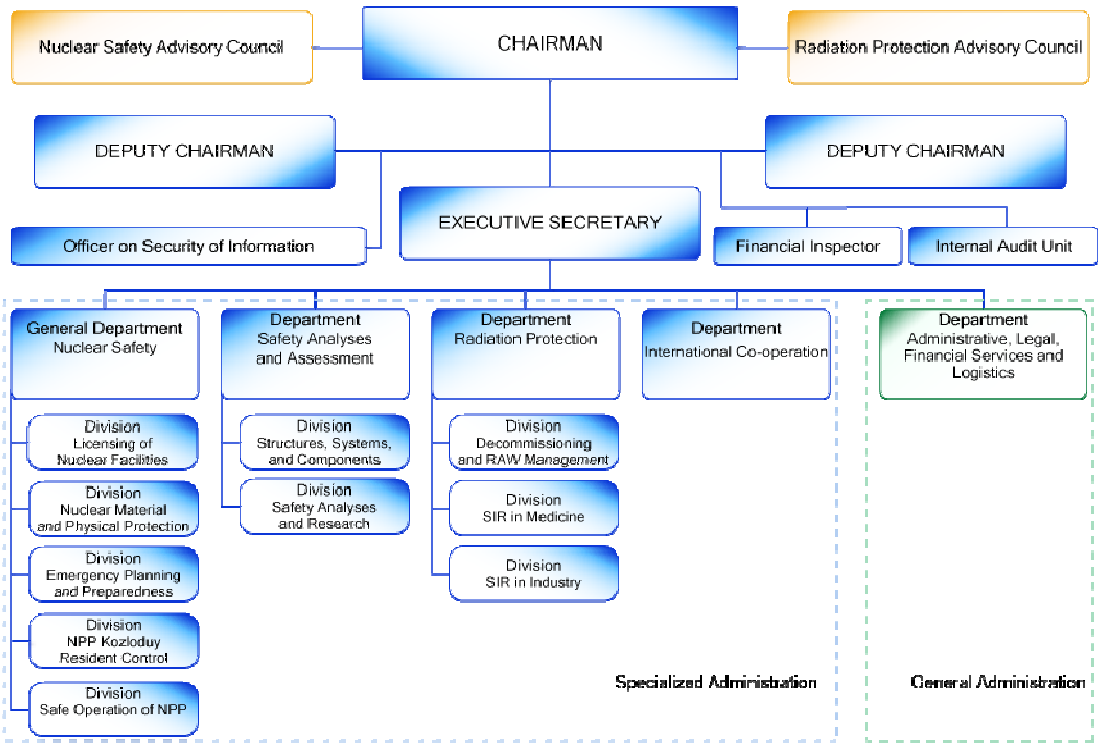
- Act as the competent authority point of contact and coordinator under the Convention on the Physical Protection of Nuclear Material;
- Develop and submit for adoption to the Council of Ministers the Regulations on the implementation of the *ASUNE.*

The *ASUNE* 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 Chairman shall exercise other authorities as may be entrusted thereto by the national legislation.

Organisational structure

According to the *ASUNE*, the NRA Chairman is assisted by an Administration organized in a Nuclear Regulatory Agency which is a legal entity, funded by the state budget and with headquarters in Sofia. The structure, operation and work organization of the Agency and its staff are determined by Rules of Procedure, adopted by the Council of Ministers upon a proposal by the NRA Chairman.

The NRA structure is consistent with the Administration Act, which sets out uniform requirements for the structure of the administrations in the country. The structure takes account of all activities of the regulatory authority, under the powers vested to the Chairman by the national legislation. The NRA Administration is headed by an Executive Secretary. The NRA employees are divided into general and specialized 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 Specialized Administration is organized into four Directorates and assists the Chairman in carrying out his regulatory and control functions related to nuclear facilities, sources of ionizing radiation, nuclear material, radioactive waste, emergency preparedness and international cooperation and includes a regional office at the Kozloduy NPP site. The NRA organizational structure is shown on the figure herein:



Development and maintenance of human resources

The responsibilities of the NRA staff 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 have university education (Masters' Degree) and long 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 staff positions, and as at June 2016 the NRA human resources number is 101 of actually employed staff. Regardless of the NRA's efforts to employ experts for the vacant positions, there are 13 vacancies at present. Analysis confirms that this is due mainly to the high requirements to the professional competence and expertise of the candidates, as well as the considerable difference between the remuneration rates payable by the Agency and by the basic licence holders.

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

Measures to develop and maintain competence

NRA applies a consistent approach to increase the performance effectiveness of the employees, and to achieve the organizational strategic objectives. Efforts are focused primarily in the following areas:

- Improvement of the system for planning of activities and the necessary human resources;
- Further development of the succession system;
- Improvement of the system for development of professional skills and qualifications of employees, and conduct an effective training and qualification policy;

- Effective and efficient use of leadership skills of senior staff;
- Encouraging the development of teamwork in the organization performance and ensuring responsibility and accountability in planning and execution of tasks; etc.

To fulfil its public responsibilities and functions, the NRA establishes and maintains a level of competence that secures regulatory decision-making.

In 2015 the NRA developed and implemented a new *Procedure for qualification and training*. The procedure defined the policy and objectives in the area of qualification and training of staff and formalizes the processes of training and qualification enhancement.

Financial resources

The financial independence of the regulatory body is secured by the Act on the Safe Use of Nuclear Energy. Under the Act, the NRA activities are financed from the state budget, and revenues from fees collected under the ASUNE. The NRA is a primary manager of budget funds, which means that it draws its own budget that is directly negotiated with the Ministry of Finance. As a result, in recent years, there has been stability in the financing of the organization.

Quality Management System

To meet its mission of protecting human health, the public, future generations and the environment from harmful effects of ionizing radiation, the Nuclear Regulatory Agency develops, implements, and continuously improves a Quality Management System (QMS).

The QMS has been developed on the basis of the IAEA standards.

The QMS documents are divided into four main levels, as follows:

- Level 1 - Documents determining policy and quality objectives, and how to achieve them;
- Level 2 - Procedures defining the NRA policy and basic principles for implementation of activities;
- Level 3 - Work Instructions, giving detailed directions on how to plan and implement activities;
- Level 4 - Guides to support the implementation of procedures and instructions or perform the tasks and related documents.

In accordance with the NRA policy the QMS is an open and live system that reflects changes to international standards in the area in a timely manner. Following the adopted new IAEA safety standards, which reflect the integrated management system concept, the NRA has been taking appropriate actions to comply with the new requirements.

In the course of the last three years, the existing quality management system (QMS) was further developed into an Integrated Management System (IMS). The compliance of the QMS with the requirements of the IAEA Safety Standard *IAEA GS-R-3, 2006 "Management System for Facilities and Activities*" has been reviewed and measures implemented to eliminate non compliances. The structure and processes of the IMS, necessary for the NRA policy implementation and achievement of the strategic goals, including performance indicators, are determined.

Openness and transparency

The public 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 a lot of and various 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 ionizing radiation sources, licences for specialized training and individual employment licences for activities with SIR or work on nuclear facilities.

At the web address: 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 the events on nuclear facilities or events with SIR. It is one of the tasks of the organization 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 experts and the language of the public on such important topics is a challenge. For that purpose the NRA regularly organizes training seminars for journalists, traditionally attended by representatives of all national media, as well as the public relations officers of the organizations concerned.

External technical support

The NRA has a specialized organizational unit for review and assessment of nuclear safety and radiation protection. This unit works in close cooperation with the rest of the specialized units, 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. The NRA maintains a data base of the engineering organizations with capabilities in different technical areas. The NRA is fully responsible for the regulatory decision-making, and has provided human and financial resources to secure the efficient 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 assessment reports, awarded to external organisations;
- Availability, within the NRA and at the engineering organisations of necessary assessment tools and computer codes to carry out the assessments;
- Sufficient financial resources to sign on contracts;
- Access of the NRA staff to new developments in science and technology;
- Continuous improvement of staff competence 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 ASUNE, two advisory councils are established in support of the NRA Chairman:

- 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 Chairman or by an authorized representative. The Advisory Councils support the NRA Chairman by giving advice on scientific aspects of nuclear safety and radiation protection. Their standpoint 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 of NRA priorities;
- Discuss and give standpoints 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 Chairman in preparation of the national reports under the international conventions and treaties;
- Assist the communication and exchange of information and expertise, including international experience among the experts in 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 Chairman.

Pursuant to the provisions of Article 9 of ASUNE, the Advisory Council's staff is appointed by an order of the NRA Chairman. The advisory councils include prominent Bulgarian scientists and experts in the field of nuclear energy and ionizing radiation, management of radioactive waste and spent nuclear fuel. The members of the Advisory Councils have rich academic, research or operating experience in various aspects of nuclear safety and radiation protection.

Article 8 (2) Status of the regulatory body

Place of the regulatory body in the governmental structure

In terms of Article 4 of the ASUNE, and Article 19, Paragraph 4 of the Law on Administration, the Chairman of the Nuclear Regulatory Agency is considered an executive authority. As such, the Chairman 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 ionizing 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 ASUNE).

As an independent regulatory body within the system of the executive power, the NRA Chairman reports directly to the Prime Minister. In addition, the NRA Chairman 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.

International regulatory review service

Upon the request of the Government of the Republic of Bulgaria, from 11th to 18th April 2016, a team of leading international experts conducted a Follow-up Mission to review the implementation of the recommendations of the main Full-Scope Integrated Regulatory Review Service in Bulgaria, conducted in 2013. The mission team consisted of 9 experts (leading experts from IAEA member states and IAEA staff members). On behalf of the Bulgarian institutions in the mission took part representatives of the NRA, the Ministry of Health (MH) and the National

Centre of Radiobiology and Radiation Protection (NCRRP) at the Ministry of Health (MH) with regard to their responsibilities for the radiation protection of patients, personnel and the public.

The mission reviewed and assessed the implementation of the recommendations of 2013. According to the Follow-up IRRS mission report, 13 out of 15 recommendations and 31 out of 34 suggestions made from the IRRS mission in 2013 have been incorporated and are considered completed. Two new suggestions have been added.

The main conclusion of the mission is that the Nuclear Regulatory Agency has achieved significant progress in the implementation of the recommendations from 2013 and has demonstrated serious commitment to implement IAEA standards. The international experts also noted that the team of the Bulgarian regulator has been very open in discussions and has provided full support to the team partners. The mission was a unique opportunity to exchange information and experience among the team members and their colleagues from the NRA and the Ministry of Health.

Article 9 Licence Holder Responsibility

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 licence holder to ensure the safety of nuclear installations is regulated by the *Act on the Safe Use of Nuclear Energy*, the *Regulation on ensuring 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 *ASUNE* 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.

One of the fundamental principles specified by the *ASUNE* states that "nuclear energy and ionizing 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 both present and future generations, environment and property against the harmful effects of ionizing radiation. In art.3 (2) is introduced the principle that 'the responsibility for ensuring nuclear safety and radiation protection, rests entirely with the persons responsible for the facilities and the activities, and may not be delegated to other persons.

According to art.5(1) of the *Regulation on ensuring the safety of NPPs:* 'The operating organization holds 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 specialized regulatory authorities, in the field of nuclear energy and ionizing radiation'. The same Regulation requires the operating organizations to establish organizational 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. Any change in the organizational structure that is important to safety shall be justified in advance, systematically planned, and evaluated after its 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 conditions for its implementation, the obligations to maintain adequate financial, human and other resources and specific conditions that must be provided in respect of:

- Nuclear safety, radiation protection, physical protection, quality management, emergency preparedness, management of radioactive waste and spent fuel, notification of the regulatory body about deviations and accidents;
- Providing information to the regulator about: the operations, including compliance with the licence conditions; the procedure for notification in case of change of the circumstances under which the licence was issued;
- The obligations of the licensee in connection with the NRA regulatory control, the applicable legislation, interface with other permits or licences; etc.

For issuing a permit or a licence, the applicant has to demonstrate an adequate organizational 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 Organization and Operation of the licensee is subject to authorization by the NRA.

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

The allocation of the responsibilities of the licence holder is made by the management and organizational structure and internal organizational documents of Kozloduy NPP. *Rules for the Organization and Operation of the Kozloduy NPP*, specifies the principles for the overall company organizational structure; management units, 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 organizational structure of the company is specified by the instruction: *Management of organizational 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, which functions, tasks and responsibilities 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 regulatory authority shall ensure that the licence holder is fully responsible for safety

In accordance with the *Act on the Safe Use of Nuclear Energy*, the NRA controls nuclear safety, physical protection and radiation protection in the use of nuclear energy, ionizing radiation and the management of radioactive waste and spent fuel, and that control is conducted by:

- Preventive control when issuing licences and permits for activities under this Act;
- Current control over the implementation of the conditions of the licences and permits issued;
- Follow-up control on the implementation of certain recommendations or directives.

One area of regulatory control is over the amendments of internal documents under which the licence is issued. 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 are to be made to internal rules for performing the activity, the regulatory body issues individual permits.

When changes important to safety are being made to the organizational 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 regulatory requirements, and whether they have been planned and systematically assessed, as per the internal documents established for the purpose.

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

Kozloduy NPP conducts a number of activities for communication with the public, including the population of the region, NGOs, the younger generation and others, using the mechanisms of the

IAEA Action Plan on Nuclear Safety in the part to improve transparency and efficiency in communicating information. These activities include as follows:

- Maintaining corporate website on the Internet with the following headings: About the Plant; Current Information; Power Production; Safety; Information Centre;
- Maintaining a constant dialogue with the mass media: press releases with updated information on the activities of Kozloduy NPP; press conferences and briefings on important events; reports and interviews with the management team and experts from the NPP; annual meeting of the plant management with representatives of mass media; preparation and distribution of printed publications and information;
- Annual reports in Bulgarian and English, presenting the overall activity of Kozloduy NPP;
- Group or individual visits of citizens and students;
- Annually conducting "Doors open day";
- 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

In the organizational structure of Kozloduy NPP is established a separate department - Emergency Preparedness (EP), which is within the Safety Division at the Safety and Quality Directorate (see Article 10 - Safety Management). The EP department is responsible for maintaining and updating the *On-site Emergency Plan of Kozloduy NPP*; providing and maintaining the emergency technical equipment, the automated information systems and communication tools in the Emergency Response Centre; the emergency teams and their training; the emergency kits; develops and conducts emergency drills and exercises; maintains lists and inventories of the technical means and equipment on site and the list of emergency personnel. The EP department coordinates and interacts with the other authorities of the scheme for emergency response – the on-site Fire Safety and Civil Protection Regional Service, the on-site Police Department of the Ministry of Interior, the plant Occupational medical centre (OMC) and the plant Transport Department (for more information see also Article 16).

The assessment of the adequacy of the available organizational 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 drills. A comprehensive assessment is made by conducting emergency exercises and drills of:

- Adequacy of the regulated requirements for the organization of actions in the emergency plan and procedures;
- Adequacy of management and executive staff;
- Adequacy of the technical means on site including for management of multi-unit severe accidents with fuel melt down;

- coping in case of management of simultaneous occurrences with fuel melt down at the various facilities on-site;
- Sufficiency of emergency supplies, including diesel fuel.

Annually are held drills to master the plan and a general emergency exercise on site; every 5 years is conducted a full-scale emergency exercise involving the national 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 applies a single policy to administer of resources to all processes and activities, with main priority to ensure safety.

In implementation of a measure from the NAcP, in 2013 was performed reassessment of the existing organizational measures in the *On-site Plan of Kozloduy NPP* and the emergency procedures for management of multi-unit severe accidents with fuel melt down on site. The emergency procedures were reassessed. Assessment was made of the sufficiency of management and executive personnel and of the emergency teams. 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 multi-unit severe accident. The adequacy of the technical means on-site for management of multi-unit severe accidents has been assessed. Under development is a *Procedure for Action of the Emergency Response Teams in Case of Simultaneous Accidents at Different Facilities on Kozloduy NPP site.*

On 25 and 26, November 2014, within the national full-scope exercise “Defence 2014", a general emergency exercise was conducted at Kozloduy NPP entitled: *A severe accident at Kozloduy NPP- accident management and mitigation of consequences.* The overall assessment is that the current organisational measures and technical means envisaged in the *On-site Emergency Plan of Kozloduy NPP* are sufficient for management of multi-unit severe accident with fuel melt down on site.

Article 10 Priority to Safety

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

Overview of the arrangements and regulatory requirements regarding policies and programmes of the Licensee to ensure priority of safety in activities for design construction and operation of nuclear installations, including:

- Safety policies;
- Safety culture programmes and developments;
- Arrangements for safety management;
- Arrangements safety monitoring and self-assessments;
- Independent safety assessments;
- Safety culture improvement measures;
- A process-oriented management system.

One of the fundamental principles specified by the Act on the Safe Use of Nuclear Energy, states that nuclear energy and ionizing 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 both present and future generations, environment and property from the harmful effects of ionizing radiation. During the use of nuclear energy, nuclear safety and radiation protection have priority over all other aspects of this activity.

The Regulation on Ensuring the Safety of Nuclear Power Plants requires the operating organization to adopt a document - *Safety Policy*, which shall give highest priority to safety over all other activities, and assume a clear commitment to continuously improve safety, and encourages staff to have critical attitude towards the works 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.

To implement the *Safety Policy*, the licensee shall develop directives for its application and monitoring of activities with clearly defined objectives and intentions that can easily be controlled and monitored by the management. *The Policy* shall 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 of substantially new information related to the safety of the nuclear plant.

The licensee shall develop and apply a safety monitoring system and systematic self-assessment at all levels of the operating organization. Monitoring shall include staff behaviour and their attitude towards safety, violations of OLCs, operational procedures, regulatory requirements and the conditions of operating licences. Safety performance indicators have to be appropriately elaborated to allow the management to detect and respond to weaknesses and non-compliances in safety management. As a result from the monitoring and the safety performance indicators review, corrective measures shall be identified and implemented under control and assessment.

Measures taken by licence holder to implement regulatory requirements for priority of safety

Kozloduy NPP

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

Kozloduy NPP 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, Industrial 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.*

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

Programmes for safety culture improvement

Safety Culture (SC) improvement is subject to systematic long-term approach, applied at Kozloduy NPP. This approach includes periodic Safety Culture assessment, annual planning of the activities to enhance safety culture, engaging the whole staff to actively participate in these activities, and motivating appropriately the personnel for his attitude to work, that leads to positive outcomes. The plant has implemented *Guide on the Formation of Values Maintaining high SC*, *Guide on SC Self-assessment, Guide for Continuous SC Enhancement and Self-Assessment Methodology*. Organization and implementation of the activities is managed by the Safety Culture Council, which functions in support of the Safety and Quality Director. *The Safety Culture Council Plan* is approved annually. The council activity is reported in the Annual Report on the Status of Nuclear Safety and Radiation Protection at Kozloduy NPP.

One approach to developing SC is conducting a periodic review and assessment of its level. In the period 2014-2015 a SC self-assessment was performed, which includes several stages:

- Collecting data through interviews, questionnaires, review of documents, surveys 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 Improvement.*

The analysis of the self-assessment identified five areas of interest in which there are both good performance practices outlined and weaknesses registered, related to: attitude to safety; organization of work processes; knowledge - a major factor contributing to safety; external factors affecting safety and creating an atmosphere of trust and no-blame. For improvement of performance in the areas with deficiencies a *Corrective Action Programme* was developed. Activities designed to enhance SC are not limited to those set out in the *Programme*. 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 SC 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.

To exchange experiences and improve the quality of performance in the areas of Safety Culture and Operating Experience meetings have been held with Cernavoda NPP, Romania. It is planned that scope of participants in these meetings shall be extended and they become regular.

Management of safety

Methodological guidance, coordination and control to ensure and maintain safety of Kozloduy NPP is realized through the Safety and Quality Directorate, that is directly subordinated to the Kozloduy NPP Chief Executive Officer. The Directorate, by means of three divisions - Safety, Security 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; organizes and takes part in developing and updating of internal guiding and working documents, training programmes and materials in the areas of control;
- Conducts supervision in the safety areas and issues mandatory improvement notices;
- Analyses and assesses the general status of safety and activities, and prepares reports periodically, develops measures to maintain and enhance safety culture and level of safety;
- Organizes the entire process of obtaining permits and licences, required as per the ASUNE, controls the implementation of the conditions set in them and reports on it to NRA.
- Administers the activity of the Safety and Quality Council, Safety Culture Council and ALARA Council;
- Controls and reports the implementation of: *Nuclear Safety Enhancement and Radiation Protection Programme; Programme of Corrective Actions for Safety Culture Enhancement; Complex Programme for Radioactive Waste (RAW) Management; the measures of the plant within the National action plan after the Fukushima NPP accident; On-site Emergency Plan; Programme for Radiation Monitoring of the Environment; Onsite Radiation Monitoring Programme, etc.*

Safety and Quality Director is the authorized officer reporting on safety status to NRA, notification and reporting of events, incidents and accidents.

Measures for safety monitoring and self assessment

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

- Quality assurance and management system;
- 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 part of the management tools for monitoring and control. 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 specialized technical council meetings. Regarding indicators that deviate from the set targets, the corrective actions are implemented.

Regarding the self-assessment of Safety Culture, see previous item *Programmes for SC improvement*.

Independent safety assessments

Besides the NRA, the following state bodies, within their responsibilities for government regulation, carry out preventive, current 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 and of ensuring fire safety on Kozloduy NPP site.
- The Executive Agency General Labour Inspectorate through the Regional Directorate Labour Inspection in the field of providing of industrial safety;
- The State Inspectorate for National Security in relation to the protection of strategic sites and activities and specialized control in accordance with ASUNE.

Regularly, Kozloduy NPP hosts international peer reviews for independent safety assessments. Annex 3 contains a list of the peer reviews conducted in Bulgaria. Information on the international missions held in the period 2014-2016 and the results from them is provided in Article 6.

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 guidelines and recommendations in the IAEA Safety Standard GS-R-3, *The Management System for Facilities and Activities, 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 safe working conditions, 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 Build plc

Kozloduy NPP - New Build plc is a sole joint stock company, the long-term goal of which is feasibility study completion, design, construction and commissioning of nuclear power facilities of the latest generation at the site of Kozloduy NPP.

At present, the project is at a pre-design stage of development, the Company holds a Site-Selection Permit of the nuclear facility.

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

ASUNE assigns to the NRA as an independent specialized authority of the executive power to conduct state regulation and control of nuclear safety and radiation protection in the use of nuclear energy. Regulatory processes for monitoring and oversight of the licensees are expressed in the following activities:

- Preventive control through the issuance of licences and permits with defined basic requirements, obligations to provide periodic information and conditions for the implementation of the activity;
- Current control on the implementation of the licensing conditions and legislative framework; inspection control at the site;
- Follow-up control on the implementation of given recommendations or issued directives.

In pursuance of its regulatory functions NRA carries out routine, planned and reactive inspections at Kozloduy NPP through the Resident Control Division at the site and the inspectors from the NRA headquarters. Inspection activities are conducted under procedure for inspection activities at nuclear facilities and inspection plan. The overall objective of regulatory inspections is to ensure the implementation of all activities of the licensee, having safe operation as the major priority. Safety management is a key topic in the scope of inspections in the Management System area. Safety Culture is an integrated part of the regulatory inspections. In all the areas of inspection oversight the *Procedure for Monitoring the Safety Culture of Licensees* is applied. A proactive approach is used that improves the monitoring process and identifies weaknesses and negative trends in the organization and staff behaviour.

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

According to ASUNE, during 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 Act on the Safe Use of Nuclear Energy, the European legislation and the relevant IAEA standards.

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

Another mechanism for ensuring the priority to safety is the independence of the regulatory body. It is secured by the following elements: assuring of budget and resources; qualification and training of the employees; assuring non-interference in the work of the regulator; implementation of international cooperation; power to enforce corrective actions and impose enforcement 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 lifetime.

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 lifetime.

Article 11 (1) Financial Resources

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

The requirements for the operator to have sufficient financial, technical and material resources and organizational structure in order to maintain a high level of safety for the entire lifetime of the nuclear installation and for the management of radioactive waste and spent fuel, as well as during decommissioning, are set in ASUNE, the Energy Act and the special regulations to these acts. These requirements are incorporated in the operating licences according to ASUNE and in the licence for electricity generation, according to the *Energy Act*.

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

The guiding document, by which the Kozloduy NPP states its strategic and business objectives through specific actions and measures, is the *Company Business Programme. The Business Programme* is developed for a five-year period and integrates implementation of all measures related to the *Production Programme of the plant, Nuclear Fuel Management Programme, Programme for Maintaining and Enhancing Safety* (nuclear safety and security of nuclear material, licensing activity, operating experience, radiation protection, emergency planning and preparedness, RAW management, industrial safety, radiological monitoring, environmental management, fire safety, physical protection), *Investment Programme and Maintenance Programme*.

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

- Paramount importance in providing financial resources for the safety management;
- Sufficiency of the resources provided;
- Timeliness in providing the necessary resources;
- Adequacy of the organizational structure and the financial-economic relations, guaranteeing the implementation of commitments to ensure the safety.

The system for budgeting and planning, development, approval, implementation and oversight of the activities on maintaining and enhancement of safety in place, guarantees that the funds planned, secured and spent on these activities are adequate in terms of amount and timeliness.

The implementation of the *Programme for Maintaining and Enhancing Safety* and the investment projects, related to safety are monitored by the NRA.

Principles for financial provisions during the period of commercial operation for decommissioning and management of spent fuel and radioactive waste from nuclear installations

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

To implement the state policy for safe management of radioactive waste, including disposal, the activity and the support of SERAW, and the activities on decommissioning of nuclear facilities the following two funds have been established under auspices of the Minister of Energy:

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

The funds are assigned funds, established in accordance with ASUNE and governed by managing boards. The procedure for assessment, collection, spending and control of funds as well as the amount of due contributions to both funds are stipulated in regulations adopted by the Council of Ministers. Revenues to the RAW fund are collected from contributions of the entities that, as a result of their activities generate radioactive waste, subject to delivery, and resources from the state budget, etc., the accumulated funds are expended solely for the operation and support of SERAW. Revenues to the DNF fund are collected from contributions of legal entities operating nuclear facilities, from the state budget, etc., The funds accumulated are expended solely to finance projects and activities on decommissioning.

The basic principles that are followed to ensure the financing of both funds during the commercial 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 a dead load to future generations;
- Transparency in the financial management of the funds, while ensuring that these funds will not be diverted unduly for other purposes;
- Purposeful and effective spending.

According to the *SNF and RAW Management Strategy 2030*, the expenses of Kozloduy NPP on management of spent nuclear fuel, including transport, storage and reprocessing, are recognized as part of the cost of electricity. In case the shipment of spent nuclear fuel for storage and reprocessing is not possible to be realized, the amount of allocated money is provisioned. These funds are charged to a special deposit account and are spent solely for the purpose of management of spent nuclear fuel in the next years.

Statement on the adequacy of financial provisions

Kozloduy NPP

To implement the legislative requirements related to operating licence activity, Kozloduy NPP applies a single Business and Finance Management Policy to all processes and activities with main priority to ensure safety.

Funding of the measures under the *Programme for maintaining and enhancing safety* is ensured with priority, the costs being integrated into the *Annual Plan* and the long-term *Business Programme.* Costs are covered by revenues from sales of electricity.

The Investment Programme includes several large-scale strategic tasks:

- Extension the operating lifetime of Units 5 and 6, the design lifetime of which expires in 2017 and 2021 respectively;
- Reactor Thermal Power Uprate of up to 104%;

- Implementation of the measures under the *National Action Plan of the Republic of Bulgaria* arising from the stress tests;
- Maintaining and enhancing safety of the nuclear facilities.

In the period 2013-2015 investment activities have been implemented for the total amount of 199,8 million euro, including 32 million on enhancement of safety of the nuclear facilities. For the period 2016-2020, the planned investment programme amounts to 432 million euro. The activities of investment type are financed by own revenues by means of depreciation and profit included in the selling prices of electricity. The Company realises good financial results and all necessary measures are being implemented in full.

RAW Fund and DNF Fund

According to *ASUNE* and the *Regulations on the Procedure for Determination, Collection, Spending and Control of the Resources and on the Amount of Due Payments in the Radioactive Waste Fund, and the Fund for Decommissioning of Nuclear Facilities*, monthly contributions to each Fund shall be determined by a methodology that is based on the assessment costs for decommissioning of nuclear facilities relative to the entire lifetime of the facility and methodology for assessing the cost of waste management, including their disposal. At present, the contributions of Kozloduy NPP payable to both funds, in the capacity of licence holder for operation of nuclear facilities, amount to 10.5% of the revenues from electricity.

Since the establishment of both funds in 1999, until the end of 2015, over 401 million BGN have been accumulated in the RAW Fund (about 92% of the resources are provided by Kozloduy NPP), the amounts spent are about 290 million BGN. For the same period, the funds raised in the DNF Fund exceed 1441 million BGN, mostly contributed by Kozloduy NPP, and by the end of 2015, around 3% of them were spent.

By decisions of Council of Ministers the WWER-440 units that are shut down, were transferred to the SE RAW. With a Framework Agreement between the European Bank for Reconstruction and Development and the Republic of Bulgaria a Kozloduy International Decommissioning Support Fund (KIDSF) was created to support the decommissioning of the shutdown units of Kozloduy NPP. The Fund was established to manage the grants awarded by the European Commission to reduce the consequences of the early decommissioning of the closed Kozloduy NPP Units in two aspects: (1) activities on decommissioning and dismantling, the so-called „nuclear window" and (2) mitigating measures in the nuclear sector, i.e. "non-nuclear window". A total of 788 million EUR were accumulated through the KIDSF Kozloduy for the "nuclear window" activities in the period 2003-2020.

Financial provisions assessment process

Periodically, but not less frequently than once every five years, the estimated expenses of both funds are re-assessed, including the costs of managing spent nuclear fuel, that remains on site after the final closure of operation of the units. If necessary, the contributions of the 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 ASUNE when a decommissioning project implementation occurs to be more expensive than the cost estimates approved by the Board of DNF fund, the additional costs are to born by the person who has been last operator of the nuclear facility.

Considering the contributions accumulated in both funds as of 31 December 2015, in the period until the end of the design lifetime of units 5 and 6 of Kozloduy NPP, in 2017 and 2021 respectively, it is expected around 2,2 billion BGN to be deposited. In case of extending their operating lifetime by 30 years, about 4,7 billion BGN of nominal value /without discount and without the revenues from the management accumulated resources/ will be made in both funds.

The financial shortfall for the decommissioning of units 1-4 for the period 2021-2030 was estimated at about 83 million Euro, under the hypothesis that only the resources contributed as a results of the operation of Units 1-4 of Kozloduy NPP (156 million Euro) were to be used from the DNF Fund. The Republic of Bulgaria will seek opportunities to provide the necessary funding after completion of the assessment of the resources necessary for the decommissioning of units 5 and 6 of Kozloduy NPP, taking into account the plans to extend their operating lifetime. Taking into account this assessment, a reassessment will be made of the adequacy of the RAW Fund and the DNF Fund to identify possible sources and /or measures of financing. These measures may be included as an adjustment to the due contributions of Kozloduy NPP to the DNF, on one hand, and on the other steps may be undertaken to secure funding from external sources, including European programmes.

Description of arrangements to ensure the necessary financial resources in case of an event of a radiological emergency

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

The terms and conditions for maintaining the insurance by the operator as well are the procedure, the terms and limits for the allocation of compensation for damages caused by a nuclear accident by the operator are covered in detail in the *Act on the Safe Use of Nuclear Energy, the Energy Act and the Regulation on Licensing of Energy Operations.* The liability of the operator for damage caused by any nuclear accident, according ASUNE is limited to 96 million BGN. Under the Energy Act, the Energy and Water Regulation Commission (EWRC), which is an independent regulator, shall annually monitor insurance contracts, and the evidence of their validity. Kozloduy NPP maintains a *General Liability Insurance with the Bulgarian National Nuclear Insurance Pool* covering liability for nuclear damage.

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 Reconstruction and Support*, headed by the Minister of Interior. The support and recovery in case of disaster/accident includes providing emergency and rehabilitation support to the victims and carrying out urgent restoration works. The urgent aid is organized, and provided by the mayors of the municipalities. The Act provides for a procedure for provision of funds for unforeseen and/or urgent expenses in the part for prevention, management and overcoming the effects of disasters/accidents. The resources are available to finance the rescue and emergency works, urgent restoration works, preventive and other activities.

Article 11 (2) Human Resources

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

ASUNE requires each licensee to possess sufficient number of qualified and competent personnel with the appropriate education and training for the implementation of all activities under the licence, and is obliged to provide training for the staff, as well as continuous improvement and control of qualification. The activities related to ensuring and/or control of the nuclear safety and radiation protection shall be carried out only by professionally qualified personnel, holding an *Individual Employment Licence,* issued by the NRA Chairman. The specific job positions with these functions are specified in the operating licence. For the other staff, professionally engaged at nuclear facilities, specialised initial and continuing training shall be provided by organization, holding a *Licence for Specialised Training*.

The Regulation on Ensuring the Safety of Nuclear Power Plants requires that the adequacy of staff and staff qualification shall be analysed and confirmed in a systematic manner, and any change in staff numbers, which could be significant for safety, shall be planned and justified in advance, and evaluated after implementation. The operating organization shall define the requirements regarding the qualifications of the staff at all levels and provide the required training. It shall analyse and determine the training needs and the objectives of the training programmes, and also conduct control on training sessions and evaluate training programmes. Staff training shall ensure sufficient knowledge about the design basis, the characteristics and performance of the SSCs, safety analyses, design and operating documents of the unit in all operational states and emergency conditions. The operating experience shall be used in the training of personnel involved in activities that have an impact on safety. The operations staff of the MCR shall pass a full-scope simulator training at least once a year, while the operating shifts shall undergo periodic emergency drills. The maintenance personnel shall be trained on mock-ups or real components for the improvement of professional skills and reducing the duration of activities with radiological hazard.

The Regulation on the terms and procedure for obtaining of vocational qualification and on the procedure for issuing of licences for specialised training and of individual licences for use of nuclear power stipulates the general requirements to personnel selection and qualification, the conditions and procedure for acquiring professional qualification, for provision of specialised initial and continuing training, for holding exams and acquiring and renewal of individual employment licences to perform activities on nuclear facilities. The Regulation stipulates the rules for issuance of a *Licence for specialized training,* the obligations and responsibilities of the Licensees.

In accordance with regulatory requirements, the IAEA Guide *NS-G-2.8*: *Selection, qualification and training of NPP personnel* and the *Kozloduy NPP Policy on Human Resources Management for Provision of Qualified and Competent Personnel,* at Kozloduy NPP are applied staff selection and qualification procedures, that are related to:

- Holding a staff selection;
- Medical and psycho-physiological selection;
- Ensuring of specialized initial and continuing training;
- Maintaining a high level of safety culture;
- Initial and periodic knowledge assessment;
- Control on the requirements for specialized training and qualification of Kozloduy NPP staff.

Staff selection follows the requirements of the job descriptions that mandatory include education and qualification requirements, professional experience for the given position, the minimum of knowledge and skills to perform the respective activity, the individual certificates needed (if any) for the position.

Kozloduy NPP holds a *Licence for Specialised Training*, which activity is performed by the *Personnel and Training Centre Division.* The Training Centre is equipped with a full-scope simulator (FSS-1000) referent to Unit 6 of Kozloduy NPP. The training process starts from the moment of signing of the contract between the employee and the Kozloduy NPP, and continues until the end of employment. Before admission to work, newly recruited workers and professionals need to complete an initial training in order to acquire knowledge and skills related to operation and maintenance of relevant to the job SSCs, procedures, technologies and operating instructions, specific requirements for nuclear safety and radiation protection, and also to develop

attitudes, ensuring high safety culture. Knowledge and skills, obtained after the initial training are maintained, further developed and build within the continuing training – periodic or extraordinary before conducting specific or rarely occurring tasks.

The initial training for a job position (for newly recruited workers or newly appointed for position related to safety) is conducted as an off-the-job training. The staff is admitted to work after successfully passed exam before an examination commission. The staff engaged in activities related to ensuring and control of nuclear safety and radiation protection possess individual employment licences issued by the NRA Chairman.

Continuing training is conducted on the basis of training plans/schedules and requests for training. It varies in duration according to the position type, the needs of individuals/job positions and the training topics are connected with keeping and developing knowledge, with modifications to SSCs, legislative and internal documents, etc. It can be either on-the-job training or off-the- job training.

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

In terms of qualification requirements, Kozloduy NPP staff is differentiated into 4 groups (A, B, C, D) in accordance with the functions performed and the relationship with nuclear safety, radiation protection and the operated SSCs. The job positions related to safety are included in the first two groups, as Group A is the operations personnel.

Input to the planning and conducting of training are the results from the analysis of the specialized training needs. 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:

- Requirements for appointment to any job position, the key functions and duties, rights and responsibilities as described in the job descriptions;
- Requirements defined in the applicable international and national legislative documents;
- Data and requirements regarding the manner of implementing the activities, described in the internal rules, instructions and procedures;
- Rules and requirements for nuclear safety, radiation protection, and industrial safety for the staff performing activities in the controlled area, etc.
- Internal and external operating experience;
- Implemented and upcoming modifications in the nuclear facility or related to sources of ionizing radiation.

Kozloduy NPP is conducting individual job performance assessment of its staff. The objectives are assessing the level of achievement of the individual job performance set goals: performing duties and developing personal competence; determining the needs for development of each employee and improving his/her professional competence; improving staff relationships, including those between managers and subordinates, as well as within teamwork; creating conditions for implementing fair and transparent procedures for professional and career development.

Arrangements for initial training and retraining of operations staff, including simulator training

The initial specialised training of the operating personnel is carried out in the Training Centre by applying a systematic approach for training. The scope and duration of training is determined in

the training programmes and courses developed for each specific position. The total duration of training for the MCR staff ranges from 40 days to 18 months, depending on the specific position. Training at the full-scope simulator (FSS-1000) is mandatory for the operating personnel. The initial FSS training, depending on the job position, lasts from 10 days to 2 months, while the annual refresher training takes from 5 to 10 days. Upon completion of the specialized training internal exams are conducted to confirm the acquired knowledge and skills. The operations staff is admitted to work after successfully passed exam before a qualification examination commission at the NRA and issuance of individual employment licence by the NRA Chairman. The validity of the *Individual Employment Licence* is five years.

Continuing training of the operating personnel is conducted in the Training Centre on the basis of training programmes. Topics include refresher courses from the initial training programmes, modifications to SSCs, regulations and internal documents, topics resulting from the operating experience feedback, etc. The training is conducted as an off-the-job training only.

Capability 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 Conditions and Procedure for Acquiring Professional Qualification and for the Procedure for Issuing Licences for Specialized Training and Certificates for Qualification*, and also in the *NRA Guideline on licensing of full-scope simulators at NPPs*. The particular technical requirements to simulators, as an engineering tool, are based on the US national standard for NPP simulators for training and evaluation of operations staff - ANSI/ANS-3.5-1998.

The scope and quality of simulation models in the full-scope simulator for units 5 and 6 (FSS-1000) ensures its adequate functioning as a training and engineering tool for initial and periodic training and evaluation of operations personnel. The man-machine interface is a copy of the main control room, while the simulation model supports capabilities to operate under different modes, such as normal operation, transients, and design basis accidents. This creates the conditions needed for the operators to perform the same actions and the same procedures for control of the processes and systems on the reference unit.

The technical characteristics of FSS-1000, allows the facility to be used also as an engineering tool for the validation of symptom-based emergency operating procedures, testing of design modifications, testing of technical decisions, testing of operating instructions and procedures, and analysis of operating events. For the operations of FSS-1000, have been developed and implemented internal documents of Kozloduy NPP such as: *Procedure for Providing Compliance of the Technical Training Aids with the Equipment at Place, Procedure for Corrective Simulator Discrepancies*, and *Procedure for Simulator Functional Testing*.

At the end of each year, an annual plan is prepared, related to the next period activities on maintaining the FSS-1000 in conformity with the reference unit. The plan includes analysis of the planned changes and modifications on the unit, associated with the FSS-1000 configuration, description of the necessary activities and conditions, deadlines 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 analogical 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 training and depending on the type of the activity and the characteristics of the workplace it is carried out as:

- Theoretical training - lectures, seminars and interactive computer based training;
- Practical training in workshops, laboratories, mock-ups, computers, as well as radiometric, dosimetry and spectrometry instrumentation and other technical training aids.
- Practical training on site in work environment;

The forms of training are applied in a combined manner, according to the training programme, to ensure proper acquisition of full knowledge, relevant skills and behaviour. Kozloduy NPP has facilities for training of maintenance personnel, equipped with appropriate mock-ups and technical training aids. Before the implementation of complex maintenance tasks or tasks with increased dose rates, trial activities are carried out on mock-ups in order to familiarize the maintenance personnel with the implementation of the work. Prior to the implementation of significant modifications, and in case of necessity, extraordinary pre-job briefings are conducted for the personnel and after the modification implementation, the personnel is briefed on the analysis of the maintenance activity performed.

Mandatory company training for maintenance and repair of supplied equipment is an integral part of the contracts with the suppliers.

Improvements to training programmes as a result of safety analyses, operational experience, development of training methods and practices, etc.

The annual analyses performed on the evaluation of training effectiveness, are the basis for planning and taking of corrective actions to improve all activities, associated with the training process. The training effectiveness evaluation is a joint activity between the Training centre and the plant organizational units. The training effectiveness is evaluated on the grounds of data analysis from various sources:

- Feedback or inquiry forms filled in by trainees, trainers or managers;
- Results from the training;
- Reflection in the training process of modifications to SSCs, operating procedures, operating experience, etc.

The results from the training effectiveness analysis serve as a basis for assessment of the needs of: personnel training; training programmes development, improvement or updating; organizing 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 sufficiency

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

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

The composition of the operations shift is defined and structured in a manner to manage and control the whole technological cycle. The shift turnover schedule is determined for one calendar year and is approved by the CEO. The shift schedule is organized in five shifts in a way that the 24-hour duration of the working day is covered by 3 shifts of 8 hours. 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 job position.

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

Pursuant to the licence conditions for the nuclear facilities in operation, Kozloduy NPP has implemented and maintained a system for assigning, management and control of subcontractors, while bearing the responsibility for the activities they perform. Performance of nuclear hazardous works may not be assigned to contractors, according to the regulatory requirements.

Requirements towards contractors and their staff qualification are determined by the contract terms of reference (ToR) during the tendering process, and the terms of the contracts awarded. The contractor's personnel that perform works on-site shall have the appropriate qualification group, as per the relevant legislative requirements, the activity's specifics, and the rules adopted at Kozloduy NPP. In case of performing specific activities, additional requirements shall be in place to specific qualification and certification of the contractor's personnel.

Kozloduy NPP controls the activities of contractors through on-site inspections, reporting of the inspection results, control over recovery of non-conformities found, and carrying out of quality audits of contractors.

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

The operating organization specifies the responsibilities and the requirements on necessary specific qualifications and certification of the contractor's personnel, within the contract scope. The contractors are required to demonstrate their personnel are of adequate number and qualification to perform the activity. Established is a system for assessment of the attached evidence of qualifications and certification of the personnel at the tender stage and at the stage of agreement of the contract.

One of the requirements is the availability of a certified Quality Management System and, in certain cases, the contractor shall present a Quality Assurance Programme and/or a Quality Control Plan. The Programme and/or the Plan are subject to approval by the Kozloduy NPP before providing the contractor with access to the site. Also, before being admitted to work, the whole staff of contractors shall pass a mandatory training at the NPP Training Centre.

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

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

- Secondary vocational education;
- Higher education for obtaining the relevant degree (MA or Bachelor) in natural sciences and engineering, and the educational and research doctor's degree;
- Initial and support specialized training to obtain an individual licence to work at a nuclear power plant, taking a specific position (further professional qualification in licenced specialized training centres).

Secondary vocational education in nuclear technology and science is annually provided for about 770 students (48 of whom take the 'Nuclear Energy' subject) in two specialized secondary vocational schools.

In the Republic of Bulgaria, the higher education of graduates in nuclear technology and nuclear science is carried out in the following professional fields: physics, nuclear engineering and

chemical technologies in five accredited higher schools. These schools have a total of 79 students taking bachelor's programmes, and 46 students involved in master's programmes.

The total number of people employed in the nuclear power sector is around 6500 employees. The majority of them (about 56% as at the end of 2015) are directly involved in the maintenance and operation of the Kozloduy NPP, 20% of the staff is part of companies providing repair and maintenance of equipment, approximately 10% are employed in science, education and engineering activities. More than 50% of the staff has a Master's Degree, while 8 % of the employees hold scientific research degrees. The average age of workers in the nuclear power sector is about 50, and particularly for Kozloduy NPP the major part is in the range of 41-50 years.

Methods used for the analysis of competence, availability and sufficiency of additional staff in connection with severe accident management, including contracted personnel or personnel from other nuclear installations

The assessment of 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 drills, emergency trainings, general national and full-scale emergency drills. After each training and drill analysis and report are prepared containing the identified actions for improvement. An independent assessment of the general emergency drills is given by an expert committee which includes experts from the NRA, MI, ME, BEH, etc. The identified weaknesses are reflected in amendments to the emergency plan, the emergency procedures, SBEPs and SAMGs.

On the grounds of the Stress Tests performed, and the conclusions drawn from the subsequent emergency drills at Kozloduy NPP, and in implementation of a measure from the NAcP, in 2013 was made an assessment of the sufficiency of emergency managerial and executive personnel and of the emergency teams at the plant, in case of multi-init events on site involving fuel. Updated was the *Procedure for organization and carrying on duty to ensure the Emergency Planning of Kozloduy NPP*, the total number of emergency personnel was increased to achieve exchangeability of the teams in case of a severe accident at all facilities.

In November 2014 a national full-scale emergency drill 'Defence 2014' was held on the topic: *Reaching a severe accident at Kozloduy NPP - accident management and mitigation of consequences* with regards to multi-unit events on site involving fuel melt. The overall assessment is that the current organizational measures and technical means are sufficient for management of simultaneous accidents with core melt/fuel damage on the various facilities on-site.

Kozloduy NPP is a member of the newly established Regional Crisis Centre of WANO Moscow centre, following the Fukushima NPP accident, which 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 drills with Member States.

Regulatory review and control activities

The NRA undertakes review and assessment of the applicant's documents, supporting a licence application for specialized training in compliance with the provisions of ASUNE and the Regulation on the Conditions and Procedure for Acquiring Professional Qualification.

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

The NRA inspectors carry out inspections on the activities of licensees and persons, who have been issued individual employment licences. During regulatory inspections for unit start up after annual outages, the NRA verifies the availability of MCR staff and their training.

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 arrangements and regulatory requirements to take human factors and organizational issues into account

The Regulation on Ensuring the Safety of Nuclear Power Plants imposes requirements to the nuclear installation design for being tolerant to human errors to the utmost possible degree. The Regulation requires that the design shall provide technical means, which help to exclude human errors or to limit their consequences. The design instruments and means for control, operation and information should be sufficient to enable the operations staff to operate and control normal operation, clearly and quickly define the status and behaviour of the unit, maintain the operational limits and conditions, easy assess the general plant status for anticipated events and accident conditions, control the reactor and all SSCs, identify the safety important changes.

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 operations personnel with information about the effect of their impact, provide on-line diagnostics of their operability.

The plant design shall provide sufficient and reliable communication between the Main Control Room/Emergency Control Room, Local Control Rooms and the Emergency Response Centre. The changes in the normal operation condition which could affect the safety should be attended by sound and light signals in the Main Control Room (MCR). The working areas and conditions should be designed taking into account the ergonomic principles and should allow reliable and efficient task performance. The operations staff in the Main Control Room and Emergency Control Room should be protected against internal and external impacts in accident conditions with high levels of radiation.

The personnel should be provided with the necessary resources and conditions for implementation of activities in a safe manner. The operations personnel should operate the nuclear power plant in compliance with written instructions and procedures. At any time, during the operations of NPP at least two control room operators holding licences issued by the NRA Chairman should be in the MCR. The actions of staff for diagnostics of the plant in accident conditions, for restoration or compensation of impaired safety functions, and prevention or mitigation of core damage consequences, shall be defined in Severe Accident Management Guidelines (SAMG) and Symptom-Based Emergency Operating Procedures (SBEOP).

The Regulation on the Conditions and the Procedure for Notification of the Nuclear Regulatory Agency about Events in Nuclear Installations and Sites with Sources of Ionizing Radiation requires that the analysis of events associated with the human factor shall contain the causes and circumstances in which human behaviour problems have occurred and which have contributed to the event occurrence and development. The analysis shall result in defining the areas of human errors which can be associated with procedures, training, communications, man-machine interface, management or surveillance and corrective actions shall be planned.

I safety assessment, the human factors and man-machine interface in all normal operation modes, anticipated events and accident conditions should be defined. The scope of PSA should also include the human error analysis in all operating states and accident conditions.

Consideration of human factors in the design of nuclear facilities and subsequent modifications (also refer to Article 18(3) of the Report)

The regulatory requirement that the design of Kozloduy NPP Units 5 and 6 shall be tolerant to human factor is implemented by:

- Automatic actuation of interlocks in case of operating actions or change in the equipment status, leading to a change within the operational limits;
- Automatic actuation of safety systems in case of operating actions or changes in equipment status exceeding the operational limits, or levels of safety system activation;
- Automatic actuation of the reactor scram system, bringing the reactor to and maintaining the reactor core in subcritical state;
- The safety systems design provide for non-interference of the operator in their function;
- The parameters data and the means for their operation in normal operation state and in accident conditions, are appropriately located in the MCR;
- The MCR data for the parameters and the actuators positions are sufficient to detect failures and assess the effects of the operators' actions;

The Modernization programme for Units 5 and 6 (2001-2008) was implemented observing the requirement for the design to take into account the human factor and be tolerant towards human errors. The implemented new computerized systems are with a modern man-machine interface and significantly improved functional features. All good practices in designing similar systems in NPPs were applied in the implementation of the new projects for protection, control and information systems. The new systems are capable of diagnostics and self-diagnostics for both measuring channels and control devices.

There are design and software measures provided for protection against unauthorized access to the main control room, the unit premises, panels and cabinets of the safety, control and protection systems with generation of a signal to the MCR. The access identification of the user and its rights for each separate device are configured to avoid unauthorized access to the system functions. The following measures are applied to avoid human errors during operation and maintenance of the software support: easy access during operation, well distinguished marking, data visualization, precise indication.

As a result of the performed design modifications and upgrades, the following additional diagnostics systems, providing information for early diagnostics, precise monitoring of occurred processes supporting the operators' decision making process, were implemented:

- primary circuit loose part detection system for reactor, steam generators, reactor coolant pumps and piping;
- primary circuit leakage monitoring system;
- primary to secondary circuit leakage monitoring system based on reference nuclide ^{16}N in the main steam pipelines;
- post -accident monitoring system (PAMS);
- safety parameters display system (SPDS);
- containment hydrogen measuring system;
- reactor coolant level monitoring system in accident state;
- seismic monitoring system on Kozloduy NPP site;

- containment leakage detection system;
- automatic information system for off-site radiation monitoring within the urgent protective action planning zone (UPZ);
- automatic information system for on-site radiation monitoring;
- on-line primary and secondary water chemistry monitoring system;
- on-line primary coolant flow activity monitoring system;
- reactor cooling pumps vibration monitoring system;
- on-line bearing condition monitoring system;
- primary circle fatigue monitoring system;
- television monitoring system for controlled area equipment;
- meteorological monitoring system.

The design of Units 5 and 6 provides for loud speaker communication between the MCR, local control panels and on-site plant equipment. The DECT system for communication between the operations personnel, plant management and the inner telephone exchange has been put into operation. This system provides freedom of connections to the one provided by mobile phones. Following the Fukushima Accident, a wireless communication cellular network is implemented for communication and contact with the plant management, operations and maintenance personnel, as well as emergency and on-call personnel. Also, a satellite communication system, an alternative communication channel between the MCR and ERC was installed in case of disasters and accidents.

As a result of the performed stress tests it was demonstrated that the design solutions in the MCR provide for operability and habitability of the staff in radiation accident conditions including station blackout. This is ensured by emergency ventilation system, which maintains overpressure in the MCR and includes aerosol/iodine filter. The potential deterioration of the work environment in the MCR, ECR, local control panels for severe accident management with core melt were analysed in the frames of the National Action Plan. A change was made in the SAMG for moving the control room operators from the MCR to ECR for certain conditions upon severe accident.

Reconstructions and repairs of the rooms for the operations personnel in the Turbine Hall, station shift supervisor room and replacement of the local control panels have been performed over the past three years in order to improve the work environment for the operators.

The Unit 5 and 6 equipment and the common plant facilities are physically separated and with clear and unique identification of the separate equipment items. The doors of all process premises on-site are labelled following the internal integrated requirements. Colour distinction is in place, which is used for premises labelling, cabinets, switchgears, process designation. This colour distinction is also applied to the work order system to avoid error made by maintenance crews.

In terms of documentation, the same rules for unique and clear identification numbers are applied so that the operators recognize them easily. At the MCR is applied colour distinction of normal operating procedures, emergency procedures, alarm procedures, symptom based emergency operating procedures and SAMG.

Methods and programmes of the licence holder for analysis, prevention, detection and correction of human errors

Two methodologies of analysis of human error causes (the ASSET and the HPES) are used in Kozloduy NPP. The analysis of events associated with the human factor contains the causes and circumstances in which problems with human behaviour have occurred, contributing to the event evolution. As a result of the analysis, the areas of human errors, which may be related to procedures, training, communications, man-machine interface, management or supervision, are identified. The rules for conducting the task performance analysis for operating and maintenance personnel are defined. On the basis of the analysis are developed the corrective measures to remedy non-compliances, resulting from the performance failure or improper human performance, which may be related to changes in the assigned tasks, training, instructions, procedures, administrative measure, etc.

The goal for easy plant operation has been achieved through the implemented procedures (administrative, operational, alarm and emergency) to facilitate the staff-unit interaction. The SBEPs and SAMG are implemented, for which more information is available in art.19 (4). The requirements for operational relationships between the operating and the management staff, and the separate divisions in Kozloduy NPP are clearly defined. The rules for keeping the operating documentation are specified.

Each unit has a Chief Process Engineer for Operations who does not work on shifts and is responsible for the integral plant operations. All important planned switch-overs, tests, trials, start-up, shutdown operations, etc. are performed with his consent.

Kozloduy NPP carries out risk assessment so that actions are taken to handle the occupational hazards in the workplace, through preventive measures, reducing the likelihood of hazards in the job activities. The risk assessment covers production work processes, work equipment, compartments, workplace, work organization, use of resources and raw materials, and other outside factors that may pose a risk. *Health and Safety Risk Management Programme* to assess the working and psychophysical conditions at workplaces, as well as the measures needed to change the work conditions is being implemented.

Self-assessment of managerial and organizational issues by the operator

The self-assessment indicator system at Kozloduy NPP includes the following functional indicators which are aimed at identification of the human performance and organization issues: preparedness of the operators; following the requirements of the established standards, policies, procedures and rules; level of occupational injuries; improvement of human performance; safety culture enhancement; operating experience feedback; improvement of the independent assessment process; efficiency of fire protection programmes; efficiency of radiation protection programmes.

The self-assessment of the plant employees is also included in both the annual survey on personnel motivation which has been performed since 2007, and the safety culture self-assessments of 2010 and 2014 (Article 10 contains information about the safety culture self-assessment).

The survey on personnel motivation aims at evaluating the attitude of the employees at Kozloduy NPP to 25 factors of work environment which are defined as monitoring indicators. The survey results also reflect the self-assessment of the employees on managerial and organizational issues. Another important aspect is the possibility for the employees to raise their opinions and to make proposals for improvements. The survey provides feedback in the direction from personnel to the management about the assessment of the employees of significant factors of management and work environment. In order to provide a two-way feedback, the results from the performed

surveys are published in the internal information system. If required, a corrective action plant is developed, as the Safety Culture Committee takes the decision.

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

Improving the human performance and excluding organizational weaknesses is achieved through analysis of operating experience and events, related to human and organizational factors, determining the root causes and elaborating the corrective actions and measures aiming at:

- Improving the personnel training programmes and including selected internal and external events, main conclusions and lessons learned;
- Implementing the applicable operating experience in the simulator training classes;
- Improving the methods and techniques for reducing human errors - additional training and briefings, strengthening the expectations for using written instructions and procedures, revisions of instructions and procedures, introducing additional technical and administrative barriers to minimize probability for errors;
- Improving the ergonomy and the man-machine interface through implementing design modifications;
- 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 organizational issues, Kozloduy NPP has introduced the WANO coding system since 2013 as an addition to the existing tools. The system has been developed to facilitate the comparability of the events, clear and consistent tracking of the causes, their consequences, damaged or affected SSCs, involved personnel, the work it performs, the plant state at the beginning of the event. The data for Kozloduy NPP for the period from 2013 to 2015 shows that the share of human errors and organizational issues is about 50%, which is comparable to the good practices worldwide.

For analysis of human performance and organizational factors, the low level events and near misses system is used, in which the indicator for *Relative Share of the LLEs and NMs related to human and organizational factors* is monitored. The indicator value for 2015 is the highest compared to the previous years, which is due to the continued work (including extension of the scope of the performed training) with the personnel in terms of the necessity for reporting of the LLEs and NMs, communication of the declared blame free policy at Kozloduy NPP for inadvertent human errors.

Staff individual job performance evaluation is carried out at Kozloduy NPP. The main objectives of this evaluation are: performance of the employee duties and development of personal competence; identification of the needs for development of any employee and improvement of the professional competence; goals achievement; improvement of the work interrelations, including those between supervisors and their subordinates, as well as team work relations and establishing conditions for personnel development.

Regulatory review and control activities

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

- assessment of the modifications in the SSCs in regard to the man-machine interface;
- planning and implementing activities related to the surveillance programme, as regards work load and the established working conditions;

- periodic analysis of the safety performance indicators, related to human factors;
- analysis of operating events related to human error, breached or non-fulfilled operating procedures, organizational issues;

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

Arrangements and regulatory requirements

According to the *ASUNE*, licensees who perform activities in the use of nuclear energy are required to establish and maintain an effective management system, which gives priority to safety and ensures high safety culture, as well as maintain high level of quality of activities performed.

The Regulation on Ensuring the Safety of Nuclear Power Plants requires that the operating organization develops, implements and maintains Quality Assurance System (QAS) for the siting, design, construction, commissioning and operation of NPP, including the control of activities of other entities performing works or providing services to NPPs. The entities who implement activities or provide services to NPPs, which are relevant to safety, shall develop and implement Quality Assurance Programmes for the respective activity in accordance with the quality assurance system of the operating organization.

The general guidelines and recommendations for development and maintenance of the management system, which provides for the utmost priority of safety and ensures high safety culture are given in the *NRA Safety Guide PP-8/2011Management System for Facilities and Activities*.

In connection with the implementation of the latest safety requirements and standards at the European and global level with regard to operating and new nuclear power plants, the NRA has developed a new draft *Regulation on Ensuring the Safety of nuclear power plants*. The draft regulation contains the requirements to the licensee management system for all stages of the operational lifetime of a nuclear power plant. These requirements are in compliance with the *IAEA Safety Standard GS-R-3: 2006 Management System for Facilities and Activities*.

According to the draft regulation, the operating organization shall develop, apply, assess and continually improve the management system, whose main objectives are ensuring and improving safety of the nuclear power plant, as well as promoting and supporting high safety culture of the staff. The management system shall combine all elements of management so that the requirements to protect human health and the environment, to assure physical protection and quality as well as the financial aspects of the operating organization shall not have a negative impact on the processes and activities affecting safety. The regulation draft is under the process of approval according to the established order.

Management system at Kozloduy NPP

Status with regard to the implementation of integrated management system

In order to achieve safe, efficient and green energy generation with guaranteed quality and security of supplies in compliance with the national and international standards, the management of Kozloduy NPP applies a management system (MS), integrating all requirements to the activities at the nuclear power plant. It integrates all aspects of management and ensures coordination in implementing the requirements to safety, industrial safety, environment, security, quality and business, so that safety is ensured utmost priority. The MS follows the requirements of the *IAEA Safety Standard, GS-R-3: 2006 Management System for Facilities and Activities; SSR-2/2:2011 Safety of Nuclear Power Plants. Commissioning and Operation*, as well as other applicable IAEA standards and guidelines and the Bulgarian standards: *BDS EN ISO 14001:*

2004 Environment Management Systems, BS OHSAS 18001:2007 Industrial Safety Management System, BDS EN ISO 9001:2008 Quality Management Systems. Requirements, and No.13 - Recommendations for nuclear safety with regard to physical protection of nuclear material and nuclear facilities (INFCIRC 225/ Rev.5). The system is described in the *Management System Manual*.

Main elements of the management system covering all aspects of safety throughout the lifetime of the nuclear installation, including supply of services and performance of work by contractors

The long-term intentions of Kozloduy NPP are set in the *Kozloduy NPP Management Policy and the Statement on the Company Management Policy.* From a strategic point of view, the company goal is the plant long term operation and power uprate ensuring safe and stable operation in compliance with the operating licences issued by the regulatory bodies.

In pursue of the set goal, policies which are suitable for the company activities have been developed in compliance with the *Kozloduy NPP Management Policy*. The Kozloduy NPP management gives utmost priority to safety and declares its commitment to maintaining and continual improvement of the *Safety Management Policy at Kozloduy NPP* together with the declared priorities in the Policies on: Environment Management; Industrial Safety; Security Management; Quality Management; Finance and Business Management; 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. Maintaining and continual enhancement of safety culture level, together with open communication and keeping the staff informed are among the major principles. 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 on the policies, strategies and business goals, the management of Kozloduy NPP develops a five-year *Business Programme*. The report on the business programme implementation comprises an analysis of the company activity for the reporting period, identifies the risks and the problem areas and is used in the process of decision making, including undertaking actions in the event of deviation from the programme. The assessment of the business programme implementation results is an important part of the input for the management system review. More information on the *Business Programme* is provided in the text under Article 11(1).

The Management System covers 28 processes (3 management, 4 core and 21 supporting), which comprise all the activities related to: business and planning; management of financial, material, human resources and knowledge; safety management (nuclear safety and radiation protection, industrial safety and emergency preparedness, environment and security); operating experience; operations, design management; maintenance and repairs, nuclear fuel cycle management; procurement and supply of products/services; RAW management; organizational 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 manager of the process. 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 organizations and the activities they perform are determined in a way to ensure that:

- The activities performed are in compliance with Kozloduy NPP policy for maintaining a high level of safety, continuous enhancement of safety culture, as well as in compliance with the requirements of the applicable regulations;

- There is a well established organization, clear distribution of responsibilities within the external organization (EO), as well as between the EO and Kozloduy NPP;
- The external organization develops and submits to Kozloduy NPP for approval Quality Assurance Programme for the performed works;
- The external organizations have appropriate equipment in a good working condition, special tools and personnel protective equipment necessary for work performance;
- The activities are performed by qualified and certified personnel having the required experience;
- A full assessment of the external organization ability to perform the activities in compliance with the requirements, standards and rules for nuclear safety, radiation protection, physical protection, industrial and fire safety and environmental management, which are effective at Kozloduy NPP, shall be performed.

The continuous monitoring and evaluation of the performed activities, periodic inspections and independent assessments of all processes, as well as self-assessment by the managers at all management levels prevent the deterioration in the status of safety. On an annual basis, the Management System is reviewed by the senior management of Kozloduy NPP, for which a report with improvement actions is prepared.

Licensee audit programmes

The internal audits of management system are carried out in accordance with approved five-year and annual schedules, providing for an internal audit of each process of the management system. The audits are included in the annual activity plans of the organizational units. When planning, the following is taken into account: company policy; management priorities; requirements of the existing management system; legislative, regulatory and contractual requirements; the needs of the interested parties; changes in the processes and the organizational structure; number, importance, complexity, similarity and location of the audited processes and activities; changes in the management system manual, governing documents from the management system; events occurred; state of the performance indicators; conclusions and results from previous audits and inspections.

Audits of vendors and suppliers

The responsibilities and the rules for performing purchasing activities related to procurement, selection of supplier, contract, delivery, receiving and storing the product, are well defined at Kozloduy NPP. The identification of the requirements for purchasing is based mainly on the impact of the purchased product/service on safety, health, environment, physical protection and economics, with safety having the highest priority.

The control 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 include:

- Performance of audits, on behalf of Kozloduy NPP, on the management system (quality management system) of manufacturers or vendors;
- Inspection of the materials, designed for complex and important to safety items (it could be performed by the manufacturer's organization or in the supplier's warehouses, together with its dedicated quality control bodies);
- Dedicated incoming control, which could be performed at the manufacturing organization or at the supplier's warehouses, together with its dedicated quality control bodies.

Kozloduy NPP - New Build Management System plc

Degree of development and implementation of an integrated management system

Following requirements of the ASUNE and *the Regulation on ensuring the safety of nuclear power plants* - Kozloduy NPP - New Build applies and maintains Management System developed in compliance with the requirements of the IAEA Safety Standard – *GS-R-3:2006 Management System for Facilities and Activities* and *NRA Safety Guide – PP-8/2011 Management System for Facilities and Activities*. The requirements of the following national standards are considered, also: *BDS EN ISO 9001 Quality Management Systems. Requirements", ISO 14001 Environment Management Systems, and BS OHSAS 18001 Health and Safety at Work Management System.*

The system is based on the process approach and covers all activities and organizational units at Kozloduy NPP- New Build. At the current stage of the project development for construction of a new nuclear unit, all required documents for process management related to the pre-feasibility study and the site selection have been developed and approved. When reaching the next stage, will be proceeded to extension, development and improvement of the management system.

Main elements of the management system covering all aspects of safety throughout the entire lifetime of the nuclear installation, including supply of services and performance of work by contractors

The management of Kozloduy NPP - New Build is committed to the implementation, maintenance and continual improvement of the management system, which is applicable for the company activity.

In 2015, the Management System manual was reviewed in cooperation with certified consultant and the management system was updated in connection with the approved new organization and management structure.

Audits of vendors and suppliers

The company prepared and conducted tender procedures for the implementation of the pre-designed activities in compliance with the *Kozloduy NPP - New Build Policy on Procurement of Products, Services and Construction*. As a result of the tender procedures, the following contracts were signed:

- Feasibility study to justify the construction of a new nuclear unit at the site of Kozloduy NPP;
- Site evaluation and site selection for the new nuclear unit at the site of Kozloduy NPP;
- Performance of Environmental Impact Assessment on the construction, operation and decommissioning of the new nuclear unit (EIA) and preparation of the EIA Report and Compatibility Assessment Report of the Investment Proposal.

In addition, Kozloduy NPP - New Build has assigned the performance of independent verification of the assessment and results obtained during the site selection and the preparation of Terms of Reference for Detailed Structure Plan according to the Law on Spatial Planning.

The above contracts are implemented according to the established requirements in the Terms of References and the contracts clauses for compliance with the existing rules at Kozloduy NPP-New Build for providing a quality product with the highest priority of safety. A regular control of the activities performed by the contractors and described in the Quality Assurance Programmes, which are inseparable part of the signed contracts, was carried out.

Regulatory review and control

The NRA provides for preventive control over the process of issuing licences and permits, which includes review of the documents describing the management system of the Licensee.

Verification of the practical implementation of the management system is carried out during the current control (inspections) of the compliance with the issued licences and permits. One of the areas of control in the Annual Inspection Plan of nuclear facilities is Management System.

The safety important activities, which are carried out by external organizations, are implemented in accordance with quality assurance programmes/quality plans, which after the approval of the operating organization are submitted to the regulator as part of the application set of documents for authorization of the relevant activity. The NRA can control the actual implementation of the relevant quality assurance programme/plan.

In 2013 and 2014, regulatory inspections on the actual implementation of the management system were carried out at Kozloduy NPP. The allocation of responsibilities for application and maintenance of the management system, processes and their implementation in the internal documents, staff training on the management system requirements, results of the performed independent reviews of the management system as well as the performance of corrective actions were inspected.

In the middle of 2014, a regulatory inspection was carried out in order to establish the compliance of the activities, performed by Kozloduy NPP-New Build, with the conditions defined in the Permit for Siting of the New Nuclear Unit (site selecting) in connection with the development, implementation and continual improvement of the management system. Recommendations for improvement of the functionality of the existing system were given. A programme for corrective action was developed and implemented by the end of 2015.

Article 14 Safety Assessment and Review

Every Contracting Party shall take the appropriate steps to ensure that:

i) Comprehensive and systematic safety assessments are carried out before the construction and commissioning of a nuclear installation and throughout its operation. Such assessments shall be well documented, subsequently updated in the light of operating experience and significant new safety information, and reviewed under the authority of the regulatory body;

ii) Verification by analysis, surveillance, testing and inspection is carried out to ensure that the technical condition and the operating conditions of a nuclear installation continue to be in accordance with its design, applicable national safety requirements, and operational limits and conditions.

Article 14 (1) Safety assessment

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

The ASUNE requires from the Licensees to perform assessment of nuclear safety and radiation protection of the nuclear facilities and to undertake actions and measures for their enhancement, taking into account the internal and external experience, and scientific achievements in this area.

The Regulation on the Procedure for Issuing Licences and Permits for Safe Use of Nuclear Energy requires a preliminary, interim or final safety analysis report (SAR) in the following cases:

- Preliminary SAR - for the approval of site selection;
- Interim SAR - for the design approval of new build;
- Final SAR - for issuance of operating licence or renewal of the operating licence.

To issue a permit for performance of modifications leading to changes in SSCs important to safety, operational limits and conditions and internal rules for the activity, the provisions of the regulation requires also presenting of the changed parts and sections of the SAR. The specific requirements to plant modifications are stipulated in the *Regulation on Ensuring the Safety of Nuclear Power Plants.* All modifications resulting in changes in the plant configuration or in the operational limits and conditions shall be assessed by independent experts other than those implementing the design or modification.

The Operating organization shall keep the safety analysis report up-to-date, in accordance with the modifications of systems, structures and components important to safety, conducted new analyses of transients and emergency conditions and current safety requirements, as well as in compliance with the quality management programme. The computer programmes and analytical methods used in safety analyses shall be verified and validated and the uncertainties of results shall be quantitatively evaluated.

For the purposes of PSA and the development of emergency procedures, analyses shall be carried out, which realistically present transients and accidents evolution. Detailed requirements in terms of development of transients and accidents are given in the regulatory *Guide on Deterministic Safety Assessment*. The detailed requirements to risk assessment are given in the regulatory *Guide on Development of Probabilistic Safety Analyses* and regulatory *Guide on Use of Probabilistic Safety Analyses to Support the Safety Management of Nuclear Power Plants*.

Conceptually new safety requirements to new nuclear power plants are introduced in the new draft *Regulation on Ensuring the Safety of Nuclear Power Plants.* The WENRA safety objectives

for the design of new nuclear power plants, the updated post-Fukushima Accident reference levels for harmonization of safety of the current nuclear power plants and the newest IAEA safety standards in this area are considered. The draft regulation introduces the requirements of the Council Directive 2014/87/EURATOM of 8 July 2014, amending Directive 2009/71/Euratom, for establishment of common nuclear safety framework for nuclear installations. The compliance with the provisions of the Directive, subject to transposition by the member states within the meaning of Article 2, para. 1 by 15 August 2017, is ensured.

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

The Safety Analysis Reports of Kozloduy NPP Units 5 and 6 have been developed in compliance with the requirements of the national regulatory framework, IAEA safety standards as well as taking into consideration the applicable good practices in leading countries (e.g. standards and guidelines of regulatory bodies in other countries). The design basis is assessed through deterministic analysis of the design specific postulated initiating events, selected and ranked according to their frequency of occurrence, in compliance with the requirements of the *Regulation on Ensuring the Safety of Nuclear Power Plants*. The design basis and safety assessment are reconsidered in the process of periodic safety review. In addition to the design basis assessment, the extended design basis of the plant were determined and analysed, as well as all reasonably applicable severe management measures were implemented.

The internal events, internal flooding, internal fires and earthquakes are analysed. When updating the Level 1 PSA, additional activities related to the improving the quality of the model was performed such as:

- Change from the conservative assumptions to realistic ones, if applicable;
- Consider the comments and recommendations to the model and the documentation of the study performed by the independent review;
- Develop the Level 1 PSA, integrated model (allowing to obtain results for full power, low power and shutdown states);
- Develop symmetrical model.

The initial Level 2 PSA for Kozloduy NPP Units 5 and 6 was developed in 2013 on the basis of the performed In- and Ex-vessel Phase severe accident analysis. The full power, low power and shutdown state were covered. The nuclear fuel in the reactor core and spent fuel pool is considered as a potential source of radioactivity. If required, the model is updated in order to consider the performed changes related to the containment structure.

By the end of 2018, the Level 1 PSA is expected to be updated taking into consideration all design modifications and all external events specific for the site of Kozloduy NPP.

To fulfil the requirement to keep the SAR updated, Kozloduy NPP introduced internal rules for this activity and established a structural unit responsible for the periodic and annual update of SAR as well as coordination of the changes and amendments after the NRA approval.

In the period after the sixth National report, actions to expand the scope of the severe accident management guidelines (SAMG) for Units 5 and 6 were taken, as well as procedures for shutdown state and spend fuel storage pools were implemented. The developed SAMGs were verified and validated, and were implemented. In compliance with the established internal rules, periodic reviews and, if required, update of the SBEP and SAMG are performed considering the implemented design modifications and obtained new information from analyses and studies.

In 2012, Kozloduy NPP initiated a project for power uprate of Units 5 and 6 up to 104% of the nominal power, which includes major and authorised modifications of both main equipment to handle the load and systems for monitoring, operation and protection of processes during electricity generation.

- The project is in the process of implementation and includes the following main activities:
- development of design documentation and analytical justification of safe operation of nuclear installation at power uprate 3120 MW;
- implementation of the required modifications of the SSCs;
- performance of integrated testing at nominal power and power uprate of up to 104%;

The project is well advanced at Unit 6, and tests at increased power levels are planned for 2016. The full scope of the technical works at Unit 5 is expected to complete in 2018.

In 2015, the NRA received a permit application for a transition by stages to operation by new type of nuclear fuel TVSA-12 at Unit 6, which will gradually replace the currently used TVSA type fuel. A review of the technical documentation of the fuel assemblies and the safety analysis for operation at power uprate of 104%$N_{nom,}$ is being carried out by the NRA.

In connection with the decision of the Council of Ministers, dated 11 April 2012, which gives an agreement in principle for construction of a new nuclear unit, in December 2012, Kozloduy NPP-New Build submitted to the NRA an application for issuing a permit for siting of a nuclear installation. As a result of the performed review of the submitted documents, the NRA issued a permit for site selection in August 2013. In the period after the sixth National Report, a feasibility study of the necessity for construction of a new nuclear unit, environment impact assessment (EIA) and studies and analyses for the plant siting in the proximity to the existing Kozloduy NPP were carried out. The results of the performed studies for site evaluation are included in the preliminary SAR and are verified and validated by a team of independent experts. According to the provisions of the *Regulation on the Procedure for Issuance of Licences and Permits for the Safe Use of Nuclear Energy*, the preliminary SAR is one of the documents on which basis the Order for approval of the selected site is issued by the NRA chairman. A review and assessment of the preliminary SAR is performed in order to take regulatory decision on the approval of the selected site, which is expected to be taken by the end of 2016.

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

The Act on the Safe Use of Nuclear Energy stipulates the renewal of the operating licence of a nuclear installation on the basis of the reassessment of nuclear safety and radiation protection, and assessment of the actual status of the nuclear installation. The requirements to the periodic safety review are specified in the *Regulation on Ensuring the Safety of Nuclear Power Plants.* According to the Regulation, the existing plant design and the operations of nuclear power plant shall be periodically reviewed to identify deviations from the current requirements and the internationally recognized operating experience. Decisions on design modifications, improvements or other measures shall be made depending on the safety significance of the identified deviations. The scope of the periodic safety review (PSR) is defined in the Regulation and as a minimum as the following areas should be included:

- site characteristics considered in the design and, if necessary, their re- evaluation on the basis of new data obtained or new methods used;

- plant design as build and the actual condition of SSCs taking into consideration the modifications made, ageing effects and other effects that impact safety and plant lifetime;
- current safety analysis methods and applicable new safety requirements;
- operating experience during the reviewed period and the effectiveness of the experience feedback system used;
- organizational arrangements for operation;
- safety performance indicators and effectiveness of safety and quality management;
- staff number, level of training and qualification;
- emergency preparedness;
- radiological impact on the environment.

The regulation requires that the periodic safety review shall use systematic and documented methodology, taking into account deterministic and probabilistic methods. Conclusions shall justify practically achievable improvement measures, taking into account the interactions between the identified deviations.

To renew the operating licences for Units 5 and 6 (in 2017 and 2019 correspondingly), Kozloduy NPP is in the process of conduct of a periodic safety review (PSR) to demonstrate that there are all prerequisites for safe operation in the next period of validity of the renewed licences.

The PSR process for Units 5 and 6 includes:

- Preparation and planning of the activity performance;
- Review and verification of safety factors;
- Assessment of the review results;
- Identification of safety improvement measures.

In 2014, a set of methodological documents establishing the process of the PSR conduct was prepared and coordinated with the NRA. The actual review of the safety factors and global assessment of the results is under way. It is expected that the reports from the periodic safety review shall be submitted to the NRA by the end of 2016.

In connection with the expiry of the 30-year design operating lifetime of Units 5 and 6 in the next few years, Kozloduy NPP has developed a strategy for long term operation, which provides for two stages of implementation of the planned activities as follows:

- Stage 1- Comprehensive Assessment and Residual Lifetime Evaluation of Equipment and Facilities of Units 5 and 6 (2012-2014);
- Stage 2 -Implementation of the Programme for Preparation of Unit 5 for Service Lifetime Extension, (2014-2017) and the Programme for Preparation of Unit 6 for Service Lifetime Extension (2016-2019).

The first stage of the strategy for the plant lifetime extension was completed. A comprehensive investigation and assessment of the factual status of the equipment was performed. The reports for the results of the specific studies and assessment of the operating lifetime of units 5 and 6, according to the developed for this activity procedures, are prepared.

In connection with the second stage of the strategy for plant lifetime extension, Kozloduy NPP is implementing *Programmes for Preparation for Service Lifetime Extension,* according to developed schedules for Units 5 and 6, correspondingly.

Review of the performed safety assessments and their main results for the existing nuclear facilities including summary of significant results

The results of the safety reassessment performed in the frames of the stress tests to hazards which may occur during external events such as earthquakes, floods and extreme weather conditions show that there are significant margins in terms of seismic capacity of the equipment important to safety. For alternative performance of the reactor core cooling safety function through the use of the steam generators, a mobile diesel generator and at least one tank from the SG emergency make-up system in reactor shut down state is envisaged per unit.

As a result of the identified weaknesses, the following measures to improve the plant robustness for external flooding with MWL=32,93m were carried out:

- emergency response procedure in the event of wall rupture of Iron Gate I Hydroelectric Power Station and Iron Gate II Hydroelectric Power Station was developed;
- the potential for protection of the equipment at Bank Pumping Station 2 and 3 in the event of external flooding with maximum water level MWL=32.93 m was assessed;
- measures to prevent from water entry to the plant sewage system while flooding the low land were applied;
- the protection functions of the dyke in the region of Kozloduy low land were improved;
- The following activities were performed in order to improve the plant robustness in the event of extreme weather conditions:
- Assessment of possible damage on the regional road infrastructure surrounding the plant in the event of extreme weather conditions and evaluation of the reliability of routes ensuring accessibility to the plant site for equipment, supplies and personnel.
- Analysis of the extreme weather conditions at the site of Kozloduy NPP using probabilistic methods according to the IAEA methodology, considering combinations of extreme weather conditions.

The safety margins were reassessed for events with loss of safety functions which result in severe accidents for the nuclear reactors and spent fuel storage pools of Units 5 and 6. The results from the analyses of postulated initiating events with a loss of power supply and a loss of ultimate heat sink, show a good robustness of the facilities and adequate timing margins to undertake protective actions. The following measures are implemented in order to provide additional safety margin and improve the independence of the two units:

- supplied two new 0.4 kV mobile DGs in addition to the mobile 6 kV DG available on the plant site;
- scheme for recharging of each battery per unit of the safety systems by a mobile 6 kV DG;
- scheme for recharging of each battery of unit 5 by a mobile 0.4 kV DG via a new 0,4 kV power supply bus; at unit 6 this measure will be completed during the outage in 2016;
- scheme to power each reliable power supply bus 6 kV at unit 5 by mobile 6 kV DG. At unit 6 this measure will be completed during the outage in 2016.

- power supply scheme for the spent fuel pools feed water systems by a mobile 0.4 kV DG;
- power supply scheme for the primary circuit feed water system in shutdown (cold) state and reactor low pressure in the event of a failure of the emergency DGs, by a mobile 6 kV DG or mobile 0.4 kV DG;
- power supply scheme for the SGs make up system in the event of a failure of the emergency DGs, by a mobile 6 kV DG or mobile 0.4 kV DG;
- additional feed water pipeline from a mobile device to the spent fuel pools;

The plant design of the main control room, emergency control room and emergency response centre provide for human performance and habitability during severe accident, including a total loss of off-site and on-site power supply. A special shelter is provided for the emergency response staff. A measure for construction of a new Remote Emergency Response Centre is being implemented.

In 2014, the analysis of the processes in severe accident for shut down and open reactor and for the spent fuel storage pool was completed. In 2015 the analysis results were applied to the extension of the scope of the Severe Accident Management Guidelines for the corresponding states.

In 2014 was completed the implementation of the project for plugging the most vulnerable routings for running off the molten reactor core outside the limits of the containment, preventing the early containment bypass.

The possibilities for use of the available hydrogen measurement channels in the conditions of severe accident management were justified and additional passive hydrogen recombiners in the containment were installed. Measuring channels for concentration of water vapours and oxygen in the containment are being implemented.

Engineering tools for ensuring the possibility for direct water injection through mobile fire protection equipment and devices to spent fuel storage pools in the event of extreme conditions were developed.

In the process of implementation is the measure for studies and research of the possibilities for localization of the molten core in the event of severe accident.

The National Action Plan provides for the implementation of a total of 77 measures. There are 58 (75%) measures performed and 19 measures underway at the beginning of 2016. Kozloduy NPP submits to the NRA quarterly progress reports on the implementation of the national plan, and a final report for the entire plant will be submitted after the completion of all measures.

Regulatory review and control activities

The conducted reviews and assessments of the submitted to the NRA documents are related to the authorization process and are mainly connected to the following activities at Units 5 and 6:

- Performance of 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 internal rules to perform activities, procedures and programmes annexed to operating licences;
- Annual update of the SAR, which includes changes and amendments from the previous year;

- reporting the implementation of the permits' and licence conditions;

In 2013, the NRA developed and adopted *Position on the periodic safety review for long term operation of Units 5 and 6 at Kozloduy NPP in the light of Fukushima NPP accident,* in connection with the declared intentions for renewal of the units' operating licences. 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. It specifies the regulatory framework and provides guidance to Kozloduy NPP about the format and content of the methodological and reporting documents for the periodic safety review in order to provide the compliance with the new IAEA safety standards, and SSG-25 in particular. The NRA reviews the submitted documentation from the separate PSR stages and pronounces on their compliance with the regulatory requirement, IAEA safety standards, updated WENRA reference levels and NRA guidance. In 2015, the NRA also prepared a draft of the regulatory *Guide on Periodic Safety Review of Nuclear Power Plants*, which specifies the guidance on the application of the regulatory requirements to the PSR process and the scope of the separate safety factors.

The regulatory activity related to the long term operation of Units 5 and 6 at Kozloduy NPP follows the implementation stages of the planned measures. The reports submitted during the first stage of the comprehensive assessment of the actual condition of systems, structures and components, and assessment of the residual lifetime were reviewed by the NRA experts and in addition an independent external review was carried out by a technical support organization on selected aspects of the performed specific studies. As a result of the performed assessment, recommendations for additional studies in compliance with the methodology for the conduct of integrated plant assessment were given. Implementing the second stage, Kozloduy NPP developed and submitted *Programmes for Preparation of Units 5 and 6 for Service Lifetime Extension.* In terms of importance of the measures of these programmes, their complexity as well as necessity for confirmation of their completeness and sufficiency, the conduct of a similar external expert evaluation is also planned for the second stage of the activities for long term operation preparation.

In 2012, the preliminary documentation for justification of Units 5 and 6 safe operation at increased power levels within the safe operating limits and conditions were submitted. As a result of the performed review, the requirements for the performance of a broad range of pre-feasibility studies, activities for design and engineering analysis for safety justification were defined. In 2015, the main part of the modifications for Unit 6 related to power uprate were licensed. In 2016, the planned modifications for unit 6 and comprehensive tests will be completed according to a programme coordinated with the NRA. The positive results from the systems comprehensive tests, as well as the analytic safety assessment are a prerequisite for the power uprate operation. The same activities for power uprate are planned for unit 5.

In 2015, Kozloduy NPP submitted an application for issuing a permit for a gradual transition of Unit 6 to operation with advanced nuclear fuel (TVSA -12 type). The planned modification is to improve the efficiency and safety of the fuel cycle at a power uprate operation. The modification is connected with the entire plant safety assessment for normal operation and accident conditions. A special programme was developed for regulatory review of the documentation, specifying the stages and their deadlines for 2016. The NRA also proceeded to the assignment of an independent expert evaluation and review calculations of selected safety analysis.

The first step of the licensing procedure for the construction of a new nuclear plant is the activity related to the site selection. After the application of Kozloduy NPP- New Build in August 2013 a Site Selection Permit was issued. Additional requirements to the engineering researches and studies, related to the assessment of the selected site are defined in the permit conditions. In 2014, documents certifying the compliance with the permit conditions for siting of a new nuclear

installation were submitted to the NRA. The next step in the licensing process is the approval of the selected site by an Order of the Chairman of NRA. In June 2015, the request for issuing the Order for Approval of the selected site with technical and administrative documents confirming the compliance with the requirements of the current regulation was submitted by Kozloduy NPP -New Build. In December 2015, an external expert evaluation of the preliminary SAR of the nuclear installation was assigned by NRA. The objective of the independent expert evaluation is to confirm the assessed characteristics of the selected site, the possibility for location of the nuclear installation and the absence of excluding factors for safe operation. Prerequisite to issue an order for approval of the selected site is also the positive opinion on the EIA Report (No 1-1/2015) taken by Minister of Environment and Water.

The process of regulatory control of the implementation of the UNAcP covers the review of the quarterly progress reports on the measures and documentation of their results. The implementation of the measures is also supervised by the NRA inspectors in conducting inspections related to the control activities.

Article 14 (2) Verification of safety

Overview of arrangements and regulatory requirements for safety review

According to the requirements of the Regulation on Ensuring the Safety of Nuclear Power Plants, the technical and organizational arrangements of the operating organization shall include responsibility to maintain the SSCs important to safety in a proper condition through early identification of defects, taking preventive measures, replacement of structures and components with expired lifetime, and arrangement of an effective recording system for performed works and operating control.

The SSCs important to safety, their design, location and operational state shall ensure option for testing, maintenance, repairs, inspection and control throughout the entire operating lifetime of the NPPs, without significantly reducing their operability. The primary coolant monitoring programme shall ensure radiation monitoring, cracking due to stress corrosion, radiation embrittlement, and ageing of structural materials, particularly in places with high levels of radiation and other factors. The status of the base metal and the welded joints of SSCs important to safety shall be monitored periodically, through qualified non-destructive testing in respect to areas, methods, defect identification and efficiency, using specifically established procedures.

The operating organization shall develop, periodically review and implement programmes for testing, maintenance, repair, inspection and control aimed at maintaining the operability and reliability of structures, systems and components important to safety, in accordance with the design and throughout the plant operating lifetime. The frequency of tests, maintenance, repair, inspection and control should be based on:

- Their importance to safety;
- Reliability and the manufacturers' requirements;
- Operating experience and surveillance results;
- Possible impact of the performed activities on plant safety.

Procedures shall be developed for the implementation of different types of testing, maintenance, repair, and inspection and control activities, in accordance with the quality management system.

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

The documents used to verify the technical condition of SSCs of Units 5 and 6 at Kozloduy NPP are:

- outage and refuelling programme, programme for plant shutdown and start-up, equipment testing during shut down and start-up. etc.;
- certification of pressure vessels and pipes programmes;
- in-service inspection of the base metal, welded surfaces and joints of primary and secondary equipment and pipelines programmes;
- corrosion monitoring programme;
- specific programmes for RPV radiation ageing assessment;
- rector installation load cycles programme;
- nuclear fuel load cycles programme;
- functional testing programmes of systems important to safety;
- report on the neutron-physical characteristics of the new reactor core performance and analysis the compliance with the accepted criteria;
- time schedules for annual outages and refuelling.

The programmes are implemented by qualified personnel, mainly from the operating organization. Part of the in-service inspection, separate maintenance works and some specific activities are contracted to external organizations.

The Units 5 and 6 *Equipment Surveillance Programmes* cover all planned activities which are performed to verify the plant compliance with the design operational limits and conditions, and prompt identification of the deterioration of SSCs properties, which could result in violation of the operational limits and conditions.

Surveillance Programme

The surveillance programme objectives are:

- verification that the design safety conditions are maintained during the plant operation;
- verification that the safety level complies with the requirements and provides for sufficient margins in the event of equipment failures, anticipated operational events and human errors.
- maintain and improve equipment operability;
- detection and elimination of any violation from normal operation before the occurrence of any significant consequences to safety.

In order to achieve these objectives, the surveillance programme was developed taking into consideration the design requirements, the SAR, the Technical Specifications, results from the safety systems reliability analysis (with actual data for failures and defects), operating experience, requirements of statutory technical documents for specific surveillance activities and manufacturers, control authorities. The surveillance programmes are focused on the control of:

- Protective barriers condition;
- Safety systems availability;

- Availability and operability of systems important to safety;
- Availability and operability of systems for normal operation, whose failure could result in reduction of the plant electrical output.

The Kozloduy NPP Units 5 and 6 surveillance programme includes all planned activities in order to check the compliance of the plant with the design operational limits and conditions and prompt detection of the deterioration of the SSCs. The programme is developed for all activities related to:

- Control of the units' parameters and the common plant systems;
- Check and calibration of instrumentation;
- Testing of components and systems;
- Evaluation of the results of the above activities;
- Feedback to determine the scope and the type of the administrative, technical and practical measures that are undertaken as a result of the identified deviations.

The surveillance programme covers the organizational and procedural aspects of the above mentioned activities without detailed technical guidance for specific equipment components. The programme was developed on the basis of the current statutory documents, quality management system at Kozloduy NPP and the IAEA recommendation, as the following principles are applied:

- Coverage of all SSCs important to safety (including also auxiliary systems);
- Identification of the types of surveillance activity and its frequency, depending on their importance to safety, requirements of the regulations, the need for taking the systems out of stand-by mode or operation, operating data for reliability of the components and systems;
- Limit the reduction of design lifetime of the equipment as a result of surveillance testing;
- Implementation of additional surveillance activities when performing design modifications which have impact on safety.

The frequency and the scope of surveillance for separate SSCs is determined on the basis of their relative importance to safety. Furthermore, the control area access restrictions and the requirements for maintaining the personnel exposure dose rate as low as reasonably achievable (the ALARA principle), should be taken into account. The procedures, programmes and documents related to the activities included in the Surveillance Programme define the preliminary conditions and provide guidance on performance of the required work in compliance with the plant strategy, policy and programmes.

Due to the wide range and diversity of the surveillance activities, as well as specific requirements for the specific surveillance areas, the management system for the surveillance programme activities was developed in four levels - Technical Specifications, administrative and operating procedures, operating documentation for implementation of specific activities, and implementation of surveillance and documenting the results. At the beginning of every year, an annual report on the activities of Kozloduy NPP Units 5 and 6 is prepared with evaluation of the control and the surveillance activities in the previous year.

In the period from June 2012 to September 2013, the Risk Watcher software for monitoring the risk at full power, low power and shutdown reactor was supplied, and the PSA model was transformed into risk monitoring model. By means of this software, the risk level is analysed providing for relative comparison between the evaluation of the current risk of reactor core

damage and statutory limit values (areas) of this risk. This is performed through qualitative and quantitative calculation using the Level 1 PSA at full power, low power and shutdown reactor.

Elements of the ageing management programme

An *Ageing management programme* of the SSCs important to safety is applied to Kozloduy NPP to identify all ageing mechanisms, the potential consequences of the processes and the potential measures to restore the operability of the impacted SSCs. The programme covers the activities of the maintenance, production and investment programmes such as maintenance and repairs, in-service inspection, modernizations and modifications, equipment testing and equipment qualification. The selection of SSCs covered by the Ageing Management Programme and subject to monitoring and assessment of their residual lifetime was made with regard to safety according to the following criteria:

1. Safety classification and qualification of SSCs;
2. Importance of SSCs on the performance of safety functions;
3. Performance of safety functions in the event of fire, transients without SCRAM and station blackout;
4. Efficiency, realistic consideration of the likelihood of failures, potential degradation, inspection frequency and functional limitations of the SSCs;
5. Cost efficiency;

The ageing management programme is a second level document of the management system of Kozloduy NPP and is considered an integrated approach to monitoring, identification, documentation, analysis of the SSCs ageing, resulting in reduced operability and implementation of corrective measures for restoration of design characteristics.

In the frames of the Maintenance, Investment and Production Programmes, the residual lifetime assessment and qualification of SSCs is carried out according to approved operating procedures of a lower level, for example:

- Welded joints, corrosion build-ups, base material in stress concentration areas and areas located opposite the core, pipelines reducers, packing surfaces of covers and vessels, supports, studs, metal in threaded joints and bearing surfaces of clamping rings, headers welded joints, SG tube plates, sections with water-steam phase transitions, welded sections of reducers between connections and vessels, pipe connections and T-joints;
- Mechanical properties of metals by applying periodic inspection of surveillance specimens, metal chips (destructive method), determining hardness;
- Through monitoring and measurement of various parameters in the process of operation compared to the values of the incoming control by using diagnostic systems, mechanical or optical measuring devices, thickness measurement, ultrasound inspection, etc.;
- Qualification and assessment of the lifetime of I&C systems and instrumentation;
- Measures to replace the SSCs whose lifetime has expired.

The activities related to identification, maintenance and qualification of SSCs important to safety are established in *Quality Procedure for Equipment Qualification Management of Units 5 and 6 at Kozloduy NPP*. Separately, as part of the qualification programme for structures, systems and components of safety systems and systems important to safety, a list of the SSCs required for plant shutdown and maintaining a safe state in accident and post accident conditions (Safe Shutdown Equipment List (SSEL) is developed. The list contains:

- Safe Shutdown System List (SSSL);
- Safe Shutdown Equipment List (SSEL);
- Harsh Environment Component List, (HECL);
- List of control and parameter measurement systems during severe accident.

Arrangements for internal review by the Licensee of safety cases to be submitted to the regulatory body

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

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

Regulatory review and control activities

According to the licence conditions of Units 5 and 6, Kozloduy NPP shall submit for review to the NRA within an established period prior to the unit 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;
- Outage time schedule;
- Report on the neutron-physical characteristics of the new reactor core configuration.

The procedure for unit 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, the Licensee shall notify the NRA Chairman. In this relation an Order is issued by the NRA Chairman to set up a Commission to inspect the unit preparedness for start-up and operation with an approved programme, including at least the following topics:

- state of the reactor core and the unit at the time of the inspection;
- implementation of measures to increase the unit safety, functional tests and modifications 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;

- control of the facilities of high risk important to nuclear safety;
- metrological certification;
- radiation protection during outage, generated RAW and preparedness of the radiation control systems;
- primary and secondary water chemistry and corrosion examination;
- analysis of operating events, implementation of the approved corrective measures;
- compliance with the licensing conditions and staffing with qualified and licensed personnel;
- condition of systems, workplaces operating documentation and housekeeping.

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

In a month period after the notification of the NRA Chairman for 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 of fuel integrity tests;
- results of the comparison of the calculated neutron-physical characteristics of the reactor core with the fuel performance operational data;
- fuel resource data;
- residual lifetime of the reactor pressure vessel and the equipment whose residual lifetime is being assessed;
- results of the programme for equipment testing;
- results of the reactor vessel neutron flux monitoring programme;
- results of the unit start-up programme.

During unit power operation, the NRA site inspectors control the performance of the safety systems tests, the annual outage activities and the remedy of 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 power plants are set out in the *ASUNE, the Regulation on Basic Norms for Radiation Protection (RBNRP) and the Regulation on Ensuring the Safety of Nuclear Power Plants.*

On the safe use of nuclear energy and ionizing radiation and the management of radioactive waste and spent fuel, exposure to ionizing radiation of workers and the public shall be kept as low as reasonably achievable.

The Regulation on Basic Norms of Radiation Protection defines:

- General principles, requirements and radiation protection measures;
- Main and derivative (secondary) constraints for external and internal exposure;
- Boundaries for the purposes of radiation monitoring and protection planning;
- Rules and limits for free-release of materials.

The limit of the effective dose from occupational exposure for each individual year is set on 20 mSv. The limit for the annual equivalent dose for the eye lens for personnel is set on 20 mSv**.**

According to the *Regulation on Ensuring the Safety of Nuclear Power Plants* the basic requirements and criteria for providing the radiation protection in a nuclear power plant (NPP) are the following:

- the radiation impact under all operating states (consisting of normal operation and anticipated operational events) shall be maintained lower than the regulatory range of dose limits from external and internal exposure of workers and the public and shall be at reasonably achievable low level. Under all states of normal operation and anticipated operating events, the annual effective dose to members of the public due to liquid and gaseous radioactive discharges from the NPP site to the environment shall not be greater than 0,15 mSv irrespective of the number of nuclear installations on site;
- under severe accident (BDBA which results in significant damage to the reactor core) the activity of vented cesium-137 to the atmosphere shall not be greater than 30 TBq, which does not enforce restrictions on long-term use of soil and water in the surveillance area around the NPP. The combined discharge of other radionuclides shall not cause in a long-term perspective, beginning three months after the accident, risk greater than the risk due to the release of cesium-137 with activity of 30 TBq;
- regarding NPPs commissioned before the Regulation on Ensuring the Safety of Nuclear Power Plants became in force, the annual effective dose to members of the public due to the impact of liquid and gaseous discharges into the environment shall be less than 0,25 mSv at all operating states of the NPP.

Around the nuclear facilities shall be established special statutory areas, as follows:

- Preventive protective measures area - the territory around nuclear facility, established for limitation of the exposure of population in case of accidents;

- Surveillance area - the territory outside the boundaries of the Preventive protective measures area, where the necessary for the purposes of radiation protection control is carried out.

The NPP design shall include on-line radiation control system at the NPP site and on-line radiation monitoring system within the Preventive protective measures area and the Surveillance area. These systems shall provide information on the necessary radiation monitoring data, the status of the protective physical barriers and the activity of the radionuclides, as well as information for predicting the dynamics of the processes in case of emergency.

The On-lone Radiation Monitoring System shall include technical devices for:

- Radiation technological control;
- Radiation dose monitoring;
- Radiation monitoring of the premises and the NPP site;
- Radiation monitoring to limit the dissemination of radioactive contamination.

The Radiation monitoring in the Preventive protective measures area and the Surveillance area is responsibility of the licensee and shall cover as minimum the measurement of:

- Dose rate from external gamma radiation;
- Total and specific activity of liquid and gaseous discharges into the environment;
- Specific activity of ground-air, atmospheric depositions, topsoil and vegetation (flora);
- Specific activity of the surface and groundwater and water supply networks and facilities;
- Specific activity of plant and animal raw materials and products;
- Radioactive contamination of vehicles;
- Meteorological parameters.

The scope and volume of the radiation monitoring is agreed with the competent authorities – NRA, Ministry of Health (MH) and Ministry of Environment and Water (MEW). The radiation monitoring of the environment and the agricultural products within the Preventive protective measures area and the Surveillance area, including the assessment of the exposure of population within these areas, is carried out by the licensee, as well as by the state authorities for specialized control.

Regulatory requirements to the licensee to optimize radiation doses and implement the ALARA principle

In line with the ALARA principle, in the RBNRP are introduced dose limits (dose quotas) for the personnel and the public and assurance factors for planning the protection from external and internal exposure. The dose quotas for the different nuclear facilities are justified in the course of the licensing process.

The quantities which are rated in the RBNRP include the following:

- Secondary (derivative) levels in external and internal exposure of individuals from the personnel and the population, which include limits for equivalent dose rate and the annual intake of radionuclides in the body via inhalation and ingestion;

- Limits for the radiation control and protection planning (control limits) in the external and internal exposure of individuals from the personnel and population, which include: limits on the annual average volume activity of aerosols and radioactive noble gases in the air of working premises for the personnel; limits of the surface radioactive contamination levels; limits of the annual average density of ionizing particles flux (electrons, photons, neutrons) for external exposure to personnel (body, ocular lens and skin); limits for the annual average volume activity of radioactive noble gases and aerosols for ground atmosphere; limits for the annual average volume activity of radionuclides for drinking water.

The requirements for radiation protection of the occupationally exposed individuals are defined in the RBNRP:

- Preliminary risk assessment and optimization of protection;
- Classification of the work places and zoning of the territory;
- Categorization of occupationally exposed individuals;
- Radiation Monitoring of the working environment, including individual monitoring;
- Medical surveillance of personnel.

Radiation protection programmes at Kozloduy NPP

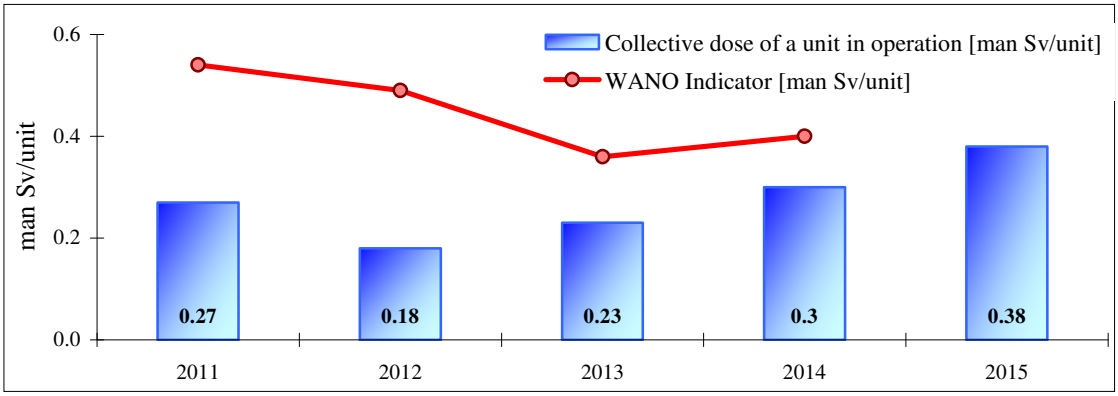
Monitoring results of the occupational exposure

The independent monitoring of the occupational exposures is performed by the *Personal Dosimetry Control Centre* which is accredited by the Executive Agency "Bulgarian Accreditation Service" as per BDS EN ISO/ IEC 17020.

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

	Indicator	2011	2012	2013	2014	2015
	Collective effective dose [manSv]	0.6	0.4	0.5	0.6	0.8
	Internal dose percentage[%]	0.5	0	0.4	0.2	0.14
	Exceedance of the annual limit for occupational exposure (RBNRP)	0	0	0	0	0
	Average individual effective dose for the monitored individuals [mSv]	0.28	0.16	0.17	0.24	0.3
	Maximum effective dose [mSv]	6.86	6.75	8.22	9.08	8.21

The collective dose in 2015 for Kozloduy NPP, normalized to the number of the reactors in operation (WWER 1000) is 0.38 manSv/unit. For the last five years the collective dose is comparable or lower than the mean value from the WANO indicator for PWR-type reactors (as shown in the figure).The increased value of the collective dose for the last years is due to the planned activities, connected with the implementation of modifications for units 5 and 6 lifetime extension.



For this period the maximum individual effective dose is in the range of 6 to 9 mSv per year and does not exceed the established administrative control level of 12 mSv at the plant.

Conditions for the release of radioactive material to the environment, measures for operational control and main results

The main principles, norms and rules which shall be observed in the course of releasing radioactive substances into the environment, obtained as a result of authorized practices, are specified in the *ASUNE* and the *Regulation on the Basic Norms of Radiation Protection.*

The ASUNE does not foresee the issuance of a separate permit for the release of gaseous and liquid radioactive substances in the environment. The radioactive releases from nuclear facilities are evaluated during the review of the technical design of the facility and are permitted via the licence for operation as an integral part of the limits and condition for operation of the nuclear facilities.

Liquid discharges in the environment

The dose quota of liquid discharges per capita adopted for Kozloduy NPP site is 50 μSv/a. On the basis of this dose quota are defined limits and control levels of activity that is released into the environment by liquid discharges, for all facilities on the site. These limits are also included in the technical specifications of the units, containing limits and conditions for safe operation.

For control of liquid discharges into the environment are established restrictions by two parameters - total activity discharged for a period of time and volume activity registered at the time of drainage of waste water. The control levels are set at around 20% of the limit values. In order to prevent discharge of high activity for a short time, for liquid discharges, except annual limits, are set quarterly limits.

The activity, which is released into the environment with liquid discharges from the operation of Units 5 and 6 for the last years, is shown in the table below. There are no direct discharges from the SFSF. Wastewater from the SFSF (15 m^3 average per month) is treated into the auxiliary building of Units 3 and 4. The total activity is formed as the sum of the activities of the individual radionuclides. The list of the controlled radionuclides and their input to the released activity is specified in compliance with the Recommendation of the European Commission 2004/2/Euratom.

Year	Total Activity, MBq (excl. ^{3}H)	^{3}H TBq
2012	368	23,8
2013	147	20.3
2014	364	17,7
2015	137	21.2

Gaseous discharges in the environment

The annual limits for the gaseous radioactive discharges are defined through separate components, so that the annual individual effective dose to a member of the public shall not exceed 50 μ Sv/a. The resulting limits are for the entire site (units 1-4 included) and are allocated to the separate ventilation stacks (VS) on the basis of operating experience.

As the actual discharges are much lower than the specified limits, the main goal in the control of gaseous discharges is early identification of negative trends in the units operation and optimization of the radiation protection of the population. For this purpose are introduced daily control levels. The daily control levels are monitored by on-line control systems. Moreover, based on samples, obtained by continuous sampling, periodically is performed a detailed evaluation of the radionuclide composition and activity contained in the discharges. This periodic radiation monitoring aims to provide data for the most realistic assessment of doses of the population and provide information to the public about discharges from the plant into the environment.

The table presents the results of the monitoring of gaseous discharges through the ventilation stacks of Units 5 and 6 and the SFSF for the period 2012-2015. The values given for radioactive noble gases (RNG) and aerosols represent sum totals of the values obtained for each radionuclide of the respective group. The list of the controlled radionuclides and their input to the released activity is specified in compliance with the Recommendation of the European Commission 2004/2/Euratom.

Component	RNG, TBq		^{131}I,MBq		Aerosols, MBq		$^{*14}C$, GBq		$^{*3}H$, GBq	
Year	Spent Nuclear Fuel Storage Facility (SNSF)	Units 5,6	Spent Nuclear Fuel Storage Facility (SNSF)	Units 5,6	Spent Nuclear Fuel Storage Facility (SNSF)	Units 5,6	Spent Nuclear Fuel Storage Facility (SNSF)	Units 5,6	Spent Nuclear Fuel Storage Facility (SNSF)	Units 5,6
2012	0	0.941	0	1.90	0	3.35	0	706	0	586
2013	0	0.585	0	4.93	0.08	9.79	0	557	0	428
2014	0	0.553	0	1.33	0	24,1	0	655	0	486
2015	0	0,690	0	2.36	0	11.2	0	631	0	513

** The values are for total quantity of ^{14}C u ^{3}H (organic and inorganic forms)*

During the period 2012-2015 the radioactive substances released into the environment with gaseous and liquid discharges from the Kozloduy NPP are less than 1% of specified limits. The activity of tritium in liquid discharges is about 13% of the specified limits.

The total dose exposure of the population in the 30km zone around the Kozloduy NPP site due to radioactive discharges is as follows:

Year	Maximum Individual Effective Dose, [Sv/a]		
	Airborne	Liquid*	Total
2012	$1{,}33.10^{-6}$	$4{,}49.10^{-6}$	**$5{,}82.10^{-6}$**
2013	$8{,}77.10^{-7}$	$3{,}87.10^{-6}$	**$4{,}75.10^{-6}$**
2014	$1{,}46.10^{-6}$	$3{,}34.10^{-6}$	**$4{,}80.10^{-6}$**
2015**	$6{,}14.10^{-7}$	$4{,}08.10^{-6}$	**$4{,}69.10^{-6}$**

* - *for a critical population group*
** - *used micro climatic data*

For calculation of the additional dose exposure of population due to the plant radioactive discharges to the environment, are used verified and validated software codes for evaluation based on the CREAM methodology, which is approved by the EU, and they are adapted to the relevant geographical and hydrological features of the region of Kozloduy NPP.

Implemented processes and steps undertaken to ensure applicability of ALARA principle for all operational and maintenance activities

Kozloduy NPP maintains personnel and public dose exposure levels which are comparable to the best international practices and makes efforts to optimize the radiation protection in the following main areas:

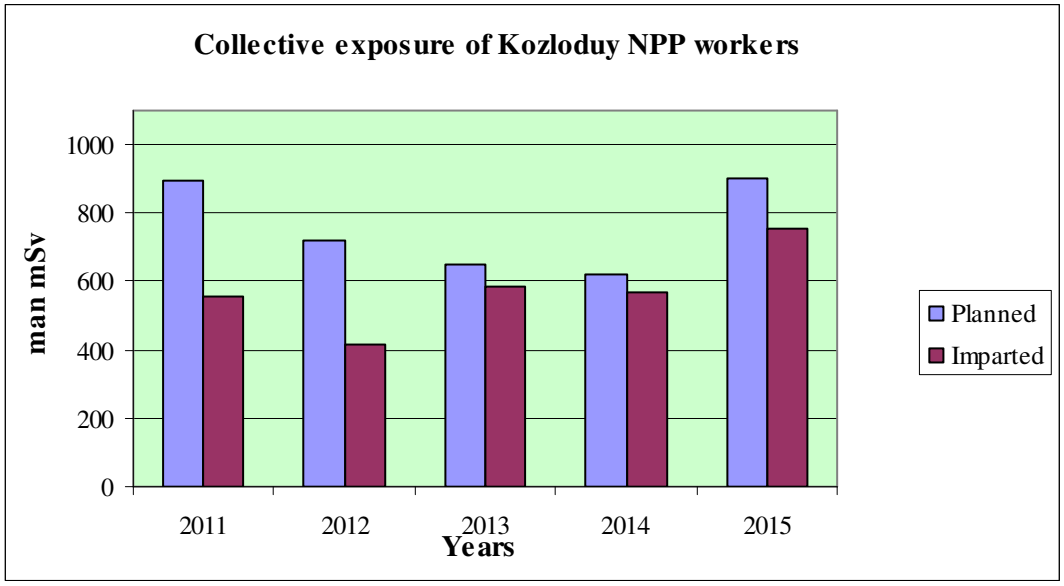
- Administrative management of the measures for optimization of the dose exposure;
- Better integration of the radiation protection measures in the production process, together with other industrial safety measures;
- Reduction of the dose exposure at the annual outages;
- Reduction of the dose exposure in-between outages.
- Improvement of the dosimetry work permit system and the dosimetry monitoring system;
- Informational and methodological provisions for activities with higher radiation risk; ;
- Training of personnel;
- Reports and analyses of activities with higher radiation risk;
- Feedback from operating experience;
- Evaluation of the efficiency of the implemented measures.

The basic approaches, applied in planning and administrative control of personnel exposure are:

- Determination of dose quotas for annual individual radiation exposure.

- Optimisation of control levels for the surface contamination of the premises within the Controlled Area, dose rate and content of radioactive substances in the air;
- Assessment of the radiation risk in performing certain maintenance operations;
- Preparation of dose budgets for the periods of planned outages;
- Maintaining exposure of the public as low as achievable by establishing control levels of liquid and gaseous radioactive discharges into the environment.

The results of the planned and imparted dose exposure of the personnel for the last few years are presented in the figure below:



Environmental monitoring and main results

The volume and scope of the conducted environmental radiological monitoring of Kozloduy NPP meets the requirements of Article 35 of the Euratom Treaty and Recommendation 2000/473/Euratom. Control results are verified by independent control of the national control authorities - *the National Centre for Radiobiology and Radiation Protection (NCRRP)* to the Ministry of Health and the *Executive Environmental Agency (EEA)* to the MEW. The plant Environmental Radiological Monitoring Departmental is accredited according to BDS EN ISO/IEC 17025 since 2012.

On-line and laboratory control of the radiation parameters in the Bulgarian section of the surveillance area (30 km) and comparative measurements in benchmarking points within the 100 km area are conducted. The on-line radiation monitoring system of settlements in the surveillance area includes 13 local measuring stations, information of which is transmitted to the national network for radiological monitoring under the Law on Environmental Protection. In public places in these settlements are situated stationary devices for visualization of gamma radiation background.

Around Kozloduy NPP site are situated 36 control points for measuring and sampling of human induced radionuclides. The airborne radioactivity, atmospheric deposits, vegetation, soil and radiation gamma background are monitored periodically. Beyond those stations are analysed samples of water, milk, fish and others with special focus on drinking water sources and the Danube River, where there are several sampling points at its stream. Standardized and validated methods of practice are in use, such as gamma spectrometry, alpha-spectrometry, low background radiometry for total alpha and beta activity, liquid scintillation spectrometry for

measurement of tritium, carbon-14, strontium, etc. A specialized mobile laboratory is used for the radiation surveillance and field measurements. Annually, over 2200 samples from different spots of the environment are tested, whereas the total number of laboratory analyses exceeds 4000. Over 1200 measurements of the radiation gamma background are performed in the control points and routes with portable dosimetry devices and static thermo-luminescent dosimeters. The quality assurance of the analyses is performed by analyses of blank, duplicate and marked samples, control tests of the instrumentation and regular participation in international laboratory comparisons and tests of competence.

The results of the radiological monitoring are reported periodically to NRA, MEW and NCRRP.

Regulatory Control

NRA

The operating licences of the units of Kozloduy NPP include specific requirements for radiation protection, radiation monitoring and the frequency and type of reporting the results of control. Monthly reports on gaseous and liquid discharges at the site of Kozloduy NPP, annual reports on the results of the occupational exposure control and annual reports on the results from the environmental radiation monitoring, including assessment of dose exposure of the population are all submitted to NRA.

NRA implements regulatory control on the radiation protection at Kozloduy NPP by inspecting the site and performing analysis and assessment of the documents submitted by Kozloduy NPP on the implementation of the conditions of the issued licences. The results of the regulatory control are published in the annual reports of NRA.

Procedure for independent regulatory control of radioactive discharges from Kozloduy NPP has been developed by the NRA. The procedure describes the scope and organisation of the control, the programme and timetable for taking and analyzing samples, the responsibilities of the different participants. The sampling programme includes at least 5% of the number of samples of Kozloduy NPP depending on their type. The procedure defines the conduct of regulatory control by assigning the performance of the sample analyses to an independent laboratory. There is also an aerosol sampling device owned by NRA, situated at the site of Kozloduy NPP. Since 2009 annually are analysed more than 90 samples from the radioactive discharges of Kozloduy NPP for gamma radionuclides, transuranium elements, ^{90}Sr, ^{3}H and ^{14}C. The data from the sample analyses records indicate a very good correspondence with the results of Kozloduy NPP.

Since the beginning of 2016 NRA implemented a safety *Guide on Criteria for Authorization and Control of Radioactive Discharges and Environmental Monitoring*. The guide provides guidance to licensees on the control of authorized radioactive discharges from nuclear facilities and the monitoring of radioactivity in the environment. It describes the methods of implementation of regulatory requirements and the details expected to be included in the documents submitted by applicants and licensees in the process of providing radiation protection to the population.

Ministry of the Environment and Water

The Ministry of Environment and Water through the *Executive Environmental Agency* and its regional structures implements an independent monitoring of the environmental radiation status in the 30km zone of Kozloduy NPP.

Radiological environmental monitoring is carried out in two ways through:

- on-line monitoring;
- laboratory-analytical system for off-line monitoring.

The on-line and periodic monitoring is performed over the following radiological parameters:

- radiation gamma-background;
- atmospheric radioactivity;
- concentration of human-induced radionuclides in uncultivated plots in the surveillance area;
- radiological indicators in surface water from the 30-km zone and discharge waters from the power plant;
- concentration of human-induced radionuclides in sediments from the Danube.

The Executive Environmental Agency (EEA) administers the *National On-line System for Monitoring of Gamma Background.* The system consists of 27 local monitoring stations, located throughout the whole country with a greater concentration in the 100km area around Kozloduy NPP site. Users of the system are also the Ministry of Interior - Directorate General "Fire Safety and Civil Protection" and the Nuclear Regulatory Agency - the Emergency Centre. There are 8 on-line stations from the environmental monitoring system of Kozloduy NPP, integrated to the national system, located in the 1.8 km radius of the power plant. The national system is integrated into the European Radiological Data Exchange Platform (EURDEP). Under normal conditions, data is being transmitted to EURDEP once a day, and in the presence of increased values - every hour.

EEA also administers the *On-line System for Radiation Monitoring of waters from the Danube River in the vicinity of Kozloduy NPP.* The system consists of two local monitoring stations located at the Port of the town of Kozloduy, before the NPP site, and at the Port of the town of Oryahovo, downstream the hot channel of the plant. The stations perform continuous sampling of the river and carry out on-line analysis for concentration of gamma-emitting radionuclides. The system has not identified any abnormal levels of human-induced radionuclides as Cesium-134 and I-131.

The radiometric field measurements, sampling and laboratory-analytical activity in the region of Kozloduy Nuclear Power Plant are carried out by the *Regional Laboratories for Radiation Measurements* in Vratsa and Montana under the EEA. Periodic monitoring is performed for: atmospheric aerosols, uncultivated soils, discharge waters from the plant, surface water and sediments of the Danube River and other water basins in the region. The data obtained from the measurements indicate a lack of influence of the operation of the plant on the environment.

The results from the ongoing radiological monitoring are published in periodic journals of the EEA - daily and quarterly newsletters and the *National Report on the Environment.*

Ministry of Health

The Ministry of Health through the *National Centre for Radiobiology and Radiation Protection (NCRRP)* carries out the state public health control on the work and living environmental factors affecting the exposure of individuals from sources of ionizing radiation and assesses the exposure and the radiation risk for the population as a whole, or for certain groups of it. The State Health Control at Kozloduy NPP is performed by the *Inspectorate for control in nuclear energy* under the NCRRP and it includes:

- preliminary control by assessment and issuance of statements of opinion on the compliance with the health requirements and the requirements for radiation protection of personnel and population at: design, construction, reconstruction, expansion, commissioning and other activities with sources of ionizing radiation;

- current control by sampling or measurements of radiation factors of the working environment, laboratory analyses, data processing and preparation of records/reports and when violations are detected, issuance of mandatory directives.
- topic inspections for the compliance with requirements for radiation protection and the condition of documentation, assessment of the radiation risk to workers and of the individual radiation exposure of personnel and the implemented measures to reduce the exposure.

To assess the annual effective dose and foreground exposure of the population from the activities of Kozloduy NPP, the *NCRRP* carries out radiation monitoring on sites of the terrestrial and aquatic ecosystems in the region (3-90 km area) of the plant and through analyses determines the content of human induced radionuclides, including strontium-90, in atmospheric depositions, water, sediments, vegetation, soils and foods of local origin.

The evaluation of the additional foreground exposure of the population in 2013, in 2014 and the preliminary assessment for 2015 shows that the annual individual effective dose does not exceed a few micro Sieverts, a value which is far below the limit of 0,25 mSv in 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 installations and cover the activities to be carried out in the event of an emergency. For any new nuclear installation, 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 installation are provided with appropriate information for emergency planning and response.

3. Contracting Parties which do not have a nuclear installation on their territory, insofar as they are likely to be affected in the event of a radiological emergency at a nuclear installation 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 organization of the emergency preparedness are specified in the *Disaster Protection Act (DPA), the Act on the Safe Use of Nuclear Energy (ASUNE), the Ministry of Interior Act (MIA), and the Regulation on emergency planning and emergency preparedness in case of nuclear and radiological emergencies The DPA* is harmonized with *ASUNE* regarding the requirements for the development of emergency plans, their contents, the necessary human resources, material and technical support and others, while ASUNE determines additional specific requirements for emergency preparedness and response to nuclear or radiological emergency.

According to the *DPA*, the Council of Ministers establishes the state policy and conducts overall guidance to protect the population in disaster, adopts a *National Plan* and a *National Programme for protection in case of disasters*; it also introduces a *National System for Early Warning and Notification* of the executive authorities and population in case of disaster and determines, through a Regulation, the conditions and the procedure for its functioning and provides for financial resources for protection, including in case of nuclear or radiological emergency. The Minister of Interior shall draw up the *National Disaster Protection Plan* in conjunction with representatives of ministries, agencies, the Bulgarian Red Cross and local authorities. Disaster protection is planned at municipal, regional and national level. The district governor organizes the development of a regional plan for disaster protection, together with the regional structures of the executive authorities and municipal mayors. The mayor of the municipality develops the municipal plan for disaster protection, together with agencies and entities related to disaster protection in the territory of the municipality.

The *National Plan for Disaster Protection* (NPDP) contains an analysis of the hazards that may occur on the national territory. For each hazard have been developed particular measures to protect the population, eliminating the consequences and restoring the affected area. Plans for disaster protection at the regional level are also prepared for any hazard specific to the area. The parts of the plan for earthquake, flood, nuclear or radiation accident are obligatory for each

administrative area. The executive authorities develop plan for the implementation of their obligations provided under the *NPDP.*

According to ASUNE state authorities and licensees 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 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 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 emergency, the licensee shall:

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

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

- conditions and rules for development of emergency plans; persons who implement emergency plans and their obligations; actions and measures for mitigation (localization) and liquidation of consequences of a nuclear or radiological emergency; methods of informing the public; order to maintain and test emergency preparedness;
- risk categories of sites, facilities and activities and classification of emergencies;
- intervention levels as values of predicted dose and averted dose for s certain period of time, dose rate and specific activity values when begins the implementation of protective measures.

The Emergency Regulation complies with the IAEA recommendations: *GS-G-2.1: Arrangements for Preparedness for a Nuclear or Radiological Emergency, EPR-Method(2003): Method for Developing Arrangements for Response to a Nuclear or Radiological Emergency etc.* and is being updated to reflect the new requirements of IAEA defined in *GSR Part 7: Preparedness and Response for a Nuclear or Radiological Emergency.*

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

- on-site emergency planning zone - a protected zone (zone No.1);
- off-site emergency planning zone, divided as follows to:
  - precautionary protective action zone (PPAZ) with a radius of 2 km (zone No. 2);
  - urgent protective action zone (UPAZ) with conditional radius of 30 km (zone No. 3);
  - long term protective measures zone (LPMZ), (zone No. 4), with no defined external boundary. Its dimensions depend on the results of the radiation monitoring.

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

- *Regulation on the conditions and procedure for establishing of special statutory areas around nuclear facilities and sites with sources of ionizing radiation;*
- *Regulation on basic norms of radiation protection;*
- *Regulation No.28 on conditions and procedure for medical assurance and health standards to protect individuals in the event of a radiological accident;*
- *Regulation on the construction, maintenance and use of collective protection equipment;*
- *Regulation on the conditions and procedure for functioning of the National Early Warning and Notification System of the executive authorities and the population in case of disasters and announcement in case of air hazard;*
- *Regulation on the procedure for establishment, storage, renewal, maintenance, delivery and recording the stocks of personal protective equipment;*
- *Regulation No.11 on setting requirements to the limits of radioactive contamination of food in a radiation accident;*
- *Regulation on the conditions and procedure for notification of the NRA about events in nuclear facilities and sites with sources of ionizing radiation.*

Main elements of the National Plan for Disaster Protection, including hierarchy of management, roles and responsibilities of the licensee, the regulatory body and other main actors, including state organizations

The *National Disaster Protection Plan* (NDPP) determines the order of introducing the plan in action; analysis of possible disasters and the anticipated consequences, including nuclear and radiological emergencies; measures to prevent or mitigate the consequences; measures to protect the population; procedure for request or rendering international assistance; obligations of the executive authorities and the persons responsible for implementation of protective measures to the public; funds and resources provided for liquidation of the consequences; ways of interaction between the executive authorities and procedures for notification in case of disasters. An integral part of *NDPP* is *Part 3*: *Kozloduy NPP Off-site Emergency Plan.*

The protection activities to the population in case of disasters are performed by the *Unified Rescue System (URS)*, which consists of basic and auxiliary structures. The basic structures of the URS are the *General Directorate Fire Safety and Civil Protection* at the Ministry of Interior (GDFSCP-MI) and its regional directorates, the District Police Directorates and the Emergency Medical Centres. The auxiliary structures include: authorities to ministries and administration departments; regional and municipal councils; trade companies and sole traders; medical and health institutions; legal non-profit entities, voluntary formations and the Military forces. The main structures of the URS provide continuous preparedness to receive messages in case of disasters, their evaluation and taking immediate actions. They are set up throughout the country in accordance with the administrative-territorial division. The auxiliary URS structures provide assistance upon request according to their plans, while the military forces with the permission of the Minister of Defence. The entities that provide electronic communications assist the Ministry of Interior to implement the communications and assist the National Emergency Call System using the European number 112. The coordination between the URS structures is implemented through the operational centres of the GDFSCP. The interaction between the structures in the disaster area (point of intervention) is conducted by a manager on site who is the head of the regional unit of the GDFSCP or is an official authorized by him.

The NRA is part of the URS and as a regulatory body executes corresponding obligations under ASUNE, DPA and the *Regulation on emergency planning and emergency preparedness in case of nuclear and radiological accident. The* NRA Chairman performs the functions of a central authority and a contact point for notification of an accident, participates in the *National Headquarters for Coordination and Control*, which is organized at the Ministry of Interior in case of a nuclear or radiological accident, collects and processes incoming data that characterize the accident and the radiation situation, makes prognosis for the development of the accident and for the consequences for population, maintains an emergency response team, as part of the specialized administration. The NRA Chairman is a national competent authority and a contact point for notification of an accident and for provision of assistance according to the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency.

Implementation of measures for emergency preparedness by the licensee

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

The 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 accident at the plant. *The on-site emergency plan* is a part of the documents required for issuing a licence. It is mandatory for implementation by the plant personnel and the personnel of organizations located on site and in *the PPAZ.* The emergency plan is developed on the project documentation, the additional engineering analyses and safety assessments, the requirements of the applicable national legislation and international recommendations, established common standards and practices in emergency planning and preparedness, nuclear safety and radiation protection.

The EP considers and classifies both nuclear and radiation accidents, as well as events without direct radiological consequences (non-radiation, conventional accidents), that create actual or potential prerequisites for significantly reducing the level of safety at the plant. 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 River with oil products, accidents with other sources of ionizing radiation and actions related thereto) are subject of separate emergency plans, instructions and procedures.

In case of an emergency, the emergency condition is classified by procedures for initial assessment of the initiating event and for periodic assessment of the facilities, based on:

- state of the reactor installation;
- level of radiation at the plant;
- state of spent fuel storage facilities;
- plant safety status (events, natural disasters, human activity etc.);
- dose rate on site and around the plant.

The operations manager on shift is the Plant Shift Supervisor. He is responsible for the organization and implementation of immediate actions in case of emergency and for providing first aid to the injured. The Responsible officer for the overall management of activities under *On-site EP* is the Emergency Response Manager (ERM). Until the formation of the emergency teams the responsibilities and obligations of the ERM are performed by the Plant Shift Supervisor.

The structure of the response authorities includes the following services:

- Fire Safety and Civil Protection Regional Service (FSCPRS) – Kozloduy NPP site;

- Regional Police Station - Kozloduy NPP;
- Occupational Medical Centre (OMC);
- Kozloduy NPP Transport Department.

The services have developed their own emergency plans that are jointly implemented and coordinated with the *On-site emergency plan* of Kozloduy NPP.

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.

Classification of emergencies

In the On-site Emergency Plan emergencies are classified in accordance with the *Regulation on emergency planning and emergency preparedness in case of nuclear and radiological emergency* and the IAEA definitions, published in documents TECDOC-953 and TECDOC-955, in respect of the possible consequences and related activities that shall be carried out, as follows:

- General emergency;
- Site area emergency;
- Facility emergency;
- Alert;
- Other emergencies.

In connection with the new IAEA requirements, established in GSR Part-7, an update of the emergencies classifications is forthcoming.

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 management team and the emergency personnel working at the ERC. The ERC is situated on site and it is equipped with means for communication with the regional and national authorities. The external power supply is backed up. There is an independent electrical supply with two diesel generators. It is fitted with an independent filter-ventilation system with the possibility to operate in three modes (pure ventilation, filter ventilation and complete isolation mode), and also with air monitoring devices, independent water and sewage system with reserve of service water and a stock of foodstuff.

The ERC is equipped with technological, radiation and meteorological monitoring means; software and hardware means for assessment, prognosis and visualization of the situation. The radiation monitoring of the premises is carried out with portable devices, including for aerosol control. The individual dose monitoring of the emergency personnel is performed by TLD and digital reading dosimeters. Each working place in the ERC is provided with the necessary technical, operating and emergency documentation.

Information stations from the following systems are provided in the ERC:

- Safety Parameters Display System /SPDS/ and Post-Accident Monitoring System /PAMS/ for Units 5 and 6;
- On-line information system for off-site radiation control;
- On-line information system for on-site radiation control;
- Meteorological monitoring system (MMS);

- On-line information system for radiation monitoring on the 30 km surveillance zone;
- On-line monitoring system for the hydraulic dual channel mode for technical water supply of Kozloduy NPP and monitoring of the level of the Danube River.

The data from the radiation monitoring systems, meteorological monitoring and the source of discharge information are used as input software data to specify the protective measures for the personnel and the population. At the time of an accident data will be provided from the mobile laboratories for environmental monitoring, via a GPS radio channel. Monitoring of Kozloduy NPP site will be performed by off-road vehicles. All data are sent to the NRA Emergency Centre, too.

In implementation of a measure from the UNAcP was introduced a *Procedure for notifying Kozloduy NPP in case of accident in the "Iron Gates water supply system.* The Bulgarian Academy of Sciences (BAS) submits data to Kozloduy NPP about upcoming extreme weather events with a period of two days before the event.

The following software products are installed in the ERC:

- Software JROSOS and ESTE for calculation of the radiological impact on environment in radiological accident and the protective actions for the personnel and the population. These programmes are installed at the NRA Emergency Centre, too;
- Smart Fuel programme to control the location of nuclear fuel;
- Scale programme for calculating the accumulated isotopes and residual heat release;
- Programme to control tension on the containment ropes.

Work started on building a remote ERC offsite the plant, in the town of Kozloduy.

Inventory of the available emergency equipment on site and a list of emergency personnel are annexed to the On-site EP:

- Inventory of fire equipment and devices at the FSCPRS of Kozloduy NPP site;
- List of personnel and equipment for evacuation and emergency restoration works;
- Inventory of mobile equipment necessary for safe cooling of the reactor;
- List of available quantity of diesel fuel.

Annex 4 has a list of systems and means of the licensee to ensure emergency preparedness and accident management.

Drills and exercises, activities of their evaluation and main results of performed exercises, including lessons learned

Systematic approach is applied in training of emergency preparedness and response. Emergency personnel at national level are trained at the Training Centre of the Ministry of Interior. Initial and continuing training for nuclear or radiological accidents are conducted there. Training of Kozloduy NPP personnel is held at the plant Training Centre and at the ERC.

To maintain emergency preparedness and improve emergency response, the executive authorities, local authorities and entities conduct periodic emergency drills in compliance with the *Regulation on emergency planning and preparedness in case of nuclear and radiological emergencies.* National emergency drills and exercises are organized and conducted:

- every 5 years - full-scale emergency drill to master the National Plan for Disaster Protection;

- annual exercises to master the elements of the plan.

In order to train all activities in the emergency plans was prepared a list of targets to be achieved in exercises and drills for a period of five years.

In the full-scale emergency drills are involved the executive authorities, the operator and entities included in Part 3 of the *National Plan for Disaster Protection*, as well as local authorities and the population in the zones of emergency planning. The scenario for each drill is approved at national level by the Minister of Interior. It includes the objectives of the drill, the components of the emergency plan which will be trained, participants (ministries, administrative structures, population, media, etc.), observers and supervisors of the drill, as well as a performance timetable with the major tasks that will be trained.

Drills and exercises are performed by a programme, prepared and approved in advance. The assessment of general emergency drills is given by an expert committee, the composition of which may include representatives of NRA, MI, ME, BEH and others. After each drill is prepared an analysis and an Order is issued with measures for eliminating the weaknesses and shortcomings found during the exercises.

In the period following the last CNS review were conducted the following national and international exercises:

- annual drills for action in case of an accident at Kozloduy NPP – twice a year with scenarios on various topics;
- headquarters exercises with the participation of Kozloduy NPP and NRA - 6 exercises per year;
- international IAEA exercise to verify the emergency notification forms;
- drills within the EU for the use of the ECURIE early warning system;
- full-scale national drill "Protection 2014 - *Reaching a severe accident at Kozloduy NPP, accident management and mitigation"*.

In November 2014 was held the national full-scale emergency drill "Protection 2014" on the following topic: *"Reaching a severe accident at Kozloduy NPP"- accident management and mitigation"* with simultaneous events with fuel melt at various nuclear facilities on the site. In the course of the drill were found a number of good practices that increase the efficiency of the state authorities and rescue teams, good coordination of actions were set up. For conducting radiation monitoring and decontamination of the URS teams and the population, were used new modern systems and equipment.

With the drill were evaluated the existing organizational measures and technical means at Kozloduy NPP site for actions during events with fuel melt at various nuclear facilities on site:

- sufficiency of requirements for the organization of actions in the emergency plan and procedures;
- sufficiency of the managerial and executive (rescue) personnel;
- sufficiency of technical resources on site to cope with simultaneous events with fuel melting at various nuclear facilities on site;
- sufficiency of diesel fuel.

The overall assessment is that the existing organizational measures and technical means of action in the On-site Emergency Plan of Kozloduy NPP, for simultaneous events with fuel melting at various nuclear facilities on site are sufficient. Concrete measures were identified to improve the

activity of state authorities and rescue teams of the URS, which will be reflected in the update of the Off-site emergency plan for Kozloduy NPP. An inter-institutional working group has been created to update Part 3: *Off-site emergency plan for Kozloduy NPP* from the *National Plan for Disaster Protection.*

See also the information in 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; and Article 11: Methods used to analyse the competence, availability and sufficiency of additional personnel in the severe accidents management, including contracted personnel or personnel from other nuclear installations.

Regulatory review and control activities

The NRA participates in international and national drills (full-scale, computer-simulated) for actions in various disasters (nuclear or radiological accident, flood, earthquake, terrorist attack etc.). In 2015, the NRA took part in all the drills of the series ConvEx (organized by the IAEA) for international exchange of information in case of nuclear or radiation accident and the international exercises ECURIE and INEX, organized by the EU. The NRA representatives participate in international workshops and meetings of the EU and the IAEA in emergency preparedness (emergency group of HERCA, RODOS-users, WebECURIE- users), for creating new documents in this field and for protection of critical infrastructure in relation to the preparation of an EU directive. NRA officials take part in IAEA missions in the area of emergency preparedness and response to nuclear or radiological accidents.

In the NRA Emergency Centre are displayed the parameters of the Safety parameters display system /SPDS/ and Post Accident Monitoring System /PAMS/ from Units 5 and 6 of Kozloduy NPP, which provide continuous monitoring of process parameters. Video link conference station is established with the ERC in Kozloduy NPP. The means of communication among NRA, Kozloduy NPP, Ministry of Interior, the IAEA and the EU ECURIE system for operating notification in case of emergencies are tested on schedule. A Programme is being executed for conducting bilateral exercises between NRA and Kozloduy NPP for using the software products "RODOS" and "ESTE", for prognosis of the radiation conditions and population doses in nuclear accident.

In implementation of a measure of the UNAcP*: Plan for systematic training of personnel involved in emergency planning and preparedness in NRA*, in 2015 NRA completed an IAEA project for *Development of a programme for systematic training and preparation of training materials for members of the emergency team of NRA (BUL/9/024)* and introduced a plan for systematic training of personnel, training programmes and procedure on training of the emergency team. The results of the project were presented at a one-day seminar before experts in emergency preparedness and response from the Ministry of Interior, MEW, ME, MH, NIMH, INRNE- BAS and Kozloduy NPP.

As a regulatory authority, NRA develops the requirements on emergency preparedness and response to nuclear and radiological accidents in accordance with the IAEA recommendations. Annual inspections are carried out at the nuclear facilities in accordance with the Annual Inspection Plan. In conducting inspections in the area of emergency planning and preparedness, the following main topics are addressed:

- 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 and drills, documentation and feedback;
- Informing the population, preliminary information, notification and periodic testing of the notification system.

International arrangements, including those 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 Emergency*. Under both *Conventions* the NRA performs the functions of a national contact point with the IAEA (USIE-IARA). The NRA is a contact point also in accordance with the EU requirements (ECURIE-EU).

The Republic of Bulgaria has signed intergovernmental agreements on cooperation in the field of nuclear safety and the exchange of information in an emergency with Greece, Romania, Turkey and Ukraine. The signing of an intergovernmental agreement with the Republic of Serbia is forthcoming.

Agreements for notification and exchange of information on nuclear or radiation accident have been signed between NRA and the regulatory bodies of Greece, Macedonia, Romania, Russia and Ukraine. At the beginning of 2016 was signed a new agreement with the National Commission for Control of Nuclear Activities (CNCAN) of Romania on exchange of information and cooperation in the regulatory activities and control of nuclear safety and radiation protection. Signing new agreements with the nuclear regulators of Greece and Turkey is forthcoming.

Kozloduy NPP is a member of the newly formed Regional Crisis centre of WANO – Moscow Centre, following the accident at Fukushima NPP, which provides expert on-line support in a severe accident at Kozloduy NPP. The Crisis centre has an approved work plan.

Article 16 (2) Informing the public and neighbouring countries

Arrangements for informing the public in the vicinity of the nuclear facility about emergency planning and emergency situations

According to ASUNE, the NRA provides the public with information about the condition of the nuclear safety and radiation protection in normal operation, as well as in emergency situations. According to the *Regulation on emergency planning and emergency preparedness in case of nuclear or radiological emergencies* the executive bodies are obliged to notify the public in case of emergency within their competencies.

The National Disaster Protection Plan and the disaster protection plans to the executive authorities defined the requirements and the procedures for immediate notification and periodical information to the public, for the whole period of the emergency until the final elimination of the consequences.

In the event of an accident, the affected population of the zones for emergency protective measures shall be notified immediately by the early notification system of Kozloduy NPP and the regional structures of GDFSPP-MI and shall be periodically informed about the accident, its characteristics, the implemented protective measures and if necessary, the protective measures that must be undertaken. For notification is used the national communication-notification system which includes:

- fixed and mobile phones, faxes;
- sirens, transmitting sounds and speech information;

- loud speakers;
- national and regional radio and TV stations, local radio translators, mobile radio stations, satellite video and radio channels;
- the national telecommunications and postal network;
- inter-institutional networks for transmission of information;
- computer networks.

Special attention is paid to the public awareness on emergency planning through the preparation of information materials, brochures, meetings with students, meetings with local authorities and population.

The information policy of Kozloduy NPP upon activation of the emergency plan aims to provide the public informed about the emergency and transparency of the implemented actions and measures, undertaken to protect plant personnel and to limit the consequences of the accident. For the purpose is envisaged the provision of timely and accurate information to the public by sending messages to the media and on the Internet site of the plant. Information and communication with the media is carried out by an Off-site emergency information centre (OEIC), which is a structure of the emergency team in charge of activities on liquidation of the accident. When entering the emergency plan, the OEIC 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.

Arrangements to inform 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. In order to achieve cross-border harmonization of communication between local authorities in Romania and Bulgaria, in January 2016 was signed a new agreement between NRA and CNCAN for cooperation on nuclear safety, regulatory control and exchange of information in case of nuclear or radiological emergency. The Agreement provides for Kozloduy NPP to send both the original message on the accident to the local Bulgarian authorities and to a defined contact point for notification of local authorities in Romania. For this purpose, the forms for notification of Kozloduy NPP were translated into Romanian and English.

Regular meetings between representatives of Kozloduy NPP, responsible for emergency planning and the Kozloduy Municipality are carried out. At these meetings are discussed issues related to the activity and status of the plant that are of public interest, and issues related to preparation for action in case of emergency. Similar meetings between NRA, CNCAN- Romania, Kozloduy NPP and the local Romanian and Bulgarian authorities are planned to take place.

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 site related factors

Overview of arrangements and regulatory requirements relating to the siting and evaluation of sites of nuclear facilities

The authorization regime for determining the location of a nuclear facility (siting) is specified by the *Act on the Safe Use of Nuclear Energy*. It represents a two stage decision making process – granting of a *Siting Permit* for conducting site selection activities and approval by the NRA Chairman of the selected site by issuing an *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 act specifies the organization of public discussions of the EIA report, in conjunction with the municipal authorities, state and public organizations, 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 preliminary site investigations, description of the measures to implement the studies, methods to be used for the investigations and for evaluation of the results.

For approval of the selected site, the applicant shall submit a Preliminary Safety Analysis Report, which shall include, apart from the other information, comparative analyses of the proposed sites in respect of nuclear safety and radiation protection, and selection of an option based upon:

- Impact of man-induced or natural origin factors 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 emergencies;
- 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, groundwater and surface water monitoring, and monitoring of other natural phenomena;
- A programme for additional site investigations (of the selected site), if such a need is identified by the SAR;
- Positive decision on the EIA Report, issued by the Minister of Environment and Water.

For approval of the selected site, it is necessary to be demonstrated that all factors which may affect safety have been identified, as well as the applicable requirements and criteria for evaluation and selection of the site have been met.

The *Regulation on Ensuring the Safety of Nuclear Power Plants* defines the scope of the engineering studies and investigation processes, phenomena, and factors of natural and man-induced origin, which may affect the safety of the NPP and requires determination of the following:

- Characteristics of the tectonic activity;
- Characteristics of the initial fluctuations of the earth layers during earthquakes with a frequency of 10^{-2} events per year and frequency of 10^{-4} events per year at a site elevation zero;
- Probability for the development of karst, suffusion, and karst-suffusion processes;
- Presence of specific earth layers (biogenic, collapsible, swelling, salted, alluvial, man-induced), their thickness and physico-mechanical properties (deformation modules, strength limits, etc.);
- Zones of water-saturated, segregated earth layers that are subject to self-liquefaction under seismic effects of intensity up to SSE inclusive;
- Impact on the safety of the NPP due to increase of the level of groundwater and flooding of the site during spread of the groundwater rise from dams, filtration of irrigated land, leakages of water, rainfall, and snowmelt;
- 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. For the NPP site, the characteristics of the potential maximum flooding, due to spill of the river with a frequency of 10^{-4} events per year in combination with tidal waves caused by wind, shall be evaluated;
- For the coastal sites, the probability of occurrence and maximum height of the tsunami or seiches shall be determined, taking into account the seismotectonic conditions, seaside configuration, landslides, and collapsing into the water;

- Intensity of the tornado, maximum tangential values of the speed of the wall and translational speed of the tornado, pressure drop between the periphery and the centre of the tornado funnel;
- Other processes, phenomena and factors of natural origin (hurricane, extreme rainfall, air and water temperature, icing, thunderstorms, dust and sand storms, erosion of river and lake banks).

The Regulation requires study of the area and site of the NPP in order to identify the sources of potential man-induced hazards. Sources of man-induced hazards for which the frequency of occurrence of accidents is equal to or greater than 10^{-6} events per year shall not be neglected. The Regulation also specifies the requirements for determination of the parameters of impact of man-induced hazards as well as the requirements for their analysis, including: external fires; fixed and mobile blast sources; fixed and mobile sources of emergency discharge of chemicals; discharge of explosive, highly flammable, toxic, and corrosive gases and substances from industrial sites, ground and water transport; aircraft crashes; floods; watercraft accidents and accidents in coastal port areas with blasts and fires, discharges of dangerous chemicals in case the NPP is situated on a coast; electromagnetic radiation.

For the site selection, it is required to determine the effect of the NPP on the public and the environment performing the following:

- Study of the atmospheric, hydro-meteorologic, hydro-geologic, and geochemical conditions of radionuclide dispersion, migration, and accumulation as well as the natural radiation background. A prognosis for the variation of these conditions throughout the entire period of operation of the NPP shall be drawn up;
- Assessment of atmospheric dispersion by taking account of the light wind, air stagnation, air temperature, ground and altitudinal 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 basin, meeting the conditions specified in the Regulation.

Concerning site selection, the radiological situation for all operating modes and emergency conditions shall be justified and technical and organizational measures for the safety of the public shall be developed. Assessment of the radiological situation for all operating modes shall be carried out applying probabilistic distribution of the parameters of atmospheric dispersion that are typical for the area of the NPP. Assessment of the radiological situation for emergency conditions shall be carried out for the most unfavourable weather conditions typical for the area of the NPP site.

The specific requirements and acceptance criteria for the New Build sites are also defined in the Regulation on Ensuring the Safety of Nuclear Power Plants as well as the factors precluding the construction of a nuclear power plant. Generally, the conditions and factors taken into account concern the following:

- Compliance with the legislation on environmental protection, with the standards and regulations for radiation protection, with the fire protection requirements for technological buildings, and with the physical protection requirements;
- Geological and geographical realities, as for example low intensity of the maximum design basis earthquakes, non-floodability of the site, absence of differentiated earth crust movements, and potentially active or abated landslides, or other dangerous slope processes;

- Climatic prerequisites, such as: characteristics, intensity, and significance of occurrence of extreme weather conditions.

The new draft version of the Regulation on Ensuring the Safety of Nuclear Power Plants complies with the latest versions of the IAEA standards related to the assessment and reassessment of the NPP site characteristics including NS-R-3/Rev. 1 and SSG-25.

Overview of assessments carried out and criteria applied for evaluating all site factors which may affect the safety of the nuclear installation, including multi-unit failure, loss of infrastructure and site access following an event

In selecting sites for nuclear power plants, the characteristics and the frequency of occurrence of phenomena and natural and man-induced factors are investigated and evaluated, whenever possible. The presence of excluding conditions and factors is assessed, and when they do not exist the sites are assessed whether they are favourable for construction of nuclear power plants. In order to consistently apply the defence-in-depth concept in the NPP designs, the impact parameter values for the respective periods of recurrence of external events that could affect safety are defined. Potential consequences of external events, considered in the NPP design bases, are analysed using deterministic methods to confirm the selected defence concept. Reasonably applicable measures are planned for protection from the consequences from rare phenomena and events, including extreme external events and natural phenomena that could impact the whole site simultaneously.

Kozloduy NPP site and the region are subject to investigation since 1967, when the site was selected for the construction of the first Nuclear power plant in Bulgaria. During the following period a number of additional analyses and investigations have been performed to identify the possible natural phenomena and hazards and the sources of potential man-induced risk. The methodologies of the evaluations carried out and the results thereof are documented in the safety analysis reports of 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 processes were identified:

- Earthquakes;
- Loess collapsing;
- Settlements due to large loads from certain facilities;
- Subsidence of embankments;
- Filtration of service water and transfer of contaminants to the aquifers;
- Liquefaction of structurally unstable soils;
- Erosion and flooding of the ‘Marichin valog’ tributary valley.

Measures were taken to limit those processes and prevent their effects, applying various methods for bedrock enhancement.

In 1992, a reassessment of seismic loads was carried out at the Kozloduy NPP site – a Review Level Earthquake (RLE) was established for qualified equipment for a recurrence period of 10,000 years. Based on this reassessment, the following parameters of the impact were determined:

- Maximum horizontal peak ground acceleration for the NPP site for SL-2 Design Basis Earthquake (recurrence period of 10,000 years) – 0.2g;

- Maximum horizontal peak ground acceleration for the NPP site for SL-1 earthquake (recurrence period of 100 years) – 0.1g;
- Design floor response spectra at the free surface and respective 3D accelerograms with a duration of 61 s.

The methodology of the probabilistic analysis of seismic hazard is based on the Cornel standardized mathematical model and on the McGuire 1976 and Toro&McGuire 1988 software.

The seismic levels, design floor response spectra and respective 3D accelerograms were reviewed and confirmed by IAEA experts during the period from 1992 to 2008. Following the IAEA recommendation the floor response spectra and respective 3D accelerograms with duration of 20s have been determined.

Apart from the geological, engineering-geological and seismotectonic investigations on Kozloduy NPP site and the location area, the meteorological and hydrological conditions were also studied to determine the design bases of the power plant as regards 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 the phenomena causing floods and inundations, the Danube flow rate was determined as well as the maximum inundation level which was compared with the Kozloduy NPP site. The crown of the hydro-technical facilities supplying the plant with service water was also determined. It has been concluded that the Kozloduy NPP site is not jeopardised by flooding from the Danube. The maximum water levels of the river are below the elevations of the facilities' crown and site.

The frequency of occurrence of rare and extreme external impacts, e.g. hurricane, extreme rainfalls/snowfalls, air and water temperatures, icing, thunderstorms, dust and sand storms, river and water basins banks erosion, and tornado, was also assessed.

As regards the sources of man-induced hazard in the region of the plant, they have been identified through analyses and studies based on the distance and probability level screening methods. Applying those two methods, the man-induced sources in a radius of 30 km from the Kozloduy NPP site were identified. The potential impact of the following human-induced hazards was assessed:

- Explosion at Kozloduy NPP site and the fixed and mobile explosion sources located in immediate vicinity;
- Emergency release of chemically active substances, including from industrial site where toxic and corrosive substances are processed, used, stored and transported;
- Fires off-site the NPP, including on river and road transport vehicles, etc.

As a result of the analyses, no initiating events were determined with frequency exceeding the limit value of the annual probability rate for occurrence of events with potential radiological consequences (Screening Probability Level).

During the stress tests of the European nuclear power plants, carried out in 2011, following the accident in Fukushima NPP, an assessment was made of the plant response as a whole 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. The available margins in the facilities and equipment capacity until occurrence of boundary conditions were assessed and the results thereof are summarized in the Report Section referred to in article 17(3). Pursuant to the National Action Plan of the Republic of Bulgaria resulting from the stress tests, the IAEA Action Plan on Nuclear Safety, and the conclusions of the Second extraordinary 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. Those measures refer mainly to:

- Analysis of extreme meteorological conditions using probabilistic methods;
- Reassessment of the technical provisions and the organizational arrangements for action in case of simultaneous accident with fuel melting in all nuclear facilities on site;
- Developed an emergency procedure for actions to be taken in case of destruction of hydro facilities 'Zhelezni Vrata 1 and 2';
- Update of the on-site and the off-site emergency plans in the context of a simultaneous accident, deteriorated infrastructure and impeded access to the facilities on site.

In relation to the Governmental Decision "in principle" for the construction of a new nuclear unit in the area of Kozloduy NPP, an application was submitted to the NRA, in the end of 2012, for issuance of a permit for determining the location of a nuclear facility (siting) in immediate proximity to the Kozloduy NPP site. In August 2013, the NRA issued a *Permit For Siting* of a nuclear facility (site selection) to the *Kozloduy NPP – New Build plc*, a subsidiary of the operating organisation Kozloduy NPP. Thus, in the period 2013-2015, a project was completed on the study of the 4 potential sites in the immediate vicinity of the operational NPP, determination of a preferred site for the construction of a new nuclear unit, and assessment (reassessment) of its characteristics. Detailed information on the reassessment of the parameters of impact of the site-specific factors that can compromise safety is depicted in the text referred to in Article 17(3).

Review of the design provisions used against man-induced external events and natural occurring external events such as fire, explosion, aircraft crash, external flooding, extreme weather conditions, and earthquake as well as the impact of secondary natural disasters (tsunami due to earthquakes, mudslides/alluviums due to heavy rains)

The layout of Units 5 and 6 reactor buildings complies with all fundamental requirements for ensuring protection of the personnel, the public and the environment from the radiological impact and it is in conformity with the generally accepted principles and international practices related to designing of NPPs, which are reflected in the IAEA documents INSAG-3, INSAG-10, etc.

In 2004-2006 the seismic stability of the buildings was studied and analysed at 0,2g for SL-2 (0.1g for SL-1); the safety systems equipment behaviour was also analysed in case of earthquakes. As a result of this, measures were identified and implemented for the seismic re-qualification and securing seismic stability of the safety systems equipment and the building structures with regard to the increased seismic impact.

Based on their intended functions, a list of the SSCs required for the unit shutdown and keeping in a safe state during accidents and in post accident conditions (safety shutdown list) was prepared. This list includes safety related SSCs which failure can compromise a basic safety function.

In 2006-2007, containment pre-stress and strain analyses were carried out applying the end elements method and using data from the automatic control systems as well as laboratory testing and studying of components. The assessment of the containment strength properties was expanded and specified in 2012, at the update of 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 unit. The ageing processes were analysed, critical elements were identified, and an Ageing

Management Programme was developed. The analysis and the evaluation results demonstrate that Units 5 and 6 containments are able to fulfil their functions in all types of design basis external and internal events.

The analysis of SSCs' design solutions conducted during the stress tests at the European NPPs in 2011 following the Fukushima NPP accident proved sufficient margins to boundary effects for the equipment and facilities. As a result, nothing shall be changed concerning 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 and mudslides due to torrential rains). The National Action Plan of the Republic of Bulgaria resulting from the stress tests include measures to ensure and support safety at the nuclear facilities in the event of an accident affecting the entire site and surrounding infrastructure such as:

- Installation of additional mobile diesel generators supplying power to the safety related systems, including battery charging;
- Specifying roads for on-site transport of the mobile diesel generators, as well as alternative routes for transport of supplies and emergency response teams.
- Construction of a Remote Emergency Response Centre;
- Analysis of extreme weather conditions at the Kozloduy NPP site applying probabilistic methods in accordance with the IAEA methodology and considering combinations of extreme weather conditions.

Regulatory review and control activities

With reference to the decision for the construction of a new nuclear unit, in the end of 2012, an application was submitted to the NRA for issuance of a permit for determining the location of a nuclear facility in immediate proximity to the Kozloduy NPP site. As a result of the regulatory review and assessment of the compliance between the data submitted and relevant regulations, the NRA issued in 2013 a permit to the Kozloduy NPP – New Build for siting of a new nuclear unit. The conditions of the permit define the basic requirements for the activity and preliminary studies related to site selection and determination of the processes and phenomena impact parameters.

Upon completion of the activities involving 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 accompanied by the following information:

- Preliminary Safety Analysis Report (PSAR);
- Report from an independent verification of the results of the 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 EIA Report.

The independent verification of the results of the selected site assessment conducted under a contract awarded 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 number of studies related to the siting for the

construction of a new nuclear unit, had been completed in accordance with the national regulations and current IAEA standards.

As part of the ongoing regulatory review of the documents submitted, the NRA awarded in 2016 a contract for the review of the PSAR for approval of the selected site for construction of a new nuclear unit on the territory of Kozloduy NPP, pursuant to Article 33(4) of the *Act on the Safe Use of Nuclear Energy*. This review is aimed at considering and assessing the consistency of filed data on the site characteristics, in the relevant PSAR sections, as well as in the submitted thematic reports. A specific objective of the review is to check the correctness and validity of the data related to the geological, seismic, hydrological, and meteorological characteristics of the site and its surroundings in order to verify the absence of dismissing factors. The following site specific risks are 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 presence of 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.

The regulatory activities related to the review of the implementation of the National Action Plan of the Republic of Bulgaria, resulting from the stress tests conducted at the nuclear facilities on the site of Kozloduy NPP, are described in the text referred to in Article 14 of this Report as well as in the National Action Plan itself. NRA representatives took part in the Second ENSREG workshop held in Brussels in April 2015 to discuss the progress in the implementation of the EU Countries' National Action Plans.

Article 17 (2) Impact of the installation on the population, society, and environment

In accordance with the ASUNE, the proposal for construction of a new build shall be submitted by the Minister of Energy, accompanied by assessment of nuclear safety, radiation protection and environmental impact. The Minister makes arrangements for a public discussion of the proposal, which is attended by state and local authorities, representatives of public organizations and interested individuals and legal entities. When the operation of NPP might impact the population and 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 to analyse and assess the possible impact of the plant on their territory, from the viewpoint of public safety and environmental protection.

The *Regulation on Ensuring the Safety of Nuclear Power Plants* requires that during site selection the radiation conditions shall be defined for all operating states and emergencies and technical and organizational measures to ensure public safety shall be developed. The potential radiological consequences on population and environment in the surveillance zone in accidents have to be determined taking into account the required conservatism and specificity of the nuclear facility design and the respective site. The limit of the individual effective dose from

internal and external exposure of the population, caused by the impact of liquid and gaseous releases to the environment, in all operating states of all nuclear facilities at the NPP site, is specified by the *Regulation on Ensuring the Safety of Nuclear Power Plants*. This regulation also limits and individual effective dose from internal and external exposure of the population for the first year, following a design basis accident. In case of severe accidents, the limit value of Caesium-137 discharges into the atmosphere, which will not require long term restrictions in the usage of soils and water in the surveillance zone, is 30 Tbq. The mixed discharges of other radionuclides, different from the Caesium isotopes, should not cause in long term aspect, beginning three months after the accident, a higher risk than the one defined for the Caesium discharges within the stated limit.

Pursuant 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, in addition, a positive decision on the EIA Report and Site Monitoring Programme are required. For authorization of commissioning of a nuclear facility, the same Regulation requires the submission of a *Programme for on-site radiation monitoring* a *Programme for environmental monitoring* during its operation.

Pursuant to the Environmental Protection Act, an EIA Report for the Kozloduy NPP Units 5 and 6 was prepared in 1999. The results from the analysis of Kozloduy NPP impact on the population and the environment are included in the updated Safety Analysis Reports of Units 5 and 6. In accordance with the provisions of the operating licences issued for Units 5 and 6, Kozloduy NPP, being the licence holder, shall submit to the NRA information on an annual basis regarding the state of the nuclear safety and radiation protection, on the fulfilment of the on-site radiation monitoring and the environment monitoring programmes and the personnel radiation protection programme.

Article 15 of this report provides data on the monitoring of gaseous and liquid discharges to the environment from Kozloduy NPP as well as data on the dose exposure of the population within the 30 km zone for the period 2012 – 2015.

The construction of a new nuclear in the vicinity of Kozloduy NPP falls within the scope of the *Environmental Protection Act* which provides for the conduct of an EIA. An EIA Report was drawn up concerning the construction of a new nuclear facility in immediate proximity to Kozloduy NPP where the impacts 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 applied for 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 regulations 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 organizations, and natural and legal persons have been held. Five public hearings have been held on the territory of the Republic of Bulgaria and three in the Republic of Romania. The demands of the Republic of Austria have also been 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 on the Kozloduy NPP site.

As noted above, the positive decision on the EIA and the monitoring programmes are part of the licensing documents to be submitted to the NRA with the application for approval of the selected site for construction of a new nuclear unit. The drawn up programmes for monitoring of the Kozloduy site include 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 control of the variables, provision of the necessary resources, archiving, processing, and transmission of information and the manner of its use, reporting of results to the competent authorities; and 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 site related factors as mentioned in Article 17 (1) ensuring continuous acceptability of the safety of the nuclear installation performed in accordance with the relevant standards and practices

Re-evaluation of the factors resulting from the Stress Tests

As part of the stress tests, 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.

In the course of the re-evaluation, it was established that there existed analyses of the seismic resistance of the equipment having safety functions in these scenarios 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 resisting without the occurrence of a severe fuel damage and radioactive releases into the environment were determined. The BDB seismic impact analysis proves that in terms of seismicity the Kozloduy NPP SSCs are capable of ensuring plant safety in the event of the maximum possible seismic effects for the site.

Based on the re-evaluation of the site flooding frequency, a new maximum water level was established and the duration of its occurrence was re-considered. The possibility for ice-blocking of the river was studied and the possibility for combination of a maximum water level with other unfavourable phenomena was assessed. The new maximum water level for the Kozloduy NPP site (32.93 m) was determined based on the maximum water level of the Danube River with recurrence period of once in 10,000 years, accident at the hydroelectric power plants 'Zhelezni Vrata 1 and 2', and maximum values for rain and wind. A probabilistic analysis was conducted of the combination of the 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'. The calculated water levels are as follows:

- $p = 10^{-5}$ (once per 100,000 years) for water level of 32.98 m;
- $p = 10^{-6}$ (once per 1,000,000 years) for water level of 33.26 m;
- $p = 10^{-7}$ (once per 10,000,000 years) for water level of 33.42 m.

These results confirm the unfloodability of the Kozloduy NPP site situated at elevation 35.00 m.

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 protective means and organisational measures ensuring house load 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 respect of the governmental decision for construction of a new nuclear unit, in the period 2010 – 2015, the permit holder for siting, Kozloduy NPP – New Build, completed a project on the survey of 4 potential sites situated in the immediate vicinity of the operational Kozloduy NPP. As part of this project, a comprehensive re-evaluation of the site characteristics was conducted. A systematic review of the database from previous surveys was carried out. Existing data were analysed for completeness and compliance with the current regulations and a Programme for Additional Studies was drawn up. The obtained results and existing data were used for comparative assessment of the proposed sites. The national regulations related to the siting process in effect at the time of the survey and the relevant IAEA safety standards were considered in the assessment methodology. The criteria for comparative assessment of the proposed sites were grouped in respect of the relevant 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. The preferred site location has been selected based on a comprehensive assessment taking into account all current criteria.

As part of the project on survey and selection of a site for the new nuclear unit, the following assessments and studies were conducted:

- Engineering-geological studies of the potential sites;
- Modelling of radionuclide migration to the subterranean part of the potential sites;
- Update of the site seismic hazard;
- Definition of the seismic design basis;
- Analysis of geophysical fields and current movements of the earth's crust;
- Climatology and local meteorology, dispersion characteristics of the atmosphere;
- Hydrology of the Danube;
- Demography and man-induced effects;
- Additional engineering-geological and geophysical surveys of the selected site;
- Additional analysis of the Kozloduy site protection against hazardous meteorological, hydrological, and geological phenomena.

As part of the reassessment of 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. Using those loads, an "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 assessment was carried out, and their margins in terms of resistance to loads due to weather effects were determined. For the civil structures lacking the required resistance, the interaction of the relevant structural element with other SSCs was analysed and, based on that, organizational 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 covering sufficiently wide area around the site of the Plant were used. The data from the standard meteorological observation archives from the meteorological stations in Bulgaria were also used, thus obtaining the required input for determination of the design meteorological characteristics, containing a number of annual values of the parameters, as well as information on distinguished maxima for different periods of various durations. The analyses of the ratio between the regional

long-term weather characteristics and local parameters clearly confirmed the representativeness of those characteristics for the site. Besides that, a quantitative and probabilistic assessment for a wide range of phenomena was provided – with recurrence period of 100 years (Level 1) and 10,000 years (Level 2).

Characteristic extreme weather impacts that may occur in the area of Kozloduy NPP consist of extreme snowfall, including snow storms and snowdrifts; extreme rainfall; extremely low and high temperatures; extreme winds; tornado; and icing. In order to address beyond design extreme external impacts with 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 genesis extreme impacts, e.g. extreme rainfall and hurricanes; extremely low temperatures – high wind – icing were considered.

The level of groundwater at the Kozloduy NPP industrial site is monitored on a monthly basis (over 100 drilling wells). The data are submitted for processing, analysis, and storage to the relevant NPP experts on hydro-engineering facilities.

Regulatory review and control activities

The regulatory activities related to the licensing of the selected site for the construction of a new nuclear unit in the vicinity of Kozloduy NPP are depicted in the text referred to in Article 17(1).

Regarding the existing nuclear facilities at Kozloduy NPP, the regulatory activities for review and control of the reassessment of factors related to the site are carried out in the course of the administrative proceedings on renewal of the operating licences. The authorization regime, as specified by the ASUNE, provides for the extension of the operating licence of a nuclear facility based on assessment of the nuclear safety and radiation protection (periodical safety review). According to the Regulation on Ensuring the Safety of NPPs, the periodical safety review includes a re-assessment of the site characteristics considered in the design, based on the obtained new data or new assessment methods used. Pursuant to those provisions, it is expected that in the course of the Periodic Safety Review of the Kozloduy NPP Units 5 and 6 the results of the site characteristics reassessment conducted for the purposes of the licensing of a new nuclear unit will be considered.

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, EIA Regulation, and Convention on EIA in a Trans boundary Context to which the Republic of Bulgaria is a party.

Romania, being a country affected by the construction of a new nuclear unit at Kozloduy NPP site, was notified by the MEW. In response to the notification, Romania expressed its willingness to participate in the EIA procedure. In the course of the EIA procedure, Romania was provided with the Terms of Reference reflecting the scope of the EIA about which the country delivered an opinion. The MEW provided access to the EIA Report and its annexes in the English language as well as to the Romanian version of the non-technical summary and Part 11, Transboundary Impact, and informed the Ministry of Environment and Climate Change of Romania about the public hearings in Bulgaria providing an opportunity for public and institutional participation on behalf of Romania as well as translation to Romanian language. Romania, on the other hand, notified the MEW of its intent to hold public hearings on the EIA Report in Romania, providing comments on the documentation. On 18 December 2014, 19 December 2014, and 20 December 2014, in the towns of Dăbuleni, Craiova, and Bucharest, Romania, public hearings attended not

only by Romanian citizens, institutions, and organizations, but also Bulgarian non-governmental organizations were held. Translation to and presentations in Romanian language as well as the Romanian versions of the EIA documentation – Parts 2, 4, 5, 9, 11, 12 – and non-technical summary were provided. After the public hearings in Romania, the Ministry of Environment and Climate Change of Romania communicated to the MEW questions, statements, and comments resulting from the public access. On this occasion and in response to the expressed opinion of the contracting authority which was sent to Romania, the affected country provided its final opinion on the cross-border EIA procedure filing proposals that were included as conditions in the Decision on the EIA, No. 1-1 of 27 January 2015.

In connection with the construction of a new nuclear unit, considering the letter Austria sent to the MEW with the request for obtaining information on the Investment Proposal, a notification was sent to Austria to. Due to the fact that the Austrian Federal Ministry of Agriculture, Forestry, Environment, and Water Management (BMLFUW) had registered its interest to participate in the EIA procedure, the MEW informed Austria about the access through the web site of the Ministry to the English version of the Terms of Reference reflecting the scope and content of the EIA Report. Austria delivered an opinion with questions and comments that were considered in the EIA Report. MEW provided information to the Austrian Federal Ministry of Agriculture, Forestry, Environment, and Water Management about the access to the EIA Report and its annexes in the English language as well as to the German version of the non-technical summary and Part 11, Transboundary Impact, and informed Austria about the public hearings in Bulgaria providing an opportunity for public and institutional participation on behalf of the interested country. In response, Austria provided the comments of the public and opinion of the Austrian Environment Agency commissioned by the Austrian Federal Ministry of Agriculture, Forestry, Environment, and Water Management. In addition, Austria sent an independent report with comments and expressed its final opinion on the cross-border EIA procedure. Based on the conclusion from the Independent Report, Austria considered the consultation stage in the transboundary context closed since there were no more questions and requests for holding a public hearing on its territory

The EIA Report is consistent with the results of all the consultations held in Bulgaria as well as with the countries that have expressed their willingness to participate in the EIA procedure. It addresses the aspects of the transboundary impact and proposes measures for prevention and limitation of such impact.

On 19 January 2015, a sitting of the Supreme Environmental Expert Council, in its capacity as advisory body to the MEW for taking a decision on the environmental impact assessment for approval of the Investment Proposal, was held. On 27 January 2015, based on Decision No. 1-1 of 2015, the Minister of Environment and Water approved the implementation of the Investment Proposal for construction of a new nuclear unit of the latest generation on the Kozloduy NPP site.

Bilateral agreements with neighbouring countries

Bilateral Agreements have been 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 those Agreements, the Contracting Parties shall notify each other when any of them has plans for construction of new nuclear facilities; they shall also provide the required technical information about those facilities.

In accordance with the recommendations from the Second Extraordinary Meeting to the Convention on Nuclear Safety held in August 2012 and the IAEA Action Plan on Nuclear Safety, Bulgaria reviewed the existing bilateral agreements with neighbouring countries on early notification and exchange of information in the event of a radiological incident. At the level of the regulatory authorities, the agreements with Russia and Romania were revised and renewed,

while with Serbia, a new agreement, approved by the Council of Ministers of Bulgaria, was signed. The agreement with the Greek regulator is also about to be renewed. Pursuant to those Agreements, the Contracting Parties shall notify each other when any of them has plans for construction of new nuclear facilities; they 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) Implementation of defence in depth concept

Overview of the arrangements and regulatory requirements concerning the design and construction of nuclear facilities

The basic criteria and rules for the nuclear safety and radiation protection, as well as the organizational matters and technical requirements for ensuring safety during siting, design, construction, commissioning and operation, are defined by the *Regulation on Ensuring the Safety of Nuclear Power Plants (NPPs).* Pursuant to this regulation, the NPP safety shall be ensured by consistent implementation of the concept of defence in depth, which is based on using a system of physical barriers in the pathways of ionizing radiation and radioactive substances spreading; and by a system of technical and organizational measures to protect barriers and maintain their effectiveness, as well as to protect the public, staff and environment. The physical barrier system of each nuclear installation consists of: fuel pellet, fuel elements cladding, reactor coolant boundaries, and reactor containment. It is required the technical and organizational measures system shall cover all levels of protection:

- Level 1 - prevent from anticipated operating events;
- Level 2 - prevent from design basis accidents through the normal operation systems;
- Level 3 - prevent from beyond design basis accidents through the safety systems;
- Level 4 – management of beyond design basis accidents;
- Level 5 - development and implementation of on-site and off-site emergency plans.

The defence in depth concept is applied at all stages of activities, related to ensuring the safety of NPPs. The measures to prevent adverse events on the first and second level of protection have priority over other safety related measures.

The regulation specifies the requirements on the design basis and safety assessment of a nuclear power plant. The design basis shall specify the necessary capabilities of the plant, which ensure that the radiological limits for internal and external exposure of personnel and the public and the limits for release of radioactive substances into the environment are not exceeded in all operational states and design basis accidents. The design basis shall include design limits, plant operating states, safety classification of the structures, systems, and components (SSC), design key assumptions, and in individual cases, special methods of analysis.

The Regulation requires that, as a minimum, design limits shall include:

- Radiological and other technical acceptance criteria for all operational states and accident conditions;

- Criteria on protection of fuel cladding, including fuel temperature, departure from nucleate boiling, cladding temperature, fuel rod integrity (tightness), and acceptable fuel damage at all operational states and design basis accidents;
- Criteria on protection of the coolant pressure boundary, including maximum pressure, maximum temperature, thermal and pressure transients and loads;
- Criteria on protection of the containment, including temperature, pressure and leak rates, considering the necessary margins ensuring its integrity and leak tightness in case of extreme events, severe accidents, and combination of initiating events.

The design shall define the design basis accident initiating events to determine the boundary conditions according to which the SSCs important to safety are designed, manufactured and installed. The selection of postulated initiating events shall be based on the use of deterministic and probabilistic methods.

The Regulation requires that postulated internal initiating events shall be grouped into different categories depending on their frequency of occurrence per calendar year. At the same time, possible human errors and possible combinations of internal and external events based on realistic assumptions shall be considered as initiating events within the NPP design.

The NPP design shall consider the specific environmental conditions and loads of the SSC important to safety, resulting from internal events and NPP site specific external events and hazards.

In addition to the design basis, the plant performance in beyond design basis accidents shall be assessed. The list of beyond design basis accidents with no severe core degradation shall be defined, as considered by the design, if not prevented by the reactor inherent safety features and the design principles.

If the analysis of severe accident consequences does not confirm the implementation of the criteria for the radiological exposure of the public, as specified by the Regulation, the design shall provide for additional technical measures for severe accident management in order to mitigate their consequences. Furthermore, the plant shall be designed in such a way that the frequency of a large radioactive release into the environment, that requires undertaking of immediate protective measures for the public, shall be extremely low.

SSCs important to safety shall withstand the conditions of postulated initiating events with sufficient margins. To identify the cases where application of the principles of diversity, redundancy and independence is needed to achieve the necessary reliability, the potential for common cause failures shall be analysed and considered in the plant design. The plant design shall prevent to a practically achievable level:

- Conditions, resulting in compromising the physical barriers integrity;
- Failure of a physical barrier, if there are conditions under item 1;
- Physical barrier failure, resulting from another physical barrier failure.

The plant shall be able to perform its fundamental safety functions and the proceeding safety functions at all operational states and accident conditions. The design shall consider, to the extent practicable, the diversity principle, the self-checking capability in safety systems and techniques for precluding interference of individual SSCs.

The postulated initiating events shall be analysed using the single failure criteria for an initiating event of an active or a passive component of the safety systems, which has the most adverse effect on the accident progression or a single, independent from the initiating event human error. In addition, any latent (undetected) failures challenging the safety limits shall be considered.

Conceptionally new requirements to safety of new nuclear power plants are introduced to the draft of the new *Regulation on Ensuring the Safety of Nuclear Power Plants*. The WENRA safety objectives of the new nuclear power plants design, the updated post-Fukushima Accident reference levels for harmonization of the current nuclear power plants safety and the newest IAEA safety standards in this area are considered. The draft of the Regulation introduces the requirements of the Council Directive 2014/87/EURATOM of 8 July 2014, amending the Directive 2009/71/Euratom, and 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 considers the last revisions of the IAEA standards referring to: Safety of Nuclear Power Plants: Design SSR-2/1/Rev.1; Construction of Nuclear Installations SSG-38; Safety Classification of Structures, Systems and Components in Nuclear Power Plants SSG-30; Design of Electrical Power Systems and Instrumentation and Control Systems for NPPs SSG-34 and SSG-39.

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

Kozloduy NPP Units 5 and 6 designs were developed in the early 80's, in the former USSR, based on the unified reactor design WWER-1000/V-320. The safety principles and criteria, which the original design is based on, are included in the part of the design “Technical justification of safety". The basic design principles and safety criteria are considered 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 basic principle incorporated in the design basis is provision of radiation protection for the staff and the public from external and internal exposure and protection of environment from radioactive substances contamination. The design is developed based on a conservative approach and provides for inherent safety features of the reactor installation. The design provides technical measures and means directed to ensuring the safety in case of a single failure of a normal operation device, which may coincide with a long lasting hidden failure of another normal operation device. Together with the failure of a normal operation device, a failure of one of the independent active protection devices and one of the independent active localization devices is considered. The protective and localisation devices perform their safety functions in all design accident conditions considered, including the so-called “maximum possible design basis accident” and they have characteristics, sufficient to perform their functions, and have triple redundancy, including power supply. The primary coolant boundary is located completely in the containment. All containment penetrations in the wall are equipped with localizing devices, individual testing devices are provided for penetrations which have seals to withstand design pressure.

The sudden guillotine break of a main coolant pipeline in the case of a total loss of external power supply and in the event of a safe shutdown earthquake (SL-2) is considered a "maximum design basis accident" in the technical design.

The symptom-based emergency procedures (SBEP) and severe accident management guidelines (SAMG), implemented at Units 5 and 6, define the staff actions for diagnosis of the unit status, recovery or compensation of violated safety functions and prevention or mitigation of the core damage consequences.

The applied basic design principles and safety criteria, including application of independence, redundancy and diversity, as a whole implement the fundamental concept of the defence in depth, as defined by the IAEA documents INSAG-3, revised by INSAG-12. 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 from 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 have been installed to reduce the consequences from beyond design basis accidents in order to protect the personnel and public.

With regard to the external initiating events of natural origin - the stress tests conducted at Kozloduy NPP show that the margin of units 5 and 6, in terms of earthquake, represents 0,13 g or 65% compared to RLE (PGA = 0,2 g), i.e. the units can withstand without fuel damage to an earthquake 1.65 times greater than the RLE. The equipment which is important to safety and included in the scenarios is analysed for seismic resistance and the parameters describing its provisional probability of failure are defined (fragility curves). The limit values of the peak ground accelerations which every nuclear facility on site can endure without a severe fuel damage and radioactive release to the environment are determined. The analysis of the beyond design basis earthquake is conservative enough and provides for that the SSCs on Kozloduy NPP site in seismic terms are able to ensure the safety of the plant at the maximum possible for the site seismic impacts.

At the same time, the maximum water level (MWL) and its duration is defined for the purposes of stress tests, the possibility of blockage of the Danube by ice is examined and the possibility of combination of MWL with other hazards is evaluated. The results confirm the non-floodability of Kozloduy NPP site.

Extend of use of design principles, such as passive safety or the fail safe function, automation, physical and functional separation, redundancy and diversity, for different types and generations of nuclear installations

The design of Kozloduy NPP units 5 and 6 SSCs important to safety considers design solutions based on a passive principle of actuation, the fail-safe principle and the inherent safety features (self-control, heat inertia and other natural processes). The presence of internal self-protection and passive elements of the safety systems provides for significant safety margins for the safe shut down of the reactor and long-term reactor cooling.

The specific technical solutions, applied in the safety systems design, are related to the implementation of the basic legislative requirements – multi-channel structure (redundancy), physical separation and diversity. The multi-channel design enables the safety system to perform its functions regardless of any failure of a train (single failure). Automatic devices are actuated by signals, generated by comparing several measurements, in order to prevent spurious actuation of the safety systems in accidental deviation in measurements. After the safety systems actuation they cannot be terminated until completing their function to bring the unit into a safe state. The safety systems channels physical separation is achieved through the layout of each channel in a separate room and provision with separate cable trays. This design feature ensures the successful work of the safety system, even in the event of failure of one of the channels due to internal events (fire, explosion, high temperature, flood, etc.). The diversity of the physical principles for performance of the safety systems functions is applied to the design by using both active (pumps, electric valves) and passive devices (pressurized tanks, check valves), in order to eliminate the possibility of failure of all safety systems due to loss of total power (power supply, working environment, etc.). The combination of redundancy, diversity and physical separation ensures the safety systems resistance to common cause failures.

There is no physical connection between the units 5 and 6 in operation and the spent fuel storage facilities (dry and wet type) - they are physically and functionally separated.

Implementation of design measures or modifications to prevent beyond design basis accidents and mitigate their radiological consequences in the event of a severe accident (for the entire nuclear installation including SFP)

As a result of the periodic safety reviews 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 installed to prevent the occurrence of severe accidents or mitigate the consequences thereof. Significant part of the modification made and new systems installed are as follows:

- Containment filter ventilation system;
- 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 severe accidents at Kozloduy NPP Units 5 and 6;
- Alternative steam generator make-up system, that can be power supplied by the mobile diesel generators- MDG 6 kV or MDGs 0.4 kV;
- Replaced batteries of the three safety system channels;
- Power supply from the batteries to the valves of the emergency gas removal system from the primary circuit and the fast acting valves between the primary circuit and the hydroaccumulators to ensure severe accident management;
- Additional Spent Fuel Pool make-up pipeline from mobile device was installed;
- A design on the hydrogen, oxygen, carbon dioxide and steam concentration measurement within the containment during and following a severe accident, was developed;
- Instruments for monitoring, qualified for severe accidents and measuring the parameters within the range of severe accidents were installed, such as:
  - temperature sensors at the exit of the reactor core up to 1200ºC and the coolant level in the reactor vessel sensors;
  - wide range radiation sensors within the containment: $10^{9} \div 10^{15}$ Bq/m^3; $10^{-2} \div 10^{6}$ Gr/h;
  - reactor vessel temperature sensors at the expected area with a maximum critical thermal flux in case of severe accident, with measuring range 500÷1300ºC.

The data from the measurement channels of these instruments enter into the Safety Parameters Display System (SPDS) and the Post Accident Monitoring System (PAMS), which are installed in the main control room (MCR), Emergency Control Room (ECR) and Emergency Response Centre (ERC). For the alternative SGs make-up system, in case of accidents with total loss of electrical power supply (blackout), measures have been implemented to provide for additional power supply from either of the mobile DGs.

The tests conducted on the new batteries following the events at the Fukushima NPP proved that their capacity is sufficient to provide for power supply to the required consumers up to 11 hours.

The implementation of particular measures, where appropriate, to maintain the containment physical integrity to prevent the continuous external contamination and particular actions undertaken or planned to cope with extreme weather conditions, more severe than those considered in the design basis.

As a result of the implementation of the above-mentioned measures (containment emergency filter ventilation, service plugs made of high temperature resistant material for prevention of early containment bypass, hydrogen passive recombiners in the containment, monitoring systems, qualified for severe accidents etc.) and together with the developed severe accident management guidelines (SAMGs) is improved significantly the protection ability of the reactor coolant pressure boundary and the containment structure boundaries to mitigate the consequences of severe accidents and bring the reactor installation into a controlled state.

A Level 2 "*Probabilistic safety analysis*" (Level 2 PSA) was conducted at Kozloduy NPP units 5 and 6, including analysis of the scenarios affecting the integrity of:

- Containment structure;
- Containment structure behaviour in different scenarios;
- Radioactive source size.

Within the scope of Level 2 PSA are assessed:

- Strength characteristics of the containment (pressure capacity and effects of temperature);
- Phenomena;
- Release categories.

Improvements implemented for nuclear power plants designs as a result of the deterministic and probabilistic safety assessments; overview of the main improvements made following the nuclear installation commissioning

Based on the results of the probabilistic safety analyses, suggestions are made for safety improvement changes at Units 5 and 6 in the following major areas:

- Emergency procedures and training;
- Planning of outages and maintenance schedules, and organization and control of maintenance activities;
- System design and technological requirements;
- Seismic risk analysis;
- Risk analysis of internal and external fire.

The main part of the performed modifications, required to bring the units in accordance with the international recommendations regarding safety and reliability, are resulting from the implementation of the Units 5 and 6 Modernization Programme (completed in 2008). This programme included a total of 212 measures to improve the safety and reliability of the units and two thirds of the measures improved the equipment reliability. Various studies were conducted in different aspects of safety such as:

- 5 neutron-physical analyses;
- 32 thermal-hydraulic analyses;
- 4 radiological analyses;

- 7 mechanical strength analyses.

The scope of the analysis was significantly expanded within the Modernization Programme with the aim of defining the possibilities of the units for design basis and beyond design basis accident management.

The most important results of these analyses are as follows:

- The survey on the risk of brittle fracture of the reactor vessel confirmed that the operational lifetime of the reactor pressure vessels is ensured for a period of time exceeding the provided in the initial design 40 years under the current schemes of core refuelling;
- The modified algorithms of some protections and interlocks (SGs level control, reactor power control) improved the unit resistance to dynamic transients. Thus, the reduction of possible deviations of the parameters from the operational limits reduces the frequency of occurrence of emergency processes;
- The analyses of various transient processes, resulting from initiating events with extremely low frequency demonstrate the inherent safety of the reactor core;
- The considered large, medium and small leaks from the primary circuit, and the radiological consequences of intersystem leaks, confirm the capability of the current safety systems to bring the units into a safe subcritical state, to ensure core cooling and limit the radioactive releases within the established norms.
- Sufficient seismic stability and margins of the civil structures related to safety at the designated site new seismic impact SL-2 = 0.2g. Therefore, 27 analyses on the equipment and 47 analyses of the pipelines were performed.

A number of measures were implemented to eliminate well known design deficiencies of WWER-1000/V-320 type units. In addition to the above-mentioned measures, can be defined such as:

- Strengthening of the main steam and feedwater pipelines against local mechanical effects due to ruptures;
- Automated system for protection from cold overpressure of the reactor vessel during shut down and start-up operation modes;
- System for continuous monitoring of the 6 kV motor insulation in a stand-by mode;
- Additional diesel generator for each unit for power supply to the switchboards for normal operation;
- Replacement of the analogous control systems with digital ones;
- Implementation of technical solutions for charging any safety system battery from MDGs;

In connection with the implementation of the National Action Plan of the Republic of Bulgaria following the Fukushima NPP accident, Kozloduy NPP has prepared a "Programme to implement the recommendations of the stress tests conducted at the Kozloduy NPP nuclear facilities".

Within the envisaged control on the implementation of the National Action Plan, in January 2014, the NRA reviewed the Plan and issued a new revision. Part 4 - New measures and activities - was added in this revision. Part 4 contains a list of 10 new measures for implementation or conduct of new analyses, resulted from already completed measures from the

NAcP, revision of December 2012. The updated NAcP (UNAcP) is published on the NRA internet page on the following link:

http://www.NRA.bg/en/nuclear-facilitie/stress-tests/Kozloduy /uNAcP-bg-2015-en.pdf

The measures included in the UNAcP can be divided into four main groups:

- Measures to improve the plant resistance to earthquake;
- Measures to prevent and mitigate the consequences of floods;
- Measures to improve plant resistance in case of a loss of ultimate heat sink and safety systems;
- Measures to improve the severe accident management capabilities.

The implementation of the UNAcP measures has been ongoing in 2016. At the end of 2015, of a total number of 77 measures, 58 (75 %) have been completed, while 19 measures are in progress.

Regulatory review and control activities

The implementation of the licensing regime, as required by the *Act on the Safe Use of Nuclear Energy*, is carried out following the requirements of the *Regulation on the Procedure for Issuing Licences and Permits for Safe Use of Nuclear Energy*. The Regulation, among others licences and permits, establishes the process of issuing a design permit for a nuclear facility and a permit for construction of a nuclear facility.

The modifications of SSCs important to safety are carried out after issuing a permit by the NRA in compliance with the ASUNE 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 that should be submitted by the applicant for review and evaluation. Follow-up control of the modification made is accomplished by conducting inspections.

The process of a regulatory evaluation and analysis covers the following main activities:

- Establishing the compliance with the regulatory requirements on the design basis and operation of structures, systems and components, including facilities of high-risk, related to nuclear safety;
- Review and evaluation of documents submitted to the NRA in compliance with the regulatory requirements, conditions of licences and permits issued and recommendations made, and other documentation required by the NRA;
- Review and evaluation of external independent expertise, studies and researches performed;
- Review and evaluation of all other documents necessary for making regulatory decisions on the safety of the nuclear facilities.

In the course of the evaluation process, if necessary and at the discretion of the NRA Chairman, the following may be performed:

- Inspection of the facility site subject to authorization;
- Use of external consultants;
- Support of the process of decision making by advisory councils.

Article 18 (2) Incorporation of proven technologies

Arrangements and regulatory requirements for the use of technologies proven by experience or qualified by testing or analyses

In accordance with the Regulation on Ensuring the Safety of Nuclear Power Plants, the design technical solutions, technologies and procedures should be defined and justified in accordance with the recent development of science and technology and internationally recognized operating experience. The own and international operating experience and scientific and technical achievements in the nuclear technology shall be systematically analysed and used for the activities continuous improvement.

All structures, systems and components (SSC) (including control system software) important to safety should be defined and classified under safety classes. They should be designed, manufactured, installed, tested, operated and maintained in a way of ensuring their quality including their reliability in accordance with the classification plan. The classification plan should specify the appropriate standards for design, manufacturing, installation and inspection for each safety class.

Measures taken by the licensees to implement 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 modification to the design is implemented in compliance with a specific technical decision no matter what modification is undertaken - hardware or software. The specific requirements for the SSC are defined in the technical decision considering the SSC's classification and qualification status in accordance with the regulatory requirements.

The existing integrated information system for organisation of the operating activity ensured that all phases on the planning and implementation of the technical decisions should be performed following a thorough and systematic review by the process owners. An assessment on the impact of the planned activities on the safety should be performed for each design modification.

Considering the international expertise and engineering and marketing researches made and the receiving inspection performed by the authorised plant subdivisions ensures that the equipment requested and delivered comply with the requirements of the design documentation for 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), which failure may compromise specific safety functions, was performed within the periodic safety review (PSR) conducted in the period 2015-2016.

The relevant analyses to confirm the SSC qualification - seismic, environmental and protection against electromagnetic interference - were performed for all newly installed digital control systems, instrumentation and automation commissioned at Units 5 and 6 following the Sixth Review Meeting of the Contracting Parties to the Convention on Nuclear Safety (for example the hardware- software equipment of the safety control systems; replacement of cable joint boxes, cables and terminal blocks of the qualified equipment installed in the areas of LOCA or HELB; replacement of switchgears 6 кV etc.). Complete tests at the manufacturing facility and at the Kozloduy NPP site are performed to verify the design characteristics including harsh work environment (LOCA or HELB) and the results are documented in the relevant certificates, acts

and/or reports. The pre-operational tests are carried out in accordance with the step-by-step procedures for validation and verification of the software.

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.

Regulatory review and control activities

The Regulatory review and control of activities are described under Article 18 (1) in accordance with the existing legal framework and cover the aspects listed above.

Article 18 (3) Design for reliable, stable and manageable operation

Overview of arrangements 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 of the technological process management. The management and control of the normal operation systems and safety systems of each power unit should be provided for on the main control room (MCR), emergency control room (ECR), normal operation control systems, control safety systems and autonomous devices for information registration and storage. A possibility should be provided to maintain the unit in a safe state or to restore this state 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 in anticipated operational occurrences

The NPP design shall consider human errors as possible initiating events and possible combinations of internal and external events based on realistic assumptions. Probabilistic safety analysis shall include analysis of human errors with consideration of factors that may influence the behaviour of the operations staff in all operational states and accident conditions.

The layout of the control and operations means, and the presentation of information at the MCR, should be such as to enable the operating staff to clearly and quickly determine the status and the behaviour of the power unit, to keep the operational limits and conditions, to identify and control the automated actuation and functioning of the safety systems.

The specific consideration of the human factor and human-machine interface is discussed in details in Article 12.

Implementation measures taken by the licensee

For the safety system and normal operation system management and control of each unit the following have been planned:

- Main Control Room (MCR);
- Emergency Control Room (ECR);
- Normal operation control systems;
- Control Safety Systems;
- Autonomous devices for information registration and storage.

There is a possibility to control all process safety systems and systems important to safety and undertake measures to maintain the unit in a safe state and restore this state in all deviations from normal operation from the MCR.

The safety system control, brining and maintaining the reactor in a subcritical state, providing for heat removal from the primary circuit and SFP and control over the reactor installation state can be implemented by the ECR.

After the refurbishment of the instrumentation and control (I&C) systems, a new control work station was installed at the ECR for control and monitoring the systems for normal operation. It enables the personnel to receive access to the entire information about the equipment status of the systems for normal operation. During normal operation, the work station functions as an information system.

In situations when the access to the MCR is impossible, from the ECR it is possible to fully control and monitor not only the safety systems, but also the normal operation systems through the “Soft control” function of the new control work station. The doubled equipment provided in the ECR is physically, electrically and functionally separated from the MCR equipment.

Managerial and organizational 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 legislation 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 authorization to operate a nuclear installation is based upon an appropriate safety analysis and a commissioning programme 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 operating 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 analyse 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 organizations 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 authorization

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 from the operating organization the development of a Commissioning Programme to confirm that the construction and assembling work is in compliance with the design, and that the SSC characteristics and parameters of the plant technological processes are in compliance with the design requirements. The NPP commissioning shall be performed at sequential stages and a separate programme for each stage shall be developed. The implementation of each subsequent stage shall be preceded by an evaluation of the results from the previous stage and a confirmation that the 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 for obtaining a commissioning permit for each separate stage.

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 Chairman (a licensing stage prior to commissioning). Commissioning programmes shall provide for all necessary tests to confirm the design characteristics of the NPP referred to in the interim SAR.

Commissioning programmes

The programme for each stage shall comprise the objective, description and implementation schedule for all important activities during the respective stage. The programmes shall specify:

- The sequence, duration and interface between the activities within the stage;
- The preconditions for implementation of the tests;
- The work organization and necessary staff;
- The requirements for process preparation and supply with energy and fluids;
- The initial and final state for the stage;
- The acceptance criteria and evaluation of the results;
- The conditions for transition to the next stage.

After implementing all stage commissioning programmes the following goals shall be met:

- All the necessary tests to confirm the compliance of the constructed nuclear power plant with the design requirements are implemented;
- Tests are performed in logical sequence;
- "Hold points" are defined in the commissioning process;
- The operating staff is trained and the procedures are validated;
- The conducted tests do not lead to operational states and emergency conditions that have not been analysed in the interim safety analysis report.

Programmes for verification that installations, as constructed, are consistent with the design and in compliance with safety requirements

The programmes for verification of SSCs shall be developed as early as the conceptual design phase. Verification shall be conducted in the harmonization process between the design basis system functions and the 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 compliance with the design requirements and the imposed new criteria and safety requirements. Combining existing verification programmes and such concerning equipment and modifications made during the subsequent commissioning stages shall be described and evaluated on the basis of documents (e.g. preliminary design report, notes on the design stages, research of facilities, and documentation of system definition, regulatory documents, design-related procedures or practices).

Before the initial fuel loading, the following shall be completed: SSCs important to safety and required at this stage should be installed, tested and operable; tests to determine the characteristics of the reactor coolant circuit shall be completed; the biological shielding effectiveness shall be tested; and radiation monitoring shall be performed at the compartments, the site, the precautionary protective and the surveillance zones.

Before the initial reactor criticality, functional tests of SSCs important to safety shall be carried out to confirm the implementation of intended functions and the compliance with design characteristics. The transition to next power levels shall be made after successful neutron physics tests (experiments) of the reactor installation and completion of all construction and assembling works at the plant.

After completing the tests and the experiments, reports shall be produced, that shall include:

- Description of the performed activities;
- Analysis of the compliance of the design with the actual characteristics of the tested equipment;
- Description of defects and failures;
- Analysis and conclusions about the causes and acceptability of deviations of the actual characteristics from the design characteristics and measures for their elimination.

Regulatory review and control

The Regulation on the Procedure for Issuing Licences and Permits for Safe Use of Nuclear Energy requires that prior authorisation for the performance of each subsequent commissioning stage a NRA commission shall inspect the site for compliance with the declared data and circumstances and the readiness for performing the stage. The inspection commission shall conduct:

- assessment of the procedures and the acceptance criteria;
- review of the procedure implementation;
- direct observation of the performance of key tests;
- evaluation of the results of selected tests;
- confirmation of the integrity of each engineering barrier.

Based on the commission inspection report, reports issued by other specialized authorities as well as the NPP report on the resolved identified non compliances, the NRA Chairman may issue 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 Plant*s requires the operation of nuclear power plants to be conducted in compliance with the operational limits and conditions, in order to maintain all levels of protection of the physical barriers available. The Operational Limits and Conditions (OLC) shall be identified and justified on the basis of the technical design, the safety analyses and the tests during commissioning. They shall be reviewed periodically and as necessary in order to consider the operating experience, modifications to SSCs important to safety, new safety analyses and development of science and technology. Modifications of the operational limits and conditions shall be justified through analyses of the safety margins and independent verification of the analyses.

The Operational Limits and Conditions shall cover all operational states, including start-up mode, power operation, scheduled and unscheduled outage, reactor sub-critical and refuelling, and all transitional states between these modes of operation, maintenance and testing of SSCs. They shall include as a minimum:

- safety limits;
- limiting safety systems settings;
- operational limits and conditions;
- tests, inspections, surveillance and in-service inspection of SSCs important to safety;
- minimum number of operating personnel in the operational states, including qualified and authorizes MCR staff;

- operators' actions to e taken in case of deviations from the operational limits and conditions.

The OLC, collected in an individual document (Technical Specifications) shall be easily accessible to MCR staff, which shall be highly knowledgeable of them and their technical basis.

Implementation of operational limits and conditions, their documentation, training in them, and their availability to plant personnel engaged in safety related work

The operational control on the compliance with the operational limits and conditions and their recording is performed by the MCR operating staff. The administrative control on the implementation of the operational limits and conditions is carried out by the managers of the operations sections. The compliance with the operational limits and conditions is considered at the daily briefings at the Chief Engineer's office. In case of touching upon areas restricted by the operational limits, immediate actions are undertaken to bring the plant in compliance with them. Such cases are documented in accordance with the operating procedures and are reported to the NRA. Violations of operational limits and conditions are monitored through monthly self-assessment indicators.

The compliance with the operational limits and conditions is part of the plant safety culture and the staff receives appropriate training, in accordance with the methods and programmes for initial and continuing training. When the operational limits and conditions are modified or supplemented, briefings are held, and additional training, if needed, is carried out.

Review and revision of operational limits and conditions as necessary

In case when there is a need of modification of the safe operational limits and conditions, it is assessed as modification with significant impact on safety. Changes in the operational limits and conditions may be required by the implementation of technical modifications of SSCs important to safety, by operating experience, by change in the state 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 authorization of the amendments to the technical specifications. Changes affecting operational limits and conditions defined as category one in terms of their impact on the unit safety shall be coordinated with the nuclear installation Chief designer.

In connection with the large amount of modifications to SSCs important to safety, as a result of the implemented modernization programme for Units 5 and 6, new structure and contents of the technical specifications was developed. The new revision takes into account the IAEA Safety Guide *NS-G-2.3 "Operational limits and conditions and operational procedures for NPPs"*.

Regulatory review and control

The NRA site inspectors carry out daily control on the licensee activities and on the compliance with the operational limits and conditions. Changes to OLC are subject to authorization, which requires their detailed justification. In reviewing the documents, submitted to NRA with requests for authorization of modifications to SSCs important to safety, one of the cornerstones of the analysis is the impact of the modification on the actual 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 the operating personnel shall operate the NPP in accordance with written operating instructions and

procedures, developed on the basis of the design and technical documentation, OLC and commissioning results. The operating instructions and procedures shall include personnel responsibilities, methods of operating interface, and specific directions for tasks implementation under all operating conditions. The operating procedures shall be prepared before the commissioning stage and the operating personnel shall be trained on them. The final version of these procedures is based on the results and experience of commissioning.

The operating organization shall develop programmes for tests, maintenance, repair, inspection and control in order to maintain the operability and reliability of SSCs important to safety, in accordance with the design and the quality assurance system. To conduct various types of tests, maintenance, repair, inspection and control, written procedures shall be developed in accordance with the quality assurance programme.

The status of base metal and welded joints shall be periodically inspected according to specifically developed procedures and through qualified non-destructive testing of areas, methods, personnel, ability to detect defects, and effectiveness. Control activities and tests that are not described in the Technical specifications or operating procedures, shall be implemented using specially developed programmes and procedures, following a positive statement by the NRA.

According to the *Regulation on the Procedure for Issuing Licences and Permits for Safe Use of Nuclear Energy* the set of application documents for an operating licence shall comprise operating procedures, schedules and testing procedures and control of the systems important to safety, schedule of maintenance and repair of major 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 the 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).

The operational documentation includes:

- Operating procedures for SSCs, including operating procedures for returning to service and taking out of service of safety systems, complete procedures for unit start-up and shut down;
- Programmes (procedures) for testing, maintenance, repair, inspection, and control of SSCs important to safety;
- Procedures to conduct various activities (procedures on reporting events, design modifications, operational interface, conduct of operations, etc.);
- Emergency procedures and severe accidents management guidelines;

The level of detail in each instruction, programme or procedure shall be consistent with the objectives of the document in order to provide clear, concise and, as possible, verified and sufficient guidance for action.

The quality management system determines the order to develop, update and control the operating procedures and instructions, which shall reflect the consistence with the actual status of SSCs and the safety requirements. Requirements for controlled documents in terms of format and contents, development methods, identification, coordination, approval, as well as distribution and their keeping up to date are specified by quality procedures. The documentation management

system ensures the use only of the latest versions of all documents. Modifications in documents take effect after their approval by the relevant authorizing document.

Availability of the procedures to the relevant staff of the nuclear power plant

The operating instructions and procedures are clearly identified and easily accessible in all control rooms as well as at other operational compartments, if required. A list of documents in force is maintained at the work places. The Quality Assurance System determines the procedure for periodic review of all procedures and instructions, for document modifications and for making the operating staff aware of those modifications. Reviewed documents take effect after their approval by an authorizing document.

The programmes and procedures for maintenance, testing, inspection and surveillance are used in conducting the respective activities. Check-lists for step-by-step implementation and recording of results are annexed to them.

Involvement of relevant staff in the development of procedures

The operational procedures and programmes for testing, inspection and surveillance are developed by staff with the appropriate competence and knowledge compliant with the requirements. There is a practice the best operators to be assigned the development of important operating procedures or test procedures. Verification and validation of operational documents is being conducted with the participation of the operating personnel.

Incorporation of operational procedures into the management system of the NPP

The management of documents and records at Kozloduy NPP is performed by the auxiliary process "Management of documents and records" of the integrated management system. The process ensures that staff at all job positions uses the required documents for their activities that are clear, unambiguous, identified, have undergone the respective checks, approved through the established order, latest revision with amendments incorporated. The documents are structured in hierarchical levels, determined according to their function and their area of application. The 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

ASUNE requires permit authorization for changes leading to a modification of the internal rules and documents for performing the activities of the licence holder. The operating licence includes an annex, which lists the operating programmes and procedures, technical specification, emergency response procedures, metal control, radiation protection, physical protection, RAW management, radiation monitoring, organizational documents and operations management documents, whose modifications requires the issue of a permit. Required permits are issued if the proposed amendments are not contradictory to the legal requirements and the conditions of issued operating licence.

Article 19 (4) Procedures for responding to operational events and accidents

Overview of arrangements and regulatory requirements on procedures for responding to anticipated operational events and accidents

The *Regulation on Ensuring the Safety of Nuclear Power Plants* requires that personnel actions in DBA and BDBA shall be specified by symptom based emergency operating procedures (SBEOP), and severe accidents management guidelines (SAMG), which shall be developed on the basis of the Final (updated) SAR, the plant design and the technical documentation, OLC, and further studies and analyses of plant behaviour in severe accidents.

SBEOP shall cover DBAs and scenarios at which significant fuel damage in the reactor core or in the spent fuel pool could be prevented. SBEP shall provide guidance to the staff for diagnostics of the plant state, for optimal recovery in case of transients and DBAs, for monitoring the plant state and for restoration of the safety functions, preventing fuel damage and leading to steady and safe state of the nuclear installation for a continuous period after the accident, including ensuring transition towards SAMG.

SAMG should mitigate the consequences of severe accidents in the cases when the staff actions, including the measures as defined in the SBEP were not successful to prevent the reactor core damage or fuel damage in the spent fuel pool. The guidelines shall be based on the management strategies for the severe accidents scenarios of the plant and of the possible measures for re-establishment or compensation for lost safety functions and for prevention and mitigation the consequences of a core damage, including for protection of the containment.

The *Regulation* specifies the format, structure and contents of SBEP and SAMG. The emergency procedures and the guidelines shall be verified and validated by a team of independent experts. The practical capability for implementation of operators' actions in SBEP shall be validated using simulator tools. The procedures shall be updated regularly, and after each change they shall be re-validated and enforced after operators' training.

Establishment of symptom based emergency operating procedures

The operators actions for diagnostic of the Kozloduy NPP units state in all DBAs and at a wide range of BDBAs, and for recovery or compensation of lost safety functions, are specified in the symptom based emergency procedures (SBEP), which replaced the event oriented emergency procedures. SBEP are developed for full power operation, low power operation and shutdown and pressurized reactor, and shut-down and depressurized reactor. They are implemented after successful verification, validation and simulator training of the staff.

Each SBEP set includes:

- Diagnostic procedure;
- Procedure for operating actions at total blackout;
- Procedure for optimal recovery;
- Procedures for recovery of critical safety functions;
- Accident type procedures with degraded barrier, covering BDBAs.

The implementation of the SBEP was preceded by a significant analytical work, justifying the critical safety functions and their degradation, as well as the main and alternative operators actions. The most important projects in this area are:

- *International Nuclear Safety Programme (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, the SBEP are regularly reviewed and updated. When performing safety analyses and assessments, as well as when implementing design modifications whose safety assessments are related to SBEP, the procedures are being amended.

For elimination of disturbances of normal operation and emergency conditions, which do not result in reactor scram activation or safety system activation, are developed emergency procedures.

Establishment of procedures and guidance to prevent severe accidents or mitigate their consequences

Kozloduy NPP has developed Severe Accidents Management Guidelines (SAMG), which follow the format of the SBEP and upon certain criteria are introduced with a transition from the SBEP. The guidelines are developed in compliance with the requirements of the *Safety Reports Series No.32, Implementation of Accident Management Programmes in Nuclear Power Plants,* following the approach of *Safety Reports Series No.48, Development and Review of Plant Specific Emergency Operating Procedures. 2006.*

Pursuant to the internal procedures of Kozloduy NPP, the process of implementing SAMGs in operation includes development of the guidelines, verification and validation by a team of independent experts according to the "table top" method, and subsequent training of the operators for the basic processes running through different stages of the severe accident management strategies, set in SAMGs. The SAMGs consists of two types of sets - one for MCR/ECR (two-column format) and one for the Emergency Response Centre (in graphical text type in the form of flow-charts).

The implementation of SAMG is preceded by significant an extensive study and system analysis of the processes and the plant design modifications with respect to severe accidents within the framework of a PHARE project. In the end of 2012, SAMG corresponding to full power operation, low power operation and shutdown reactor with sealed primary circuit were put in place.

In pursue of the measures of the National Action Plan after the stress tests, the analyses of the phenomena during a severe accident in the SFP and of a shut down and open reactor were completed in 2014. Based on that, the SAMG scope was extended in and 2015 five new guidelines were introduced:

- Severe Accident Management Guideline at blackout of shutdown unit;
- Severe Accident Management Guideline at blackout and depressurized unit;
- Severe Accident Management Guideline for URP (Underwater Refuelling Pool) at shutdown unit;
- Severe Accident Management Guideline for SFP (Spent Fuel Pool);
- Severe Accident Management Guideline for the containment at shutdown unit;

Establishment of procedures and severe accident management guidelines for multi-unit nuclear installations and/or multi- facility sites

In implementation of the measures from the National Action Plan, after the stress tests, a *Procedure on Action of the Emergency Response Teams in Case of Simultaneous Events at Different Facilities On-site* is in the process of development. It is foreseen that this procedure will become an underlying document for action of the emergency response team at the Emergency Response Centre and will cover all emergency states on site, define the organization, the actions and the responsibilities of the emergency team members at multi unit accidents on Kozloduy NPP site.

Regulatory control and review activities

The NRA gives methodological guidance and controls the process of developing SBEP and SAMG. All licensee documents related to elimination of deviations from normal operation and the actions at incidents and accidents are part of the set of documents on whose basis the operating licence is issued and they are subject to control by the NRA. In all cases when the licensee applies for modifications to SSC or to operational documents, assessment is made of their impact on SBEP or SAMG.

The NRA controls the implementation of the National Action Plan after the stress tests through quarterly reports from the licensee on the status of the measures and an annual inspection to check the activities for the plan implementation.

Article 19 (5) Engineering and technical support

General availability of necessary engineering and technical support in all safety areas

Construction, commissioning and operation of Kozloduy NPP units have been conducted with the engineering and technical support from Bulgarian and Russian design and engineering organisations and research institutes, as well as the manufacturers of the equipment. Chief Designer of the nuclear facilities is the OKB "Gidropress" and a supervisor is the Kurchatov Institute. The Bulgarian Design Institute "Energoproekt" is the designer of some secondary circuit systems and the plant common systems.

In the last two decades when implementing programmes and measures for modernization of the nuclear units, the services of consortia of European and American organisations are used together with the Russian engineering and technical institutes.

Availability of necessary technical support on the site of the licensee and procedures for ensuring the most important resources for the nuclear installations

At the Kozloduy NPP are established two technical divisions - Maintenance and Technical Support. The Technical Support Division covers the activities on the modification and reconstruction management of SSCs; safety analyses and assessments; analyses and assessments of designs and research, analyses of the periodic testing results of safety systems. All technical support activities are carried following instructions and procedures, which define the rules, requirements, responsibilities and interactions between internal and external structures.

The Engineering and technical support of maintenance activities is provided by the Maintenance Division. In the case of using external contractors, the division prepares the ToRs, performs technical evaluation of the tender documents, and carries out supervision during the implementation and acceptance of maintenance and repair activities. These activities are specified by internal instructions and procedures.
The resources needed for upkeeping the nuclear installations are planned in the long term in the *Company's Business Plan* - supply of the necessary spare parts, new equipment or tender procedures. The public procurement procedures, signing of contracts and receipt of supplies are managed by the Commercial Division.

Dependence on consultants and contractors for technical support of the nuclear installations

Specific activities of scientific support, consultancy assistance or services are performed by specialized technical organisations and research institutes in Bulgaria or the Chief Designer of the nuclear installations. The major maintenance works of turbine hall equipment - turbines, generators and pumps, and maintenance of specific and non-standard equipment and instrumentation, as well as the metrology inspection of specific and non-standard measuring devices are performed by specialized external organizations; Kozloduy NPP has contracts with

the Chief Designer and the manufacturers of the basic equipment for engineering support on site. For specific equipment there are contracts for technical service.

Regulatory review and control activities

The operating licence conditions require that the licensee shall submit to NRA the *Business plan of the Company.* This enables the regulator to assess and monitor the projected engineering and maintenance activities under the production, maintenance and investment programmes, both on long-term and short-term (annual) plans.

Engineering support, maintenance and SSCs important to safety are three of the main areas of regulatory inspections in the annual inspection plan of the NRA. The planned engineering and maintenance activities are controlled and inspected also during the complex inspections of the units' preparedness for start-up after scheduled annual outage.

Article 19 (6) Reporting of incidents significant to safety

Overview of arrangements and regulatory requirements for reporting incidents significant to safety

The procedure and rules for notifying the NRA of events significant to safety are defined in the *Regulation on the Conditions and the Procedure for Notification of the Nuclear Regulatory Agency about Events in Nuclear Facilities and Sites with Sources of Ionizing Radiation.* The Regulation classifies the events in 3 categories - deviation from normal operation, incidents and accidents. It defines the scope of events in all categories, the procedures, deadlines and methods of notification. The form of notification and the requirements to the contents of the submitted information are also specified. For successful implementation of the analysis and event evaluation, the Regulation specifies the requirements for collection, recording and investigation of the event, determining the causes for its occurrence, and implementing corrective measures to prevent re-occurrence. According to the regulation the importance of the event in terms of nuclear safety and radiation protection is determined by the IAEA INES scale initially by the licensee, and the final assessment is determined by the NRA.

The licensee might notify the NRA of other significant events, as well, that are not classified in these three categories, if estimated that these events are potentially significant to the nuclear installation safety.

Overview of the reporting criteria and procedures for events significant to safety, near misses and accidents

Internal events at Kozloduy NPP are classified into 3 categories:

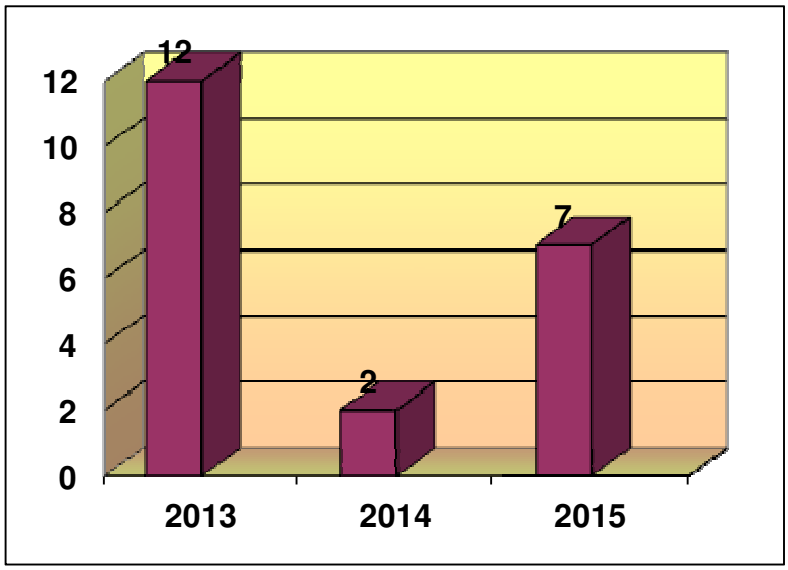
- **Category 1:** Significant events to be reported to the NRA. Criteria and procedures for reporting of the category 1 events are specified in "Safety Procedure. Report and analysis of category 1 operating events at Kozloduy NPP". These criteria are consistent with the event categories defined in the *Regulation on the Conditions and Procedure for Notification of the Nuclear Regulatory Agency about Events in Nuclear Facilities and Sites with Sources of Ionizing Radiation*, as deviations, incidents and accidents.
- **Category 2:** Events not to be reported to NRA - events insignificant in terms of nuclear or radiation safety, but having impact on the operability of the equipment, production, industrial safety, etc. Criteria and procedures for reporting and analysis of events of category 2 are specified in "Safety Procedure. Report and analysis of category 2 operational events at Kozloduy NPP plc."
- **Category 3:** Low-level events and near misses - subject to recording, coding, tracking and trending to identify common causes. Criteria and procedures for reporting and

analysis of the category 3 events are specified in "Safety Procedure. Report and analysis of low-level events and near misses at Kozloduy NPP Plc".

Statistics of reported events significant to safety for the past three years

For the period 2013-2015 a total of 21 events (category 1) were reported by Kozloduy NPP for Units 5 and 6, assessed as level "0" according to the INES scale. Their occurrence throughout the years is as follows:

- 2013 – 12 events
- 2014 – 2 events
- 2015 – 7 events



A total of 91 events of category 2 and category 3 were analysed in the three-year period (2013-2015).

Documentation and publication of events and incidents reported by the licence holder and the regulatory body

Documentation

Kozloduy NPP stores all data 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.

Analogically, the NRA stores the correspondence and the reports of the licensees on events and incidents in an electronic database and on paper.

Publication

For any registered incident or accident, 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 and they are also published on the NPP web site and in the internal information network on the same working day. The 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 the *ASUNE* and the *Regulation on the Conditions and Procedure for Notification of the Nuclear Regulatory Agency about Events in Nuclear Facilities and Sites with Sources of Ionising Radiation*, NRA provides information on events at nuclear facilities to the specialized international organizations, state bodies, legal entities and citizens. The announcements on events are published on the Agency website, in Bulgarian and in English language on the date of receipt by the licensee. The NRA publishes a summary analysis and a list of the events reported by the licensee in its annual report, which is accessible on the Agency's website as well. The events are reported also to the international system for reporting of events IRS.

Policy for use of INES scale

Pursuant to the *Regulation on the Conditions and Procedure for Notification of the Nuclear Regulatory Agency about Events in Nuclear Facilities and Sites with Sources of Ionising Radiation*, the significance of the event as regards safety and the event level 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 Chairman of the NRA. The INES User Manual is used for assessment of the events.

The algorithm for the level evaluation according to INES is entered into an electronic database for event analysis. 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 defence in depth. The events distribution according to the INES scale is used as one of the main indicators for safe plant operation.

Regulatory review and control activities

An *Events Analysis Group* is set up at the NRA, whose activity is specified in the *Procedure on the activity of the Events Analysis Group at nuclear power plants.* The group gathers regularly and performs analysis and its own assessment by INES of significant or selected operational events and discusses the corrective measures undertaken by the licensee. If considered necessary, additional information is demanded, meetings with the staff are carried out, and proper investigation is performed. The secretary of the Events Analysis Group keeps the database for the operational events at the NRA and publishes the events in the International Events Reporting System IRS.

During regulatory inspections, before unit start-up after annual outage, the implementation of the corrective measures for events from the previous fuel cycle is being checked. The *Annual Inspection Plan* includes also inspections on safety significant operational events and important corrective measures.

Article 19 (7) Operating experience feedback

Arrangements and regulatory requirements to the licensee to collect, analyse and share operating experience

The *Regulation on Ensuring the Safety of Nuclear Power Plants* requires the licensee to establish and systematically apply a programme for collection, analysis and documenting of internal and external operating experience, as well as of operational events. Suitably trained staff shall be assigned for determining adequate recommendations for improvement. The assessment of the operating experience shall detect all hidden failures, precursors and tendencies towards degrading the safety performance or reduction the safety margins, and undertaking of corrective actions.

Operational events and deviations that are significant to safety, including near misses and low level events, shall be reported and investigated in compliance with the established procedures

and criteria. In order to prevent re-occurrences and to counteract undesired trends, timely and appropriate corrective measure shall be implemented, and good practices shall be reported.

The information deriving from the operating experience shall be disseminated to the relevant staff, shared with all interested national and international organizations and used in the training of staff, performing activities with impact on safety. Periodic reviews of operating experience feedback based on certain indicators or criteria shall be implemented within the process of self-assessment or by an independent team.

The Regulation on the Conditions and the Procedure for Notification of the Nuclear Regulatory Agency about Events in Nuclear Facilities and Sites with Sources of Ionizing Radiation requires that the licensee shall conduct statistical analyses according to safety indicators, agreed with the NRA, and methodology for their calculation. The operating experience analysis shall identify trends in the operating staff behaviour and the equipment performance, and conclusions and recommendations for improving shall be drawn.

Overview of licensee programmes for the feedback of own and others operating experience

The requirements, basic principles, responsibilities and obligations in the use of operating experience at Kozloduy NPP are specified in the procedure *"Safety rules. Operating experience feedback system."* An organizational unit is established – "Operating experience and self-assessment indicators" and at the plant there are operational *Commission on review and assessment of the operating experience feasibility* (screening after the initial examination) and *Council on operating experience*.

The Commission is permanently acting body, having its meetings on a monthly basis. It performs a secondary review of the received information on external operating 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 operating experience before they are presented for review and endorsement for implementation by the Council on operating experience.

The feedback system consists of two major programmes:

- Programme for utilization of the internal (own) operating experience;
- Programme for utilization of the external (industry) operating experience;

Programme for utilization of the internal operating experience

Sources of external operating experience are operational 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 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 (programme and organizational);
- 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 programme, 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.

Programme for utilization of the external operating experience

Sources of external operating 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 applicability of the selected information by the Screening Commission 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 the programme for utilization of external operating experience.

The evaluation of the effectiveness of the programmes for operating experience feedback is being 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 at Kozloduy NPP are classified into three categories, for each category there is a separate procedure that specifies the way for reporting and analysis.

For analysis of events 1 and 2 categories the approved ASSET methodology is used and some techniques from the HPES system, as described in the procedure: *Methodology for analysis of events and operating experience.* The analysis is carried out by a commission set up for each event, which obligatory involves a root cause analysis expert. Statutory deadlines for the analysis are respectively 25 days for the events of category 1 and 45 days for the events of II category.

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 being done on an annual basis.

Procedures for the analysis of external events

Review (screening) and analysis of external events at Kozloduy NPP is carried out according to the *Procedure on exchange and dissemination of operating experience*. The main evaluation criteria for the applicability of external operating experience, which is carried out by the *Commission for review and evaluation of operating experience*, are:

- SOER, SER;
- Severe accidents or incidents and damages;
- Personnel over-exposure;
- Personnel traumatism;

- Human error;
- WWER reactors;
- Significant operating experience.

Procedures to draw conclusions and to implement any necessary modification to the installation and to personnel training programmes and simulators

Kozloduy NPP has established an operating experience system, which is documented in the *"Procedure for the use and dissemination of operating experience."* The procedure is based on the guidelines of the IAEA and WANO (GL_2003-01: Guidelines for Operating Experience at NPP and NS-G-2.11: A System for the Feedback of Experience from Events in Nuclear Installations). The review of the external operating 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 (1 and 2 category) and operating 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 operating experience (basically, information about events) is included in pre-job briefings, in continuing training programmes and simulator sessions.

The best practices identified in internal audits and self-assessments of individual organizational units are disseminated among the other units for information.

Mechanisms for sharing experience with other operating organizations

Dissemination of operating experience outside Kozloduy NPP is specified by the procedure *"Exchange and dissemination of operating experience"*. The criteria for dissemination are set in accordance with WANO "Operating Experience Programme Guideline - WANO/WPG02" and "GL 2003-01 Guidelines for Operating Experience at Nuclear Power Plants".

The main mechanisms for sharing important operating experience with other operating organisations are:

- Providing information to the WANO Moscow Centre for significant events at Kozloduy NPP;
- Publication of events occurring at Kozloduy NPP in the information system of the IAEA - IRS (through the national coordinator in NRA);
- Provision of information on issues through the system for technical inquiries of WANO Moscow Centre;
- Presentation of information on operating experience through presentations during international workshops and technical meetings to exchange experience (benchmarking) with operators of the same type reactors;
- Exchange of experience and information through participation in missions of the IAEA and WANO.

Use of international databases on operating experience

Kozloduy NPP has organized access to the information databases, which store information about shared operating experience of nuclear power plants, namely:

- Database of WANO;

- Database of IAEA - IRS.

The access to the WANO database is implemented by a contact person of the plant with the association on the programme of operating experience. Access is organized through a special VPN channel. More than 10 people have access to the IRS database.

Reports on significant operating experience of *SOER* type (Significant Operating Experience Report) and SER (Significant Event Report), as well as information on target instructions (JIT - Just-in-Time) are translated in Bulgarian language and are reviewed in the shortest possible period after their publication. The other reports are used in Russian or English. Screening and evaluation of newly published information is performed once a month.

Use of information is regulated in the procedure for *Exchange and Dissemination of Operating Experience*. The procedure regulates the activities related to information search from external sources, responsibilities for the initial processing of this information and specifies the priorities for processing.

Regulatory review and control activities for licensee programmes and procedures

The operating experience feedback system is subject to periodical regulatory inspection, when instructions and procedures at corporate level and within the organization are discussed, as well as the practice to use others experience and connections to exchange information with international organizations (IAEA and WANO). The results and the effectiveness of the operating experience feedback system are inspected. Operating experience feedback is an independent inspection area in the *Procedure for inspection activity in nuclear facilities* of the NRA.

Every three months the licensee submits to the NRA information on certain safety indicators. Analysis and report on the safety indicators are contained in the self-assessment reports, the periodic and the annual reports of the NPP.

Regulator's programmes for operating experience feedback and use of existing mechanisms for sharing experience with international organizations and other regulators

An *Events Analysis Group* is set up at the NRA, whose activity is specified in the *Procedure for Events Analysis Group at nuclear power plants*. The Group is summoned periodically and performs a review and evaluation of events for which it has received information by the International Reporting System for Operating Experience – IRS, WANO, WWER forum of nuclear regulators, including information from seminars, training courses, etc.

The Group performs analyses and its own assessment according to INES of all operational events, reported by the licensees and the corrective measure they have undertaken. For significant events that would be of interest to other international organizations or regulators an event report is produced which is published on the IAEA IRS system.

A report to the NRA Chairman is prepared for each session, with conclusions and proposals; it is published on the Agency's internal information network. The Secretary of the *Events analysis group* maintains the Operational events database at the NRA.

Article 19 (8) Management of spent fuel and radioactive waste on the site

Overview of arrangements and regulatory requirements for handling of SF and RAW on the site

According to the *ASUNE*, the management of radioactive waste and spent fuel is carried out by legal entities, after receiving of the respective permit and/or licence for the safe implementation of the activity. The *Regulation on Ensuring the Safety of Spent Nuclear Fuel* specifies the

requirements on ensuring nuclear safety and radiation protection in the management of spent fuel at all lifetime stages of the SF management facilities.

The *Regulation on the Safety of Radioactive Waste Management* requires that entities whose activities generate RAW shall develop RAW Management Programmes, which describe and justify the actions taken and planned for the management of all generated RAW, till their final disposal or release from regulatory control. The Regulation contains requirements for pre-processing, subsequent processing, conditioning, storage and disposal of RAW.

On-site storage of spent fuel

SF is stored on Kozloduy NPP site under water in the reactor spent fuel pools of units 5 and 6 for a certain period of time, as required by the supplier, which is reflected in the Technical Specification and the operating procedures; after that it is transported to the "wet" type spent fuel storage facility (SFSF). The requirements for storage of spent fuel concern keeping the operating conditions in terms of chemical indicators, activity, leakage and temperature of the coolant. Control of the operating conditions is performed by the operating staff of Kozloduy NPP. The SFSF stores SF from the shut-down WWER-440 units, and from units 5 and 6 (WWER-1000).

From the SFSF, SF is sent for processing or storage in a dry storage facility of container type (only SF from WWER-440). In 2016 the NRA issued an Operating Licence for the Dry Spent Fuel Storage Facility for SF from WWER-440 reactors.

On-site treatment, conditioning and storage of RAW

RAW activities are performed in accordance with the *Comprehensive Programme for Management of Radioactive Waste from Kozloduy NPP*. Kozloduy NPP carries out collection, sorting, processing and temporary storage of solid RAW. Processing of liquid RAW consists of collecting in streams, chemical treatment, settling, pre-treatment (evaporation, filtration), temporary storage of the concentrate and release of condense water into the environment. Operational RAW is stored in dedicated by the design locations, in unprocessed or processed form, with no limitations on the options for their further treatment, release from regulatory control or disposal. The activities are carried in compliance with the administrative dose limits and radiation protection programmes.

The approach adopted by Kozloduy NPP since 2005 is directed to transfer for processing to SERAW of all currently generated RAW and gradual release of accumulated historical RAW from the storage facilities. RAW management activities are carried out on the basis of administrative units, having clearly defined statute, functions and tasks and clear allocation of rights, obligations and responsibilities of the two licensees on site - Kozloduy NPP and SERAW.

Activities to keep the amount of generated waste to the minimum practicable for the process, in terms of both activity and volume

To minimize the generated RAW, organizational and technical measures are provided in the following directions - minimizing the quantities of RAW generated by the source and of secondary RAW; prevention of unjustified radioactive contamination of clean materials; providing a direct link between RAW generation and subsequent RAW management stages.

The following activities are implemented at Kozloduy NPP to minimize the generated RAW:

- Minimization of solid RAW - reducing operational RAW; timely actions to collect and sort RAW by physical and radiological characteristics;
- Minimization of liquid RAW - organizational measures related to planning, improvements in procedures, respecting the safety culture in operation, training of staff, analysis of results;

- Technical measures - control of the status of purification installations, separation of oil fractions, maintaining cleanliness in the premises, regeneration of boric acid.

Established procedures for free release of radioactive waste

In compliance with the provisions of the *Regulation on the Basic Norms for Radiation Protection*, activities with ionizing radiation sources that meet the following dose criteria are not subject to regulation by *ASUNE*:

- Effective dose, expected to be received over one year by any individual from the population shall not exceed 10 μSv;
- Effective dose, expected to be received over one year by any individual from the population at scenarios with low occurrence probability shall not exceed 1 mSv;

Radioactive materials originating from licensed practices, which are foreseen to be disposed, recycled or reused, are subject to regulation by *ASUNE*. Radioactive material is free released, for each particular case, with an order by the NRA Chairman, provided that the licensee or the holder of the permit has submitted documents proving the compliance of the radioactive characteristics of the material with the free release criteria.

The *Regulation on the Basic Norms for Radiation Protection* requires that the specific activities of radionuclides contained in the materials are determined by an accredited laboratory and the conformity to the free release criteria is verified by an accredited control body.

The materials subject to disposal, recycling or reuse are unconditionally free released provided that at any one moment for all radionuclides the sum of the relations of their specific activities towards the levels of unconditional free release for the respective radionuclides is less or equal to one. If the specific activities of individual nuclides are higher than the respective free release levels, then the material could be released provisionally. To that end, a preliminary justification is required as regards the intentions, the method and area of use of the respective materials. For each specific case the NRA makes an assessment of the compliance with the dose criteria.

Kozloduy NPP prepares procedures for free release of materials for each specific case, including preliminary sorting of the materials, preliminary assessment of the activity, determination of the radionuclide composition (incl. difficult to measure radionuclides) by an accredited laboratory, verification of the results by an accredited body. Following the completion of the procedure, the results are submitted to the NRA with a request for free release of that particular batch of materials.

Regulatory review and control activities

The management of SF and RAW at Kozloduy NPP site is subject to continuous review by the NRA inspectors. The NRA Annual inspection plan includes inspections in that area. The periodic information, submitted to the NRA under the provisions of the operating licences is analysed and evaluated.

Annex 1

List of operating events reported at Kozloduy NPP for the period 2013 – June 2016

Date	Site	Description	INES level
31 January 2013	Unit 6	Faulty electronic integral plate for control of a valve on the secondary circuit of Unit 6 in one of the safety system trains	0
09 February 2013	Unit 6	Automatic trip of a main circulation pump at Unit 6 as a consequence of the closure of the fast acting steam isolation valve of the steam generator during planned activities at the instrumentation and control systems	0
13 February 2013	Unit 6	Impossibility to switch a breaker into working position from a safety system I after scheduled performance tests completed	0
14 April 2013	Unit 5	Disconnection of Unit 5 from the grid due to leak of hydrogen from the generator.	0
28 May 2013	Unit 6	Planned disconnection of Unit 6 from the grid to eliminate a leak from a welding joint of impulse line to a pressure sensor.	0
11 July 2013	Unit 6	Taking the fire extinguishing system first train pump out of a stand-by mode	0
08 August 2013	DSF	Loss of bridge crane power supply in the dry spent fuel storage facility during a spent fuel cask movement	0
14 August 2013	Unit 6	Taking Unit 6 safety system III train diesel generator out of a stand-by mode	0
21 September 2013	Unit 6	Failure of a secondary high pressure protection device at Unit 6 during testing	0
13 October 2013	Unit 6	Sharp rise in the temperature of the reactor planned cooling system pump external bearing during Unit 6 outage	0
28 October 2013	Unit 6	Disconnection of Unit 6 from the grid due to leak of a turbine drainage pipeline.	0
30 October 2013	Unit 6	Unit 6 reactor scram due to loss of main power supply of the control and protection system adjustment devices	0
20 December 2013	Unit 5	Disconnection of Unit 5 from the grid due to leak of hydrogen from the generator and SCRAM	0
10 April 2014	Unit 6	Taking a Unit 6 steam generator emergency feed water system pump out of a stand-by mode	0

Date	Site	Description	INES level
20 April 2014	Unit 5	A control and protection system adjustment device remains in a medium position during performance tests following a planned Unit 5 reactor trip for outage	0
03 January 2015	Unit 6	Unit 6 generator trip due to electrical protection actuation	0
07 January 2015	Unit 6	Unit 6 power decrease due to a steam generator feed water pump trip	0
06 February 2015	Unit 5	Unit 5 generator trip due to electrical protection actuation	0
17 March 2015	Unit 5	Failure of a reactor emergency cooling pump during a planned Unit 5 safety system train test	0
14 September 2015	Unit 6	Temporary cooling failure of the Unit 6 spent fuel pool during returning of the safety system train following an outage	0
14 October 2015	Unit 5	Taking one of Unit 5 spray system trains out of a stand-by mode to eliminate a service water system leak	0
21 October 2015	Unit 6	Unit 6 reactor scram during turbine and generator tests following an outage	0
05 January 2016	Unit 5	Failure of a reactor emergency cooling pump during a planned Unit 5 safety system train test	0
11 February 2016	Unit 5	Taking a Unit 5 spray system pump out of a stand-by mode to eliminate a cooling water leak	0
11 May 2016		Taking out of one train of the fire protection system	0

Annex 2

List of secondary legislation for implementation of the ASUNE

Rules of Procedure of the Nuclear Regulatory Agency – adopted by CM Decree No. 278 of 9 December 2013, promulgated in SG issue No.107 of 13 December 2013, amended in SG issue 5 of 19 January 2016, in force as of 19 January 2016.

Regulation on the Procedure for Issuing Licences and Permits for Safe Use of Nuclear Energy - adopted by CM Decree No. 93 of 4 May 2004, promulgated in SG issue No.41 of 18 May 2004, amended in SG issue No.78 of 30 September 2005, in force as of 1 October 2005, SG issue No.93 of 24 November 2009, in force as of 24 November 2009, amended and supplemented in SG issue N.76 of 5 October 2012, SG issue 4 of 15 January 2016.

Regulation on the Terms and Procedure for Delivery of Radioactive Waste to the State Enterprise "Radioactive Waste" - adopted byCM Decree No.35 of 20 February 2015, promulgated in SG issue No. 16 of 27 February 2015.

Regulation on Ensuring the Safety of Nuclear Power Plants - adopted by CM Decree No.172 of 19 July 2004, promulgated in SG issue No. 66 of 30 July 2004, amended in SG issue No.46 of 12 June 2007, in force as of 12 June 2007, SG issue No.53 of 10 June 2008, SG issue 5 of 19 January 2010.

Regulation on Ensuring the Safety of Research Nuclear Installations - adopted by CM Decree No. 231 of 2 September 2004, promulgated in SG issue No. 80 of 14 September 2004

Regulation on radiation protection in activities with sources of ionizing radiation - adopted by CM Decree No. 200 of 4 August 2004, promulgated in SG issue No. 74 of 24 August 2004, amended and supplemented in SG issue No. 74 of 08 September 2006, in force as of 01 January 2007, SG issue No. 46 of 12 June 2007, in force as of 12 June 2007, SG issue No.5 of 19 January 2010, SG issue No.7 of 21 January 2011, amended and supplemented in SG issue No.76 of 05 October 2012.

Regulation on the Terms and Procedure for Notification of the Nuclear regulatory Agency about Events in Nuclear Facilities and sites with sources of ionizing radiation - adopted by CM Decree No. 188 of 30 July 2004, promulgated in SG issue No.71 of 13 August 2004, amended in SG issue No.46 of 12 June 2007, in force as of 12 June 2007, SG issue No.5 of 19 January 2010, SG issue No.7 of 21 January 2011.

Regulation on the Terms and Procedures for Exemption of Small Quantities of Nuclear Material by application of the Vienna Convention on Civil Liability for Nuclear Damage - adopted by CM Decree No.201 of 4 August 2004, promulgated in SG issue No.72 of 17 August 2004.

Regulation for Safety of spent fuel management - adopted by CM Decree No. 196 of 2 August 2004, promulgated in SG issue No. 71 of 13 August 2004, amended and supplemented in SG issue No.76 of 30 August 2013.

Regulation for Safe Management of Radioactive Waste - adopted by CM Decree No.185 of 23 August 2013, promulgated in SG issue No.76 of 30 August 2013.

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 - adopted by CM Decree No.209 of 6 August 2004, promulgated in SG issue No.74 of 24 August 2004, amended in SG issue No.46 of 12

June 2007, in force as of 12 June 2007, SG issue No.5 of 19 January 2010, amended and supplemented in SG issue No.27 of 14 April 2015, SG issue No.4 of 15 January 2016.

Regulation on emergency planning and emergency preparedness in case of nuclear and radiological emergencies - adopted by CM Decree No. 313 of 22 November 2011, promulgated in SG issue No.94 of 29 November 2011, in force as of 29 November 2011,SG issue No.57 of 28 July 2015, in force as of 28 July 2015.

Regulation for the Provision of Physical Protection of Nuclear Facilities, Nuclear Material and Radioactive Substances – adopted by CM Decree No. 283 of 19 October 2015, promulgated in SG issue No.82 of 23 October 2015.

Regulation on the Basic Norms for Radiation Protection- adopted by CM Decree No. 229 of 25 September 2012, promulgated in SG issue No.76 of 5 October 2012.

Regulation for the conditions and procedure for establishing of special-statutory areas around nuclear facilities and facilities with sources of ionizing radiation - adopted by CM Decree No.187 of 28 July 2004, promulgated in SG issue No.69 of 06 August 2004, amended in SG issue No.46 of 12 June 2007, in force as of 12 June 2007, SG issue No.53 of 10 June 2008, SG issue No.5 of 19 January 2010.

Regulation on the terms and the procedure for collection and provision of information and for maintaining registers on the activities pertaining to the application of safeguards in Connection with the Treaty on the Non-proliferation of Nuclear Weapons - adopted by CM Decree No. 210 of 6 August 2004, promulgated in SG issue No.74 of 24 August 2004.

Regulation on Safety During Decommissioning of Nuclear Facilities - adopted by CM Decree No. 204 of 5 August 2004, promulgated in SG issue No.73 of 20 August 2004

Regulation on the Procedure for Payment of the Fees Collected pursuant to the ASUNE - Annex No. 1 to Article 1 of CM Decree no. 206 of 17 September 2003, promulgated in SG issue No.85 of 26 September 2003.

Regulation for the procedure for assessment, collection, spending and control of the financial resources and definition of the amount of contributions due on the Nuclear Facilities Decommissioning Fund - adopted by CM Decree No. 300 of 17 December 2003, promulgated in SG issue No.112 of 23 December 2003, in force as of 01 January 2004, SG issue No.78 of 30 September 2005, in force as of 01 October 2005, amended and supplemented in SG issue No.20 of 7 March 2006, SG issue No.110 of 21 December 2007, in force as of 12 December 2007, SG issue No.93 of 24 November 2009, in force as of 24 November 2009, amended and supplemented in SG issue No.19 of 08 March 2011, amended in SG issue No.26 of 29 March 2011, amended and supplemented in SG issue No.47 of 22 June 2012, SG issue No.75 of 02 October 2012.

Regulation for the procedure for assessment, collection, spending and control of the financial resources and definition of the amount of contributions due on the Radioactive Waste Fund– adopted by CM Decree No. 301 of 17 December 2003, promulgated in SG issue No.112 of 23 December 2003, in force as of 1 January 2004, supplemented in SG issue No.13 of 17 February 2004, amended in SG issue No.78 of 30 September 2005, in force as of 1 October 2005, amended and supplemented in SG issue No.105 of 22 December 2006, SG issue No.3 of 11 January 2008, amended in SG issue No.93 of 24 November 2009, in force as of 24 November 2009, amended and supplemented in SG issue No.19 of 8 March 2011, amended in SG issue No.26 of 29 March 2011, amended and supplemented in SG issue No.47 of 22 June 2012.

Regulation on the Terms and Procedure for **Transport of Radioactive Substance** - adopted by CM Decree No. 156 of 13 July 2005, promulgated in SG issue No. 60 of 22 July 2005, amended and supplemented in SG issue No.13 of 14 Febrary 2014.

Regulation on Radiation Protection in Activities with Radiation Defectoscopes - adopted by CM Decree issue No. 93 of 15 April 2013, promulgated in SG issue No.38 of 23 April 2013.

Regulation on Radiation Protection in Activities with Materials with Increased Content of Natural Radionuclides - adopted by CM Decree issue No. 229 of 25 September 2012, promulgated in SG issue No.76 of 5 October 2012.

Tariff on the Fees Collected by the Nuclear Regulatory Agency pursuant to the Acton the Safe Use of Nuclear Energy - Attachment No. 2 to Article 2 of the CM Decree No. 206 of 17 September 2003, promulgated in SG issue No.85 of 26 September 2003.

Annex 3

List of the peer reviews conducted in Bulgaria

1. IAEA mission for operational events review (ASSET), Kozloduy NPP units 1-4, November 1990.
2. IAEA mission for operational safety and design review (SRM), Kozloduy NPP units 1-4, June 1991.
3. IAEA mission for operational safety review (OSART), Kozloduy NPP units 5 and 6, July 1991.
4. IAEA follow-up mission for operational events review (ASSET Follow-up), Kozloduy NPP units 1-4, June 1992.
5. IAEA follow-up mission for operational safety and design review (SRM Follow-up), Kozloduy NPP units 1-4, April 1993.
6. IAEA final mission for operational events review (ASSET Final), Kozloduy NPP units 1-4, September 1993.
7. IAEA mission for operational events review (ASSET), Kozloduy NPP units 5 and 6, November 1994.
8. IAEA mission for design review (SRM) - Modernization 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. IAEA mission for nuclear facilities physical protection review (IPPAS), November 1996.
11. IAEA mission for nuclear safety and radiation protection regulatory infrastructure review (IRRT), NRA, November 1997.
12. IAEA mission for operational events review (ASSET), Kozloduy NPP units 5 and 6, November 1997.
13. Mission under the PHARE programme for review of the activities related to Probabilistic Safety Analyses, level 1 (PSA level 1), Kozloduy NPP units 5 and 6, November 1998.
14. IAEA mission for operational safety review (OSART), Kozloduy NPP units 1-4, January 1999.
15. IAEA mission for development, validation and verification of emergency procedures, Kozloduy NPP units 5 and 6, August 1999.
16. Targeted review by the Western European Nuclear Regulators of the European Commission (WENRA, EC), Kozloduy NPP units 1-4, October 1999.
17. IAEA mission for design review (SRM) - Modernization Programme, Kozloduy NPP units 5 and 6, July 2000.
18. IAEA mission for design review (SRM) - Modernization Programme, Kozloduy NPP units 1-4, October 2000.
19. IAEA follow-up mission for operational safety review (OSART Follow-up), Kozloduy NPP units 1-4, January 2001.

20. IAEA follow-up mission for nuclear facilities physical protection review (IPPAS Follow-up), February 2002.
21. IAEA follow-up mission for design review (SRM Follow-up) - Modernization Programme, Kozloduy NPP units 3 and 4, October 2000.
22. IAEA mission for nuclear safety and radiation protection regulatory infrastructure review (IRRT), NRA, June 2003.
23. World Association of Nuclear Operators (WANO) Peer Review - Kozloduy NPP units 3 and 4, November 2003.
24. Atomic Questions Group within the European Commission (EC AQG) Peer Review - Kozloduy NPP units 3 and 4, November 2003.
25. World Association of Nuclear Operators (WANO) Peer Review - Kozloduy NPP units 5 and 6, June 2009.
26. World Association of Nuclear Operators (WANO) Follow-up Peer Review - Kozloduy NPP units 5 and 6, November-December 2011.
27. World Association of Nuclear Operators (WANO) Technical Support Mission in preparation for the OSART mission - Kozloduy NPP units 5 and 6, February-March 2012.
28. IAEA mission for operational safety review (OSART), Kozloduy NPP units 5 and 6, November 2012.
29. IAEA mission for nuclear safety and radiation protection regulatory infrastructure review (IRRS), NRA, April 2013.
30. IAEA mission on the issues of the probabilistic safety analysis (IPSART), Kozloduy NPP units 5 and 6, June 2013.
31. World Association of Nuclear Operators (WANO) Peer Review - Kozloduy NPP units 5 and 6, December 2013.
32. IAEA follow-up mission for operational safety review (OSART Follow-up), Kozloduy NPP units 5 and 6, June 2014.
33. World Association of Nuclear Operators (WANO) Follow-up Peer Review - Kozloduy NPP units 5 and 6, June 2015.
34. World Association of Nuclear Operators (WANO) Technical Support Mission - Kozloduy NPP units 5 and 6, March 2016.
35. IAEA follow-up mission for nuclear safety and radiation protection regulatory infrastructure review (IRRS), NRA, April 2016.

Annex 4

List of systems and tools of the licensee to ensure emergency preparedness

1. The on line information system for off-site radiation monitoring consists of two basic and eight control stations measuring the equivalent dose rate (EDR) of the I-131 gamma radiation and surface concentration.

2. The on line information system for on-site radiation monitoring provides for information on the gamma background and air temperatures within 21 points of the Kozloduy NPP site.

3. The meteorological monitoring system provides for a representative meteorological information for the Kozloduy NPP site through 3 meteorological stations. The information is used for preparing radioactive transfer and dose rate prognosis within the emergency planning zones.

4. The on line aerological probing system (AAPS) enables to determine the direction and speed of the main transference and the height of the layer of mixing for the Kozloduy NPP region. The AAPS is integrated with the Meteorological Monitoring System (MMS). The data from the AAPS are provided to the national institutions.

5. Six water stations for monitoring the specific liquid discharges and sewage waters volume activity.

6. The on line information system for radiation monitoring of the settlements in the Kozloduy NPP surveillance area provides information about the gamma background and air temperature within 14 points of the Kozloduy NPP supervised area (30 km).

7. The on line water level monitoring system for service water supply at the two-canal systems to the Kozloduy NPP including the Danube water level.

8. Notification devices

The notification of the public is provided with the following technical means installed:

- Local system for early warning and notification installed in the open areas of the Kozloduy NPP site and settlements within the 12-km zone;
- National system for early warning and notification of the public and regional control station installed in the ERC, enabling the electronic sirens actuation within the UPZ from 0 to 30 km;
- Digital telephone station Alcatel 4400;
- TETRA communication system to transmit voice and text messages to the Kozloduy NPP site and UPZ from 0 to 30 km;
- IP speaker system for communication with the staff in the radiation controlled area and containment of the two units;
- Motorola two-way radios consisting of two basic stations providing for network connection within the 12-km zone;
- Radio-notification (Paging) system including three transmittals installed in the Kozloduy Municipality territory;
- Institutional radio stations.

All other communication technical means are also used for notification such as: home and mobile telephones and dispatcher loudspeaker station.

9. Communication means

Kozloduy NPP has the following communication means available:

- Digital telephone station Alcatel 4400;
- TETRA communication system to transmit voice and text messages to the Kozloduy NPP site and UPZ from 0 to 30 km;
- Motorola two-way radios consisting of two basic stations providing for network connection within the 12-km zone;
- IP addressable speaker system for communication with the staff located in the radiation controlled area and containment;
- Satellite telephones installed in the MCR5, MCR6 and ERC;
- Dispatcher loudspeaker station;
- Operating digital telephone station;
- Operating dispatcher console at the On-site Police Department and the FSCP RS;
- Operating ultra short waves radio network at the On-site Police Department and the FSCP RS;
- Direct telephone lines from the On-site Police Department to the workplaces of PSS, MCR unit 5 and MCR unit 6.

List of Abbreviations

ALARA	As Low As Reasonably Achievable
AO	Annual Outage
ASUNE	Act on the Safe Use of Nuclear Energy
BAS	Bulgarian Academy of Sciences
BEH	Bulgarian Energy Holding
BPS	Bank Pump Station
CM	Council of Ministers
CNS	Convention on Nuclear Safety
CPPNM	Convention on the Physical Protection of Nuclear Material
DG	Diesel generator
DGS	Diesel Generator Station
DPA	Disaster Protection Act
DSF	Dry spent fuel Storage Facility
EC	European Commission
ECR	Emergency Control Room
ECURIE	European Community Urgent Radiological Information Exchange
EEA	Executive Environment Agency
EIA	Environmental Impact Assessment
ENSREG	European Nuclear Safety Regulators Group in the areas of nuclear safety and radioactive waste management and spent nuclear fuel safety
EO	External organization
EP	Emergency Plan
EPA	Environment Protection Act
ERC	Emergency Response Centre
ERM	Emergency Response Manager
EU	European Union
EURDEP	European Radiological Data Exchange Platform
EWRC	Energy and Water Regulatory Commission
FSCP RS	Fire Safety and Civil Protection Regional Service
FSCPDG	Fire Safety and Civil Protection Directorate General
FSCPRD	Fire Safety and Civil Protection Regional Directorate
FSS	Full-Scope Simulator
IAEA	International Atomic Energy Agency
IAEA	International Atomic Energy Agency
IMS	Integrated Management System
INES	International Nuclear Event Scale
INRNE	Institute for Nuclear Researches and Nuclear Energy
IRRS	International Regulatory Review Services
IRS	International Reporting System
KIDSF	Kozloduy International Decommissioning Support Fund
LPMZ	Long term Protective Measures Zone
MCR	Main Control Room
ME	Ministry of Energy

MEW	Ministry of Environment and Water
MH	Ministry of Health
MI	Ministry of Interior
MIA	Ministry of Interior Act
MP	Modernization Programme
MS	Management System
MWL	Maximum water level
NAcP	National Action Plan
NCRRP	National Centre of Radiobiology and Radiation Protection
NDPP	National Disaster Protection Plan
NIMH	National Institute of Meteorology and Hydrology
NPP	Nuclear Power Plant
NPP	Nuclear Power Plant
NPT	Non-Proliferation Treaty
NRA	Nuclear Regulatory Agency
NS	Nuclear Safety
OMC	Occupational Medical Centre
OSART	Operational Safety Review Team
PAMS	Post Accident Monitoring System
PIE	Postulated Initiating Events
PLEX	Plant lifetime extension
PPAZ	Precautionary Protective Action Zone
PSA	Probabilistic Safety Analysis
PSAR	Preliminary Safety Analysis Report
PSR	Periodic Safety Review
PSS	Plant Shift Supervisor
PWR	Pressurized Water Reactor
QA	Quality Assurance
QMS	Quality Management System
RAW	Radioactive Waste
RB	Reactor Building
RBNRP	Regulation on the Basic Norms for Radiation Protection
RCA	Radiation Controlled Area
RP	Radiation Protection
RPCMA	Rules of Procedure of the CM and its administration
SALTO	Safe Long Term Operation
SAMG	Severe Accident Management Guideline
SAR	Safety Analysis Report
SBEP	Symptom Based Emergency Procedures
SC	Safety Culture
SE RAW	State Enterprise Radioactive Waste
SFP	Spent Fuel Pool
SFSF	Spent Fuel Storage Facility
SG	Steam Generator
SIR	Sources of Ionizing Radiation

SIS	System important to safety
SNF	Spent Nuclear Fuel
SPDS	Safety Parameters Display System
SS	Safety System
SSC	Structures Systems and Components
TLD	Thermoluminescent Dosimeter
UNAcP	Updated National Action Plan
UPAZ	Urgent Protective Actions Zone
URS	Unified Rescue System
VS	Vent Stacks
WANO	World Association of Nuclear Operators
WCh	Water Chemistry
WENRA	Western European Nuclear Regulatory Authorities
WWER	Water-Water Energy Reactor