EUROPEAN 'STRESS TESTS'

Kozloduy NPP

Updated National Action Plan of the Republic of Bulgaria

following the accident at the Fukushima NPP

Nuclear Regulatory Agency

December 2014

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UPDATED

NATIONAL ACTION PLAN OF THE REPUBLIC OF BULGARIA

following the accident at the Fukushima NPP

(December 2014)

INTRODUCTION

Immediately after the severe nuclear accident at the Fukushima Daiichi Nuclear Power Plant (NPP), caused by a major earthquake and the following large tsunami wave in March 2011, the Bulgarian Government took urgent actions to reassess the preparedness of Kozloduy NPP to respond to extraordinary situations and emergencies. Following the directions of the Bulgarian Nuclear Regulatory Agency (BNRA) and in compliance with the actions recommended by the World Association of Nuclear Operators (WANO), the Nuclear Power Plant developed and implemented by the middle of June 2011, a 'Programme for Review and Assessment of the Preparedness of Kozloduy NPP to Manage and Mitigate the Consequences of Beyond Design Basis Accidents, External and Internal Events'. A large number of additional inspections of the operability and assessment of the technical status of safety important structures, systems and components (SSCs), the availability and applicability of instructions and procedures, and preparedness of the personnel to respond to extraordinary situations were carried out within the frames of the programme.

- ***'Stress-tests' of Kozloduy NPP***

Following the Fukushima Daiichi NPP accident, the European Council requested the European Commission (EC) and the European Nuclear Safety Regulators Group (ENSREG) a safety review of all NPPs in EU countries on the basis of a comprehensive and transparent risk assessment ('stress tests'). In May 2011, the ENSREG and the EC adopted a Declaration and EU 'Stress test' Specifications, defining the stress test as a targeted reassessment of the safety margins of the European nuclear power plants in case of external initiating events.

The purpose of these 'stress tests' was to perform a targeted reassessment of the safety margins of nuclear facilities under extreme external events, loss of safety functions and severe accidents. In compliance with the EC and BNRA requirements, in 2011 Kozloduy NPP carried out stress tests for the nuclear facilities on site. At the end of 2011 the BNRA presented the Bulgarian National Report for the Stress-tests of Kozloduy NPP to ENSREG. In the period February to March 2012, all national reports of the EC countries operators of nuclear facilities were subject to reviews, discussions and peer reviews by ENSREG.

- ***National Action Plan of the Republic of Bulgaria after the 'stress-test' (December 2012)***

In 2012, ENSREG and the EC requested that each member state should develop A National Action Plan (NAcP) as a follow-up of the stress tests, taking into account the national planned measures, general ENSREG recommendations and the decisions taken at the extraordinary meeting (EOM) of the Convention on Nuclear Safety (CNS), held in August 2012, at the International Atomic Energy Agency (IAEA), Vienna.

The National Action Plan (NAcP) of the Republic of Bulgaria (December 2012) contains systematic information on the extent of implementation of the recommendations of ENSREG, and the planned additional measures resulting from the peer review by ENSREG and the related WANO Programme after the accident at the Fukyshima Daichi NPP. The National Action Plan is structured in accordance with the recommendations of ENSREG.

The measures in the National Action Plan are structured at two levels - Kozloduy NPP Site level and Institutional level.

The Operating Organisation shall report to BNRA its obligations under the implementation of the NAcP measures at Kozloduy NPP Site level, and shall develop and maintain an up-to-date programme for implementation of the relevant measures. For each measure a time schedule with deadlines, milestones (analyses and safety assessments, justifications, decisions and authorisations of regulatory bodies, feasibility studies, preparation of detail designs, equipment supply, construction works, etc.) and coordinator shall be defined. The proposals for design changes or modifications shall be supported by engineering and/or financial justification. The Operating Organization shall prepare quarterly progress reports on the implementation of the NAcP. In case of delay in the interim milestone implementation, the reasons shall be justified in the report. The final implementation deadline shall not be subject to modification except for the cases of delays, which are beyond the responsibilities of the Operating Organization. When a given measure is cancelled due to proven impossibility for implementation, an alternative measure shall be proposed (if possible). The Operating Organization shall provide BNRA with information, containing the parameters of the external events that should be reported; the main design solutions; the technical characteristics of the supplied equipment and the results from the qualification tests. In cases when a research or analysis is needed, the terms of reference and methodology shall be submitted to BNRA.

The implementation of each NAcP action at NPP site level shall be reported by the Operating Organization in a summary report. After the final implementation of all measures, the Operating Organization prepares a complete report on the NAcP implementation at that level.

The measures at the Institutional Level are adopted by a Governmental Decree of 2 May 2012. These measures are reported according to the periodic review process for the implementation of the CNS obligations, as the Government approves the corresponding reports. During the implementation of the measures at Institutional Level, the BNRA ensures the coordination with Ministries, Institutions and Organizations in Bulgaria in the frames of its competence.

A total of 63 measures and activities were envisaged in the National Action Plan of December 2012, as most of them were planned to be implemented by the end of 2014. The implementation of some long-term measures that require further analyses and assessments, as well as additional design and financing is scheduled for the period 2015-2017.

- ***Regulatory control of the implementation of the NAcP***

For the NacP progress supervision, a Task-force group was established in BNRA headed by the Deputy-Chairman with the following task: receiving and analyzing objective information on the technical content, the status of implementation and records on the results of the implementation of the measures. The implementation of the measures is also supervised by the BNRA inspectors during performance of different types of inspections related to the control activities of the BNRA.

The implementation of the measures is also controlled by the BNRA site-inspectors, who periodically perform different types of inspections and checkups of the status of the structures, systems and components (SSCs) designed for protection/ monitoring against/of external events, and of the adequacy of the emergency procedures and training of the personnel for their implementation. The BNRA inspectors also attend the periodic test performance and qualified walk downs of these SSCs.

The NAcP measures at the Kozloduy NPP site level are subject to peer review in the frame of the corresponding rules and processes adopted by the ENSREG. These actions are also subject to reporting in compliance with the periodic review process under the CNS.

- ***National Progress Report on the implementation of the NAcP of the Republic of Bulgaria (January 2014)***

In April 2013 a workshop was held in Brussels to peer review the contents and status of implementation of the measures in the NAcPs of the EC member states. As a result of this review

conclusions were made on the implementation of the NAcP of each country and some general recommendations were identified. At the end of 2013 ENSREG requested the member states to present until the end of January 2014 national progress reports on the status of the NAcPs and the implementation of the general recommendations of the workshop of April 2013. For this purpose Kozloduy NPP presented at the end of 2013 a summarized progress report of the NAcP measures and an updated plant Programme for implementation of the 'Stress Tests' Recommendations. The updated Programme reflects the current status of the measures up to the end of December 2013 and specifies 10 new measures for implementation of design solutions or conduct of further investigations resulted from already completed measures, comprising analysis or studies.

- ***The National Action Plan of the Republic of Bulgaria (revision January 2014)***

In January 2014, the BNRA updated the status of the National Action Plan and issued a new revision. In this revision of the NAcP was added Part IV: "New Measures and Activities". Part IV contains a list of 10 new measures for implementation or conducting new analyses resulted from already completed measures from Part I and Part III of the NAcP of December 2012, related to completed researches or studies. The activities and measures envisaged in this part are at the Site level. The NAcP includes also a new *Attachment 4* which specifies in tabular form the new measures. The same table also indicates the interface with the previous measure, the status of implementation and deadline for completion.

A total of 73 measures and activities were included in the NAcP of January 2014, as most of them were planned to be implemented by the end of 2014. The implementation of some long-term measures that require further analyses and assessments, as well as additional design and financing is scheduled for the period 2015-2017.

The National Action Plan (revision January 2014) was published on the BNRA website.

- ***Updated National Action Plan (December 2014)***

During the ENSREG workshop for peer review of the NAcP held in April 2013 it was decided to organize a second workshop in 2015. The main objective of the second workshop is to use a similar process of peer review of the progress of the implementation of the national action plans, as well as to exchange technical information on the measures and activities included in the NAcPs. For the second workshop of ENSREG in 2015 it is necessary that each country prepares an Updated NAcP by the end of December 2014, which shall reflect the changes that have occurred since the initial approval of the NAcP, as well as the current status of the planned measures and their implementation. For this purpose, BNRA prepares and publishes this Updated NAcP, which includes a new Part IV – Update of the National Action Plan.

The updated National Action Plan (December 2014) has the following structure, in accordance with the ENSREG requirements:

Introduction

Part I – Information about the activities at Kozloduy NPP site level and conclusions with regards to the reporting of each general recommendation and suggestion of the respective ENSREG Compilation document, with a reference to the improvement measures set in the *Attachments*. The information is grouped in the following three topics:

- TOPIC 1- External initiating events (earthquakes, flooding, extreme meteorological impacts);
- TOPIC 2 - Loss of safety systems (loss of power supply, loss of ultimate heat sink);
- TOPIC 3 - Severe accident management (SAM).

Part II – Information about the activities at Institutional Level and conclusions in terms of each of the key topics identified during the extraordinary meeting under CNS.

- TOPIC 4 – National organizations;
- TOPIC 5 – Emergency preparedness and response ;

– TOPIC 6 - International cooperation.

Part III – Additional measures and activities: Includes country specific activities, conclusions and planned measures resulting from the Country Report for Bulgaria from the ENSREG peer review or other national or internal reviews, programmes and decisions, which are related to improving safety and/or organization and actions in extreme events, which are not included in the compilation of general recommendations for topics 1 to 6. The actions considered in this part are at the Kozloduy NPP site level.

Part IV – Update of the National Action Plan:

– Answers/explanations of the recommendations identified in the ENSREG National Action Plans Workshop Summary Report in 2013..
– Progress of the implementation and update of the National Action Plan (NAcP).
– Main changes of the NAcP made after the workshop in 2013 and the reason for these changes, including:
  a) Additional measures;
  b) Measures that have been cancelled or modified;
  c) Changes in the terms and implementation timetables of the NAcP
– Technical reasons that have caused the major changes in the NacP.
– Results of researches and analyses performed after the workshop in 2013.
– National good practices and challenges, identified when implementing the NAcP.

Attachment 1 specifies in tabular form the measures at Kozloduy NPP site level for Topics 1 to 3 from the NAcP;

Attachment 2 specifies in tabular form the measures at Institutional level for Topics 4 to 6 from the NAcP;

Attachment 3 specifies in tabular form the additional measures included in Part III of the NAcP;

Attachment 4 specifies in tabular form the new measures, derived from already completed measures in Part I and Part III of the NAcP.

A total of 77 measures and activities are included in the Updated NAcP with a deadline for implementation of the long-term measures – 2017.

PART I – INFORMATION ABOUT THE ACTIVITIES AT LEVEL KOZLODUY NPP SITE

Pursuant the instructions for developing of the National Action Plans, below there is a summary of the activities and measures (reference issues) on each topic, resulting from the general recommendations and proposals of ENSREG arising from the stress tests peer reviews.

TOPIC 1 – EXTERNAL INITIATING EVENTS (EARTHQUAKE, FLOODING, EXTREME METEOROLOGICAL IMPACTS)

The National Report analyses the seismic stability of structures, systems and components (SSCs) of Kozloduy NPP important to safety that are considered in the accident scenarios. The limit values are identified of the seismic accelerations that each nuclear facility on-site can withstand without the occurrence of severe fuel damage and release of radioactive substances to the environment. The seismic stability analysis demonstrates that the SSCs of Kozloduy NPP are capable of ensuring plant safety in case of seismic impacts, considerably exceeding the current design basis.

Within the stress tests scope, the maximum water level (MWL), and its duration for the site was assessed in combination with other adverse events. The analysis of the results confirms that the Kozloduy NPP site is not floodable.

The systems and components important to safety are not directly affected by extreme meteorological impacts. The studies within the stress tests scope demonstrate that the considered civil structures have the loading capacity needed to withstand increased loads caused by extreme meteorological impacts.

1. SUMMARY OF ENSREG RECOMMENDATIONS AND SUGGESTIONS

1.1. Risks (Hazards) Frequency of Occurrence

The current seismic characteristics of the Kozloduy NPP site were re-assessed in the period 1990-1992. Reassessment was completed against the IAEA safety standards. By means of comparative analysis and additional investigations they were found to comply with the requirements of the current IAEA document Safety Standards Series No. SSG-9: Seismic Hazards in Site Evaluation for Nuclear Installations, 2010. Re-evaluation is valid for all nuclear facilities. Definition is provided for the so called RLE (Review Level Earthquake). The following seismic levels are defined with the help of probabilistic and deterministic methods:

- Operational Bases Earthquake (OBE) (also SL1) of PGA 0.10 g, with return period of 100 years;
- Design Bases Earthquake (DBE) (also SL2, Safe-shutdown Earthquake) of PGA 0.20 g, with return period of 10 000 years.

According to the Bulgarian regulations, the maximum water level (MWL) on the site is evaluated for possible maximum flood in case of river overflow with annual frequency of 1E-4 events, in combination with high tide resulting from damage of the Hydro-power Facilities Zhelezni Vrata 1 and 2, and flood surge caused by wind. The analysis was developed on the basis of the current routine hydrological study of the Danube in 2010.

The extreme winds for the region of the site are evaluated at 1E-4 frequency of occurrence and at 1E-6 – for tornado.

No need of additional measures was identified in this area. The current assessments of natural hazards are included in the periodic safety analysis for all nuclear facilities on the site.

1.2. Earthquake Secondary Effects

The report presents and analyses the results from possible earthquake secondary effects such as floods or fires, considered in the Kozloduy NPP Seismic Probabilistic Safety Assessment (PSA). The most conservative scenario is analyzed for a catastrophic wave caused by a sudden and complete damage of the Hydro-power Facilities Zhelezni Vrata 1 & 2, resulting from a beyond design basis earthquake in combination with maximum water level of the Danube, maximum precipitation in the region, and the maximum water level on the site, namely MWL=32.93m (elevation 0.00 on KNPP site corresponds to elevation +35.00 as per the Baltic Altitude System). That scenario is also considered for assessment of safety margins in case of floods. The National Report also considers water levels of lower probability (1E-5 to 1E-7) with the above combinations, the result being that the maximum level of the water will not exceed the level of 33.42 m with a probability of occurrence of 1E-7/year. The analysis of the results confirms that the Kozloduy NPP site is not floodable.

A measure is scheduled in the National Report to enhance the plant robustness in case of external flooding, to avoid secondary effects of beyond design basis flood of external sites: (Measure B-1-1 in *Attachment 1*).

1.3. Protected Volume Approach

Our off-site flooding analysis used the 'protected volume' approach to demonstrate the protection from flooding of the buildings, rooms and places important to safety. Potentially endangered rooms and equipment are identified and possible measures for plant robustness enhancement are planned against external flood of MWL=32.93m, in order to avoid secondary effects of floods (measures B-2-1, B-2-2 and B-2-3 in *Attachment 1*).

1.4. Early Warning

The Danube high levels and the water quantity trends are indicated by the readings of the implemented Automated System for Water Level and Hydraulic Regime Monitoring ("AQUA"). The system automatically monitors water levels and water volumes in the two canals, and the level and temperature of the Danube river water. Daily data are electronically transmitted by the Danube Study Agency in Ruse.

Automated meteorological monitoring system is built on-site of the Kozloduy NPP.

Procedures are developed for preventive actions of the staff in case of notification of as follows: extreme weather conditions, emergency low level of the Danube, freezing of the water along the River Bank Pump Station (BPS), low temperatures that can result in pump grids freezing in the Circulation Pump Stations 2-4.

A measure is scheduled to enhance the plant robustness in case of external flooding, to avoid any secondary effects of it (Measure B-1-1 in *Attachment 1*).

1.5. Seismic Monitoring

The Kozloduy NPP site seismic monitoring is performed by the following independent systems:

- The seismic monitoring and control system which registers and records seismic events above certain threshold (0.01g); the system detectors are installed on Unit 6, and there are annunciators for registered events on the information panels of the Main Control Room (MCR) 5 and 6;
- Accelerograph system for seismic monitoring of equipment and structures consisting of 10 accelerographs arrayed separately in the free field and at identified places of the civil structures. The system registers and records seismic events above a given threshold (0.01g);
- Equipment for industrial seismic protection intended to cause automatic reactor shutdown in case of a registered seismic acceleration movement of the base plate exceeding 0.05g;
- Local seismological network consisting of three peripheral seismic stations situated around the Kozloduy NPP site which perform on-line seismic monitoring of the plant surroundings. The local seismic network (LSN) provides reliable registration and localization of seismic events on the territory of the country and surrounding regions that may affect the Kozloduy NPP safe operation.

Written procedures are developed for each activity in compliance with the quality assurance system. Activities are performed by qualified personnel.

An Emergency Response Procedure for the unit shift operator actions in case of an earthquake and a plan for the actions of the staff during and after an earthquake are developed. An Earthquake Event Emergency Procedure is developed describing response in case of an earthquake.

No need of additional measures was identified in this area.

1.6. Qualified Walkdowns

The Department of Hydrotechnical Facilities and Civil Structures is a part of plant organisational structure. This Department carries out the seismic monitoring of the facilities, provides for the cadastral servicing of the company territory, controls status and development of engineering and civil sites through specialized surveillance and measurement, post- maintenance or post-modification testing, development and/or provision of corrective measures for the sites, and change control. Geodetic monitoring of Hydrotechnical facility deformations, civil structures, and process equipment is carried out, and the implementation and control of cadastral activities on the territory of Kozloduy NPP. Written procedures are developed for each activity containing criteria for assessment of conformity. Activities are performed by qualified personnel.

No need of additional measures was identified in this area.

1.7. Assessment of Flood Safety Margins

The assessment of margins in case of external flooding is based on the individual margins of all buildings and facilities that are directly related to the safety of the plant. The margin of a given building is identified according to its lowest point from where theoretically flooding can result of the room holding systems, structures and components for bringing the facility in safe condition.

The MWL, its duration, and the sequence of direct flooding of facilities in the valley are identified. The MWL of 32.93 m is well below the 0.00 level of the NPP site which corresponds to the level of +35.00 m as per the Baltic Altitude System. This confirms the selected site is not floodable. An expected secondary effect of the valley flooding can be flooding of some premises via the sewer system. The flooding margin is identified for such premises that house safety important equipment in critical proximity.

No buildings or facilities are found to directly impact the safety functions of the plant when flooded. Nevertheless, measures have been planned to enhance the plant stability against secondary effects from off-site flooding with MWL = 32.93 m (measures B-1-1, B-2-1, B-2-2, B-2-3 and B-3-1 in *Attachment 1*).

1.8. Safety Margins for External Impacts

The equipment important to safety and included in the emergency scenarios is analysed for seismic stability, and parameters are defined to describe its provisional probability of failure (fragility curves). All ranges of seismic impacts are analysed consecutively, defining for every range the safety important SSCs which fail. The limit values are identified of the seismic accelerations that each nuclear facility on-site can withstand without the occurrence of severe fuel damage and release of radioactive substances to the environment.

The analysis of the beyond design basis earthquake is conservative enough and provides assurance in the capability of the KNPP systems, structures and components to ensure the plant safety for the maximum potential seismic impacts on the site.

The margin of Units 5 and 6 according to the analyses conducted is 0.13 g or 65% as compared against RLE (PGA =0.2g).

Despite the significant margins in terms of seismic stability of equipment important to safety, measures for potential improvements are planned for Units 5 and 6 (measures A-1-1, A-1-2, A-1-3 in *Attachment 1*).

The Spent Fuel Storage Facility (SFSF) margin is 0.16g as a minimum or 80% compared against RLE (PGA=0.2 g).

No measures to enhance the seismic stability of the SFSF are proposed.

As regards the flooding margin, the defined MWL of 32.93 m is well below the 0.00 level of the NPP site, which corresponds to the level of +35.00 m as per the Baltic Altitude System. The estimated maximum water level values at lower probability (1E-5 to 1E-7) show that the water level will not exceed 33.42 m. This confirms the selected site is not floodable. Nevertheless, the measures undertaken to improve the plant robustness to extreme flooding are described in section 1.7.

The assessment performed for region specific meteorological impacts (such as extreme winds, tornado, snow pack and icing, extreme temperatures, and extreme precipitation) and analyses of the technical condition of the structures, organisational and technical measures performed to ensure the power supply of the site consumers and nuclear fuel cooling have shown that the systems important to safety are in compliance with the design requirements, and the available instructions and procedures are applicable to the actions of the personnel in extreme situations.

Part III of the plan envisages performing additional analyses of the extreme weather conditions and combinations thereof on the KNPP site (measure E-1 in *Attachment 3*).

TOPIC 2 - LOSS OF SAFETY SYSTEMS

The reassessment of the safety margins in case of loss of safety functions that could lead to severe accidents is based on safety analysis performed with deterministic approach. The results of the analysis of the postulated initiating events with loss of power supply and loss of ultimate heat sink show the strong robustness of the Kozloduy NPP nuclear facilities and available adequate time period for implementation of additional recovery actions, if necessary.

1. SUMMARY OF ENSREG RECOMMENDATIONS AND SUGGESTIONS

1.1. Alternate Cooling and Heat Sink

As it is stated in the National Report, the following alternative cooling means and ultimate heat sinks in case of loss of the main ultimate heat sink and the connection with it have been provided at the Kozloduy NPP site:

- Emergency bank pumping station, providing independent water supply (with its own Diesel Generator (DG)) in an emergency volume of the inlet channel through two independent steel pipelines;
- Emergency water volume in the inlet channel pumped out with motor-driven pumps or diesel-pumps of the service water system to fill in the spay ponds;
- Six shaft pump stations which are powered by the DG of the emergency pump station and are sufficient to supply the spray ponds;
- Closed cooling loop through the spray ponds to the atmosphere;
- Passive Steam Generator (SG) make up by demineralised water and heat sink to the atmosphere through the secondary side steam dump.

Number of measures related to investigation of the possibilities and the implementation of various plans for decay heat removal from the nuclear facilities onsite have been planned in order to provide additional safety margins (C-2-1, C-2-2, C-2-3, C-2-4, A-1-2, A-1-3, D-2-4 and D-2-5 in *Attachment 1*).

1.2. AC Power Supplies

The design provisions for off-site power supply of Kozloduy NPP include 3 independent connections with the national grid of Bulgaria and its neighbour countries throughout 13 transit electric lines of 400 kV, 220 kV and 110 kV.

The existing Restoration Plan of the National Grid After Severe Accidents ensures the prioritized restoration of the plant power supply from three different channels, including power supply from the Hydro Power Plant (HPP) with a possibility for black start and from other national grids (Romania, Serbia) whereas the restoration time varies from 15 minutes to 4 hours.

The following levels of protection in case of loss of off-site AC power supply have been provided in the design of Units 5 and 6:

– 3 emergency diesel generators for each unit (one for each safety system train);
– Additional Diesel Generator for each unit ;
– Mobile diesel generator (MDG) on site;

In order to ensure additional safety margin, additionally two MDGs for Units 5 and 6 have been planned to be delivered (measure A-1-1 in *Attachment 1*).

1.3. DC Power Supplies

According to the design, 3 batteries are provided per each unit (one for each of the safety systems trains) and three batteries for the normal operation systems. The design for DC power supply has been modernized with which the redistribution of loads is ensured, as well as permanent monitoring of the condition of the equipment and extended availability time. Based on real test performed it was proven that the discharge time of the safety systems batteries is over 10 hours.

In order to ensure additional safety margins, a measure has been planned to make provisions to supply one safety system battery per unit by a mobile DG (measure C-1-1 in *Attachment 1*).

1.4. Operational and Preparatory Actions

Arrangements, procedures, control and responsibilities have been established at Kozloduy NPP to provide the required survival resources of fuel, oil and consumables to ensure the continuous operation (beyond 10 days and nights) at full load of all on-site back-up power supply sources.

The requirements for continuous operation of the DG and diesel pumps in emergency mode have been specified in the Technical design of the particular nuclear facility and the auxiliary on-site facility, in the Safety Analysis Reports and/or the Technical Specifications. In compliance with the Operational Limits and Conditions of the nuclear facilities, the required emergency reserves of boron acid, reagents, chemical agents for the chemical and radiochemical laboratories, boron concentrations and demineralised water shall be maintained.

The operational and organizational activities on providing consumables are assessed as sufficient and there is no necessity of applying additional measures.

1.5. Instrumentation and Monitoring

Within the period 1998-2008 Kozloduy NPP implemented a huge modernization programme at units 5 and 6, whereas one of the programme objectives was to provide qualified, triple redundant channels for measurement and control of the significant parameters for accident management beyond the design basis in the reactor and in Spent Fuel Pool (SFP) including the implementation of Safety Parameter Display System (SPDS) and Post-Accident Monitoring System (PAMS). For this purpose during the development of the symptom-based emergency operating procedures (SBEOP) and the Severe Accidents Management Guidelines (SAMG) systematic analyses were performed of the available measurement channels. Wide measurement range temperature detectors have been installed for monitoring the temperature of the reactor vessel (measure D-3-4 in *Attachment 1*). Apart of that, the operational radiation monitoring systems and the environmental radiation monitoring systems have been modernized in the framework of the Modernization Programme of Units 5 and 6 and qualified wide range redundant continuous measurement channels have been provided.

I&C for the main systems for accident management are located both at the MCR and at the Emergency Control Room (ECR) and are available to the operators. The emergency procedures include specific actions and specify required control instrumentation. In the course of the stress tests performed, it was concluded that Units 5 and 6 do not have available system for direct monitoring of water steaming and oxygen within the containment, but it is scheduled to install such a system with a measure D-3-2 in *Attachment 1*.

1.6. Shutdown Improvements

In order to enhance safety in shutdown states a number of analyses have been performed and SBEOPs have been developed and implemented for a reactor shutdown states with closed reactor (measure D-2-1 in *Attachment 1*). The introduction of SBEOP for a shutdown reactor state with open reactor (measure D-2-2 in *Attachment 1*) is forthcoming.

As per the results of the stress tests performed at Kozloduy NPP, it is planned to provide power supply for the motors of valves connecting the pipelines of the hydro-accumulators by batteries to ensure the possibility of primary circuit make-up in cold condition (measure C-2-3 in *Attachment 1*). Availability of at least one tank of the SG emergency feed water system at units 5 and 6 in a shutdown unit state has been provided (measure A-1-3 in *Attachment 1*).

1.7. Reactor Coolant Pump Seals

The design, construction, and manufacturing of the Reactor Coolant Pump (RCP) seals for WWER-1000 reactor units allow maintaining the tightness of the reactor coolant pressure boundary in case of loss of power supply. Their robustness for at least 24 hours at high temperature and without cooling media has been experimentally verified by the manufacturer and has been assessed as sufficient. No additional measures are required.

1.8. Ventilation

As a result of a review performed on the accident management equipment, the operability of the control systems to perform their functions in the conditions of a continuous blackout has been confirmed with no necessity of ventilation of the respective premises.

Necessity of additional measures in this field has not been found.

1.9. Main Control Room (MCR) and Emergency Control Room (ECR)

The designs of the MCR, ECR and emergency response centre (ERC) provide operability and habitability of the personnel during nuclear and radiation emergency including station blackout (SBO). As it is specified in Topic 3, further analyses shall be performed to identify the possibility of degradation of the work environment due to the high level of radioactive contamination (in certain areas) and failure of on-site equipment and its potential impact on the access and habitability of the MCR and the auxiliary control panels (measure D-2-8 in *Attachment 1*).

Two autonomous DG have been installed in the ERC and, thus, the emergency response centre is independent in the event of total loss of on-site and off-site power supply. In the event of moderate seismic impacts (below DBE of the plant), the functionality of the ERC depends upon secondary seismic effects, whereas the degradation of the above-ground structures hinders the access of the personnel to the ERC. This issue is considered in the design and there is an emergency independent underground access to the ERC premises. The National Report includes a measure for the construction of a new off-site ERC (measure D-1-2 in *Attachment 1*).

1.10. Spent Fuel Pool (SFP)

The spent fuel pools at Kozloduy NPP Units 5 and 6 are located in concrete buildings which are part of the containment. In this regard, they are reliably protected from external impacts. The design characteristics of the SFP exclude modes related to occurrence of criticality and drainage of the pools. Emergency operating procedures (SBEOPs) have been introduced in case of emergency conditions in the SFP, which include strategies with the use of alternative sources for fuel cooling. The monitoring devices in the SFP have an indication displayed in the MCR and the ECR including alarm signals, whereas their power supply is ensured by a battery.

As it is specified in the text under item 2.1 of the Plan, in order to provide additional safety margin, a measure has been envisaged to ensure electrical supply of the heat removal systems or SFP filling by a mobile DG (measure C-2-2 in *Attachment 1*).

1.11. Separation and Independence

Design solutions based on both active and passive principle of operation are used in the design of the systems and equipment important to safety.

The specific technical solutions applied in the design of the safety systems are: multi-channel structure (redundancy), physical separation and diversity. The combination of these solutions ensures the robustness of the safety systems to common cause failures, i.e. the total loss of the ability of safety systems to perform their function.

Moreover, the Kozloduy NPP design specifies a number of means to ensure alternative (independent) implementation of the safety functions avoiding the dependence of the support and auxiliary function systems (e.g. alternative cooling sources and methods specified under item 2.1 of the Plan).

Additional measures have not been planned in this area.

1.12. Flow Path and Access Availability

Electric power supply sources and operational inventories of working media and cooling water ensure autonomy of safety systems for more than 72 hours. Based on real test performed, it was identified that the batteries discharge time is over 10 hours. In order to ensure additional safety margins, a measure has been planned to supply one of the batteries of the safety systems by a mobile DG (measure C-1-1, *Attachment 1*).

The emergency procedures clearly define the valves positions in case of loss of all AC power supply sources.

The access of personnel to the equipment and control panels is performed through emergency exits operating on mechanical principle.

1.13. Mobile Devices

As it is specified in the National Report on the stress tests performed, there is one MDG set on a platform on the Kozloduy NPP site. The platform transportation to the electrical board of the SG Alternative Feed water System is performed with a tractor. The actions of the operating personnel in the event of a loss of power supply are specified in the emergency procedure, the SBEOP for actions in case of a full station blackout and the procedure on the transportation and actuation of the MDG to the premises busbars. The established success criterion is the time from giving the alarm on the total loss of power supply until the pump actuation to be less than 2 hours. The criterion is verified during the emergency drills performed.

In order to ensure safety margins, the procurement of two new MDGs has been planned (measure A-1-1 in *Attachment 1*). The measure is integral and it envisages implementation of actions

at several stages, including the provision of adequate storage conditions, construction of connection points to reliable electrical supply busbars and development of operation manuals, process tests and maintenance.

1.14. Bunkered/ Hardened Systems

As it is stated in item 1.13 above, Mobile devices, one MDG is available on the Kozloduy NPP site and procurement of two new MDGs is planned (measure A-1-1 in *Attachment 1*) in order to provide additional level of protection in the event of beyond design basis accidents and possibility for their simultaneous use at Units 5 and 6. It is envisaged to provide possibilities for power supply of key systems by the new MDGs:

- power supply for charging of one battery of a safety system train of each unit (measure C-1-1 in *Attachment 1*);
- electrical boards for power supply of the SG Alternative Feedwater System of both units by the MDG (implemented) ;
- power supply of SFP cooling system (measure C-2-2 in *Attachment 1*).

The sites selection for the location of the MDGs in view of the robustness of the sites to wide range of extreme events has been planned as part of measure A-1-1.

1.15. Multiple Accident

The accident management systems for the nuclear facilities at the Kozloduy site have been designed and implemented separately for each facility and there is no sharing of systems or human resources. ERC is located at the Kozloduy NPP site and is equipped with both emergency procedures for each nuclear facility on site, as well as with common emergency response instructions. In order to improve the response preparedness and the interfaces with the off-site organizations, measure D-1-1 in *Attachment 1* has been planned.

The survival emergency resources of fuel, oil and consumables are sufficient to ensure the continuous operation (over 10 days and nights) at full load of all on-site emergency power supply sources.

1.16. Equipment Inspection and Training Programs

Additional equipment for beyond design basis accidents management is available at the plant site, such as a MDG, mobile diesel pumps, fire-extinguishing techniques. The maintenance and periodic inspections of this equipment are regulated in specific programmes and schedules for their performance. The technical and operating maintenance is performed by trained and qualified personnel.

There is no necessity of application of additional measures in this field.

1.17. Further Studies to Address Uncertainties

- *SFP integrity*

The spent fuel pools represent a reinforced concrete structure with inner metal coating and are located within the containment. This ensures the robustness against all external impacts and tightness in case of boiling. Measure D-2-6, included in Part III as an additional measure resulting from the ENSREG peer review, makes provision for extended severe accident management guidelines for the SFP and for shutdown reactor states.

- *Functionality of the control equipment during SBO*

The WWER-1000 design solutions ensure a stable natural circulation without operator actions in case of station blackout (SBO) until the coolant in the horizontal SGs is spent. The systems and components, performing overpressure protection functions at primary and secondary side and in the containment, are powered by batteries or operate on a passive principle. In order to ensure additional safety margins and increase the availability of the control valve in the event of total loss of power supply, measures A-1-1, C-1-1, C-2-3 in *Attachment 1* have been envisaged.

- *Further studies to assess operation in the event of widespread damage*

The issues related to the necessity of further studies with regard to the arrangements of the emergency response actions and logistics have been reviewed in Topic 3 of Part I.

TOPIC 3 - SEVERE ACCIDENTS MANAGEMENT

The results from the severe accidents management review show that the applicable actions for recovery of the control over the nuclear facilities are regulated, including in combination of an accident and other extraordinary situations. The measures related to the severe accidents management, planned to be fulfilled after 2010 are verification, validation and implementation of SAMGs, preventing early bypassing of the containment and updating and extending the PSA - level 2 scope.

According to the National report of Bulgaria, the programmes for completing those actions are in process of implementation.

1. SUMMARY OF ENSREG RECOMMENDATIONS AND SUGGESTIONS

1.1. WENRA Reference Levels

- *Hydrogen mitigation in the containment*

Within the Modernization Programme, passive autocatalytic recombiners (PAR) have been installed in the containment of units 5 and 6, for hydrogen risk management in case of Beyond Design Bases Accidents. An additional analysis was made, which shows, that their capacity is sufficient also for controlling the hydrogen from the in-vessel phase of a severe accident.

In order to cover the whole severe accident evolution, installation of additional PAR is planned in the containments of Kozloduy NPP Units 5 and 6 (measure D-3-1 in *Attachment 1*).

- *Hydrogen monitoring system*

Within the Modernization Programme, measuring devices were installed in the containment of Units 5 and 6 for measuring the hydrogen concentration. The analyses related to the design of the post-accident monitoring system (PAMS), as well as the analysis performed under PHARE Project BG.01.10.01: "Phenomena investigation and development of SAMGs, in accordance with the European requirements", justified the possibilities to use the available hydrogen measuring devices in severe accident conditions.

Measure D-3-2 is planned in *Attachment 1* for installing measurement devices for water steams and oxygen concentration within the containment space.

- *Reliable depressurization of the reactor coolant system*

Within PHARE Project BG.01.10.01: "Phenomena investigation and development of SAMGs, in accordance with the European requirements" implemented in 2005 a strategy was developed for reactor vessel depressurization, which is covered by the scope of the SAMGs. The main technical provisions for primary circuit depressurization and preventing the evolution of severe accident at high pressure are the pressure relief valves of the pressurizer and the primary circuit gas mixture emergency

removal system. An additional option for primary depressurization is the drain valves of the RCP sealing water system. In order to ensure a practical possibility for using the primary circuit gas mixture emergency removal system under conditions of severe accident evolution, a modification of the system valves electrical power supply was performed, ensuring redundancy of electrical power supply of the respective valves from batteries.

In the current design the Kozloduy NPP WWER 1000 reactors have technical provisions for reactor coolant system depressurization to avoid high pressure melt ejection, which are available in SBO conditions. The required operator's actions are described in the emergency instructions:

- the symptom based emergency operating procedures provide for strategies for accident management - restoring the critical safety functions (CSFs) - heat removal and core cooling, restoring the electrical power supply. The successful fulfilment of the actions foreseen in those strategies will prevent the fuel damage, and will depressurize the primary circuit;
- SAMGs foresee actions for restoration of the coolant inventory into the reactor vessel. As a means of coolant delivery to the primary circuit could be used the available trains of the safety systems - High Pressure Emergency Core Cooling System (ECCS-HP), low pressure (ECCS-LP), feed and bleed systems trains (TK system).

No need for additional measures has been identified in this area.

- *Containment overpressure protection*

Within the Modernization Programme (2001-2008), in conformity with the recommendations of IAEA-EBP-WWER-05, Safety Issues and their Ranking for WWER-1000 Model 320 Nuclear Power Plants, March 1996, in 2006 at units 5 and 6 pressure reduction filtering systems were installed, which act in passive way, in order to control the pressure under severe accident conditions.

No need for additional measures has been identified in this area.

- *Molten core stabilization*

Within PHARE Project BG.01.10.01: "Phenomena investigation and development of SAMGs, in accordance with the European requirements" implemented in 2005, an analysis was made of the phenomena related to the core melting, reactor vessel degradation, melted core spill over the containment basement, and the threats associated with these processes. There are prevention strategies for those phenomena developed in SAMGs. Wide-range temperature sensors have been installed for monitoring the temperature of the reactor vessel (measure D-3-4 in *Attachment 1*). A project is currently ongoing for plugging the most vulnerable ways for spread of melted core outside the containment and preventing containment bypass (measure D-3-3 in *Attachment 1*).

1.2. SAM Hardware Provision

On the basis of the results from the investigation of units 5 and 6 under PHARE Project BG.01.10.01 "Phenomena investigation and development of SAMGs, in accordance with the European requirements" strategies have been developed for severe accidents management and the associated technical provisions for their implementation. Measuring devices have been defined for monitoring in severe accident conditions. The selection criteria for the SSCs thus identified was their capability to survive, to reset and to fulfil their functions under conditions of severe accidents. As a rule, these provisions are located in the buildings on the site and are not exposed to extreme meteorological conditions.

Specific SSCs have been additionally designed for severe accident management and prevention the containment failure, such as passive filter venting system for containment depressurization, SGs

alternative feedwater system, PAR, located in the containment. These provisions have proved their capability to perform their functions in severe accident conditions.

1.3. Review SAM Provision Following Severe External Events

As a result of the review made of the available provisions for severe accident management it was concluded that there are adequate response measures in such conditions. The nuclear facilities have sufficient independence and recourse, which allow undertaking necessary actions in these conditions. Despite of this, measures to enhance the facilities resistance have been mapped out (measures A-1-1, A-1-2, A-1-3, A-3-1 and D-3-3 in *Attachment 1*).

1.4. Enhancement of Severe Accident Management Guidelines (SAMGs)

The SAMGs in Kozloduy NPP are unit-based and each nuclear facility on the site is capable to react independently to the symptoms in case of severe accident. The planned measure for issuing SAMGs for use was implemented in October 2012 - SAMGs for units 5 and 6 were issued for use, as well as SAMGs for the ERC (measure D-2-3 in *Attachment 1*).

In case of Emergency plan (EP) actuation specific emergency arrangements on the site are established in the Emergency Response Centre, where the management of the emergency actions is fulfilled. The Emergency Actions Supervisor (EAS) is authorized to involve the regional and national structures in the emergency actions, s/he disposes of and allocates the resources on the site and makes the major decisions with regard to the accident management. Within the ERC accident management organizational structures, a Technical Support Centre for the Operators (TSCO) is established, which comprises a reserve shift of operators, Groups for analyses and prognoses. The TSCO provides logistic support to the EAS with regard to SAMGs, as well as replacement of the nuclear facilities operators.

The on-site and off-site emergency plan of Kozloduy NPP was reviewed and updated this year, with a view to taking into account possible effects from physical isolation, caused by external hazards (measure D-1-1 in *Attachment 1*). The updated revision of the EP was issued for use.

No need for additional measures has been identified in this area.

1.5. SAMGs validation

According to Kozloduy NPP internal procedures, the process of SAMGs development involves their validation (measure D-2-3-3 in *Attachment 1*). The validation was performed on the basis of completed analyses of representative scenarios of severe accidents. The entrance conditions for SAMGs are validated using a full-scope simulator (FSS). The transfers from SBEOP to SAMGs are validated at the FSS, while a practical application of the described actions and strategies are validated by a team of independent experts following the "table top" method.

No need for additional measures has been identified in this area.

1.6. SAM exercises

Emergency planning training program and training courses are developed for three staff levels.
The following exercises and drills are carried out:

- Full-scope emergency exercise with the emergency structural units, once a year;
- Separate emergency drills with the individual working groups and teams of the emergency structural units, twice a year;
- Functional tests of the notification and communication means performed by the maintenance and servicing structural units, monthly.

The emergency drills and the full-scope emergency exercises are carried out according to an approved schedule and a preliminary developed and approved syllabus. The scenarios developed for full-scope emergency exercises cover the local and national emergency structural units, verifying the interaction procedures with regard to the accident management, notification, announcing and protection of the public. SAMGs, as a set of instructions for operators actions in case of severe accidents are part of Kozloduy NPP Emergency plan. During full-scope emergency exercise, the operating staff drills the emergency situation on a simulator, an assessment is made of the applicability of the strategies for exercising impact on the facility which is subject to severe accident, as well as the operative decision-making strategies by the emergency response supervising team in the ERC.

Analyses and reports are prepared for the implementation of all types of exercises and drills.

No need for additional measures has been identified in this area.

1.7. SAM Training

A full scope simulator (FSS) is used for operators training. Two types of training are carried out initial licensing training and periodical training.

The periodical training of the operators is performed according to a preliminary approved schedule, twice a year, for 5 days each time. The training is delivered by licensed instructors.

The FSS scenarios cover "emergency conditions" from the whole range of postulated initiating events. The practical exercises continue until reaching of controlled safe state (success), and/or core damage (failure). The range of topics is selected in such a way, as to cover operators' actions with the available equipment at the units, as well as the available emergency procedures. The teams are trained to work according to SBEOPs, to make transition to SAMGs and to bring in action the Emergency plan.

A lecturing course on severe accidents management guidelines is also delivered.

A training results analysis report is issued after each training.

No need for additional measures has been identified in this area.

1.8. Extension of SAMGs to All Plant States

SAMGs cover power operation, low power and shutdown pressurized reactor (measure D-2-3 in *Attachment 1*).

The states corresponding to depressurized primary circuit with open reactor are covered by the SBEOPs (measure D-2-2 in *Attachment 1*). SBEOPs are also implemented for response actions under "emergency conditions" in the SFP. The actions and strategies described in those procedures are applicable also under conditions of severe fuel damage.

The current SAMGs do not consider state of fuel melting in the SFP.

Part III includes a measure D-2-6, which foresees extension of SAMGs scope for the SFP and some reactors states (shutdown and unsealed reactor).

1.9. Improved Communication

Diverse, multi-channel and backed up information systems are established on the site:

- Safety parameter display system (SPDS) at the MCR, ERC, integrated with an emergency centre at BNRA;
- Operational radiation monitoring systems (dosimeter monitoring panels, ERC);
- Automated information systems for off-site radiation monitoring (MCR, ERC, integrated with the National automated systems for permanent monitoring of the radiation gamma background of the Ministry of Environment and Water);

- Automated information system for radiation monitoring on the industrial site (dosimeter monitoring panels, ERC);
- Meteorological monitoring system (dosimeter monitoring panels, ERC, national system for meteorological monitoring, emergency centre with the BNRA);
- Environment and Kozloduy NPP site monitoring - on-line field measurements in the areas for preventive and urgent protective measures with three off-road vehicles and a mobile laboratory. The information is communicated directly to the ERC;
- Information system in the ERC - a complex of hardware and software means for assessment of the facilities' condition, radioactive releases and radiation exposure of the population, which are necessary for making a decision and applying protective measures. The information system obtains input data from the SPDS, the automated radiation monitoring systems of NPP and the meteorological monitoring system. Information sharing between the ERC and the BNRA is provided for;
- Notification means and means of communication - backed up, independent and diversified as regards the principle of operation, contemporary communication and notification means.

The interface between the individual users is maintained through radio systems, optical connection, GPS communication, telephone and paging system and satellite connection.

No need for additional measures has been identified in this area.

1.10. Presence of hydrogen in unexpected places

In the conditions of a severe accident hydrogen could be generated in the reactor core and the Spent Fuel Pools (SFP). Both are located in the containment.

In severe accident conditions the containment is isolated and there is no possibility for hydrogen migration outside it. The installation of additional recombiners is foreseen (measure D-3-1 in *Attachment 1*) to control the hydrogen generated in the ex-vessel phase and during fuel melt in the SFP.

1.11. Large Volumes of Contaminated Water

The question was discussed during the peer review and it was proposed to examine conceptual solutions for potential treatment of large volumes contaminated water. Measure D-3-6 in *Attachment 1* provides for studies in this area.

1.12. Radiation Protection

Kozloduy NPP on-site emergency plan provides for the required resources for protection of the personnel that is engaged with the accident management. They are available on site, being serviced and kept in repair by the responsible organizational units.

The design solutions for the MCR, ECR and ERC ensure operability and habitability for the staff in conditions of nuclear and radiation accident, including in SBO. All control rooms and the ERC are provided with a continuous backed up radiation monitoring, 120% redundancy with individual emergency kits for the operators, the emergency personnel of the plant and the team on duty of the fire brigade and the police. A separate shelter is foreseen for the emergency personnel, equipped with an autonomous DG and a ventilation system.

Carrying out additional analyses of the possibility for deterioration of the working conditions due to the high radioactive contamination level (in certain areas) and damage of equipment on the site and potential impact on the access and usability of the MCR and ECR is forthcoming (measure D-2-8 in *Attachment 1*).

1.13. On-Site Emergency Centre

The Emergency Response Centre (ERC) ensures operability and habitability for the staff in conditions of nuclear and radiation accident, including SBO. There are 2 autonomous DGs installed in the ERC, which makes the emergency centre independent under SBO conditions, and ensures the ventilation of the rooms. ERC is supplied with resources for continuous functioning, communication and information systems to the nuclear facilities on the site, as well as to external organizations at municipal and national level.

At seismic impacts the ERC functioning is determined by secondary seismic effects, while destruction of surface structures would impede the personnel access to the ERC from the main entrance. This problem was taken into account in the design and an emergency independent access to the ERC rooms is foreseen.

Despite of this, a measure is planned for building an off-site ERC (measure D-1-2 in *Attachment 1*).

1.14. Support to Local Operators

The organization of the emergency planning in the country foresees, upon request by the operator, provision of external expert and hardware support in case of an accident. Measure EO-2-7 foresees additional provision of expert support from the Regional Crisis Centre in Moscow.

1.15. Level 2 Probabilistic Safety Assessments

In 2001 a level 2 PSA was developed for Kozloduy NPP units 5 and 6, which reflects the configuration of the plant before the Modernization programme in 2002. During the implementation of the Modernization programme (2002-2008), passive autocatalytic recombiners and a passive containment filter venting system were installed; the in-vessel phase and the ex-vessel phase of severe accident evolution were examined. The PSA level 2 is currently being updated. The update will reflect the implemented design modifications. The insights will be used to determine specific modes and scenarios depending on their severity as regards the consequences.

No need for additional studies has been identified in this area.

1.16. Severe Accident Studies

- *The availability of safety functions required for SAM under different circumstances*

The phenomena related to severe accidents for Kozloduy NPP units 5 and 6 have been studied within an international project - PHARE Project BG.01.10.01 Phenomena investigation and development of SAMGs, in accordance with the European requirements. On the basis of the project analyses results, the accident management strategies have been determined (hydrogen recombination, containment filter venting, reactor vessel failure, core melt localization and retention within the containment), and SAMGs for units 5 and 6 have been developed and issued for use (measure D-2-3). Measure D-2-6 foresees extension of SAMGs scope for the SFP and for specific states of the reactors (shutdown and unsealed reactor), which are not covered by the present SAMGs.

- *Accident timing, including core melt, reactor pressure vessel (RPV) failure, basement melt-through, SFP fuel uncovery, etc.*

Within PHARE Project BG.01.10.01: "Phenomena investigation and development of SAMG, in accordance with the European requirements" implemented in 2005, an analysis was made of the phenomena related to the core melting, reactor vessel degradation, melted core spill over the containment basement, and the threats associated with these processes.

Within the stress tests the time window between boiling and fuel uncovery in the SFP was analyzed. Measure D-2-6 in *Attachment 1* provides for additional examination of the emergency consequences with fuel melting in the SFP.

- *PSA analysis, including all plant states and external events for PSA levels 1 and 2*

As of 2010 an updated PSA level 1 study is available at Kozloduy NPP, which reflects the units state following the completion of the measures from the Modernization program in (2001-2008). Level 1 PSA relates to all units states (full power, low power and shutdown state) and covers all internal events (flooding, fire, missiles), and as relates to the external events - it covers only the seismic impacts. Level 2 PSA study is currently being developed, which will reflect the measures from the completed modernization of the units; it will be based on the interface with level 1 PSA developed in 2010.

Attachment 3 provides for measure E-1 foreseeing using probabilistic methods to study combinations of extreme meteorological conditions according to IAEA methodology.

- *Radiological conditions on the site and associated provisions necessary to ensure MCR and ECR habitability as well as the feasibility of accidents management measures in severe accident conditions, multi-unit accidents, containment venting, etc.*

The existing design provides for radiation protection of operational staff in MCR and ECR. As a result of the stress tests it is foreseen an additional analysis of potential degradation of performance due to the high level of contamination (MCR and ECR) and the equipment damage at the site, including the impact on the accessibility and usability of MCR and ECR (measure D-2-8 in *Attachment 1*). Direct discharge of radioactivity at the site and in the environment is prevented with passive filter venting system.

Evaluation of the existing organizational measures and technical means for simultaneous core melt/fuel damage accidents in different units/installations at the site is foreseen in measure D-2-7 in *Attachment 1*.

- *Core cooling modes prior to RPV failure and of re-criticality issues for partly damaged cores, with un-borated water supply*

The probability for a re-criticality in the reactor in case of severe accident as a result of un-borated water supply is very low, in view of "inherent safety features such as geometric configurations or the use of fixed neutron-absorbing materials". The emergency procedures (SBEOPs and SAMGs) currently do not provide for supplying non-borated water to the reactor.

- *Phenomena associated with cavity flooding and related steam explosion risks*

According to the existing design, the reactor cavity of units 5 and 6 is dry. Within PHARE Project BG.01.10.01 different accident scenarios have been considered and no accident sequences were identified, which could lead to a steam explosion as a result of melted core ejections into flooded cavity.

No need for additional studies has been identified in this area.

- *Engineered solutions regarding molten corium cooling and prevention of basemat melt-through*

Within PHARE Project BG.01.10.01 a study has been performed and currently a hardware modification is in progress, which is related to plugging of the most vulnerable points, where basement melt-through could occur and preventing bypass of the containment (measure D-3-3 in *Attachment 1*). With the aim of ensuring control of the reactor vessel temperature in severe accidents conditions

measure D-3-4 (in *Attachment 1*) was implemented. Measure D-3-5 (in *Attachment 1*) is planned, which provides for studying the possibilities for molten corium localization during severe accidents.

- *Severe accident simulators appropriate for NPP staff training*

The FSS scenarios cover "emergency conditions" from the whole range of postulated initiating events. The practical exercises continue until the reactor facility is rendered to a controlled safe state (success), and/or reaching core damage (failure). The teams are trained to work according to SBEOPs, to make transition to SAMGs and to actuate the emergency plan.

No additional studies are foreseen in this area.

Part II - INFORMATION ABOUT THE ACTIVITIES AT INSTITUTIONAL LEVEL

TOPIC 4 - NATIONAL ORGANIZATIONS

The Second Extraordinary Meeting of the Contracting Parties to the Convention of Nuclear Safety took place at the Headquarters of the International Atomic Energy Agency (IAEA), Vienna, Austria from 27 to 31 August 2012 with the objectives to review and discuss lessons learned from the Fukushima Daiichi accident and to review the effectiveness of Convention provisions. The meeting Final Summary Report (CNS/ExM/2012/04/Rev.2) summarizes the key actions taken and challenges faced by many Contracting Parties, and provides a list of issues arising from Group Discussions.

Part II of the present Action Plan address national conclusions and generic activities related to each issue identified by the CNS Second EOM and presents respective country arrangements and planned actions. Where appropriate, reference is made in *Attachment 2* "Implementation of Activities".

Review and revision of nuclear Laws, Regulations and Guides

BNRA policy is to periodically review the national legislation in respect of stakeholders feedback, EU legislation and WENRA reference levels on safety harmonization, new and changing IAEA safety requirements, own feedback on the use of the requirements. In implementation of that policy, the fundamental law in the field of safety of nuclear installations - the Act on the Safe Use of Nuclear Energy (ASUNE) was recently reviewed and revised (in force from October 2010).

Detailed requirements for nuclear safety and radiation protection are specified in the secondary legislation for application of the ASUNE (more than 20 regulations). Following ASUNE changes, BNRA developed and is implementing a Program for Review and Revision of all Regulations. Review and revision of regulatory requirements cover also consideration of the lessons learnt from the Fukushima Daiichi accident. Implementation of this Programme is included as measure N-1-1 in *Attachment 2*.

It should be noted, that Article 5, p. 7 of the ASUNE specify that BNRA Chairman shall develop regulations on the application of the law and propose amendments and supplements, when improvement of legal framework is appropriate, taking into account operating experience, insights gained from safety analyses, and the development of science and technology. BNRA policy and intentions of are to review and revise regulatory requirements, when new IAEA documents, reflecting lessons learned from the nuclear accident at Fukushima Daiichi are published - measures N-1-2 and N-1-3 in *Attachment 2*.

Concerning comprehensive periodic reviews of safety, using state-of-the-art techniques, this is already a well established practice, as the general licensing philosophy is to renew licenses on the basis of periodic safety review.

Finally, it should be mentioned that lessons learnt from the Fukushima Daiichi accident and the current IAEA and WENRA documents will be reflected in the periodic review of the BNRA Regulatory Guides - measure N-1-4 in *Attachment 2*.

Changes to functions and responsibilities of the RB

According to the ASUNE, state regulation over the safe use of nuclear power and ionizing radiation, safe management of radioactive waste and spent nuclear fuel is performed by the BNRA Chairman, who is independent specialized body of the executive power. Regulatory functions performed by BNRA in service to society, determine the organization's mission, namely: "Protection

of human life, society, future generations and the environment from harmful effects of ionizing radiation". In order to achieve its mission, Nuclear Regulatory Agency applies the internationally accepted principles for nuclear safety and radiation protection, striving to improve continuously its effectiveness, using internationally accepted best regulatory practices.

Analyses of BNRA independence show that it is legally, politically and financially independent, to the maximum practically possible extent. BNRA is provided with sufficient legislative power to make independent regulatory decisions, including the shut down of a facility or license withdrawal. One of the BNRA legal responsibility and authority (ASUNE, Article 5) is to openly and transparently communicate regulatory decisions and safety information to the public and state authorities concerned. BNRA has sufficient human resources, who are highly educated and qualified, and are able to judge on the safety of regulated facilities and activities. Respectively analyses did not identify any country actions in this respect.

Importance of inviting IRRS missions

National legislation requires openness and transparency and the implementation of periodic self-assessments. For example, the ASUNE requires that BNRA shall perform a self-assessment of national legislative and regulatory infrastructure and shall invite an international peer review, at least once in 10 years.

Governmental commitment for periodic international peer review is implemented through the invitation of an Integrated Regulatory Review Services (IRRS) Mission to Bulgaria, which is already agreed for April 2013. The mission questionnaire also includes modules, which address issues in the light of experience from the Fukushima Daiichi accident. Invitation of an IRRS Mission and the respective implementation of mission findings, review and verification of corrective actions effectiveness by a follow-up IRRS is included in measure N-2-1 in *Attachment 2*. IRRS Mission results will be disclosed and disseminated in line with the BNRA principles of transparency and publicity.

Review and improvements to aspects of National EP&R

Analysis of the organizations and their interaction showed that Bulgaria has the necessary institutions for the formation and implementation of national policy on nuclear safety, for the implementation of state regulation and control, as well for emergency response. Responsibilities and functions are clearly defined and distributed among various agencies and other interested organizations.

Topics related to periodic emergency exercises and drills, training of intervention teams, establishment of rapid intervention team to provide support to sites, international agreements, use of regional centres, as well as education of the public and the media in aspects related to emergencies are covered under topic 5. No actions were planned under this sub-topic.

Openness, transparency and communication improvements

BNRA uses several channels and mechanisms, as web page, media, formal letters and Annual Report to provide all necessary information to the public. Actual information about regulatory requirements, BNRA activities, opinions, decisions and news is available on the regulatory body web page. When there is a need for urgent dissemination of information, BNRA sends press releases via e-mails, phones and faxes (available database) to journalists. BNRA periodically organizes press conferences or briefings and BNRA representatives participate in TV and radio broadcasts. Additionally, BNRA organizes training seminars for the media, where public needs of information and its clearness are discussed.

The ASUNE requires licensees to inform the public about possible radiation risks associated with the facilities and activities. These obligations are further developed in the Regulation on Notification, according which licensees shall inform the public about deviations, incidents and accidents in nuclear facilities or sites with sources of ionising radiation, through the media, internet or in any other adequate way.

Concerning international bilateral cooperation, BNRA has planned review of its bilateral agreements which is included under measures EO-1-1, EO-1-2, EO-1-3 and EO-1-4 in *Attachment 3*.

Post- Fukushima safety reassessments and action plans

Immediately after the Fukushima Daiichi accident, the Bulgarian Government requested urgent actions to reassess Kozloduy NPP preparedness to respond to emergencies and respectively BNRA specified the areas for review and verification of the conditions of SSC, which provide protection and monitoring in extreme external events. Identified issues were included in an Initial Action Plan.

Later on, country took part in the EU "stress tests" as targeted reassessments of NPP safety margins. No additional actions are planned under this sub-topic.

Human and organizational factors

Analyses show that there is Governmental commitment for further development of the country human resource capacity and competence. The legislation requires assessment of human and organizational factors and safety culture and their continuous improvement.

Involvement of sub-contractors in the emergency response arrangements will be assessed as part of measures EP-1-1 and EP-1-2 in *Attachment 3*.

TOPIC 5 – EMERGENCY PREPAREDNESS AND RESPONSE

At the national level Unified Rescue System is established to protect people from disasters. An integral part of this system is the emergency preparedness and response to nuclear or radiological emergencies. Disaster protection is implemented at national, regional (provincial and municipal) and on-site level and at the international level through mechanisms for request (provide) assistance.

National legislation specifies the principles, criteria and procedures for maintaining emergency preparedness and response in case of incidents and accidents with radiation consequences. The infrastructure to support emergency preparedness and emergency response complies with the criteria laid down in EU legislation and the IAEA in this area.

After the accident at the NPP Fukushima Daiichi an analysis of the system for emergency preparedness and response has been performed. As a result of this analysis update of the regulations in the area of emergency preparedness and response and on-site and off-site emergency plans has been done. After completion of the relevant activities of NAcP an updates of on-site and off-site emergency plans is planned.

Expansion of the set of scenarios on which the plan was based – NPP PLUS Infrastructure / NPP PLUS chemical plant

After the Fukushima-Daiichi NPP accident, analyzes has been made on the severe accidents and the results demonstrated the need of broadening these scenarios as well as inclusion the accidents occurring simultaneously on all site facilities in combination with natural disasters. Measures EP-1-1 and EP-1-2 are planned in *Attachment 3*.

Increasing the scope of off-site exercise programs to reflect NPP plus external infrastructure simultaneous problems

Off-site drill programmes, based on the Off-site Emergency Plan and the scenarios included there, are developed on national levels. The changes of the Off-site Emergency Plan provide for expanding the off-site drill programme scope, covered by the implementation of Measure EP-1-1 in *Attachment 3*.

Use of mobile resources into planning and drill programs

The emergency plans of all levels (national, district, municipal and site) plan to use mobile resources. Within the Ministry of Interior system (fire safety and civil protection departments) there are 28 mobile labs located in each of the 28 districts as per the territorial division of the country. BNRA, MEW and MH have mobile labs, including ones for whole body counting (MH). The Operator also has a mobile laboratory. All mobile resources are covered by the Emergency Training Planning and Exercise Conduct Programmes**.**

No need of taking additional actions in this field.

Exceptional increase of the need of emergency training, conducted jointly with the neighbouring countries

Republic of Bulgaria has concluded bilateral agreements with the neighbouring countries - Greece, Macedonia, Rumania, Turkey and Serbia (in the process of preparation) on cooperation in the field of nuclear safety and radiation protection. Within the framework of the bilateral agreements emergency training is periodically conducted jointly with the neighbouring countries and they finish with conduct of exercises. Examples for such activities are the exercises that have been conducted since 1992 to now with, for example, Turkey – 2 exercises, Romania – 4 exercises, Greece – 2 exercises, Macedonia – 2. Regional exercises were conducted with the participation of the countries from the region, as the Black Sea Exercise - 2 exercises, etc.

No need of taking additional actions in this field.

Exercising all interface points (national, regional, municipal, …)

For nuclear facilities annually a full scope emergency exercise, covering all interfaces is conducted. The largest possible numbers of executive authority representatives, responsible for implementation of the off-site emergency plan take part in that exercise. Thus achieve synergies between national, regional, local and on-site emergency response structures.

There is no need of taking additional actions in this field.

Performing of longer term exercises to reflect the challenges of extreme events

Long-term exercises are periodically conducted in Bulgaria. One of the objectives of these exercises for the national and district response structures, longer than 24 hours, is to test the capability of the teams to work for long periods in extreme event conditions and sustainability of work at emergency response team replacement.

There is no need of taking additional actions in this field.

Improvement of radiation monitoring and communication system by additional diversification/redundancy

- *Radiation Monitoring*

In the Republic of Bulgaria, radiation monitoring is conducted by 5 institutions:

- The MEW Executive Agency maintains the National Gamma Background Monitoring System (BULRaMo);
- The National Centre on Radiobiology and Radiation Protection to the MH performs measurements of the gamma background;
- Directorate General Fire Safety and Civil Protection to the Ministry of Interior performs measurements of the gamma-background in 363 posts located at the territory of the country ;
- Kozloduy NPP performs measurements of the gamma background on the site and within the precautionary action planning zone with the Automated Information System for Off-site Radiation Monitoring (AISRM) which is united with the BULRaMo system;
- The Institute on Nuclear Research and Nuclear Energy to the BAS measures at the Mussala Mount (Rila Mountain), and on the territory of the institute and, at the site of the research reactor.

The results from the measurements are daily published on the Internet website of each of the mentioned organizations and summarized on the Internet web site of the BNRA. The radiation monitoring systems of the different organizations are different and independent of one another and redundancy of monitoring is secured.

After the Fukushima accident, the operability of BulRaMo system was analyzed and the need of its upgrading was identified. Measure EP-1-4 in *Attachment 3* was envisaged in result of that analysis.

- *Communications*

Republic of Bulgaria has a real experience in using communications gained during emergency exercises and in response to real emergencies. According to the national legislation, communications are provided by the Minister of transport, communications and information technologies. The Ministry of Interior uses the TETRA system to provide communications of emergency teams – this system is different from the one provided by the Ministry. Redundancy of connections is ensured in this way.

There is no need of taking additional actions in this field.

Development of a common source term estimation approach

In assessing the radiological consequences performed by the operating organization and the BNRA unified source term data are used. The determination of the quantity and the isotopic composition of the source is performed by the operating organization and provided to the BNRA. The calculated projected doses are provided to the National Headquarter in accordance with the Off-site Emergency Plan. Measure EP-2-1 is planned to facilitate the connection between the operating organization and BNRA in radioactive source assessment.

Provide access to a “big picture” (international picture) of radiological conditions

Republic of Bulgaria has ratified the Convention on Early Notification of a Nuclear Accident, and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency. During an emergency, the released information contains a lot of data, described in the Convention on Early Notification of a Nuclear Accident, and in the Ordinance on Emergency Planning and Preparedness in case of a nuclear accident and radiation emergency. Data are provided and respectively received through the Emergency Information Exchange Systems - IAEA USIE and ECURIE of the EU. By fulfilling the requirements of the convention and the EU Decisions, Bulgaria provides access of national and international organizations to the full picture of the emergency radiation situation.

There is no need of taking additional actions in this field.

Development of reference level for trans-border processing of goods and services such as container transport

Bulgarian legislation has established operational levels of intervention in identifying the level of contamination with radioactive substances. These levels are regulated in the Regulation, issued by the Minister of Health, on the terms and conditions for medical provisions and health limits for protection of people in case of a radiation accident.

There is no need of taking additional actions in this field.

Re-examination of approach and associated limits to govern the "remediation" phase

According to the off-site emergency plan, Long-term Protective Measure Teams are formed to the National Coordination and Communication Headquarter. The objective of these teams is to take actions and implement measures to recover the affected areas, and decontaminate in great scopes and duration. Case by case approach is applied during the recovery phase.

There is no need of taking additional actions in this field.

Develop criteria for the return to evacuated area and criteria for return to normal from emergency state

The criteria for returning to the evacuation area are specified in the Ordinance on emergency planning and emergency preparedness in the event of nuclear or radiation accident on the basis of the annual effective dose for the public. Limitations are identified in dependence on the value of the dose.

There is no need of taking additional actions in this field.

Improvement of the approach to establish contamination monitoring protocols and locations during the recovery phase

The environmental monitoring mobile labs measure the radiation parameters and completed a standardized protocol forms. These protocols are sent through the GPRS to the National Headquarter via the Emergency Management Centre and BNRA Emergency Centre.

There is no need of taking additional actions in this field.

Hardening of support infrastructure (Emergency Response Centres, Sheltering facilities, essential support facilities (like Corporate Offices) with back-up power, environmental radiological filtering, etc.

The Emergency Response Centre and sheltering facilities located within the emergency planning zone are equipped with independent power supply and independent filter ventilation system. Measure EP-1-3 foresees the construction of off-site ERC, protected from external, including radiological impacts.

Support infrastructure located outside the emergency planning zone has emergency power supply. Analysis shows that it is not expected to reach radioactive contaminations and radiation doses requiring radiological filtering.

There is no need to take further action in this area.

Analyzing medical and human aspects of response to support Emergency workers

The Minister of health analyzes the medical and human aspects of response in support of emergency workers. The On-site Emergency Plan identifies the hospitals, their accommodation capacities and needed medicines and care for individuals exposed in nuclear or radiation accidents. The Off-site Emergency Plan describes the routes for medical evacuation. In case of need, international humanitarian aid is requested following the established procedure**.**

There is no need of taking additional actions in this field.

Implementation of processes to enable access to inter-country support including customs processes for access for diplomats and emergency response personal

Republic of Bulgaria has actual experience in rendering international support in case of disasters. Bulgaria has ratified the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency. Following the requirements of the convention, the order of requesting/rendering support in case of a nuclear or radiation emergency is stipulated into the Off-site Emergency Plan. There is an established practice of preliminary preparation of documents and technical equipment of the rescue team which covers procedures for easy crossing of the frontier and customs and frontier clearance.

There is no need of taking additional actions in this field.

Systematic assessment of all aspects of organizations that contribute to emergency response using tools like job and task analysis

The national legislation stipulates the activities and tasks of all organizations that are bound to respond in case of a nuclear or radiation emergency. The Off-site Emergency Plan specifies in details the activities and tasks of these organizations and covers the estimation of the powers and equipment for the implementation of the activities, and the time schedule as well. In the process of off-site emergency plan updating, the activities and tasks of the involved organizations are evaluated. The evaluation is based on the experience gained in the conducted exercises and response in actual emergencies. The established shortcomings and omissions are removed by introducing changes into the off-site emergency plan.

There is no need of taking additional actions in this field.

Develop radiological reference levels for rescue and emergency response personnel in extreme events

The Instruction, issued by the Minister of the Interior, identifies the order of implementation of urgent emergency and recovery actions and the dose limits for emergency team members (rescue staff and emergency responders). The values of the total effective dose (mSv) and radioactive iodine dose for external exposure (mGy) are identified for each type of activities.

There is no need of taking additional actions in this field.

Develop reference levels for the application of immediate countermeasures such as sheltering, iodine distribution and evacuation

The reference levels for application of prompt counter measures as sheltering, iodine prophylaxis, and evacuation are regulated in the Regulation, issued by the Minister of Health on the terms and conditions for medical provisions and health limits for protection of people in case of a radiation accident are defined by the values of the averted doses.

There is no need of taking additional actions in this field.

TOPIC 6 - INTERNATIONAL COOPERATION

One of the lessons learned from the Fukushima Daiichi accident brought to the foreground the importance of the exchange of information in crisis situations. The various existing mechanisms up to this point in this field in each country and in particular in the countries with nuclear programmes, were subjected to reassessment and analysis with regard to their efficiency. The significance of this issue was assessed at a high international level and it was included for discussions as a separate topic in the Second Extraordinary Review Meeting of CNS. The interaction and the exchange of information between the countries, the Operating organizations and the respective NPPs in operation at a multilateral, regional and bilateral level were reviewed in a new light. Several main groups of measures stemmed from this are aimed at reinforcement of the already established international cooperation and the undertaking of additional initiatives.

Strengthening the peer reviews process of CNS and of IAEA and WANO missions

Lessons learned from operating experience of a single country and its ability to maintain a high level of safety, including using a mechanism to overcome or reduce the occurrence of unwanted effects contribute to improving safety in other countries. Periodic self-assessment and accompanying peer reviews are a form of international cooperation aimed at achieving this goal. Traditionally Bulgaria has been a host to such forms of cooperation under operational and under the regulatory practices.

Bulgaria shares the opinion that in the future CNS national reports information should be included with regard to the peer review missions performed, the findings and the results of these missions. With regard to the strengthening of the CNS peer reviews process and of the IAEA and WANO expert missions the following measures have been planned EO-2-1, EO-2-2, EO-2-3, EO-2-4, EO-2-5, EO-2-6, EO-2-11, EO-2-12, EO-2-13, EO-2-14 and N-1-1, which have all been indicated in *Attachment 3*.

Optimization of the global safety regime

Bulgaria shares the view expressed at the Second Extraordinary Meeting of the CNS that the growing number of international meetings, assessments, peer reviews and expanding mandates is placing high demands on existing human resources, which may become counter productive. In the period of 1991 - 2012 Kozloduy NPP was subject to over 20 international reviews organized by the IAEA, WANO and EU. The necessity of optimization of the reviews, of reduction of the duplication of topics and initiatives is obvious and this is one of the main tasks of the managers of these organizations. At the same time the concurrence of the future reviews with the Operating organization would be beneficial for the general preparation and for achieving the goals set.

No specific measures are planned under this item.

Strengthening communication mechanisms through regional and bilateral cooperation

Cooperation agreements on a bilateral or multilateral basis are a very important mechanism for connection with the international community. This mechanism is quite popular and appropriate for maintaining cooperation relationships with neighbouring or close states.

After the Fukushima Daiichi accident, the NRA performed an analysis of the existing cooperation agreements concluded by the Republic of Bulgaria with almost all neighbouring countries. In respect of improving the interactions in case of regional crisis, initiatives were undertaken for

preparation and signing new agreements on Regulatory Bodies level. These activities are addressed as measures EO-1-1, EO-1-2, EO-1-3, EO-1-4 in *Attachment 3*.

Kozloduy NPP on their part undertook measures to increase the efficiency of the activities and the information exchange between the Operating organizations in case of crisis situations, which is addressed in measures EO-2-7 and EO-2-8 in *Attachment 3*.

In addition, within the frames of interaction with the IAEA under the Technical Cooperation Programme, the NRA presented a national project related to the strengthening of its activity in the field of emergency planning and preparedness - measure EO-1-5 in *Attachment 3*.

Effectiveness of experience feedback mechanisms

The main tools for sharing operational experience feedback are located mainly in the cooperation with the respective structures of IAEA, EU, OECD, WANO and on a bilateral basis. After the Fukushima Daiichi accident at every single conference held under the aegis of these organizations such issues were discussed and specific problems were reviewed, stemming from the development of the accident.

The Forum of the regulators from the countries operating WWER reactors is a part of this system. Regular participation is planned at its annual meetings - measure EO-1-6 in *Attachment 3*. Regarding the Operating organization participation in the regular conferences for the Chief Engineers of NPPs with WWER reactors is also planned where the lessons learned from the accident are discussed - measures EO-2-10 and EO-2-16 in *Attachment 3*.

Strengthening and expanded use of IAEA Safety Standards

Significant part of the IAEA Safety Standards have been incorporated in the Bulgarian legislation. The Government policy is to observe and apply the requirements of the international documents, including the ones related to nuclear safety and through the National Act on Regulations to perform the procedure for their transposition within the national legislation. When it is necessary to introduce changes in the regulations in the field of nuclear and radiation safety, the leading safety requirements of the IAEA are always reviewed and considered. Meanwhile it is a standard practice and approach in the licensing process for the NRA to monitor whether the licensee (or the applicant) justifies safety by observing the internationally acknowledged practices addressed in the IAEA standards. This way the regulator should be convinced of the operator's capability to maintain high safety level. Bulgaria is also committed to transpose within the state legislation the reference safety levels developed by WENRA.

Specific measures for implementation under this item are not planned.

PART III – ADDITIONAL MEASURES AND ACTIONS

1. Recommendations ensuing from the ENSREG Peer Review

In the beginning of 2012, an ENSREG Peer Review was conducted to assess the results of plant stability analyses and improvement measures planned after the Fukushima Daiichi accident.

The peer review report provides the following recommendations, which have been addressed in topics 1 through 3 and are included in *Attachment 1* of the plan:

- The Kozloduy NPP considers delivering of the two additional mobile generators. As long as these mobile generators will be considered for beyond design basis events, they should be adequately protected for such events. – included in measure A-1-1;
- To perform a consolidated review of extreme weather hazards in line with IAEA guidance and development of a plan to monitor identified improvements - included in measure E-1;
- The issue of the management of large volume of liquid releases in the event of a severe accident should be investigated further - it should be evaluated whether the available provisions would be adequate - included in measure D-3-6;
- The consequences of possible adverse effects of earthquakes to the national infrastructure for severe accident management should be further investigated - included in measure A-3-1;
- Simultaneous core melt/fuel damage accidents in different units/installations at the site should be further investigated and assessed regarding interactions and the resulting special requirements that would arise for severe accident management - included in measure D-2-7;
- SAMGs fully covering shutdown states, including those with open reactor, should be developed - included in measure D-2-6;
- Accidents in spent fuel pools should be analysed in detail (for example, as part of the planned activity on the SAMGs SFP development) - included in measure D-2-6.

2. Operator's activities as per the WANO programme

In order to share and apply international operational experience to enhance nuclear safety, KNPP actively participates in the WANO International Cooperation Programme. The activities and events under this programme at the Moscow WANO Centre are listed in *Attachment 3*:

- Support the process of WANO peer reviews and missions (EO-2-5);
- Optimize coordination between operators and the WANO Regional Centre in Moscow (EO-2-1, EO-2-2, EO-2-3);
- Initiatives related to the Regional Crisis Centre of WWER reactor NPP operators, implemented by the Moscow WANO Centre (EO-2-7);
- Exchange of information and feedback among the operators through different forms of communication – workshops, working meetings, technical support missions, suggestions, and analyses (EO-2-6, EO-2-10, EO-2-11, EO-2-12, EO-2-13, EO-2-15);
- Improve communication mechanisms through regional and bilateral co-operation (EO-2-8).

PART IV - UPDATING OF THE NATIONAL ACTION PLAN (NACP)

RESPONSES/CLARIFICATIONS OF THE ISSUES IDENTIFIED IN THE RAPPORTEUR'S REPORT FROM THE 2013 WORKSHOP

A peer review workshop on the progress of implementation of the national action plans of the EU member states was carried out in April 2013 in Brussels. The implementation of the following measures was reported by each of the member states: Topic 1 - External initiating events; Topic 2 – Loss of safety systems and Topic 3 - Severe accident management, as well as the additional measures resulting from the ENSREG Peer Review Report. Findings and conclusions were drawn from the NAcP implementation of each country.

Regarding the NAcP of Republic of Bulgaria, the Report stated that the Bulgarian Action Plan covered all topics expected by ENSREC and described the implementation status of each topic by identifying additional measures, where appropriate. Several good practices were identified as follows: Development of a programme for the review and updating of regulatory requirements in the light of the lessons learned from the Japanese Fukushima Daiichi NPP accident; Plans for additional data in the Probabilistic Safety Analyses of the Kozloduy NPP site, covering the extreme weather conditions and events in compliance with the IAEA methodology; consideration of real conditions and combinations additionally to the regular field walk downs to check room conditions and equipment associated with the Severe Accident Management Guides.

A. Clarification of some of the Republic of Bulgaria Report Findings

The following findings were made in the Republic of Bulgaria Report that require clarification in this Updated NAcP:

- *Some of the measures and activities identified in the NAcP are quite comprehensive and, in fact, cover several more basic activities:*

That finding is correct since the NAcP plans the basic activities and measures. Each measure or activity is broken down in the detailed programme of operating organization Kozloduy NPP plc by identifying different stages and terms for its implementation. Thus the comprehensive Measure A-1-1 "Supply of two additional MDGs for Units 5, 6" covers 15 separate stages with respective implementation terms. For instance, those stages cover: supply of two MDG of appropriate technical characteristics; selection of the MDG sites and access routes; upgrading of some of the facilities along the access routes; provision of electric connections of the MDSs to respective switchgears; development of an instruction for connection to the units; development of an instruction and schedule for periodic tests and maintenance; design and mechanical substantiation of the needed electric, Instrumentation and Control (I&C), and process connections to provide MDG power supply, etc. The operating organization refers to each implementation stage and term for the respective measure or activity in its Quarterly Report on the NAcP Implementation. In some cases several new measures or activities originate from one comprehensive measure or activity and it is respectively identified in the Updated NAcP.

- *The internal deadlines are not identified in the document (NAcP).*

The BNRA believes that it is not expedient to provide the different stages and terms for the implementation of each measure or activity in the Updated NAcP to avoid excessive detailing. Nevertheless, those stages and terms are strictly monitored by the BNRA NAcP Task-force group and the BNRA inspectors. The cases of delayed stages are reported to the operating organizations within the scope of the Quarterly Report and that issue is respectively discussed on the next regular meeting of the BNRA NAcP Committee and possible measures to overcome the delay are identified.

- *Retain of WWER-1000 melted reactor core is analysed within the international cooperation framework and the issue can be resolved only upon the completion of those analyses.*

The NAcP involves Measure D-3-5: "Study the possibilitiesfor molten core retention in case of severe accidents ", currently under implementation. The first stage of the measure results in the development of a summary report on the outcomes of the seminars and meetings on this issue conducted in 2013 to cover an analysis of the possible concepts for melted core retention and their feasibility assessment. A Summary Report is developed on the outcomes from the three workshops that have been conducted (the first was a WANO Workshop, the second - within the programme of the Annual Conference of the Bulgarian Nuclear Society, and the third one was in connection with the 7th Framework Programme of the European Commission).

The three Workshops were focused mainly on the IVR (In-Vessel Retention) strategy as an alternative to the ExVR (Ex-Vessel Retention) strategy.

It is necessary at this stage to proceed with the efforts to analyse this issue within the international cooperation framework and the involvement of the WWER-1000/B-320 reactors Main Designer. For the time being no specific strategy for the development of this measure has been chosen. The term for the implementation of this activity is by the end of year 2017 when the results from the analyses and studies on the melted core retention concept selection shall have been available. Other measures under the NAcP associated with the implementation of either core retention concept are implemented in parallel. Measure D-3-3 "Implementation of a project for plugging of the ionization chamber channels located in the walls of the reactor vessel cavity" is completed. In the frame of this project protective plugs of high temperature resistant material block the path of molten corium to the vulnerable places on the floor of the containment structure thus preventing melt-through and early containment by-pass.

B. Implementation of the challenges set in the ENSREG Summary Report from the Workshop for Peer Review, of the National Action Plans, April 2013

The ENSREG Summary Report of the Peer Review Workshop in April, 2013, comprise the challenges to the counties specified during the workshop. The challenges to the NAcP of Bulgaria were considered during the development of the Progress Report on NAcP implementation. The report was published and submitted to ENSREG in January, 2014.

PROGRESS ON IMPLEMENTATION AND UPDATE OF THE NACP

The implementation status of the Updated NAcP at the end of December 2014 is given below.

The Updated NAcP comprises totally 77 measures (Attachments 1, 2, 3 and 4), of which:

- 48 Measures (62.3%) are completed;
- 29 Measures (37.7%) are .under implementation

Implementation status of the measures at Site level

Out of 59 Measures at Site level under Parts I, III and IV (Topics 1-3, Additional Activities, and New Measures and Activities,):

- 38 Measures (64.4%) are completed;
- 21 Measures (35.6%) are under implementation.

Implementation status of the measures at a National level

Out of 18 Measures under Part II (Topics 4-6: National Level):

- 10 Measures (55,6%) are completed;
- 8 Measures (44,4%) are under implementation.

Kozloduy NPP plc has proposed a change of the implementation terms of 7 Site Measures with a sound substantiation of each new deadline.

The most common reasons for change of terms of respective measures and/or proposal of new measures are as following:

– Extension of the measure scope.
– Planning of new activities as a result of completed analyses and studies.
– Transformation of comprehensive measures into several separate activities with implementation terms.
– Administrative issues arising from procurement procedures.

MAIN CHANGES IN THE NACP SINCE THE 2013 WORKSHOP WITH JUSTIFICATION

The NAcP was firstly revised in January, 2014 to incorporate the current status of the measures at that moment. Ten (10) new (additional) measures were added as a result of completed studies and analyses within the scope of the Action Plan.

Traceability of NAcP changes and additions is ensured by identifying the new measures with index F, followed by the index of the initial measure from which it originates, and an order number. Thus, the following 4 (four) groups of new measures are set up:

- **Group FA** - Provision of alternative possibilities for residual heat removal;
- **Group FB** - Measures to prevent flooding and mitigation of their consequences;
- **Group FC** - Measures to improve stability in case of a loss of ultimate heat sink;
- **Group FD** - Measures to improve the capabilities for severe accident management.

The current Updated NAcP:

– covers the measure implementation status as of December 2014 by keeping the same structure of the groups of measures,
– follows their development in time,
– describes the implemented modifications and clarifies the reasons for them.

For the period of one year after the last update four (4) new measures were added as a result of completed studies and analyses. The list, given in *Attachment IV*, covers a total of 14 new measures.

Below follows a review of the NAcP changes made after the 2013 Workshop, indentifying also the reasons for that changes.

Area A - Seismic Upgrading Measures

Measure A-1-1: Supply of two additional MDGs for units 5&6

The comprehensive Measure A-1-1 involves 15 different activities, associated with the supply of two additional 0.4 kV MDG that were completed within the scheduled terms.

To provide a more effective and interchangeable usage of the MDG that are available on the site (one 6 kV MDG and two new 0.4 kV MDG) in case of loss of on-site and off-site power supply, the implementation of additional design solutions and activities is envisaged. That called for planning of 4 new measures in Group FA as follows:

FA-1-1-1, related to the implementation of provisions to connect the 6 kV MDG to the reliable power supply cabinets, and scheduled for November, 2016;

FA-1-1-2, intended for implementation of provisions for charging the batteries of the safety systems by the 0,4 kV MDGs, and is to be completed by November,.2016

FA-1-1-3, aimed at seismic upgrade of the air passageways between the buildings to ensure the access routes of the MDGs – to be completed by November, 2016;

FA-1-1-4 is for construction of bunker buildings for MDG sheltering and is scheduled for October 2015.

Area B - Measures to improve stability against flooding

Measure B-2-2: Development of measures to prevent water intake in the plant sewage network in case of valley flooding

A Conceptual Design was developed within the scope of measure implementation and it considers three options for protection against flooding. The selected concept is based on tanks with mobile pumps for sewage water retain. The measure is completed with the development of a detailed design for the implementation of the selected option. The activities under the implementation of the measure are performed under the scope of a new Measure, FB-2-2-1, for implementation of provisions to prevent water intake into the plant sewage when the valley is flooded.

Measure B-2-3: Modernisation of the sewage network and drain pump system

That measure was initiated within the scope of an existing project for sewage network and drain pump system reconstruction which initially was scheduled to complete on 30.10.2013. The activities cover development of a terms of reference for civil and installation works, supply of equipment and performance of activities. Due to some problems with the equipment supply, the technical specification was revised and the final completion date was shifted by 30.11.2015.

Measure B-3-1: Improvement of the operational condition and the protective functions of the state dike in the region of the Kozloduy valley

The flooded terrace of Kozloduy valley, including the area situated between Kozloduy NPP site and the Danube, is protected against the high water levels of the Danube by an earth fill dike. Additional inspection of the dike was initiated after the Fukushima NPP accident to identify activities for improving its operational conditions and protective functions. Initially actions were taken in the dike section just opposite the Kozloduy NPP site within the deadline stipulated in the NAcP. Subsequently the necessity of improving the operational conditions of the two adjacent sections of the Danube dike was assessed because of eventual impact on the NPP facilities. To provide time for completion of the activities, the implementation term of the measure was extended to December, 2014.

Area C - Loss of safety systems

Measure C-2-4: Analysis of the possibility to install an alternative water cooling system with an independent power supply in the SFSF

The scope of the Measure covered conduct of analysis and development of conceptual design for two different options. The chosen concept employs a cooling system with one cooling unit and an air-cooled condenser.

The implementation of the measure was completed by the end of 2013 with development of a preliminary safety case for the selected design option.

The revision of the National Action Plan from January, 2014, established a new Measure FC-2-4-1 Installation of an independent cooling system in the SFSF.

Area D - Severe Accident management

Measure D-1-1: Review of the KNPP on-site and off-site emergency plans to consider the possible effects from physical isolation due to external hazards:

- ***impeded access to the Units 5, 6 ECRs;***
- ***possible draining of the spent fuel storage sections at the SFSF followed by increase of the dose rate;***
- ***provision for alternative routes for evacuation, transport of necessary fuels and materials to the plant, and operational staff access.***

The on-site Emergency Plan of Kozloduy NPP was reviewed to consider the possible effects of the physical isolation of the site caused by external hazards, and to incorporate the results from the conducted emergency drills. The assessment completed under Measure A-3-1 of possible damage of the regional road infrastructure concluded with identification of a redundant route to ensure access of equipment, supplies and emergency response staff to the plant. Respective parts of the Emergency Plan were updated in 2014.

After the completion of the full-scale national exercise "PROTECTION 2014" on a scenario with severe accident occurring simultaneously on the two nuclear units, it was concluded that further change of the on-site emergency plan is not needed.

Regarding the review of the off-site emergency plan, the related activities are implemented under Measure EP-1-1 untill the end 2015.

Measure D-1-2: Construction of KNPP off-site Emergency Response Centre (ERC)

Initially the completion was scheduled for December 2016.

The off-site emergency response centre of a bunker type is currently being designed. The building will be situated in the town of Kozloduy over an area of 2100 square metres and specific complex underground part of about 1500 square metres. Therefore the construction works will require a longer implementation period. Having in mind the need of coordinating the project with a large number of external organizations for the purposes of assignment and implementation of the detailed design, the final completion date of the measure was shifted for December 2017.

Measure D-2-4: Develop technical means to provide direct injection of water to the reactor core, SGs, spent fuel pool and the containment by mobile fire protection equipment in extreme conditions

Measure D-2-4 was detailed in the initial revision of the NAcP and scheduled for completion by the end of year 2014, having four different activities which required specific studies and design work. Following the NAcP review in December 2013, a decision was made to split it into three new measures because of the specific activities in each of them:

Measure FD-2-4-1, related to the installation of an additional pipeline to the spent fuel pool cooling system to allow cooling the spent fuel by mobile means. The completion of the measure was initially scheduled for November, 2014, but due to delay in the equipment supply, the deadline was extended with one year - by November, 2015.

Measure FD-2-4-2 Study the feasibility of direct water injection to the reactor core from an external source

Measure FD-2-4-3 Feasibility study of direct water supply to SGs from an external source.

The part of the measure, associated with the analyses and studies on the possible means to supply water to the containment, is incorporated into Measure D-3-5 with the respective completion date.

Measure D-2-5: Develop technical means to provide direct injection of water to the SFSF by mobile fire protection equipment in extreme conditions

During the implementation of the measure, a pipeline is designed to directly inject water into the SFSF sections by the means of diesel pumps of the fire protection pump station or from a fire engine. The design was completed in the scheduled scope and term. The following new measure is envisaged for the implementation of the project:

Measure FD-2-5-1 Installation of pipeline for direct water supply to the SFSF pools from a mobile source.

Measure D-2-6: Extension of the scope of SAMGs - for the spent fuel pools and for specific reactor shutdown states, not covered by the current SAMGs

The Measure was scheduled for completion on 31.12.2014. Currently verification and validation activities of the developed guides are going on and training of staff on how to use them. The deadline for measure completion and implementation of the new SAMGs is extended to 31 July 2015.

Measure D-2-8: Analysis of the possible deterioration of operational parameters due to a high contamination level (in certain zones) and equipment failure on-site (including the impact on accessibility and habitability of the MCR and the ECR)

The measure was completed within the initially scheduled term - the end of year 2014. The phenomena associated with the late phase of severe accidents and relocation of the molten core to the containment premises and Reactor Building were analysed. The airborne distribution pathways were assessed and gamma –background was evaluated. It was identified that at a certain moment the MCR habitability criteria might be exceeded (fixed as 1 mSv/h) and then the operators shall move to the ECR to manage the accident.

The following 4 (four) new measures are planned to implement the actions following the analysis on the radiation situation in the MCR and ECR during severe accidents:

Measure FD-2-8-1 Prevention of airbourne release to the MCR in the event of a severe accident by implementation of a set of organizational and technical measures.

Measure FD-2-8-2 Modifications of SAMGs and electricity supply recovery procedures from MDG to ensurerestarting of the ventilation systems for recirculation and air filtration in the MCR.

Measure FD-2-8-3 Instructions on the evacuation of the MCR staff to the ECR upon reaching the dose limit of 1mSv/h shall be added to the SAMGs.

Measure FD-2-8-4 Prevention of airbourne release to the ECR in case of a severe accident by replacement of the corridor doors with gas tight ones.

Measure D-3-2: Installation of measuring channels to monitor and evaluate the concentration of steam and oxygen in the containment

The measure was scheduled in the first revision of the NAcP for June 2014, however this time period is insufficient for completing the activities on the development of a conceptual design, detail design, equipment manufacturing and implementation of the planned changes. In this connection a decision was taken to extend the measure untill 31 December 2016.

MeasureD-3-5: Study the possibilitiesfor molten core retention in case of severe accidents

The term for implementing the measure is 2017. When revising the NAcP in December 2013 a part of Measure D-2-4 was incorporated in the scope of Measure D-3-5, related to ensuring the possibility for direct injection of water to the reactor core by mobile equipment in severe accident conditions.

Area F - New measures, resulted from studies and analysis

Field FA - Provision of alternatives for residual heat removal

As a result of the extention of the scope of measure A-1-1 with additional tasks, 4 new measures are defined:

Measure FA-1-1-1 Implementation of provisions to power the reliable supply cabinets from 6 kV MDG

Measure FA-1-1-2 Implementation of provisions for charging the batteries of the safety system trains from 0,4 kV MDGs.

Measure FA-1-1-3 Seismic upgrade of the overhead passage-wayss between Auxiliary Building and the Reactor Buildings of Units 5&6.

Measure FA-1-1-4 Construction of buildings for the MDGs sheltering.

Field FB - Measures to prevent and mitigate the consequences of floods

As a result of the completion of the study under Measure B-2-2 a new activity is planned:

Measure FB-2-2-1: Implementation of provisions to prevent water penetration into the plant sewage when the valley is flooded.

Field FC - Measures to improve stability in case of a loss of ultimate heat sink

As a result of the analysis performed under Measure C-2-4 a concept for alternative independent cooling of the spent fuel in the SFSF was chosen and planned for implementation by the following new measure:

Measure FC-2-4-1 Installation of an independent cooling system in SFSF.

Field FD - Measures for improving the capabilities for severe accident management

The following 3 new measures are specified aimed at optimization of the activities and improvement of the capabilities for severe accident management:

Measure FD-2-4-1 Installation of additional pipeline to the spent fuel pool cooling system for back up from an external source

Measure FD-2-4-2 Feasibility study of direct water injection to the reactor core from an external source

Measure FD-2-4-3 Feasibility study of direct water supply to SGs from an external source

The feasibility study and engineering of alternative water supply to the SFSF, in the scope of Measure D-2-5, resulted in the planning of a new measure:

Measure FD-2-5-1 Installation of pipeline for direct water supply to the SFSF pools from external source (diesel pumps or fire truck).

The following 4 new measures were defined as a result of the conducted analyses and studies for Measure D-2-8:

Measure FD-2-8-1 Prevention of airbourne release to the MCR in the event of a severe accident by implementation of a set of organizational and technical measures.

Measure FD-2-8-2 Modifications of SAMGs and electricity supply recovery procedures from MDG to ensurerestarting of the ventilation systems for recirculation and air filtration in the MCR.

Measure FD-2-8-3 Instructions on the evacuation of the MCR staff to the ECR upon reaching the dose limit of 1mSv/h shall be added to the SAMGs.

Measure FD-2-8-4 Prevention of airbourne release to the ECR in case of a severe accident by replacement of the corridor doors with gas tight ones.

A list of the new measures with their implementation terms and connection with the measures they derive from is available in a tabular format in *Attachment IV.*

TECHNICAL BASIS LEADING TO THE MAIN CHANGES IDENTIFIED IN THE NAcPs

The design and implementation of provisions for management of the dynamic processes in case of severe accident are often associated with some challenges to the operating organization, designers and contractors, especially when exising plants are concerned. These challenges arise mostly due to:

- lack of standards;
- need for additional activities to resolve the conflicting points between the severe accident provisions and the design bases,;
- need for optimization of the functions of the new technical provisions so that they cover the whole spectrum of severe accidents;
- need for qualification of the relevant technical provisions for severe accidents.

The integrated implementation of the comprehensive package of measures from the NAcP depends on the interface between the particular measures as well as on the current operational state of the NPP. This sometimes leads to a reassessment of the plans and terms for implementation and consideration of particular measures

Measure D-2-4 for example is divided now into 4 new measures because they concern different facilities – SFP, Reactor, SGs, Containment. This results in different relatively independent technical approaches for the implementation of the activities. The practical issue with these measures is to find and/or to construct new appropriate technological lines for incorporation to the relevant facility.

On the other hand the activities of Measure D-2-4 and the resultant FD-measures are connected with activities from Measure A-1-1 and the resultant FA-measures. The FD measures are intentended to define the routes for supply of cooling water to the nuclear facilities and the facilities that need to be protected. The FA measures are connected with electric power supply from MDG (according to A-1-1) to stationary pumps and electrical components on the routes, defined and performed in the FD-measures.

Combining the activities of the two types of measures requires a review of a large combination of potential possibilities, selection of the most appropriate and implementation of new design and operational solutions.

On the other hand the technical implementation of a certain type of measures can be performed only during the outage of the unit, for example Measures FA-1-1-1 and FA-1-1-2.

It shall be stressed that the implementation of some measures requires design and engineering of unique hardware and software that comply with the design features of the WWER-1000 plants and the expected parameters in case of a severe accident (D-3-2).

- *Measures for provision of alternative sources of power supply*

Prior to the accident at the Fukushima Dai-ichi NPP one 6 kV MDG was available at the site of Kozloduy NPP capable to supply the alternative SG feedwater pumps in case of total loss of power supply (unavailable emergency 6 kV DGs of the safety systems and additional 6 kV DG). Provisions for direct connection of the 6 kV MDG to the reliable power supply cabinets of the safety systems were not made at that time..

As a result of the performed stress tests two new 0.4 kV MDG were supplied under Measure A-1-1, one for each of Units 5 and Unit 6. The current provisions allow energizing the reliable power supply cabinets of the safety systems 0.4 kV with the following consumers:

- SG Emergency Feedwater Pumps
- Spent Fuel Pool feedwater pumps
- primary cooling/make-up pumps
- one channel of PAMS (post accident monitoring system)
- Units 5&6 radiation monitoring systems
- lighting boards

After the implementation of this measure, the alternative power supply concept is expanded and 4 new FA measures are planed. The following activities will be performed:

1. Provisions for connections of the 6 kV MDG to the reliable power supply cabinets of the safety systems of each of Units 5&6 and the Auxiliary Building. The project envisages:
   - construction of seismically qualified connection boards to the cabinets at Units 5&6;
   - power supply of the Spent Fuel Pool alternative feedwater pumps to inject borated water from Auxiliary Building;
   - power supply for emergency lighting and radiation monitoring in the Auxiliary Building.
2. Implementation of a project for construction of a new reliable power supply cabinet 0.4 kV, in order to increase the capacity of the 0.4 kV consumption under accidental conditions. The project will ensure:
   - recharging of the batteries in case of total loss of power supply;
   - power supply to one of the Direct Current sections for each Unit;
   - functional back-up of the 0.4kV MDG and 6kV MDG;
   - 100% emergency lighting in Reactor Building and Turbine Building;
   - power supply of respective interlocks, protections and alarms of the 0,4 and 6 kV reliable power supply cabinets of the safety systems.
3. Implementation of a project for seismic upgrade of the overhead passage-ways between Auxiliary Building and the Reactor Building of Units 5&6.

A need for upgrading the overhead passage-ways was identified in order to ensure the alternative access routes of the 6 kV MDG at the plant site. The project is aimed at upgrading, refurbishing and reducing the weight of the overhead passage-ways. The construction and maintenance works are planned for implementation till the end of November 2016.

4. Construction of buildings for sheltering of MDGs.

Construction of buildings for ensuring optimal conditions for hot standby of the 0,4 kV MDG and 6 kV MDG is envisaged. These buildings will be located at three different, suitable for transportation places at the KNPP site. The MDG buildings are designed with 50% margin regarding the Design Basis Earthquake. The design of the buildings considers the impact of extreme weather conditions - wind, snow, temperatures, floods, tornado, etc. Procedures were established for transportation and connection of the MDG to the connection points.

- *Construction of KNPP off-site ERC*

The Off-site Emergency Response Centre will be located outside Kozloduy NPP site, on the territory of the town of Kozloduy. The building will be bunker type and will be protected from extreme weather conditions. The centre will be provided with reliable communication means, such as the means in the existing on-site Emergency Response Centre. The Centre will receive information about the condition of the damaged unit during the different phases of the accident and about the radiological

conditions at and around the NPP site.

The Centre will provide safe conditions in case of Severe Accident for the Group for emergency response management, the standby shift for technical support to the operators and the on-call emergency teams during the early phase of the accident.

RELEVANT OUTCOMES OF STUDIES AND ANALYSES IDENTIFIED IN THE NACPS, AND COMPLETED SINCE THE 2013 WORKSHOP

The results of the main studies and analyses, which were completed to the end of 2014, are presented in this section and the need of planning of the relevant measures or activities is also pointed out.

Measure A-1-2: Investigation of possible alternatives for residual heat removal in case of loss of service water system using the Units 3 and 4 additional SGs emergency feedwater system for Units 5&6.

The conclusions of the study are that the capacity of the systems will be insufficient for applying of water-water cooldown mode through the SGs. On the other hand, the residual hear removal from the core in case of total loss of AC power supply is ensured through the SG Alternative Feedwater System, powered by the MDG. As a result this measure does not lead to subsequent activities.

Measure B-2-1: Investigation of the possibilities for protecting the equipment at the river bank pumping stations in case of external flooding with maximum water level 32.93 m

According to the results of the conducted studies changes were made in the relevant instructions for the personnel at the bank pumping station in case of flooding hazard due to rising of the Danube River level. The changes made regulate the required emergency reserve of inert materials and determine the responsibilities for control over the existing warehouse reserves.

Measure C-2-3: Analysis of the need for and possibilities to power the valve motors at the hydroaccumulator connecting pipelines from the batteries in order to provide for making up the primary circuit in reactor cold shutdown state and failure of the emergency DGs.

Analysis was conducted and the need for providing supply of category I (from batteries) was proven. Reliability analysis of the electrical boards was performed, which confirms the availability and reliability of the existing and newly incorporated consumers. Design solutions for Units 5&6 have been developed. The newly implemented circuit ensures operational possibility for the MCR (ECR) team to control the hydroaccumulator valves in case of emergency conditions involving loss of all AC power supply sources in compliance with the emergency procedures.

Measure C-2-4: Analysis of the possibility to install an alternative water cooling system with an independent power supply in the SFSF.

Within this measure a conceptual design was developed and analysed for the following options of alternative water cooling system in SFSF:

1. Cooling system with one condenser, cooled by the outside air.
2. Cooling system with a water-cooling V-shaped tower.

The chosen Option 1 includes two-circuit cooling with an air-cooled water-cooling facility, capable to transfer the heat load during all seasons. The alternative water cooling system of the SNFSF shall ensure the residual heat removal from the fuel in accident and post accident conditions resulting in unavailability of the design cooldown system. As a result a new measure for developing a detail design and installation of the system was formulated.

Measure D-2-8: Analysis of the possible deterioration of operational parameters due to a high contamination level (in certain zones) and equipment failure on-site (including the impact on accessibility and habitability of the MCR and the ECR)

An analysis and evaluation were conducted of the radiation level in the Units 5&6 MCRs, Units 5&6 ECRs and other rooms in the Reactor Building in cases of severe accident. Phenomena were assessed, which are specific for the late phase of a severe accidents related to the melted core relocation towards the rooms in the containment and the Reactor Building as well as the airbourne distribution paths. As a result, many doors in the Reactor Building will need to be sealed or replaced. The specified gamma radiation level shows that in a certain moment the criterion for the MCR habitability will be reached and the operators will have to move to the ECR to proceed with accident management actions.

In this respect, 4 new measures were formulated FD-2-8-1, 2, 3, 4 (Attachment IV), aimed at preventing of airbourne distribution to the MCR, by sealing and replacement of the doors of the rooms.

Measure A-3-1: Assessment of possible damage on the regional road infrastructure surrounding the plant followingextreme external events and evaluation of reliability of access routes for mobile equipment, supplies and personnel to the plant site

An analysis was developed of the reliability and assessment of the damages on the road infrastructure surrounding Kozloduy NPP and the possibility for ensuring accessibility to the plant site for machinery and personnel in the event of disasters and accidents, September 2013.

As a result of the analysis Kozloduy NPP main road and the ring-road were repaired. An alternative access road was chosen, which is of higher reliability in case of seismic impact and could be used in the event of damages on the regional road infrastructure surrounding the plant.

GOOD PRACTICES AND CHALLENGES IDENTIFIED DURING IMPLEMENTATION SO FAR

A. Good practices

- *Increasing the reliability and efficiency of the alternative power supply (Measure A-1-1):*

Before the Fukushima Daiichi NPP accident at Kozloduy NPP site was available one MDG 6 kV, supplying one pump of the SG Alternative Feed Water System in case of station black out. In the scope of Measure A-1-1 were provided two additional MDGs 0.4 kV and design solutions for connection to the reliable power supply cabinets 0,4 kV were implemented per one safety system for unit 5 and 6. Technical solutions and procedures were also developed for simultaneous recharging of one battery per unit by the existing MDG 6 kV. Transport and power supply procedures were introduced for the MDGs connection points. The measure was completed within the scheduled terms.

To provide **more effective and interchangeable usage of the three MDGs**, available on site (one 6 kV MDG and two new 0.4 kV MDGs) in case of loss of on-site and off-site power supply, the concept for alternative power supply was expanded and the implementation of 4 additional design solutions and activities were envisaged in field FA. The new measures will provide:

- direct connections to the 6 kV reliable power supply cabinets of units 5 and 6 safety systems and the Auxiliary Building;
- construction of a new reliable power supply cabinet 0.4 kV in order to increase the capacity of the existing ones under accidental conditions;
- recharging one battery by MDG 0.4 kV;
- **ensuring alternative access routes to the connection points and construction of bunker type shelters** for MDGs hot stand by.

- *Severe accident management provisions- before and after Fukushima accident*

The development and implementation of **significant severe accident management measures at Kozloduy NPP was initiated before the Fukushima accident**, in the frame of a Modernization Program of units 5&6 (in the period 2000-2007). The most substantial severe accident management provisions, implemented before Fukushima accident, include installation of containment filtered venting system (scrubber type), installation of hydrogen recombiners, development of PSA- level 2 and SAMGs. Following the stress tests, additional severe accident management actions were planned and some of them have been already implemented, e.g. the project for plugging of the ionization chamber channels in the walls reactor vessel cavity to prevent basement melt-through and early containment by-pass, the project for installation of wide-range temperature sensors to monitor the reactor vessel temperature and installation of additional recombiners. The scope of the EOPs has been extended to cover reactor shutdown states and spent fuel pool accidents. The SAMGs have been developed to involve two sets of documents – **SAMGs for Technical Support Team** and **SAMGs for MCR/ECR**. Measuring channels to monitor and evaluate the concentration of steam and oxygen in the containment are currently under installation.

- *Bunkered Facilities*

A **second off-site Emergency Response Centre of bunker type** will be constructed in the town of Kozloduy and will be equipped with reliable communication facilities with the on-site emergency centre. The building will be fully protected from extreme weather conditions. The Centre will receive information about the plant status and the radiological conditions on the NPP site and around it. The off-site centre could accommodate the standby Technical Support Team and standby Emergency Response Teams.

Three bunkered type buildings to shelter each MDG will be constructed on the Kozloduy site. The buildings are designed to withstand an earthquake 50% stronger than the Design Basis Earthquake, as well as the impact of extreme weather conditions - wind, snow, temperatures, floods, tornado, etc.

B. Challenges

- *Selection of core retention strategy*

The implementation of Measure D-3-5 implies performing of wide scope analytical and research activities, specific to the reactor design and exchange of knowledge among the interested countries. Kozloduy NPP iniiated and conducted 3 national and international workshops to discuss the various options and existing practices in the WWER operating countries. It was concluded that the selection of a core retention strategy (in-vessel or ex-vessel) could be performed within the framework of international cooperation projects, with the joint efforts of the WWER-1000 operating countries and the involvement of the reactor vendor and Main Designer.

- *Management of large quantities liquid RAW*

This measure envisages study of conceptual solutions for potential treatment of large volumes contaminated water in various scenarios of severe accidents recovery activities. Forecoming are initial analysis of the recovery severe accidents strategies after the completion of SAMGs for SFPs and shut-down open reactor (D-2-6).

The study is in close interface with other difficult solutions – direct water supply from external source to the containment (Measure D-3-5, December 2017), direct water supply from external source to the reactor core (Measure FD-2-4-2, December 2016), and accordingly estimating the boron and/or water solutions generated for definite time, assessment of the available volumes in tanks, analysis for

transferring liquids, availability of the water treatment facilities, assessment of the adequacy of existing measures for prevention of releases to the environment.

LIST OF ABBREVIATIONS

BNRA	Bulgarian Nuclear Regulatory Agency
BPS	River Bank Pump Station
CNS	Convention on Nuclear Safety
DBE	Design Bases Earthquake
DG	Diesel Generator
EC	European Commission
ECCS	Emergency Core Cooling Systems
ECR	Emergency Control Room
ENSREG	European Nuclear Safety Regulators Group
EOM	Extraordinary Meeting
EP	Emergency Plan
ERC	Emergency Response Centre
ESO	Electricity System Operator
EU	European Union
FSS	Full-scope Simulator
IAEA	International Atomic Energy Agency
KNPP	Kozloduy Nuclear Power Plant
LSN	Local Seismic Network
MCR	Main Control Room
MDG	Mobile Diesel Generator
MEW	Ministry of Environment and Water
MI	Ministry of Interior
MWL	Maximum water level
NAP	National Action Plan
NEK	National Electricity Company
NPP	Nuclear Power Plant
OBE	Operational Bases Earthquake
PSA	Probabilistic Safety Assessment
RAW	Radioactive Waste
RLE	Review Level Earthquake
SAM	Severe Accident Management
SAMG	Severe Accident Management Guidelines
SBEOP	Symptom-based Emergency Operating Procedure
SBO	Station Blackout
SFP	Spent Fuel Pool
SFSF	Spent Fuel Storage Facility
SG	Steam Generator
SNF	Spent Nuclear Fuel
SSCs	Structures, Systems and Components
WANO	World Association of Nuclear Operators
WENRA	Western European Nuclear Regulators' Association
WWER	Water Water Energy Reactor

ATTACHMENT No. 1: ACTIVITIES IMPLEMENTATION ON PART I: TOPICS 1 – 3

ID №	NF	Topic	Measure/Action	ENSREG Recommendations	Source	Status	Term
A-1-1	Units 5&6	External Initiating Events	Provision of two additional MDGs for units 5&6	13, 15, 26, 27, 30, 33	ENSREG,CNS	Completed *New measures envisaged in Field FA-1, Attachment 4*	December 2013
A-1-2	Units 5&6	External Initiating Events	Investigate possible alternatives for residual heat removal in case of loss of service water system using the Units 3 and 4 additional SGs emergency feedwater system for Units 5&6	13, 14, 33	ENSREG,CNS	Completed	March 2013
A-1-3	Units 5&6	External Initiating Events	Ensuring the availability of at least one tank of the SG Emergency Feedwater System as an alternative for residual heat removal in shutdown mode	13, 14, 19, 33	ENSREG,CNS	Completed	March 2012
B-1-1	NPP	External Initiating Events	Development of an emergency response procedure for the operating personnel in case of damage of Zhelezni Vrata-1 and Zhelezni Vrata-2 Water Power Facilities	7, 9, 12	ENSREG,CNS	Completed	November 2012
B-2-1	Bank Pumping Station	External Initiating Events	Investigation of the possibilities for protecting the equipment at the river bank pumping stations in case of external flooding with maximum water level 32.93 m	8, 12	ENSREG,CNS	Completed	October 2012
B-2-2	Units 5&6	External Initiating Events	Development of measures to prevent water intake in the plant sewage network in case of valley flooding	8, 12	ENSREG,CNS	Completed *New measure envisaged in Field FB-2, Attachment 4*	October 2013
B-2-3	Units 5&6	External Initiating Events	Modernisation of the sewage network and drain pump system	8, 12	ENSREG,CNS	In progress	November 2015 *New term*
B-3-1	NPP	External Initiating Events	Initiation of activities to improve the operational condition and the protective functions of the state dike in the region of the Kozloduy valley.	12	ENSREG,CNS	Completed	December 2014 *New term*
C-1-1	Units 5&6	Design Issues	Provision of recharging of one of the batteries of the safety systems by a mobile DG.	16, 25, 27, 30	ENSREG	Completed	December 2013

ID №	NF	Topic	Measure/Action	ENSREG Recommendations	Source	Status	Term
C-2-1	NPP	Design Issues	Assess the condition, efficiency and availability of the water supply system from the Shishamnov Val dam	14	ENSREG,CNS	Completed	May 2012
C-2-2	Units 5&6	Design Issues	Ensure power supply through the mobile DG for the SFP cooling systems, or for feeding the SFP	14, 23, 27	ENSREG,CNS	Completed	December 2013
C-2-3	Units 5&6	Design Issues	Analysis of the need for and possibilities to power the valve motors at the hydroaccumulator connecting pipelines to the primary circuit from the batteries in order to provide for making up the primary circuit in reactor cold shutdown state and failure of the emergency DGs.	14, 19, 30	ENSREG,CNS	Completed	December 2013
C-2-4	Spent Nuclear Fuel Storage Facility (SNFSF)	Design Issues	Analysis of the possibility to install an alternative water cooling system with an independent power supply in the SFSF	14	ENSREG,CNS	Completed *New measure is envisaged in the Field FC-2-4*	December 2014
D-1-1	NPP	Severe Accidents	Review of the KNPP on-site and off-site emergency plans to consider the possible effects from physical isolation due to external hazards: - impeded access to the Units 5, 6 ECRs; - possible draining of the spent fuel storage sections at the SFSF followed by increase of the dose rate; - provision for alternative routes for evacuation, transport of necessary fuels and materials to the plant, and operational staff access.	28, 34	ENSREG,CNS	Completed for the off-site emergency plan *In progress for the off-site emergency plan within EP-1-1 measure*	December 2014
D-1-2	NPP	Severe Accidents	Construction of KNPP off-site ERC	22, 44	ENSREG	In progress	December 2017 *New term*
D-2-1	Units 5&6	Severe Accidents	Implementation of a set of symptom-based emergency operating procedures for shut-down reactor mode with closed primary circuit	19	ENSREG	Completed	February 2012

ID №	NF	Topic	Measure/Action	ENSREG Recommendations	Source	Status	Term
D-2-2	Units 5&6	Severe Accidents	Implementation of the set of symptom-based emergency operating procedures for shut-down reactor mode with open primary circuit	19, 39	ENSREG	Completed	February 2013
D-2-3	Units 5&6	Severe Accidents	Implementation of severe accident management guidelines (SAMGs)	34, 39, 47	ENSREG,CNS	Completed	October 2012
D-2-3-3	Units 5&6	Severe Accidents	Validation of the SAMGs set of documents	36	ENSREG	Completed	July 2012
D-2-4	Units 5&6	Severe Accidents	Develop technical means to provide direct injection of water to the reactor core, SG, SFP and the containment by mobile fire protection equipment in extreme conditions.	14	ENSREG,CNS	*Transformed into 3 new measures in Field FD-2 of Attachment 4 and part in Measure D-3-5*	Terms for the corresponding measures
D-2-5	Spent Nuclear Fuel Storage Facility (SNFSF)	Severe Accidents	Develop technical means to provide direct injection of water to the SFSF by mobile fire protection equipment in extreme conditions.	14	ENSREG,CNS	Completed *New measure envisaged in Field FD-2, Attachment 4*	December 2014
D-2-8	Units 5&6	Severe Accidents	Analysis of the possible deterioration of operational parameters due to a high contamination level (in certain zones) and equipment failure on-site (including the impact on accessibility and habitability of the MCR and the ECR)	22, 43, 47	ENSREG	Completed *Four new measures envisaged in Field FD-2-8-1,2,3,4, Attachment 4*	December 2014
D-3-1	Units 5&6	Severe Accidents	Installion of additional hydrogen recombiners in the containment	31, 41	ENSREG	Completed	June 2014
D-3-2	Units 5&6	Severe Accidents	Installation of measuring channels to monitor and evaluate the concentration of steam and oxygen in the containment	18, 31	ENSREG	In progress	December 2016 *New term*
D-3-3	Units 5&6	Severe Accidents	Implementation of the project for plugging the ionization chamber channels located in the walls of the reactor vessel cavity	31, 33, 47	ENSREG	Completed	December 2014
D-3-4	Units 5&6	Severe Accidents	Complete the installation of a wide-range temperature sensors to monitor the reactor vessel temperature	18, 31, 47	ENSREG	Completed	October 2012

ID №	NF	Topic	Measure/Action	ENSREG Recommendations	Source	Status	Term
D-3-5	Units 5&6	Severe Accidents	Study the possibilitiesfor molten core retention in case of severe accidents	47	ENSREG	In progress *Added part Containment from Measure D-2-4 D-2-4*	December 2017

ATTACHMENT No. 2: ACTIVITIES IMPLEMENTATION ON PART II: TOPICS 4 – 6

№	O*	Topic	Action / Activity	CNS	Status	Term
N-1-1	BNRA	National organizations	Develop a programme to review the regulatory requirements taking into account the lessons learned from the Fukushima Daiichi NPP accident	101, 127, 128	Completed	December 2013
N-1-2	BNRA	National organisations	Revise the existing regulatory requirements upon issue of new IAEA documents that consider the lessons learned from the accident	101	In progress	On a regular basis
N-1-3	BNRA	National organisations	Participation of Bulgarian experts in the review of IAEA standards and issuance of new ones	101	In progress	On a regular basis
N-1-4	BNRA	National organisations	Periodic review and update of the regulatory guidelines to consider the lessons learned and the relevant new documents of the IAEA and the European Commission	101	Completed	December 2014
N-2-1	BNRA	National organisations	Review of BNRA activities by IRRS mission of the IAEA	103	Completed	April 2013
EP-1-1	Ministry of Internals	Emergency preparedness and response	Revise and update the National (Off-site) Emergency Plan	107, 108, 109	In progress Relation to Measure D-1-1	June 2015 New term
EP-1-2	Ministry of Internals	Emergency preparedness and response	Analyse the existing and develop new procedures, instructions and methodologies for actions of the emergency teams in line with the National Emergency Plan	107, 108	In progress	June 2015 New term
EP-1-3	Ministry of Internals	Emergency preparedness and response	Update and maintain the data base of the currently functioning volunteer emergency response teams	112	In progress	June 2015 New term
EP-1-4	Ministry of Environ-ment	Emergency preparedness and response	Update of the National System for Radiation Background Monitoring, BULRaMo	114	In progress	December 2014
EP-2-1	BNRA	Emergency preparedness and response	Installation of safety parameter display system (SPDS) and critical parameters post accident monitoring system (PAMS) of KNPP units 5&6 in the BNRA Emergency Centre	115	Completed	May 2011

№	O*	Topic	Action / Activity	CNS	Status	Term
EO-1-1	BNRA	International Cooperation	Preparation and signing of bilateral agreement with the Regulatory Body of the Russian Federation	105, 130	Completed	April 2014 New term
EO-1-2	BNRA	International Cooperation	Preparation and signing of bilateral agreement with the Regulatory Body of Serbia	105, 130	In progress	February 2015 New term
EO-1-3	BNRA	International Cooperation	Preparation and signing of bilateral agreement with the Regulatory Body of Greece	105, 130	In progress	February 2015 New term
EO-1-4	BNRA	International Cooperation	Preparation and signing of bilateral agreement with the Regulatory Body of Romania	105, 130	In progress	March 2015 New term
EO-1-5	BNRA	International Cooperation	Plan for systematic training of the staff of the Emergency Response Team in BNRA	130	In progress	December 2015
EO-1-6	BNRA	International Cooperation	Participation in the meetings of the Forum of WWER Regulators	131	In progress	On a regular basis
EO-2-4	BNRA	International Cooperation	IAEA OSART Mission ,	128	Completed	November 2012
EO-2-14	BNRA	International Cooperation	IAEA Follow-up OSART Mission	128	Completed	June 2014

*O – organization

ATTACHMENT No. 3: ADDITIONAL ACTIVITIES IMPLEMENTATION

ID No.	NF	Topic	Action/Activity	Source	Status	Term
A-3-1	KNPP	External Initiating Events	Assess the possible damage on the regional road infrastructure surrounding the plant in the event of extreme external impacts and evaluate the reliability of routes, ensuring accessibility to the plant site for machinery, supplies and personnel.	Peer Review Report	Completed	December 2014
D-2-6	Units 5, 6	Severe accidents	Extension of the scope of SAMGs - for the spent fuel pools and for specific reactor shutdown states, not covered by the current SAMGs	Peer Review Report	In progress	July 2015 *New term*
D-2-7	KNPP	Severe accidents	Assess the current organizational measures and technical means for management of simultaneous accidents with core melt/fuel damage on the various facilities on-site.	Peer Review Report	In progress	December 2015
D-3-6	Units 5, 6	Severe accidents	Assess the volume of the generated liquid RAW in the event of a severe accident as well as the adequacy of the available measures to prevent the release into the environment.	Peer Review Report	In progress	December 2015
E-1	KNPP	External Initiating Events	Analysis of the extreme weather conditions on the Kozloduy NPP site, using probabilistic methods according to the IAEA methodology, and considering combinations of extreme weather conditions.	Peer Review Report	In progress	December 2015
EO-2-1	KNPP	International Cooperation	Establish a local WANO office on the KNPP site	WANO Programme/ CNS	Completed	August 2012
EO-2-2	KNPP	International Cooperation	Appoint a WANO representative at the Kozloduy NPP site	WANO Programme/ CNS	Completed	September 2012
EO-2-3	KNPP	International Cooperation	Choose a Kozloduy NPP representative at the WANO-Moscow Centre.	WANO Programme/ CNS	Completed	April 2012
EO-2-5	KNPP	International Cooperation	WANO Peer Review	WANO Programme/ CNS	Completed	November 2013
EO-2-6	KNPP	International Cooperation	WANO Workshop – Significant Operating Experience Reports (SOER) and corrective actions efficiency.	WANO Programme/ CNS	Completed	March 2013
EO-2-7	KNPP	International Cooperation	Participation in the Regional Crisis Centre in Moscow	WANO Programme	Completed	*According to an approved working plan*
EO-2-8	KNPP	International Cooperation	Preparation and signing of bilateral agreements with other NPPs for benchmarking	WANO Programme	Completed	December 2013

ID No.	NF	Topic	Action/Activity	Source	Status	Term
EO-2-10	KNPP	International Cooperation	Participation in the working meeting of the Chief Engineers of NPPs with WWER to discuss Lessons Learned from the Fukushima Daiichi NPP accident.	WANO Programme	Completed	September 2012
EO-2-11	KNPP	International Cooperation	Respond to WANO about the implementation of the recommendations from SOER 2011-2, 2011-3, 2011-4.	WANO Programme	Completed	May 2012
EO-2-12	KNPP	International Cooperation	Analysis of the stress test results for other nuclear power plants	WANO Programme	Completed	November 2013
EO-2-13	KNPP	International Cooperation	Participation in a joint WANO and IAEA workshop on sharing of operating experience in the light of the Fukushima Daiichi NPP accident	WANO Programme	Completed	October 2012 October 2013
EO-2-15	KNPP	International Cooperation	Conduct technical support missions in various areas (planned for 2013: industrial safety – June; radiation protection –September)	WANO Programme	Completed	June 2013 September 2013
EO-2-16	KNPP	International Cooperation	Participation in the annual working meeting of the Chief Engineers of NPPs with WWER-1000	WANO Programme	Completed	On a regular basis

ATTACHMENT No. 4: NEW MEASURES AND ACTIVITIES RESULTING FROM THE PERFORMED ANALYSES AND STUDIES FOR THE PREVIOUS AREAS

ID No.	NF*	Measure/Action	Status	Interface with measure	Term
Field FA		**Provision of alternatives for residual heat removal**			
FA-1-1-1	Units 5, 6	Implementation of provisions to power the reliable supply cabinets from 6 kV MDG	In progress	A-1-1	November 2016
FA-1-1-2	Units 5, 6	Implementation of provisions for charging the batteries of the safety system trains from 0,4 kV MDGs.	In progress	A-1-1	November 2016
FA-1-1-3	KNPP	Seismic upgrade of the overhead passage-wayss between Auxiliary Building and the Reactor Buildings of Units 5&6.	In progress	A-1-1	November 2016
FA-1-1-4	KNPP	Construction of buildings for the MDGs sheltering.	In progress	A-1-1	October 2015
Field FB		**Measures to prevent and mitigate the consequences of floods**			
FB-2-2-1	KNPP	Implementation of provisions to prevent water penetration into the plant sewage when the valley is flooded.	In progress	B-2-2	December 2016
Field FC		**Measures to improve stability in case of a loss of ultimate heat sink**			
FC-2-4-1	SFSF	Installation of an independent cooling system in SFSF.	In progress	C-2-4	December 2015
Field FD		**Measures for improving the capabilities for severe accident management**			
FD-2-4-1	Units 5, 6	Installation of additional pipeline to the spent fuel pool cooling system for back up from an external source	In progress	D-2-4	November 2015 *New term*
FD-2-4-2	Units 5, 6	Feasibility study of direct water injection to the reactor core from an external source	In progress	D-2-4	December 2016
FD-2-4-3	Units 5, 6	Feasibility study of direct water supply to SGs from an external source	In progress	D-2-4	June 2015

ID No.	NF*	Measure/Action	Status	Interface with measure	Term
FD-2-5-1	SFSF	Installation of pipeline for direct water supply to the SFSF pools from external source (diesel pumps or fire truck)	In progress	D-2-5	June 2015
FD-2-8-1	Units 5, 6	Prevention of airbourne release to the MCR in the event of a severe accident by implementation of a set of organizational and technical measures.	In progress	D-2-8	December 2015
FD-2-8-2	Units 5, 6	Modifications of SAMGs and electricity supply recovery procedures from MDG to ensurerestarting of the ventilation systems for recirculation and air filtration in the MCR.	In progress	D-2-8 FA-1-1-1	November 2016
FD-2-8-3	Units 5, 6	Instructions on the evacuation of the MCR staff to the ECR upon reaching the dose limit of 1mSv/h shall be added to the SAMGs.	Completed	D-2-8	July 2015
FD-2-8-4	Units 5, 6	Prevention of airbourne release to the ECR in case of a severe accident by replacement of the corridor doors with gas tight ones.	Completed	D-2-8	July 2015

* NF – Nuclear facility