



2016

KOZLODUY NPP EAD **ANNUAL REPORT**

Our core values

- Safety first
- Commitment and mutual respect
- Personal responsibility and integrity at work
- Quest for excellence
- Continuous learning



Dear readers,



It is my honour to present to you the main performance results achieved by Kozloduy NPP in 2016. Thanks to the professionalism, competence and dedication of the nuclear plant team, these results mark the year as a truly successful one.

We, the nuclear power workers in Bulgaria, pride ourselves first and foremost on the reliable and safe operation of the 1000-megawatt units 5 and 6 effected while strictly adhering to all the high safety requirements. The conditions necessary for efficient operation and optimal loading of the generating capacities were ensured, as a result of which, in 2016, Kozloduy NPP provided 35% of the national electricity generation output.

The company accomplished successful sales of the electricity generated at both the free and regulated market segments, which lead to the stable financial position at the end of 2016, despite the serious investment costs paid over the year. All expenses were paid in due time, including the ones toward the large-scale project for plant lifetime extension that is fully funded by Kozloduy NPP.

It is with the results of this project that the year will remain memorable for us. All the scheduled activities were delivered to time, whereby the application documents for Unit 5 licence renewal for a new 10-year period were duly submitted to the Bulgarian Nuclear Regulatory Agency. This important step gives us the confidence that, with the experience we already have, we will also successfully carry out the Unit 6 lifetime extension activities, which will bring us closer to the key objective of ensuring safe long-term operation of our nuclear facilities.

In the series of achievements in 2016, we have to record the two international review missions we hosted – the pre-SALTO peer review of the International Atomic Energy Agency, and the WANO Moscow Centre Corporate Peer Review. Both missions identified practices that will be shared with the international professional community as excellence in performance attained by the Bulgarian nuclear power plant. This is yet another recognition of our contribution to the dynamic process of continuous improvement characterising modern nuclear industry evolution.

Ivan Andreev

Chief Executive Officer
Kozloduy NPP EAD



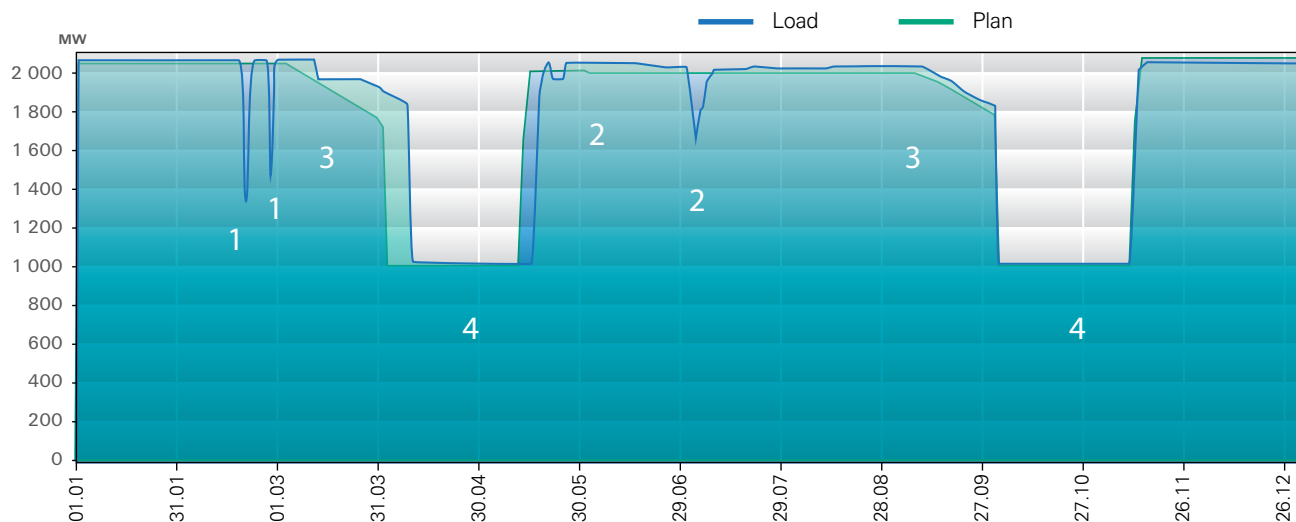
PRODUCTION AND MAINTENANCE PROGRAMMES IMPLEMENTATION

ELECTRICITY GENERATION

Kozloduy NPP successfully completed its 2016 generation output programme. As a result of the highly professional performance of the Nuclear Power Plant team, all the conditions for efficient and stable operation of the 1000-megawatt units 5 and 6 were ensured, with an optimal

load on the production capacities. During the reporting period, minimum unplanned downtime (a total of 21 hours for the whole year) was registered, and deviations with potential safety and environmental impacts were prevented.

Kozloduy NPP – Load Schedule 2016



- Legend:
- 1 – Unplanned shutdown
 - 2 – Dispatching restriction
 - 3 – Coast down operation mode
 - 4 – Scheduled annual outage with refuelling of the nuclear power unit



In 2016, Kozloduy NPP generated 15 775 844 MWh of electricity (gross) which accounted for a 35 percent share in the national electricity production for the period.

As a result, the total output of the nuclear power plant from the commercial start-up of the first nuclear power unit in July 1974 to the end of 2016 reached 585 838 342 MWh of electricity produced in compliance with all the safety requirements for the operation of nuclear facilities.

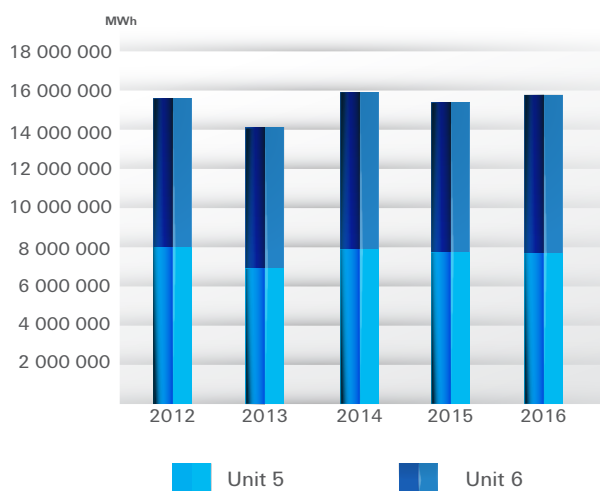
From its commissioning in 1987 to the end of 2016, Unit 5 has generated 162 699 439 MWh of electricity and Unit 6, commissioned in 1991 – 152 142 947 MWh.

Kozloduy NPP provided to the country's electricity system 14 932 477 MWh of net active power, sold according to the current legal framework.

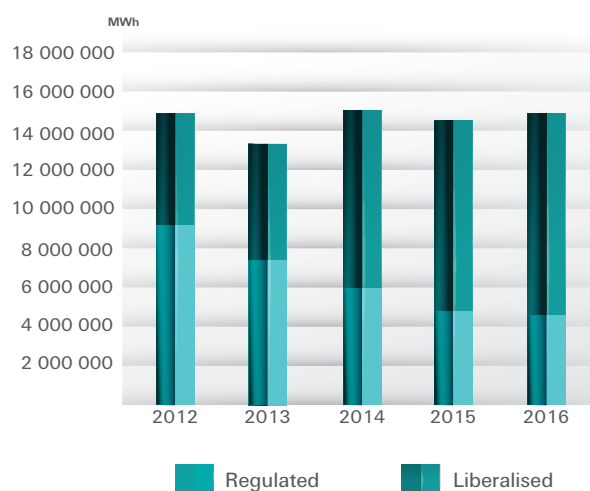
In view of the Bulgarian electricity market growing trend, in 2016, Kozloduy NPP sold 30% of its net electricity output on the regulated market, and the rest of it was successfully traded on the liberalised market.

The company has actively participated in the liberalised energy market, since its establishment in the country, and retained its leading role of a major, eligible and secure electricity supplier in 2016.

Electricity generated (gross)



Electrical energy (net) sold by Kozloduy NPP per market segments





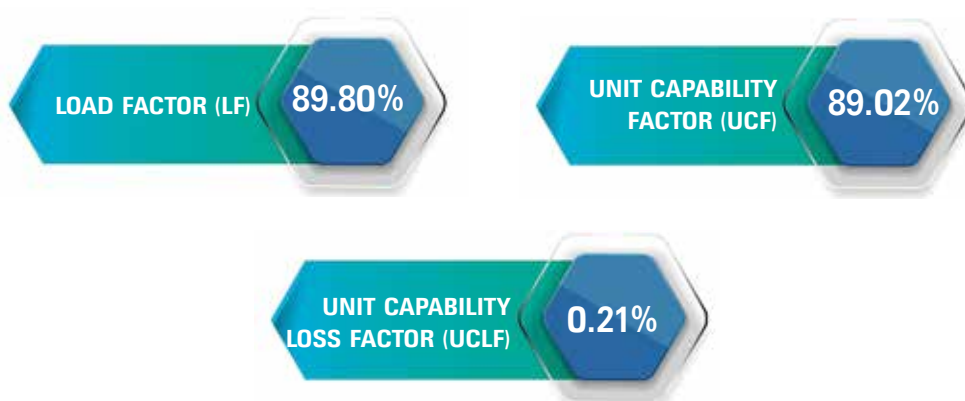
SPECIFIC PERFORMANCE INDICATORS

The plant specific performance indicators reflect the complex impact of various factors on the production, reliability, and safety of the nuclear facilities as production sites.

According to the performance criteria of the World Association of Nuclear Operators (WANO), UCF values

exceeding 85% and UCLF values up to 3% testify of a high efficiency and reliability level in the operation of nuclear power plants. The results that Kozloduy NPP achieved in 2016 for these indicators are considerably better.

Kozloduy NPP Performance Indicators in 2016



HEAT GENERATION

Kozloduy NPP also generates and supplies thermal power for the heating of on-site main and auxiliary facilities, as well as of the consumers in the town of Kozloduy. The heat sold

to the end consumers (domestic or other) throughout 2016 amounted to 80 GWh.



MAINTENANCE PROGRAMME

The scheduled annual outages of Units 5 and 6 aim at ensuring the safe, reliable and efficient operation of the nuclear facilities through the subsequent fuel campaign. The outage successful completion is essential for guaranteeing of secure energy supplies to the country and the region.

During the 2016-outages, and in conformity to the technological conditions, the manufacturers' requirements, the provisions of the technical specifications for safe operation, and the licence obligations, the plant performed preventive maintenance, routine and mid-term maintenance, and overhaul of mechanical equipment, electrical and I&C equipment, functional tests and inspections, specialised inspections and diagnostic non-destructive testing, refuelling with fresh nuclear fuel, etc.

The measures identified in the programmes for plant service life extension and reactor power uprate to 104% were implemented along with the necessary maintenance activities as pre-scheduled, with optimal organisation and coordination efficiency.

Also, a number of projects on the modernisation of main and auxiliary equipment have been successfully completed.

The annual outage of Unit 5 lasted from 9 April through 16 May. The following activities were completed on the unit: ageing management review of the turbine equipment; replacement of components on the temperature

measurement system in the primary side circulation loops; upgrading of the algorithms in the reactor control rod drive systems; modernisation of the separation systems of the two steam generators. Preparatory activities were also implemented for replacing of the stator of generator No. 9 (planned to take place in 2017) with a new one, uprated for operation at 1100 MW.

The annual outage of Unit 6 lasted from 1 October through 10 November. During the shutdown, the last phase of the project for the replacement of the stage 4 working blades of the low-pressure first cylinder of turbine K-1000-60/1500-2 was completed. The warranty major overhaul was undertaken on the No. 10 generator stator, already replaced in 2015. A comprehensive assessment was carried out on the pumping equipment, valves and civil structures within the scope of the plant life extension programme. The project for steam generator separation systems modernisation was completed. Upgrading was performed of the software for the reactor internal control system and other components, as part of the preparation for operation at 104%.

On both 1000-megawatt units, the planned maintenance and upgrade activities have been completed to the scope and high quality required. All these activities have been funded with plant own funds.



SAFETY

LICENSING REGIME

Kozloduy NPP EAD is an organisation operating two 1000 MW nuclear power units – Units 5 and 6, and two spent nuclear fuel (SNF) storage facilities.

The operation of nuclear facilities is subject to state control on behalf of the Bulgarian Nuclear Regulatory Agency (BNRA) with the Council of Ministers of the Republic of Bulgaria. The Ministry of Environment and Water, Ministry of Healthcare, Ministry of Regional Development and Public Works, State Agency for Metrology and Technical Surveillance and other government bodies exercise specialised control over the activity of Kozloduy NPP.

All the activities related to the operation of Kozloduy NPP Units 5 and 6 and the spent nuclear fuel storage facilities are performed in compliance with the provisions of the operating licences issued by the BNRA.

In January 2016, Kozloduy NPP EAD was issued a 10-year Operating Licence for the Dry Spent Fuel Storage Facility storing SNF from the WWER-440 reactors.

In October 2016, an Order of the Chairman of the BNRA modified the Operating Licence for Unit 6 to permit the unit operation at an uprated thermal power of 3120 MW (104%) while observing the new licence conditions.

On 05.10.2016, the Specialised Training Licence was renewed with a 5-year period of validity.

After the successful implementation of the activities from the Plant Lifetime Extension Preparation Programme (PLEX) of Unit 5 and a Periodic Safety Review (PSR), on 26 October 2016, an application for the unit Operating Licence renewal for a new 10-year period was submitted to the BNRA. To this end, in compliance with the regulatory requirements, the following documents were prepared:

- Comprehensive justification of the safe operation of Unit 5 during the new 10-year licensing period. It summarises the major improvements of the unit safety, the implementation of the plant lifetime extension projects, the periodic safety review, the update of the Safety Analysis Report (SAR), the implementation of the stress tests programmes, the thermal power uprate project and the optimisation of the nuclear fuel cycle. This justification demonstrates Kozloduy NPP preparedness for safe long-term operation of Unit 5 during the next licensing period;
- Summary report on the Periodic Safety Review of Unit 5, which demonstrates conformity of the design with modern safety requirements, and it is a basic document justifying the unit's safe operation;
- Report on the implementation of the BNRA-approved Plant Lifetime Extension Preparation Programme of Unit 5. The document presents the results from the assessment of the actual state and the residual life evaluation of the structures, systems and components important for the long-term operation of Unit 5, as well as the implemented measures included in the programme for the unit's preparation for PLEX. The report justifies the proposed new licensing period;
- New revision of the Safety Analysis Report of Unit 5 which incorporates the results and the conclusions from the performed analyses and investigations under the PLEX project. In the process of licence renewal the updated SAR and the PSR-2016 are the main sources for justifying the unit's long-term operation;

- Report on the implementation of the conditions of Unit 5 current Operating Licence.

Another important aspect of the licensing activity is the implementation of engineering solutions for introducing modifications in the structures, systems and components important to the safety of nuclear facilities. In 2016, 32

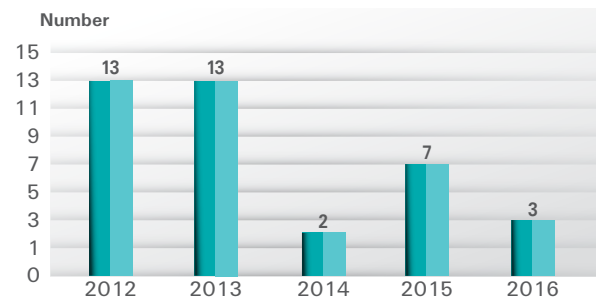
applications were submitted to the BNRA for granting permits for the implementation of engineering solutions at Units 5 and 6, and the spent fuel storage facility. A total of 37 permits were issued for making of modifications. The BNRA has granted all the required permits under the launched procedures.

NUCLEAR SAFETY

In 2016, three operating events occurred at Kozloduy NPP and were reported to the BNRA. All the events were classified Level 0 which is below the INES scale (events not important to safety). Analyses were undertaken to identify the causes for the events, based on which corrective measures were defined in order to avoid recurrence.

There were no reactor scrams at Units 5 and 6 during the reporting year.

Operating Events



RADIATION PROTECTION

An important aspect of Kozloduy NPP safety policy is maintaining the high level of radiation protection of the personnel and population. To that end, the ALARA principle (As Low As Reasonably Achievable) is applied systematically. This principle implies constant improvement and optimization of measures to limit the harmful impact of ionising radiation. This is achieved through staff training and motivation, application of good practices from in-house and international operating experience, preliminary planning and preparation of the activities before the annual outages, analysis of completed activities, and reliable and efficient radiation monitoring.

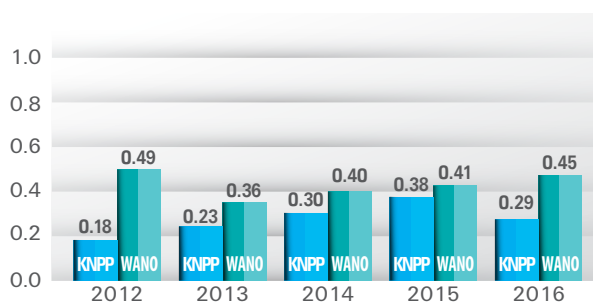
The annual values of the individual and the collective dose exposure for 2016 again rank Kozloduy NPP amongst the best power plants in the world, though a number of complex, time-intensive activities were performed during that period in the controlled area, which were related to the plant lifetime

extension of Units 5 and 6 and their power uprate up to 104%.

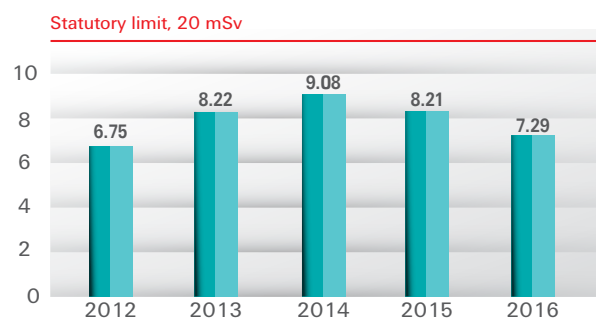
The maximum individual dose over the last year was 7.29 mSv. This is 36% from the statutory annual dose exposure limit for the staff, and is about 1 mSv lower than the previous year.

The collective dose exposure of the staff in 2016 is lower than the one reached over the past two years. The total collective dose for the two WWER-1000 reactors in 2016 was 0.58 man.Sv (0.29 man.Sv per reactor). According to data from WANO (World Association of Nuclear Operators) Annual Reports, 0.45 man.Sv/unit was the average value of the collective dose received from one PWR reactor in operation. The trend for the mean value of the collective dose per one Kozloduy NPP reactor to remain below the WANO reference indicator persisted over the reporting year.

Collective dose per Kozloduy NPP reactor compared against the WANO indicator, man.Sv/unit



Maximum individual effective dose in the controlled area, mSv





RADIATION MONITORING OF DISCHARGES TO THE ENVIRONMENT

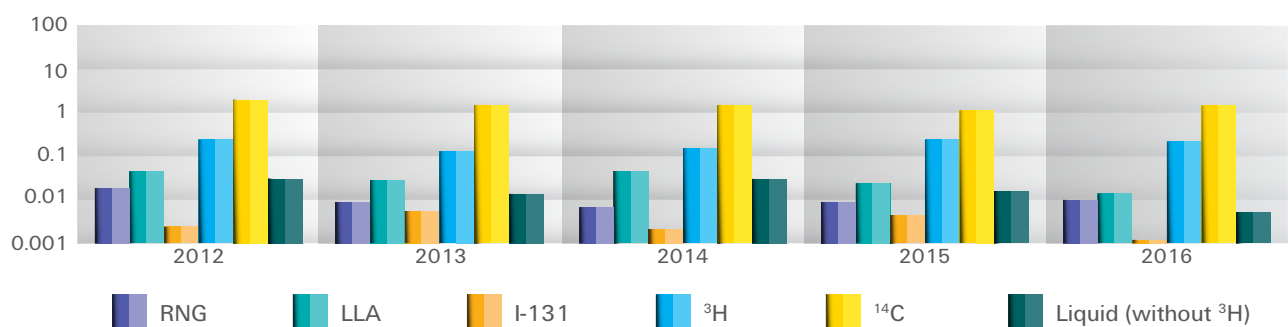
The effectiveness of the strict control over the technological processes in Kozloduy NPP is confirmed by the results from the radiation monitoring of the liquid and gaseous discharges carried out in compliance with the highest international standards. In parallel with that, the discharges to the environment are monitored also by the Bulgarian Nuclear Regulatory Agency, the Ministry for Environment and Water (MEW), and the National Centre of Radiobiology and Radiation Protection (NCRRP), which have determined admissible values for the content of radioactive substances in the effluents (air and water). In addition, Kozloduy NPP has specified reference levels for every radioactive component in the discharges, which are significantly lower than the admissible levels.

The information about the Kozloduy NPP radioactive discharges to the environment is reported to the European Commission on an annual basis.

In 2016, the results from the radiation monitoring of the liquid and gaseous discharges to the environment were again indicative of the high level of the efforts made, and of the technological facilities good performance. The trend to keep the concentration of radioactive substances in airborne discharges to the environment considerably below the reference levels is preserved. The radioactive noble gases (RNG) and radioactive aerosol emissions do not exceed 0.02% of the respective reference levels, while the iodine-131 (^{131}I) emission is 0.002% of the reference level. Since 2010, Kozloduy NPP has also monitored the content of ^{14}C and ^3H in the spent air. In 2016, the discharges of ^{14}C and ^3H were 2.5% and 0.3%, respectively, of the reference levels established for the site.

The content of radioactive substances in the liquid effluents remained significantly lower than the reference levels. The total activity (excluding tritium) of the drain waters accounted

Total activity of airborne and liquid discharges in % of statutory annual limits for the plant site



for 0.01% of the annual limit. The tritium content in the liquid discharges was approximately 14% of the annual limit. The low levels of radioactive discharges from Kozloduy NPP also made for the very low dose exposure values for the public in the plant area. The assessed maximum individual effective dose to the public for 2016 is 5.66 $\mu\text{Sv/a}$. According to studies conducted by the International Commission on Radiological Protection, this result means that the

radiological risk for the residents in the plant surroundings is negligible and complies with the best international practices. Compared further, the dose exposure assessments for the public over the years show that the additional exposure due to the discharges from Kozloduy NPP is on the average about 500 times lower than the one coming from the natural background radiation.

RADIOACTIVE WASTE MANAGEMENT

The liquid and solid radioactive waste (RAW) generated in the process of operation of the nuclear power plant do not exceed the design limits, and a downtrending is observed. In 2016, 600 m³ of compactible solid radioactive wastes and 30 tons of non-compactible solid radioactive wastes were generated. The whole amount was delivered for processing to the State Enterprise Radioactive Waste (SE RAW). The emptying of solid RAW temporary storage facilities located

in the EP-2 Auxiliary Building 3 continued, and 63 m³ of waste arisings were handed over during the year. When processing waters, 180 m³ of radioactive concentrate were generated and transferred to SE RAW for final processing, according to an approved time-schedule. The liquid RAW storage facilities indicated a trend towards tanks' free volume increase.

SPENT NUCLEAR FUEL MANAGEMENT

The spent nuclear fuel (SNF) at Kozloduy NPP is stored in compliance with all relevant safety requirements. After being kept for a certain period in the special spent fuel pools (SFP) located at the reactors, the fuel is transferred to the pool-type fuel interim wet storage facility (WSF), which is common for all the units. The dry spent fuel storage facility (DSF) stores spent nuclear fuel from Units 1, 2, 3, and 4 loaded in CONSTOR 440/84 casks inside the WSF. During the planned outage of Unit 5 in 2016, 48 fuel assemblies were transferred from the reactor to SFP-5. Ninety-six assemblies with spent fuel were transferred for wet storage from SFP-5 to the WSF. During the refuelling

outage of Unit 6, 37 spent fuel assemblies were moved from the reactor to SFP-6. Eighty-four assemblies with spent fuel were transferred for wet storage from SFP-6 to the WSF. As of 31 December 2016, the WSF stores a total of 2976 spent fuel assemblies from the two reactor types (2340 from WWER-440, and 636 from WWER-1000). There are 756 WWER-440 spent fuel assemblies stored in the dry spent fuel storage facility. In 2016, the BNRA, IAEA and EC carried out a total of fourteen inspections of the spent nuclear fuel pools at Units 5 and 6, the wet spent fuel storage facility, and dry spent fuel storage facility.

EMERGENCY PLANNING AND PREPAREDNESS

An essential aspect of securing Kozloduy NPP safety is maintaining a high level of emergency planning and preparedness of the power plant. For this purpose, an emergency response plan has been developed which incorporates a system of measures for effective limitation and mitigation of the consequences of potential accidents, natural disasters and calamities. To secure good organisation and a high level of preparedness of the response personnel in case of emergency events, theoretical and practical training is delivered, and emergency drills and exercises are implemented on an annual basis. In 2016, 1066 employees of the nuclear power plant were trained in emergency planning and emergency preparedness. In compliance with the approved annual schedule, three emergency drills and one general emergency exercise were

carried out. The topic of the general exercise was "Primary circuit coolant leakage into the containment through a pressuriser safety valve while Unit 6 is in operation, with bypass of the containment; accident suppression and activation of the Kozloduy NPP Framework Post-Accident Recovery Plan". One drill for simultaneous notification of the national headquarters, the district and the municipal coordination headquarters, and the Kozloduy NPP management team was also carried out, with activation of the Off-Site Emergency Plan of the power plant, as well as a national drill for testing of the early notification system within the 30-km Urgent Protective Action Planning Zone. The analysis of the exercise and drills results in 2016 verified the preparedness of the plant emergency response teams

to act in any emergency situations, as well as the good coordination and communication between the plant and the

national structures involved in the emergency planning and preparedness.

PHYSICAL PROTECTION

Ensuring a modern and reliable security system is of key importance for the operation of nuclear facilities.

Kozloduy NPP physical protection includes a combination of technical and organisational measures, tools and methods, targeted at effective prevention of illegal impacts and offences of nuclear material, nuclear facilities and radioactive substances, their timely detection and termination.

An open switchyard strategic zone was set up, as part of the Kozloduy NPP strategic site, in order to achieve compliance with the most recent regulatory requirements for protection of strategic sites. Additional measures for enhancing the security systems software safety were successfully implemented, so that they offer adequate response to cyber threats. Last year, a concept for enhancing the air threats protection capability for Kozloduy NPP was developed by experts from the Rakovski National Defense Academy. The scheduled activities related to the development of nuclear

security culture were regularly carried out. Specialised training courses were delivered to Kozloduy NPP police department employees by lecturers from the Security Division, on issues related to the plant's physical protection. The traditionally good interaction and coordination with the Ministry of Interior structural units – the Kozloduy NPP Police Department, District Directorate, and the structural units of the Border Police Chief Directorate were maintained also during the last year. New off-road vehicles, equipped according to the police standards were procured to enhance the efficiency of the response groups.

No violations of the nuclear power plant physical protection system were committed in 2016. A review performed by the BNRA, and a security monitoring by the Ministry of Interior concluded that Kozloduy NPP security system complies with the relevant national requirements and international standards, and is effective against potential threats.

FIRE SAFETY

Kozloduy NPP strictly observes the requirements of the fire safety (FS) laws and sublegislative acts in force in the Republic of Bulgaria. The company applies the best international practices and state-of-the-art technologies in this area.

The purpose of maintaining a high level of fire safety in the nuclear power plant is to effectively protect the staff and production process, nuclear facilities, nuclear material, and radioactive substances from fire and combustion products; also to eliminate and/or restrict as far as possible the risks from fire, and to improve the practical knowledge about fire safety of the plant employees.

To this end, a number of engineering and organisational in-depth fire protection measures are being applied, in compliance with the provisions of the IAEA Safety Guide "Protection against Internal Fires and Explosions in the Design of Nuclear Power Plants".

A total of 504 inspections were conducted in 2016 to check the adherence to the fire safety rules and standards, 39 terms of reference were agreed, and 101 statements on fire security of different site facilities were issued. Continuous training on fire safety was delivered to the operating staff and the responsible persons of each administrative unit.

The comprehensive review on the actual state of Kozloduy NPP fire safety held in June by the Fire Safety and Civil Protection Chief Directorate – Sofia, and the Fire Safety and Civil Protection Regional Directorate – Vratsa, confirmed the good organisation and adherence to the fire safety rules and standards in the Company. A technical inspection to assess

the insurance risk as regards fire safety of Kozloduy NPP conventional island was conducted by leading Bulgarian and international insurance companies; it ascertained good risk management and high level of safety in the nuclear power plant.

The permanent downtrend established for occurrence of fire events proves the efficiency of the organisational and technical measures in place at Kozloduy NPP.





RADIOECOLOGICAL MONITORING

The Kozloduy NPP radioecological monitoring covers all the major environmental components – air, water, soil, vegetation, food, etc., in compliance with European and national standards. The scope, range and monitored parameters are stipulated in a long-term programme agreed with the BNRA, the National Centre for Radiobiology and Radiation Protection (NCRRP) at the Ministry of Healthcare (MH), and the Executive Environment Agency (ExEA) at the Ministry of Environment and Water (MEW). The Programme fully complies with the relevant national and European regulatory requirements including Article 35 of the EURATOM Treaty, Recommendations of EC 2000/473/EURATOM and 2004/2/EURATOM. A parallel independent monitoring is carried out by the control bodies – the Executive Environment Agency and the National Centre for Radiobiology and Radiation Protection. The implementation of monitoring programmes is subject to regulatory oversight by the BNRA. The monitored area includes the plant industrial site, the 2-km Precautionary Action Zone (PAZ), the Bulgarian area of the 30-km Urgent Protective Action Planning Zone (UPZ), and benchmark points within the 100-km radius around the plant on Bulgarian territory. The measurements are performed in fixed monitoring posts and through field measurements with a mobile laboratory passing along specified routes. Air, water, soil, vegetation, crops, milk, fish, etc. samples are collected periodically for analysis. The background gamma radiation is constantly measured in the settlements in the region. Broad public access to the radiation situation information is provided. Over 4 300 analyses of the radioactivity in more than 2 500 samples of different environmental elements were conducted throughout 2016.

The quality of performed analyses and measurements is ensured by annual participation in prestigious international inter-laboratory benchmark meetings and competence tests involving reference samples.

The results of radiological indicators from the analyses of plant environmental samples in 2016 are within the background levels specific for the region; no impact from the nuclear power plant operation has been found. The human-induced activity levels detected are many times below the permissible limits for the relevant radiological indicators and analysed samples, which confirms that the radiological situation is completely favourable. The results of the internal radiation monitoring are verified by the independent radioecological studies under MEW and NCRRP programmes.

The background gamma levels at the on-site monitored points and measurement points within the 100-km zone for 2016 were fully comparable with and do not deviate from the natural gamma background specific for the region. There is an automated information system for radiological monitoring (AISRM) with a total of 13 local measuring posts in different populated areas, for information of the public in the 30-km zone around Kozloduy NPP. The data is displayed on information boards in public places and transmitted through wireless on-line connection to the central station at Kozloduy NPP and thence to the Executive Environment Agency. The system data also show values within the natural background limits.

The human-induced atmospheric activity was close to the background values (average of $2 \mu\text{Bq}/\text{m}^3$) and is many times below the permissible limits according to Regulation on Basic Norms for Radiation Protection (BNRP) of 2012. No



radiological effects due to the operation of Kozloduy NPP on the water of the Danube river, and drinking water sources in the region were observed. The total beta activity of the water from natural ponds ranges between 0.02 – 0.13 Bq/l, which is below 30% of the maximum permissible limit of 0.5 Bq/l stipulated in Regulation H-4/2012. The content of tritium in the samples from the open ponds is around the Minimum Detectable Activity (MDA) of up to 2.7 Bq/l. The radiological condition of drinking water complies with the health standards (Regulation No. 9 of 16 March 2001). The total beta activity measured in the regional drinking water sources ranges between 0.021 and 0.10 Bq/l. Tritium above the MDA has not been detected (average of 2.8 Bq/l). The human-induced soil activity has not been affected by the operation of Kozloduy NPP. In 2016, the activity of ^{137}Cs varies to 40 Bq/kg, the average value being 10 Bq/kg. The activity of ^{90}Sr ranges between 0.2 and 3.1 Bq/kg, which is typical for the soils in this geographic region. The human-induced activity in the vegetation studied is within the standard limits

– ^{137}Cs to 2.5 Bq/kg and ^{90}Sr – to 3.6 Bq/kg. The radioactivity of the staple foods produced in the region, such as milk, agricultural crops, etc., is within normal background radiation levels, much below the relevant permissible limits (Regulation No. 10 of 2002). The human-induced activity of fish in the Danube river, up- and downstream the Kozloduy NPP site, is studied. The results are consistent with the data from the previous years of operation and with the period preceding the plant commissioning, confirming the lack of impact from Kozloduy NPP on the staple foods and ichthyofauna in the region.

Since 2012, all the main analytical activities performed by the Radioecological Monitoring Department have been accredited by the Bulgarian Accreditation Service (BAS) according to BDS EN ISO/IEC 17025, which is an evidence of the competence and the high quality of the performed analyses. In 2016, after an audit carried out by the BAS, the validity of the accreditation was extended to 2020.

PUBLIC DOSE EXPOSURE MONITORING

Verified and validated modelling evaluation codes are used for calculating the additional public dose exposure. They are based on the CREAM methodology adopted by the European Union (EU) and have been adapted to the geographical and hydrological specifics of the Kozloduy NPP area. The results are verified by independent oversight of NCRMP/MH and are compared with published data for the evaluated doses to the population by the EU power plants (EURATOM) – European Commission radiation protection No. 176, 2013 "Implied

doses to the population of the EU arising from reported discharges from EU nuclear power stations and reprocessing sites in the years 2004 to 2008".

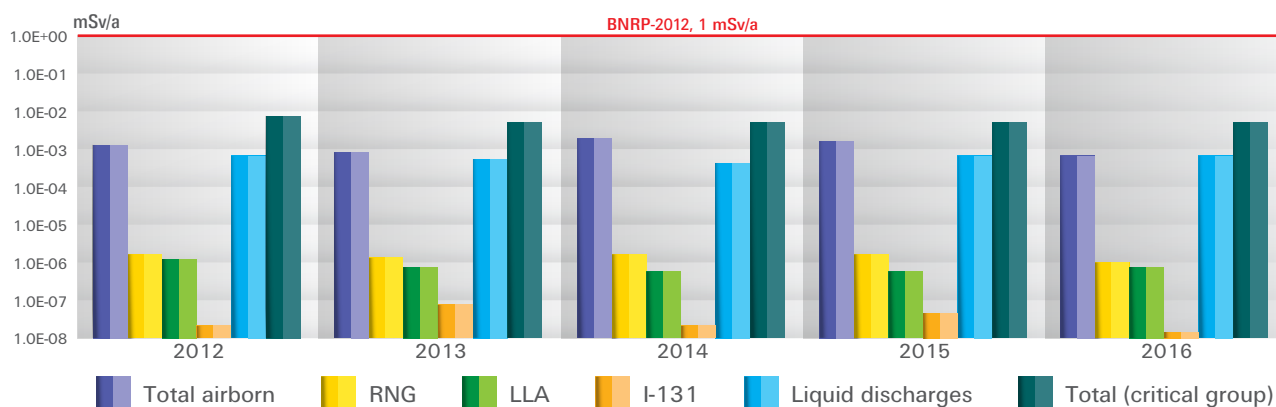
In 2016, the maximum individual effective dose for a critical group of the population from the Urgent Protective Action Planning Zone, total airborne discharges and liquid discharges from Kozloduy NPP to the environment is conservatively evaluated at 5.66 $\mu\text{Sv/a}$. This is only 0.2% from the natural radiation background exposure for the country (2.33 mSv/a),



and 0.6% from the norm for the population (1 mSv/a) as per BNRP-2012. The public collective dose within the 30-km UPZ is 0.03 manSv, (BNRP-2012, Additional provisions, item 17). The results are commensurate with those for the nuclear power plants in the EU, as well as worldwide. Over

the past 10 years, the values of the maximum individual effective doses to the population have varied in the range of 4÷7 μ Sv/a, which is several times below the natural radiation background exposure and negligible compared to the annual public limit.

Dose exposure to the population within the 30-km Urgent Protective Action Planning Zone due to radioactive discharges to the environment



ENVIRONMENTAL MANAGEMENT – NON-RADIOLOGICAL ASPECTS

An Environmental Policy has been introduced and implemented at Kozloduy NPP EAD, in compliance with the international environmental standards. The main goal of Kozloduy NPP Environmental Policy is securing such level of safety of the nuclear power plant, whereof the short- and

long-term impacts on the environment, staff and population ensure preservation of natural systems and maintain their integrity and viability.

In consistence with the regulatory environmental requirements, the company was issued 11 environment



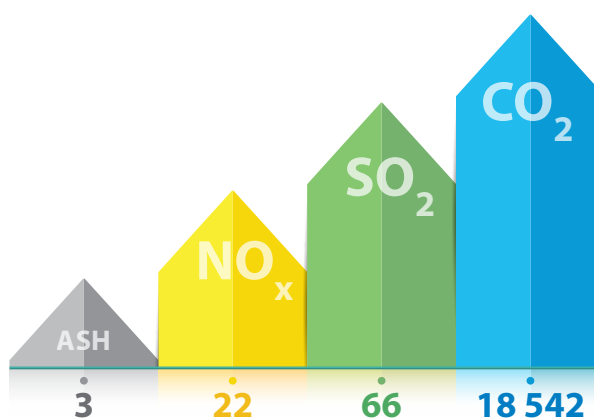
related permits which are kept up-to-date – for transport and disposal of non-radioactive waste, water usage, discharge of waste waters, greenhouse gas emissions, activities with hazardous chemical substance, etc. In 2016, all the conditions and measures in the permits were fulfilled. The fees payable according to the Water Act were promptly paid and the required information, reports and papers were prepared for the competent environmental authorities. The documents for modification and extension of the validity of the permit for waste water discharge to the main discharge channel until 2020 were submitted in January.

In accordance with the new Regulation on Prevention of Large Accidents with Hazardous Chemical Substances and Limiting the Consequences thereof (in force as of 19.01.2016), a notification was submitted to the MEW for updated classification of Kozloduy NPP under art. 103, para.2 from the Environmental Protection Law, as a company with high risk potential regarding the use of hydrazine hydrate and low risk potential regarding the use of diesel fuel. A new safety report and a report on Kozloduy NPP policy in that field were produced. The documents were provided for public access in the Executive Environment Agency (ExEA). An emergency drill entitled "Nitric acid spill in reagents facility" was held in the end of 2016.

In 2016, samples from surface, underground and waste waters were taken and analysed according to the Programme for In-House Monitoring of Waters during the Operation of Kozloduy NPP, and the Programme for Monitoring of Landfill for Non-Radioactive Household and Industrial Waste. The analyses were performed by the accredited laboratories: Regional laboratory – Vratsa with the ExEA; test laboratory

EcoLab with DIAL LTD; laboratories of the Engineering Chemistry Section, Quality Division, and Radioecological Monitoring Department, Safety Division of Kozloduy NPP. The results from the analyses of 3 000 water samples show that there was no upward trend in the monitored indicator values. There were no recorded values exceeding the permissible limits resulting from the operation of Kozloduy NPP, and the values remain close to those from previous years. The annual report on the results from the plant non-radiological environmental monitoring in the area of Kozloduy NPP was prepared and submitted to the Executive Environment Agency and Regional Inspectorate of Environment and Water – Vratsa.

Greenhouse gas and harmful gas emissions savings of Kozloduy NPP as compared to conventional thermal power plants, in 2016 (thousand tons)



In pursuance of the Programme for Management of the Non-Radioactive Waste Activities, in 2016, Kozloduy NPP handed over 84.3 tons of hazardous waste to licensed external organisations for further safe treatment.

A construction debris clearing contract was signed during the year, for wastes located in areas around Kozloduy NPP, and their utilisation in a project for strengthening the discharge canal banks of the cooling water outlet 1. All the areas with construction debris were cleared by the end of the year.

The construction and assembly works were completed and Stage 2 of the Non-Radioactive Domestic and Industrial

Waste Landfill was prepared for commissioning, with design operating life by 2032. A project for closing out and restoration of Stage 1 was approved, in compliance with the regulatory requirements.

In 2016, nine inspections were carried out by the Vratsa Regional Inspectorate of Environment and Water, and 7 – by the Pleven Water Management Basin Directorate for the Danube Region, which clearly confirmed that the Kozloduy NPP activities were performed in full conformity with the environmental regulatory requirements and the relevant permits issued.

HEALTH AND SAFETY AT WORK

Work conditions at Kozloduy NPP are maintained in compliance with the requirements of the national regulatory acts in force in. Risk assessment programmes, harmonised with the IAEA recommendations, international practice, and national regulations are implemented. They cover all the activities related to industrial safety, with the obligations resulting from the regulatory requirements on health and safety at work. Priority is given to prevention and encouragement of safety enhancement and employee healthcare solutions. Relevant training is delivered every year in order to maintain the staff awareness as regards the observation of health and safety rules during work.

Working environment parameters are regularly measured by laboratories to eliminate or minimise specific factors. Compliance with regulations is assessed on a systematic

basis, and corrective actions are prescribed, if necessary. The nuclear power plant employees are provided with personal protective equipment, free food, reduced working hours, compulsory occupational accident risk insurance of workers with greater occupational hazard.

The industrial safety accident rate at national and industry level, established by the Regulation on compulsory occupational accident risk insurance of workers/employees (prom. SG issue 15/2006), at Kozloduy NPP is traditionally lower than the values determined on an annual basis for the country and the energy sector with an order of the Ministry of Labour and Social Policy. For 2016 the rate at Kozloduy NPP is 0.38 – a considerably lower value than the mean value for the sector, which is 1.22, or the mean for the country – 0.66.



PROGRESS ON THE PROJECT OF KOZLODUY NPP UNITS 5 AND 6 LIFETIME EXTENSION

The Kozloduy NPP project for Units 5&6 Lifetime Extension is a large-scale one, combining a great number of long-term activities, on account of which they have been strategically allocated into two major implementation stages.

Stage 1: Ageing management review and residual life assessment of the equipment and facilities of Kozloduy NPP Units 5 and 6.

The comprehensive assessment of both units was undertaken over the years 2012 – 2014 by a Contractor with adequate expertise and experience, ensuring the required high quality of performance to guarantee that incontestable justification is obtained for extending the lifetime of Units 5 and 6. The necessary technical and organisational measures resulting from the comprehensive assessment of the actual condition and evaluation of the equipment residual lifetime and the timeframes for ensuring the lifetime of structures, systems and components are scheduled for implementation at Stage 2 of the Project.

Stage 2: Progress on the Programmes for Preparing Units 5&6 for Lifetime Extension (this stage is now complete for Unit 5, and ongoing for Unit 6).

The Project Management Plan for Stage 2 of Kozloduy NPP Units 5 and 6 Lifetime Extension has been developed. It identifies the scope of activities, the resources needed, dates, stages, deliverables and reporting documents for Stage 2 of the project. It regulates the organisational aspects, roles and responsibilities during the implementation of the project activities, the communications among the project manager, the team members, contractors, BNRA, etc.

The activities have been allocated in five areas, taking into account their specific focus or functional principle. The safety related measures concerning mechanical equipment, I&C systems, and civil structures have been identified

in the Programmes for Preparing Units 5&6 for Lifetime Extension (Stage 2 of the Project). The activities include analyses, calculations, time-limited ageing analyses for major and auxiliary equipment of the reactor plant, studies of the reactor building containment, the diesel generator stations (DGS) and cable ducts between DGS and the reactor building, as well as assessment of the underground trunk pipelines, spray ponds, etc.

The implementation of the plant life extension project is a dynamic process that requires timely amendments to the investment intents and the temporal and financial resources planned, cancelling some measures or developing new ones. The updated project management plan for Unit 5 Lifetime Extension includes 242 measures to be completed by the end of its licensing term. Of these 208 have been already complete, the remaining 34 are currently performed in accordance with the conservative approach adopted by Kozloduy NPP. On Unit 6, the total number of measures planned to be completed by the end of its current licensing term is 202, of which 48 have already been performed.

In 2016, the plant and respective subcontractors proceeded with the implementation of Stage 2 activities of the Programmes for Preparing Units 5&6 for Lifetime Extension. Over the year, all activities were delivered to time and in conformity to the updated documents for Stage 2 management.

The professional project management involves quality assurance and control, change management system for the projects on individual measures, efficient communication among workplace experts, holding of technical council meetings and working meetings, also project progress review meetings with the contractors.

UNIT 5 LIFETIME EXTENSION PROJECT STAGE 2 ACTIVITIES IN 2016

In 2016, the following was undertaken and complete: non destructive testing of equipment and pipelines on the primary and secondary sides; dismantling of 5HM, HN 03, 04 panels and replacing them with seismically qualified ones; activities as per the Programme for Condition Assessment of the centralised radiation monitoring information and measurement system; replacement of display devices in the main control room and emergency control room; replacement of thermal control sensors; additional survey of the DGS – mechanical part and partial assessment of the generator; further ageing management review activities on civil structures.

All the activities regarding main primary side equipment and civil structures contracted with the Consortium JSC Rusatom Service, JSC Concern Rosenergoatom and EDF have been completed.

On 25 October 2016, approval was granted to the final Report on the Performance of the Programme for Preparation for

Lifetime Extension of Kozloduy NPP Unit 5. The reporting document describes the safety related measures performed, subject to control on behalf of the BNRA. The Report forms part of the package of documents issued to the BNRA on 27 October 2016 for the purpose of Unit 5 operating licence renewal.

Each measure's completion is documented in a close-out report that acknowledges the implementation of recommendations resulting from the SSCs comprehensive assessment throughout Stage 1 of the Project, and confirms the actions taken by Kozloduy NPP for renewal and maintenance of the operating licence for Unit 5 as part of the long-term operation activities.

Regarding the contract with JSC Rusatom Service for equipment on the Unit 5 secondary side, 14 deliverables were reviewed, agreed and approved covering quality assurance, methodologies, survey work programmes, periodic reports and technical reports.

The final reports confirmed the operability and justified the possibility of extending the operating life of Kozloduy NPP Unit 5 (by 30 years) to 2047, subject to the conditions and modes of operation, frequency

and scope of maintenance and repair, in conformity with the requirements of the currently effective regulatory and operating documentation, as well as the accepted operating conditions.

UNIT 6 LIFETIME EXTENSION PROJECT STAGE 2 ACTIVITIES IN 2016

Under the contract for Unit 6 primary equipment and civil structures, awarded to a Consortium JSC Rusatom Service and Risk Engineering Ltd., the plant experts have checked, agreed and approved a total of 66 deliverables on quality assurance, methodologies, equipment survey work programmes and technical reports.

In line with the developed programmes and time-schedule, during the 2016 outage of Unit 6 and in the time between outages, the full scope of activities was performed as envisaged by the 54 programmes.

The SSCs condition surveys included non-destructive testing and measurements of the primary circuit main equipment, the heat exchanging equipment on the primary and secondary side involving tanks, heat exchangers and pipelines, pumping equipment (11 pump types), valves inclusive of safety and control ones (54 pcs.), the refuelling machine and the polar crane, the DGS mechanical part; the

support-suspension system for the main equipment (primary and secondary circuits), cabling including containment penetrations and motors; and safety systems synchronous generators.

On the instrumentation and control systems replacement was undertaken of the display devices, new LED signalisation panels were installed in the main and emergency control rooms, while the centralised radiation monitoring information and measurement system underwent recertification.

On the civil structures non-destructive tests were conducted such as concrete carbonation depth measurement, ultrasonic thickness measurement, and corrosion survey of the rebars. The ageing management review covered the DGS, the cable ducts between the reactor building and the DGS, the reactor building itself and the stack, the containment over the reactor building.



FINANCIAL PERFORMANCE

Kozloduy NPP EAD closed the year 2016 with good production and economic performance indicators which ensured financial stability of the Company.

The total income of Kozloduy NPP EAD amounted to BGN 839 million, which is BGN 12 million less compared to the previous year. This reduction is due to the smaller revenue from electricity sales on the two market segments.

The revenue from electricity sales was BGN 809 million, which is 96% in the total income structure, and it plays a key role in the financial and economic performance of the Company. The price drop on the electricity market in the period February – September, and the reduced demand during the second and the third quarters of the year had an adverse effect on the reported levels. As a result, the revenues from deregulated market electricity sales amounted to BGN 674 million, compared to BGN 681 million in 2015, in spite of the reported 7.5% market sales growth rate. The revenues from regulated price sales for 2016 were BGN 135 million, with a decrease of BGN 9 million compared to the previous year. This deviation is a result of the decline in electricity sales (316 395 MWh), due to the smaller quota determined by the Energy and Water Regulatory Commission for the current regulatory period compared to the previous one.

In relation to the participation on the balancing electricity market, the Company concluded contracts to purchase electricity deficits and sell surplus electricity in order to compensate for grid imbalances in the country. This led to BGN 60 thousand drop in the electricity sales income, which is several times more favourable figure than the reduction of BGN 4.7 million reported in 2015, as a result of implemented

measures for replacement of non-generated energy through purchase from another producer.

The total operating costs for 2016 exceeded by BGN 108 million (15%) the figure for 2015. The key factor for this increase was the reported growth of costs related to the implementation of contracts for justification of the possibility for the extension of Units 5 and 6 operating life to 60 years, analyses, calculations and quantitative evaluations of the residual lifetime of the structures, systems, and components – these were extra costs, in addition to the normal operating expenses of the nuclear power plant. The timeframe of the contracts implementation is 2015 – 2018, but their biggest share is in 2016.

Other contributors are the increased variable costs of the Company based on the obligation of Kozloduy NPP EAD to allocate monthly payments to the Electricity System Security Fund (ESSF) to the amount of 5% from electricity revenues, and the increased depreciation costs resulting from replacement and placing into service of new long-term tangible assets related to the implementation of the projects for the operating life extension of the two units, and their power uprate to 104%.

The company's profit after taxes amounts to BGN 1.4 million. Implementing an effective liabilities management policy during the past 2016 contributed to the reduction of the Company's debt. Instalments amounting to BGN 44.2 million were paid, as well as interest to the amount of BGN 2.8 million on the Units 5 and 6 Modernisation Programme long-term loan from the European Atomic Energy Community (EURATOM), obtained in 2000, pursuant to the provisions of



the Loan Agreement.

The improvement of the incoming cash flows of the Company from deregulated electricity sales over the last months of 2016 allowed for implementing measures for closing in advance of an overdraft credit to the amount of BGN 30 million. Through effective allocation of cash depending on the financial needs and the optimisation of the cash flows, all the payments throughout the year for covering the annual ongoing costs and for implementation of a complex of long-term investment actions were realised with own funds.

Kozloduy NPP EAD closed the year 2016 without overdue payments. All due payments for securing the next fuel campaigns of Units 5 and 6, obligatory insurance costs, payments to the Nuclear Facilities Decommissioning, Radioactive Waste, and Electricity System Security Funds, were effected in time. Payments to staff and social security institutions were also effected, as well as payments under the maintenance and investment programmes contracts. Financing was provided for the Company's priority activities related to the safe operation of the nuclear facilities, and the implementation of the investment projects for Units 5 and 6 lifetime extension and their thermal power uprate. BGN 291 million were paid to the state and municipal budgets in 2016. That included the payments of BGN 125 million to the Nuclear Facilities Decommissioning, Radioactive Waste, and Electricity System Security Funds, BGN 125 million for taxes and fees, and BGN 41 million for social security and health insurance contributions.

The decision of the single owner of the capital, BEH EAD, to sign a cession agreement with Kozloduy NPP EAD for

transfer of receivables from NEK EAD amounting to BGN 40 million in return for consideration, of a dividend due to BEH for the year 2015, had a positive effect on the financial situation and improvement of liquidity.

As of 31 December 2016, the financial assets of Kozloduy NPP EAD amounted to BGN 76 million.

The tables below show the key indicators of the Company's activity results, assessment of status and performance (year-on-year).



FINANCIAL PERFORMANCE INDICATORS

Nº	BGN thousand	Report 31.12.2016	Report 31.12.2015	Difference 2016/2015 (%)
c.1	c.2	c.3	c.4	c.5=(c.3/c.4)-1
1	Total operating income	839 079	851 105	-1.41%
2	Total operating costs	(834 681)	(727 166)	14.79%
3	EBITDA ¹⁾	183 239	284 148	-35.51%
4	EBIT ²⁾	4 398	123 939	-96.45%
5	EBT ³⁾	1 145	121 909	-99.06%
6	EBIT margin	0.5%	14.6%	-96.40%
7	EBITDA margin	21.8%	33.4%	-34.59%
8	Total assets	3 341 672	3 424 589	-2.42%
9	LTA ⁴⁾	2 759 914	2 836 880	-2.71%
10	Working capital ⁵⁾	325 710	329 552	-1.17%
11	Cash	76 018	89 851	-15.40%
12	Equity	2 608 757	2 657 738	-1.84%
13	Return on equity ⁶⁾	0.04%	4.59%	-99.04%
14	Return on assets ⁷⁾	0.03%	3.56%	-99.04%

¹⁾ EBITDA – earnings before interest, taxes, depreciation and amortization from continuing operation

²⁾ EBIT – earnings before interest and taxes from continuing activities

³⁾ EBT – earnings before taxes from continuing activities

⁴⁾ LTA – long-term tangible assets + expenses on LTA acquisition)

⁵⁾ Working capital – current assets minus current liabilities

⁶⁾ Return on equity – EBT/Equity

⁷⁾ Return on assets – EBT/Total assets

FINANCIAL STATEMENT

	Assets	31 December 2016 BGN thousand	31 December 2015 BGN thousand
Non-current assets	Property, plant, and equipment	2 759 914	2 836 880
	Intangible assets	5 908	5 573
	Investment property	4 059	3 034
	Investments in subsidiaries	15 161	15 161
	Loans granted to related parties	14 940	17 090
	Other long-term receivables	-	3 630
	Available-for-sale financial assets	232	232
	Non-current assets	2 800 214	2 881 600
Current assets	Nuclear fuel	224 810	235 901
	Inventories	60 320	59 156
	Trade and other receivables	57 983	56 133
	Loans granted to related parties	2 352	2 860
	Receivables from related parties	119 459	98 471
	Income tax receivables	516	617
	Cash and cash equivalents	76 018	89 851
	Current assets	541 458	542 989
	Total assets	3 341 672	3 424 589
	Equity and liabilities		
Equity	Share capital	236 165	196 493
	Legal reserves	19 649	16 561
	Revaluation reserve of non-financial assets	1 385 591	1 385 905
	Reserve from remeasurements of defined benefit liability	(30 524)	(19 883)
	Other reserves	984 126	984 126
	Retained earnings	13 750	94 536
	Total equity	2 608 757	2 657 738
Non-current liabilities	Liabilities		
	Loans	105 004	147 788
	Retentions on construction contracts	87	1 471
	Financing	185 509	190 689
	Liabilities for employee retirement benefits	44 073	24 375
	Deferred tax liabilities	182 494	189 091
	Non-current liabilities	517 167	553 414
Current liabilities	Trade and other payables	124 302	103 853
	Related party payables	1 051	11 377
	Loans	44 268	46 058
	Financing	6 036	1 047
	Retentions on construction contracts	3 522	5 776
	Liabilities for employee retirement benefits	6 627	15 384
	Income tax liabilities	-	-
	SNF provision	29 942	29 942
	Current liabilities	215 748	213 437
	Total liabilities	732 915	766 851
	Total equity and liabilities	3 341 672	3 424 589



STATEMENT OF PROFIT OR LOSS AND OTHER COMPREHENSIVE INCOME FOR THE YEAR ENDED 31 DECEMBER

	2016 BGN thousand	2015 BGN thousand
Revenues from electricity sales	809 553	825 181
Revenues from heat sales	2 010	2 026
Sales Revenue	811 563	827 207
Financing income	3 744	1 006
Income from sales of services, goods, and other sales	23 772	22 892
Material costs	(147 492)	(159 156)
Hired services costs	(174 594)	(117 141)
Staff costs	(190 309)	(184 463)
Depreciation and amortization	(178 841)	(160 209)
Other costs	(133 240)	(115 674)
Changes in work in progress	(10 266)	8 935
Acquisition of self-constructed property, plant, and equipment	61	542
Operating profit	4 398	123 939
Financial costs	(4 271)	(4 562)
Financial income	1 018	2 532
Earnings before tax	1 145	121 909
Income tax income/(expense)	214	(9 518)
Profit for the year from continuing operations	1 359	112 391
Loss for the year from discontinued operations	-	(29 957)
Profit for the year	1 359	82 434
Other comprehensive income:		
Items not reclassified to profit or loss		
Revaluation of defined benefit liability	(11 824)	(15 467)
Revaluation of non-financial assets	(22)	1 063 034
Income tax related to items not reclassified subsequently to profit or loss	1 184	(104 756)
Other comprehensive income/(loss) for the year, net income from tax	(10 662)	942 811
Total comprehensive income/(loss) for the year	(9 303)	1 025 245



CASH FLOW STATEMENT FOR THE YEAR ENDED 31 DECEMBER

	2016 BGN thousand	2015 BGN thousand
Operating activities		
Proceeds from customers	855 829	941 056
Payments to suppliers	(321 507)	(295 914)
Payments to staff and social security institutions	(185 103)	(183 654)
Payments for fees, commissions, and the like	(36)	(192)
Payments to the RAW, NFD, and ESS Funds	(124 895)	(100 556)
Income taxes received/(paid)	(5 096)	(16 394)
Cash flows related to other taxes and payments to the state budget	(97 138)	(101 821)
Insurance-related cash flows	(9 876)	(10 706)
Other cash flows from operating activities	45 411	54 665
Net cash flows from continuing operations	157 589	286 484
Net cash flows from discontinued operations	-	(15)
Net cash flows from operating activities	157 589	286 469
Investing activities		
Acquisition of property, plant, and equipment	(127 967)	(173 474)
Proceeds from sale of property, plant, and equipment	3	3 200
Proceeds from loans	2 634	1 372
Interest received	475	531
Dividends received	529	712
Net cash flows from investment activities	(124 326)	(167 659)
Financing activities		
Repayments of loans	(44 251)	(44 251)
Interest paid	(2 845)	(3 628)
Net cash flows from financing activities	(47 096)	(47 879)
Net change in cash and cash equivalents	(13 833)	70 931
Cash and cash equivalents at the beginning of the year	89 851	18 920
Cash and cash equivalents at the end of the year	76 018	89 851



INVESTMENT PROGRAMME IMPLEMENTATION

In 2016, the total amount of funds invested as per the Investment Programme (IP) was BGN 122 558 thousand, originating from Kozloduy NPP own funding. The long-term assets commissioned throughout the past year have a value of BGN 118 035 thousand.

A considerable portion of the IP items completed over the reporting year served to achieve the key priority objective of maintaining and enhancing safety, and of the strategic goals for extending the operating life of Units 5&6 and uprating their design thermal power to 104%. Funding also went towards a number of activities ensuing from the Programme for Implementing of the Recommendations from the Stress Tests conducted on the nuclear facilities, and activities of the Lifetime Management Programme for the Dry Spent Fuel Storage Facility.

The investment activities for ongoing maintenance of the power units, auxilliary facilities and infrastructure were accomplished as per plan.

Activities towards safety enhancement of Kozloduy NPP, meeting the licensing conditions or provisions of regulatory documents

The implementation of such activities aims at ensuring nuclear safety, radiation protection and environmental protection of the power units in operation and the radioactive materials management process at Kozloduy NPP.

The sum of BGN 18 186 thousand was invested toward this aim in 2016, to finance the development of a technology and a model for conducting the chemical flushing of the steam generators secondary side at Units 5&6; bear the expenses for the operation licence issued by the BNRA for the Dry Spent Fuel Storage Facility (storing WWER-440 spent

fuel assemblies); implement the procurement contract for WWER-1000 spent fuel storage baskets; upgrade the aerosol monitoring system, etc.

Progress on the Units 5 and 6 Lifetime Extension Project

The investment costs paid toward this project in 2016 amounted to BGN 18 303 thousand. The sum financed activities in the contract for Development of a Feasibility Justification for Kozloduy NPP Unit 5 Lifetime Extension to 60 Years, Analyses, Calculations and Quantitative Assessments of the Residual Lifetime of the SSCs; procurement of test benches and spare parts for the hydraulic snubbers; modernisation of the main circulation pumps, type ГЦН 195-M; procurement and installation of pumps for the planned cooling-down of the primary circuit, low pressure side; replacement of the Ø630 pipeline running between the shaft pumping stations to the spray ponds with high density polyethylene pipes; replacement of panels 5HM, HN03, 04 with seismically qualified ones; etc.

All the activities were completed to scope and date as set in the project time-schedule.

Reactor Thermal Power Uprate up to 104%

The amount invested in this project was BGN 53 940 thousand.

The activities performed include procurement of a new stator for the Unit 5 generator, retrofitting of the TBB-1000-4 Y3 type generator rotor, and retrofitting the БВД-4600-1500 Y3 exciter to ensure operation at 1100 MW. The installation works are scheduled to be implemented during the Unit 5 outage in 2017.



Justification has been prepared of the safety, and the modifications of structures, systems and components during the switch-over to an advanced type of nuclear fuel, including amending the Updated Safety Analysis Report. A contract is in progress on the development of an advanced nuclear fuel cycle and justification of the Kozloduy NPP Units 5 and 6 safe operations using modified nuclear fuel at thermal power level of 3120 MW. Activities have been fulfilled on the contracts for modernising of the temperature measurement system in the primary circuit circulation loops. Cables have been procured for the equipment in the response action area under LOCA conditions on Units 5 and 6.

A contract is under way for dismantling of the existing Q=125/20-t crane, and the design, supply and installation of an electric double girder overhead bridge crane with a crab of Q = 160/20t lifting capacity for Unit 5, at elevation 29.5.

Software and hardware development has been finalised for the emergency and alarm protection instrumentation, automatic reactor-power regulator, and reactor-power limiting device, in connection with increasing the thermal power of Units 5&6 to 104%.

The second stage of upgrading of the separation systems of steam generators type ПГБ-1000М is ongoing.

Actions ensuing from the stress tests and the National Action Plan of the Republic of Bulgaria

The fields covered are subject to re-evaluation within the framework of the conducted stress tests, and to additional measures envisaged in the National Action Plan.

In 2016, the reported costs amounted to BGN 1 651 thousand, and went toward implementation of a contract for design of a system measuring the volumetric concentration of gases

inside the Units 5&6 containment buildings; launching a procedure for installation of this system; replacement of measurement devices with seismically qualified ones; preparing a detailed design for a new crisis management centre; measures against flooding in case of high water levels of the Danube; construction of buildings to house the mobile diesel generators; power supply of 0.4 kV-MDG facilities at Units 5&6; etc.

Investment activities for routine maintenance of the nuclear power generating units, auxilliary facilities and infrastructure

The maintenance costs invested in 2016 for main and auxilliary facilities related to ensuring the normal operation of the common plant facilities and those supporting the plant generating activities amounted to BGN 30 478 thousand. The sum financed the procurement of spare parts for the Babcock and Sempell valves, control valves, replacement of 220 kV breakers – stages 1 and 2 of this procurement contract are already complete, etc. The instrumentation and control systems at Auxilliary Building 3 were modernised in view of enhancing the operating conditions.



INTERNATIONAL COOPERATION

International cooperation is an important contributor to achieving the top priority of Kozloduy NPP – ensuring of the highest level of safety in the operations of nuclear facilities. The sharing of good practices and the efficient information exchange on global experience is attained through close cooperation with the International Atomic Energy Agency (IAEA), the World Association of Nuclear Operators (WANO), and other international organisations and leading nuclear energy companies.

With the support and active participation of Kozloduy NPP specialists, in 2016, a large number of technical or working meetings and workshops were held in connection with the plant's membership in international and national non-governmental organisations as well as within the framework of bilateral cooperation with other nuclear power plants, specialised nuclear energy research or regulatory institutions. Throughout the past year, representatives of the Bulgarian nuclear power plant took part in a number of review missions and inspections such as the OSART mission of IAEA in Cernavoda NPP (Romania), WANO peer reviews at Paks NPP (Hungary), Chinon NPP and Saint Laurent NPP (France), Leibstadt NPP (Switzerland), WANO technical support missions in Kola NPP branch of JSC Atomenergoremont, Novovoronezh, Smolensk and Leningrad NPPs (Russia); Loviisa NPP (Finland), Sizewell B NPP (UK), Zaporizhzhya, Khmelnytska and South-Ukraine NPPs (the Ukraine), and also in other international nuclear forums.

An important international review was conducted by the IAEA – the pre-SALTO mission, at Unit 5 of Kozloduy NPP, in mid 2016. This is the first of a series of SALTO peer reviews at Kozloduy NPP in support of the Units 5 and 6 lifetime

extension process, while the main SALTO peer review of the plant has been scheduled for 2020.

From 26 July to 3 August, 2016, the IAEA representatives reviewed the completeness of the actions planned by the plant and their compliance with the IAEA safety standards and guidelines, as well as with internationally recognised practices. The team of reviewers obtained detailed knowledge of the large-scale Modernisation Programme implemented in 1995 – 2008 on Units 5 and 6, and also of the currently completed activities at the plant and the progress achieved in delivering the two stages of the Project for Lifetime Extension of Units 5&6. The review team leader highlighted that Kozloduy NPP staff had put a lot of effort in preparing the nuclear facilities for long-term operation and in doing so had reached satisfactory progress and completed a large scope of engineering activities.

The Moscow Centre of the World Association of Nuclear Operators (WANO – MC) undertook a Corporate Peer Review (CPR) of Kozloduy NPP EAD (31 October – 3 November) and the Bulgarian Energy Holding EAD (4 – 9 November). The team reviewed the current status of seven corporate areas (performance objectives) at BEH and Kozloduy NPP, namely corporate leadership, governance, oversight and monitoring, independent oversight, support and performance, human resources, and communications. Eight highly qualified and experienced experts from Finland, the USA, Sweden, Hungary, Slovakia, the Ukraine, and Russia participated in the WANO peer review team. Some of them were representatives of the WANO Moscow Centre, or the regional centres in Atlanta and Paris. An expert from the International Atomic Energy Agency also took part in the CPR, in the framework



of cooperation between the two organisations. The excellent atmosphere of cooperation during the peer review was highlighted on behalf of WANO. Together with the proposed two areas for improvement, the World Association of Nuclear Operators also identified a strength at the corporate level to be shared with the global nuclear community.

Under the cooperation plan between Kozloduy NPP and WANO – MC, in March the plant hosted a technical support mission entitled: Best Practices of Pre (Post)-Job Briefing for Maintenance Activities. An international workshop was organised in June on the subject of Severe Accident Management. The topics discussed included modern trends and good practices in modelling of severe accidents, supplementing the range of simulation on full-scope simulators with severe accident models, and incorporating of modifications related to the workshop theme.

In the past year, Kozloduy NPP hosted two international benchmarking meetings. During the first one together with specialists from Paks NPP (Hungary) and Cernavoda NPP (Romania) experience was shared and discussions held on the plants' performance in the areas of Safety Culture, Operating Experience, Performance Improvement, Human Factor and Emergency Preparedness. Another item discussed was the progress on implementing the WANO recommendations provided in SOER 2013-2, Post-Fukushima Daiichi Nuclear Accident Lessons Learned. A meeting was held on the topic of Configuration Management at Nuclear Power Plants. Attendees from the SS "Scientific and Technical Center", NNEGC "Energoatom" (the Ukraine), discussed the experience of Kozloduy NPP in implementing the configuration management system; the information

system for organisation of operational activity (IS OOA); the design change management; the document management, the control and update of design documentation at the plant, the SmartDoc data base, and the procedure for recovery of missing design documents.

A further high recognition of the place and role of Kozloduy NPP within WANO was provided by Mr. Anatoliy Kirichenko, first deputy director of the WANO Moscow Centre. He visited the plant on the 12 August, heading a delegation of the Tokyo Centre that consisted of experts from Japan, South Korea, India, and Pakistan. The purpose of the visit was to gain an insight of the activities of the Kozloduy NPP on-site representative office of WANO – MC. Mr. Kirichenko extended thanks to the Kozloduy NPP for its active contribution to the advancement of the Moscow Centre and underlined that with its open and highly professional performance, the plant ranks among the best ones within the Association.



HUMAN RESOURCES MANAGEMENT

The Human Resources Management Policy of Kozloduy NPP corresponds to the main objective stated by the plant management – safe, efficient and environmentally-friendly energy generation through supporting an adequate number of certified, well-trained and highly-motivated staff.

The plant has set up a recruitment system ensuring the appointed candidates meet the necessary educational and qualification criteria and possess suitable practical skills. The system has been developed in accordance with the IAEA requirements and the world's best current practices in the field, ensuring that the main priority is given to providing a high level of safety in the operation of nuclear facilities.

The staffing level is maintained as required to secure the

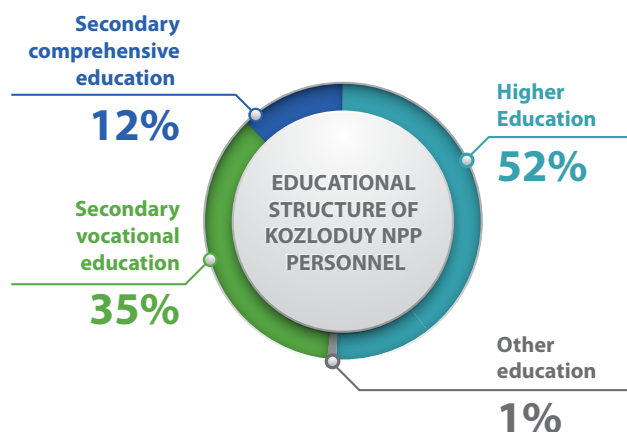
activities of the nuclear power plant. Through the current recruiting and appointment system, in 2016, a total of 158 workers and employees were appointed to the existing vacancies, of which 104 employees signed permanent employment contracts, and 54 – fixed-term contracts for seasonal jobs, temporary replacement of absent workers/employees, etc.

The predominant part of the newly appointed personnel – 62%, have a university degree; 42% of the newcomers are below 30 years of age.

The average age of the plant employees is 45, and the average working experience in the Kozloduy NPP – 17 years.

HIGHLY QUALIFIED AND WELL-TRAINED PERSONNEL

One half of the plant personnel hold university degrees, while one third have graduated secondary vocational schools. The highest percentage of the new employees – 62%, have engineering degrees in nuclear and thermal energy, power supply and electrical equipment, automation, instrumentation and control equipment; different civil and industrial construction engineering specialities, machine building; computer systems and technology, etc. The rest have degrees in business and economy, or specialities related to public protection and environmental protection, as well as in areas such as marketing, management, law, etc.





MOTIVATION OF KOZLODUY NPP PERSONNEL

The motivation level of Kozloduy NPP personnel has been subject of relevant analyses since 2007. The data from these surveys provide an insight into the work environment factors that influence the workers' motivation.

The ten-year survey results indicate high degree of motivation (exceeding 50%) as per the work environment sub factors such as: Trust in Interpersonal Contacts, Safety at Work and Healthcare, Work Performance Self-assessment, Teamwork, Management Skills of the Supervisor (Line Manager), Freedom of Action, Leadership Skills of the Supervisor (Line Manager), Recognition for the Efforts Made, Quality of Personal

Protective Equipment, Resources for Work and Provision of Training, Duties and Responsibilities, Supervision by the Line Manager Regarding the Adherence to the Safety Rules, Internal Communication, Improving of Working Conditions, Underlying Individual Development Programmes, and Attitudes towards Trade Unions.

The most recent motivation survey was conducted from 1 to 23 December 2016. It covered 380 employees from all the plant organisational units. The results point to a significant rise in the level of the Freedom of Action and Specific Plans for the Future subfactors.

TAKING CARE OF THE FUTURE SPECIALISTS

Among the key values of Kozloduy NPP are the care for young people and the support for their professional development and growth. Particular attention is paid to attracting well-trained young specialists, to whom to transfer the specific nuclear knowledge and experience accumulated in the nuclear power plant.

To this end, the plant is regularly involved in career forums organised by various higher education institutions. This allows young people to get first-hand knowledge on internships, the personnel recruitment and appointment procedure of Kozloduy NPP, and career development opportunities.

The nuclear power plant's appearance at career forums or exhibitions enjoys great popularity and interest among students. In 2016, the plant participated in a number of such events, oriented to the young – "Internships 2016", "Career

Days" (at Technical University of Sofia), the "Internships" forum at the Sofia University St. Kliment Ohridski, etc. In September, the plant took part in the Employment Exchange organised by the Kozloduy Municipality.

In the summer months, fifteen university students were allocated to various organisational units of the plant where they successfully completed their paid internship programmes. Assisted by their coaches, they developed subjects related to the plant activities and technology processes, and, following the longstanding tradition, they defended their newly adopted knowledge at presentation events specially arranged for the purpose. Another eight students took individual, non paid internship terms, thus expanding and enriching their academic training in the chosen subjects.



PERSONNEL TRAINING

Kozloduy NPP has established and applied a personnel training and qualification system ensuring conformity with the relevant national requirements and international standards. At the state-of-the-art Training Centre the necessary conditions are created to provide high-quality training.

The training process at the nuclear power plant sets goals that are consistent with the priority stated in the plant's Management Policy for maintaining certified, competent and motivated personnel – enforcing a high level of safety culture; developing a corporate culture in which qualification is of crucial importance; effective use and management of personal and corporate knowledge; encouraging the

acquiring of the necessary knowledge, skills and positive attitude to work.

In compliance with the Act on the Safe Use of Nuclear Energy, the specialised training for activities in nuclear facilities shall be delivered by a training organisation licensed by the regulatory body to provide such services. Kozloduy NPP has assigned these functions and responsibilities to the Personnel and Training Centre Division. In October 2016, the licence for conducting specialised training for operations with nuclear facilities and sources of ionising radiation was renewed for another five-year period.

HIGH STANDARDS

Kozloduy NPP conducts compulsory specialised training for acquiring, maintaining, and improving the knowledge and skills related to the nuclear facilities operations and maintenance. It is based on the requirements of the systematic approach to training – a methodology internationally acclaimed and used by most of the nuclear power plants. The specialised training proceeds in conformity with the initial or continuing training programmes; individual training programmes are developed for the licensed personnel; the rest of the personnel are trained in accordance with approved curriculum schedules. The specialised training is delivered at the Training Centre premises, or at workplaces, employing different formats such as classroom, simulator and practical training.

The same training requirements apply to both the plant's

and subcontractor's personnel assigned to perform activities in nuclear facilities.

The Training Centre provides a varied resource base for the conduct of quality training being equipped with modern training aids, classrooms, a mock-up room, workshops for hands-on exercise on real equipment. In 2016, refurbishment began of premises intended for hands-on training of individuals carrying out activities in the RCAs of Units 5 and 6.

The full-scope simulator (FSS) for reactor type WWER-1000 is continuously upgraded in line with the current state of the reference Unit 6 of Kozloduy NPP. The operating personnel performing functions related to ensuring and control of nuclear safety receives specialised initial and continuing training on the full-scope simulator. Therefore,



37 of the Unit 6 engineering solutions were identified for inclusion in the full-scope simulator configuration throughout the year. A new audio-visual system has been

installed for monitoring or recording of FSS classes from the instructors' booth at the facility.

THEORY AND PRACTICE

Besides theoretical and practical training in the training rooms and workshops of the Training Centre, the knowledge and skills of the staff is further enhanced in realistic working environment. In 2016, more than 7 300 classes were dedicated to practical training, assisted by more than 60 instructors. These classes covered various subjects related to the actual operations and maintenance activities of the trained personnel.

In the reporting year spring and autumn semestres, initial and continuing trainings sessions were held with reactor operators at the FSS, as well as initial training for VVER-1000 operator

instructors. Comprehensive analyses of the EP – 2 operators' practices resulted in the compiling of a specific Simulator Training Manual, used during the autumn semestre in 2016, and five other Guidebooks intended for use in the 2017 training classes.

In 2016, group visits, internships and professional practice terms were organised and carried out for 53 students and 8 lecturers from different study courses and programmes at the technical universities in Sofia and Varna, and the Sofia University St. Kliment Ohridski.

INNOVATION AND FUTURE OUTLOOK

In 2016, Kozloduy NPP introduced the ESTRA e-learning platform both for on-site and off-site personnel. This provides for greater flexibility in training planning so as to respond in a timely manner to the needs of the learners, while taking into account to the maximum degree the workload of the trainees. The e-learning platform creates the conditions for simultaneous training of practically unlimited number of people who can progress at their own speed while located at any place where they have access to the Internet. In addition to the induction courses – "Introduction to NPP" and "Radiation Protection (level 1/external organisations)" adapted to the e-platform in the past year, and two continuing training programmes for the plant personnel, in 2017 more

than 10 most commonly used courses and curricula are to be provided for e-learning.

In order to develop the opportunities for e-learning, the Training Centre works jointly with international partners to provide 6 web-based multimedia courses on different production process topics.

In terms of the successful international cooperation, in 2016, three groups of students at the Belarusian State University took one-week studies at the Training Centre. The longstanding interest on behalf of our Belarusian partners is another evidence of the high quality training offered at Kozloduy NPP and the professionalism of the Training Centre team.



PUBLIC RELATIONS

Providing objective, timely and accurate information is a priority in Kozloduy NPP communication with the public. In order to satisfy as far as possible the interest in one of the most high-tech companies in Bulgaria, the nuclear power plant follows a policy of openness and transparency in presenting all the aspects of its performance – generation, safe operation, social activities, etc.

In pursuit of these policies, an active dialogue was maintained over the year with media representatives, different groups from the general public, scientific and professional circles. Along with the up-to-date information published on its corporate site, www.kznpp.org, where nearly 500 000 hits were registered during the year, the nuclear power plant continued to actively use a number of communication channels, amongst which sending press releases to the mass media; preparation and free dissemination of printed materials such as the "Parva atomna" newsletter, leaflets, brochures, etc., consistent with the age and professional profile of the readers; showing topical documentaries, delivering presentations. The meetings and talks with NPP nuclear energy experts, and obtaining of personal impressions through the arrangement of visits to the plant – individual or group ones, and the traditional Doors Open Day initiative – are of great importance. For those willing to get their own view of Kozloduy NPP operation, the plant provided opportunities to Bulgarian and foreign citizens to look around

different facilities on the site – control rooms and turbine halls of the nuclear power units, the open switchyard, the Training Centre with the full scope simulator of WWER-1000 units, laboratories of the radioecological monitoring department, etc. The visitors' attention was attracted also by the interactive displays located in the Information Centre premises which show unique photographs from Kozloduy NPP construction period, attractive aerial video footage, as well as a virtual tour of the plant site. Attention to the largest generating capacity in Bulgaria retained high levels during the past year – the nuclear power plant received 1020 visitors, about 60% of which were young people, children and students from all over the country.

Obtaining feedback on the degree of public confidence in the operation of Kozloduy NPP is of particular importance. During the year, surveys were conducted among the adult Bulgarian visitors to the plant, involving 456 respondents. The purpose was to find out their attitude towards nuclear energy, the Bulgarian nuclear power plant, and their opinion on its future. The Kozloduy NPP future outlook related to the operating lifetime extension of the existing and construction of new units, is supported by two thirds of the persons inquired in 2016. The distribution of the obtained answers also shows that the majority of the respondents – about 90%, unconditionally accepted the need for nuclear energy, and this is a persistent trend.



АЭС "Роза Худой" 5 и 6 БЛОК

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0.13 μ Sv/h
Температура 24 °C



Kozloduy NPP EAD
Kozloduy 3321
phone: 0973 7 20 20
fax: 0973 8 05 91
e-mail: info@npp.bg
www.kznpp.org