ENVIRONMENTAL IMPACT ASSESSMENT REPORT

for Investment Proposal:

BUILDING A NEW NUCLEAR UNIT OF THE LATEST GENERATION AT THE KOZLODUY NPP SITE

Annex 1: Non-Technical Summary

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Corrections		
Section	**Cause and nature of amendment**	**Review**
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NAMES AND ABBREVIATIONS

COMPANIES

Kozloduy Nuclear Power Plant – New Build EAD, Owned by **Kozloduy Nuclear Power Plant EAD**	Called hereunder **Investor**
Dicon-Acciona Eng. Consortium	Called hereunder **Contractor**

ABBREVIATIONS

AA	Appropriate Assessment
AIS AMB	Archaeological map of Bulgaria Automated Information System
AQ	Air Quality
ASUNE	Act on the Safe Use of Nuclear Energy
AER	Atomenergoproekt
AMS	Automatic meteorological station
BDWMDR	Basin Directorate for Water Management Danube Region
BPS	Bank Pump Station
BRPS	Basic Radiation Protection Standards
BSR	Basic Safety Rules
CC	Cool Channel
CH	Central Hall
CHL	Cultural Heritage Law
CM	Council of Ministers
CMV	Commodity Material Values
CPB	Common Purpose Building
CPS	Central Pumping Station
CZ	Clean Zone
DBE	Design Basis Earthquake
DCTC	Diagnostics and Control Test Center
DeC	Decommissioning
DFC	Degree of Flammability Coefficient
DGS	Diesel Generator Station
DHP	Deaerators High Pressure
Directive 2000/60/EC	Water Framework Directive
EA EMDR	Executive Agency for Exploration and Maintenance of the Danube River
EAD	Sole proprietor joint stock company
EBRD	European Bank for Reconstruction and Development

EEA	Environment Executive Agency
EG	Electric Generation
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
ELB	Engineering Laboratory Building
EMF	Electromagnetic Fields
EP	Environment Protection
EPA	Environment Protection Act
EPSW	Emergency pumps for technical water
EU	European Union
EUR	European Utility Requirements
EURATOM	European Atomic Energy Community
EES	Electric Energy System
FP	Fire Protection
FPM	Fine Particulate Matter
FPS	Fire-fighting Pumping Station
FS	Fire Safety
FSFS	Facility for Spent Fuel Storage under water
GIS	Geographical Information System
HA	Health Act
HC	Hot Channel
HLW	High Level Waste
HM	Heavy Metal
HMS	Hydro-meteorological Station
HTF	Hydro Technical Facilities
IAEA	International Atomic Energy Agency
IAR	Impact Assessment Report
ICPDR	International Commission for the Protection of the Danube River
ICRP	International Commission on Radiological Protection
ICV	Immovable Cultural Valuables
IED	Individual Effective Dose
IEL	Individual Emission Limits
IP	Investment Proposal
ISAR	Interim Safety Analysis Report
LLA	Long-lived aerosols
LN-HW	Landfill for Non-Hazardous Waste
LN-RMI	Landfill for non-radioactive municipal and industrial wastes
LWR	Light water reactor
MA	Monitored Area

MAC	Maximum Admissible Concentrations
MARAW	Middle Active Radioactive Waste
MC	Monument of Culture
MDA	Minimal Detectable Activity
MDBE	Maximum Design Basis Earthquake
MDC	Main Draining Channel
MoEW	Ministry of Environment and Waters
MH	Ministry of Health
MRD	Ministry of Regional Development
MSK	Medvedev–Sponheuer–Karnik scale
NCPHA	National Center for Public Health and Analyses
NCRRP	National Center for Radiobiology and Radiation Protection
NEN	National Ecological Network
NICM	National Institute for Cultural Monuments
NIICH	National Institute for Immovable Cultural Heritage
NIMH	National Institute of Meteorology and Hydrology
NNU	New Nuclear Unit
NPP	Nuclear Power Plant
NRA	Nuclear Regulation Agency
NSEM	National System for Environmental Monitoring
NSR	Nuclear Safety Rules
NAIM – BAS	National Archaeological Institute and Museum – BAS
OMO	Occupational Medicine Office
OSG	Outdoor Switchgears
PA	Protected Areas
PAZ	Precautionary Action Zone
PCBs	Polychlorinated Biphenyls
PCZ	Possible Centre Zones
PF	Products of Fission
PMG	Project Management Group
PPE	Personal Protective Equipment
PS	Pumping Station
PSA	Preliminary Safety Analysis
PWER	Pressurised Water Energy Reactor
PWR	Pressurised Water Reactor (general name of the series water energy reactor)
PZ	Protected Zones
RA	Road Accident
RAW	Radioactive Waste

RAWPS	RAW Processing Shop
RBMP	River Basin Management Plan
REM	Radio-ecological Monitoring
RES	Renewable energy sources
RHI	Regional Health Inspectorate
RHM	Regional Historical Museum
RIEW	Regional Inspectorate Environment and Water
RMS	Repair Mechanical Shop
RNG	Radioactive Noble Gases
RP	Radiation Protection
RPS	Radiation Protection Standards
S and SF	Supplies and Storage Facility
SASCEC	System of accelerographs for seismic control of the equipment and constructions
SB	Sanitary Buildings
SB	Special Building
SC	Storage Categories
SCEM	Storage of Contaminated Earth Masses
SCRAW	Storage for Conditioned RAW
SD DeC	Specialized Department for Decommissioning
SDA	Spatial Development Act
SE “RAW”	State Enterprise "Radioactive Waste"
SE “RAW-Kozloduy”	Specialised Enterprise for Radioactive Waste
SEWRC	State Energy and Water Regulatory Commission
SGU	Steam Generator Unit
SISP	System for industrial seismic protection
SMM	System for meteorological monitoring
SNF	Spent Nuclear Fuel
SP	Spray Pond
SPB	Spent Bundles Pond
STV	Specialised Transport Vehicles
SWT	Special Water Treatment
SZ	Surveillance Zone (30 km zone allotted for Radioecological monitoring, coincides with Urgent protective action planning zone (UPAPZ)
TC	Technical Control
TCS	Toxic Chemical Substances
TLD	Thermoluminescent Dosimeters
TS	Technical Safety
TTC	Training Technical Center
UACEG	University of Architecture, Civil Engineering and Geodesy

ULF	Ultra-low Frequencies
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
UPAPZ	Urgent Protective Action Planning Zone (30 km zone allotted for emergency planning (based on dose exposure), coincides with Surveillance Zone (SZ)
WA	Waters Act
WHO	World Health Organisation
WMA	Waste Management Act
WWER	Water-cooled water-moderated power reactor (water type of reactors)
WWTP	Waste Water Treatment Plant
ZS	Zavodski stroezhi

INTRODUCTION

The Environmental Impact Assessment Report on the Investment proposal for Building a new nuclear unit of the latest generation at Kozloduy NPP site was developed in accordance with Environment Protection Act (EPA), promulgated, State Gazette, No. 91/25.09.2002, amend. State Gazette No. 27 of 15 March 2013 and the Regulation on the terms and conditions for performing an environmental impact assessment, promulgated, State Gazette No. 25 of 18 march 2003, amend., Sate Gazette, No. 94 of 30 November 2012.

The Environmental Impact Assessment Report is in accordance with the requirements of the assignment to determine the scope and contents of the environmental impact assessment, corrected after consultations held with the competent decision-making authority on the Environment Protection Act and other agencies and institutions.

By the investment proposal of "Kozloduy NPP – New Build" EAD it is envisaged to build a new nuclear unit of the latest generation (Generation III or III+) with installed electric power of about 1200 MW. As it falls in the scope of Annex 1 of the Environment Protection Act, item 2.2 "Nuclear power stations and other nuclear reactors, including decommissioning or taking out of operation of such stations and reactors, except installation for production and processing of fissile or enriched materials, whose maximum capacity does not exceed 1 kilowatt constant thermal load". The investment proposal is subject to obligatory environmental impact assessment, the competent decision-making authority on the environmental impact assessment being the Minister of the Environment and Waters.

The project of the nuclear unit will correspond to the European requirements, described in the European Utility Requirements for LWR Nuclear Power Plants and to the Bulgarian statutory arrangement in the field of nuclear energy.

The new nuclear unit will appear as reliable and secure diversified energy source ensuring the necessary balance of electric energy (production-consumption) for the Republic of Bulgaria and will contribute in the long term to:

- → ensuring a reliable source of electric energy, guaranteeing the electrical energy balance of the country;
- → a maximum economic effect and minimum risk during the supply of energy resources;
- → ensuring energy from diverse sources;
- → maintaining of acceptable and stable prices of electric energy;
- → ensuring a reliable source of electric energy, emitting no carbon pollutants in the environment;
- → possibility to sell carbon emission quotas to third countries;

→ possibility to export electric energy.

The scope of the report is entirely coordinated with the requirements of Article 96, par. 1 of the Environment Protection Act and with Article 12 of the Regulation on the terms and conditions for performing an environmental impact assessment.

The principal objective of the report of the environmental impact assessment is to identify the components and the factors of the environment, which is expected to be affected as a result of the realisation of the investment proposal, the possible accumulation of the impacts, the risk of incidents and the possible trans-border impact. Consideration gas been given on an equal basis to three main technical and component decisions for reactor installations of the latest generation (Alternative A-1 (the equipment of Belene Nuclear Power Plant) and Alternative A-2 – incorporating 2 models of entirely new reactor designs) and 4 potential sites for the disposition of the new nuclear unit. The main task of the assessment is justification and motivation of the most suitable alternative decision, proposing also measures to reduce, prevent or possibly entirely eliminate the identified impacts on the environment and on the human health.

The Environmental Impact Assessment Report on the Investment Proposal: "Building of new nuclear unit of the latest generation at the Kozloduy Nuclear Power Plant site" has been formatted as a single document, pursuant to Article 12 of the Regulation on the environmental impact assessment and to the letter of the Ministry of Environment and Waters No. 26-00-1035 of 09.04.2013.

The complete Environmental Impact Assessment Report with the annexes, including the report on the impact level assessment will be presented to the Ministry of Environment and Waters for evaluation and making a Decision.

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1 ANNOTATION TO THE INVESTMENT PROPOSAL FOR BUILDING, ACTIVITIES AND TECHNOLOGIES

1.1 CURRENT STATE

1.1.1 HISTORY OF KOZLODUY NUCLEAR POWER PLANT

The beginning of nuclear energy production in Bulgaria was set by the signing of a cooperation agreement between Bulgaria and the former Soviet Union on 15 July 1966 to build a nuclear power plant. After a detailed technical and economic analysis the site for building a nuclear power plant was chosen on the bank of the Danube River not far from the Town of Kozloduy. The construction started on 14 October 1969. The construction of the main building of the 1st and 2nd unit of Kozloduy Nuclear Power Plant started on 6 April 1970.

The official commissioning of Kozloduy Nuclear Power Plant was on 4 September 1974. The building and the putting into operation of the nuclear capacities of the Bulgarian nuclear power plant was carried out in there stages:

- → I stage: 1970 – 1975 – Construction and launching into operation of 1st and 2nd Units with Pressurised Water Reactors WWER-440, model V-230 with two independent channels of the safety systems;
- → II stage: 1973 – 1982 – Construction and launching into operation of 3rd and 4th Units with Pressurised Water Reactors WWER, upgraded model V-230 with threefold reserve of the safety systems;
- → III stage: 1980 – 1991 – Construction and launching into operation of 5th and 6th Units with reactors WWER-1000, model V-320 with hermetical protection shell, threefold reserve of the safety systems.

In connection with the commitments undertaken by Bulgaria at accession to the European Union Kozloduy Nuclear Power Plant brought an end to the operation of the first four energy units before the expiry of their project resource, which was 30 fuel campaigns – **Table 1.1-1.**

TABLE 1.1-1: INFORMATION ON THE 1 – 4 UNITS OF KOZLODUY NUCLEAR POWER PLANT

Unit	Type of reactor and power, MW	Year of joining the energy system	Decommissioning of the units	Fuel campaigns	Produced electric energy in the operational period, MWh
Unit 1	VVER-440	1974	31.12.2002	23	66 675 397
Unit 2	VVER-440	1975	31.12.2002	24	68 905 334
Unit 3	VVER-440	1980	31.12.2006	22	68 703 260
Unit 4	VVER-440	1982	31.12.2006	21	66 711 966

1.1.1.1 ELECTRIC POWER PRODUCTION

In the year 2002 – the last one during which the nuclear power plant worked with all its six installed capacities, record production of electric power was produced – 20 221 719 MWh, being 47.3% of the total production of electric power in the country.
In 2006, with its four working units the nuclear power plant came near its peak production providing 19 493 219 MWh for the energy system of the country or 42.6 % of the electric power produced by on national level – **Figure 1.1-1**.

Since the beginning of 2007 only 5th and 6th units remain in operation: reactors WWER-1000 with security systems on three levels.

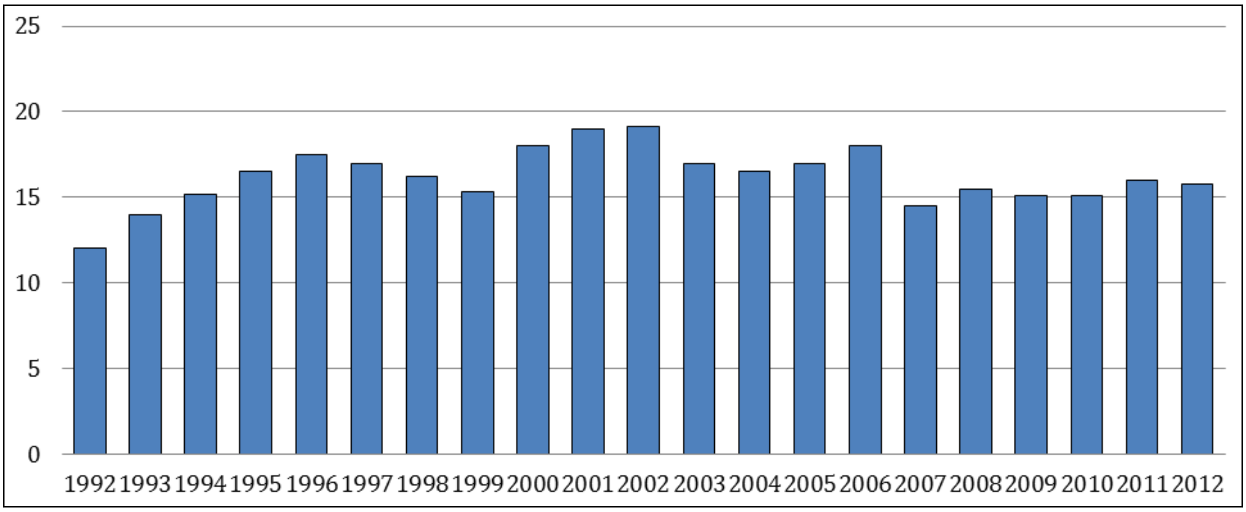

FIGURE 1.1-1: YEARLY PRODUCTION OF KOZLODUY NUCLEAR POWER PLANT

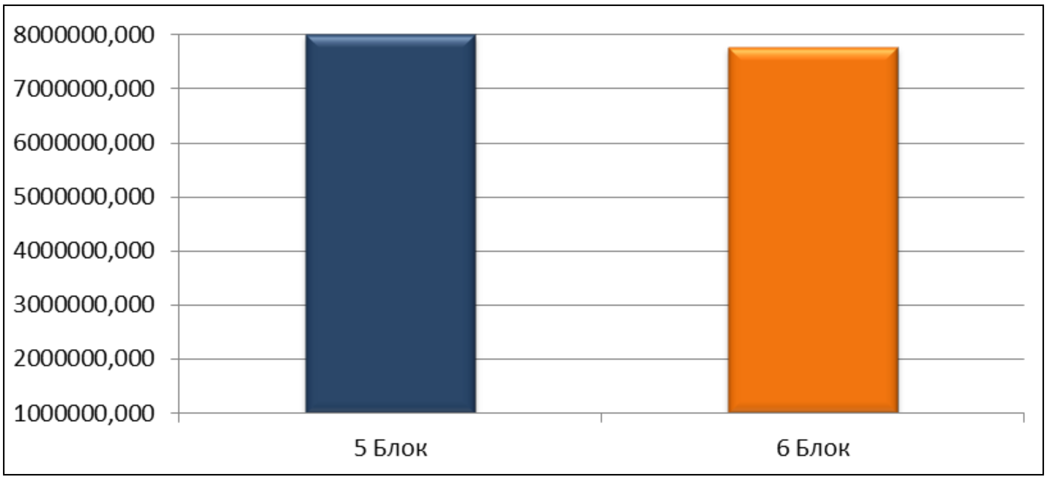

FIGURE 1.1-2: PRODUCTION IN THE PERIOD JANUARY – DECEMBER 2012

Figure 1.1-2 displays the yearly production in 2012 by each of the 5th and 6th units.

Kozloduy Nuclear Power Plant is one of the main factors of the sustainable development of electric power production in Bulgaria today and is an element of special importance for the energy mix in the country. The nuclear power plant has a great share in the national production of electric power.

1.1.1.2 NUCLEAR INSTALLATIONS AND GENERAL STATIONARY STRUCTURES AT THE SITE OF KOZLODUY NUCLEAR POWER PLANT

The site of Kozloduy Nuclear Power Plant is located in Northwest Bulgaria on the territory of Vratsa District and Kozloduy Municipality, mainly on the land area of the Town of Kozloduy and village of Hurlets. The site is 2.6 km southwest of the Town of Kozloduy, 3.5 km northwest of the village of Hurlets, 65 km north of the district centre – City of Vratsa and 200 km north of the City of Sofia. It is situated on the second non-flooding terrace of the river of Danube and its absolute altitude is + 35 m, at about 3.5 km of its right bank where the direction of the river is northwest to southeast. To the north the site borders with the Danube lowland and to the south – southwest – with the water shed plateau 90 m above the sea level.

There are no natural surface water forms – rivers, lakes, on the territory of Kozloduy Nuclear Power Plant. Inland rivers on the territory of the Republic of Bulgaria, which are nearest to the power plant, are the rivers of Ogosta and Skut to the east, the river of Tsibritsa to the west. Only the Danube River is of crucial importance for the operation and the security of Kozloduy Nuclear Power Plant. The elevation of the site was determined during the designing of the power plant with a reserve of non-floodability at flow of 10,000-yaerly high tide along the Danube River.

Dikes have been built between the site of Kozloduy Nuclear Power Plant and the Danube River dimensioned to withstand 1000-yearly high tide on the Danube river. The drainage systems have been dimensioned to take away surface water from intensive rains of diverse longevity and volume.

The Danube River is a superficial water body of the category river and name DanubeRWB01 and code BG1DU000R001, defined in the Danube region River basin management plan, which was prepared according to the requirement of Directive 2000/60 of the EU and the Waters Act and approved by Order No. 293/22.03.2010 of the Minister of Environment and Waters. The whole length of the Bulgarian part of the Danube River from the village of Novo Selo to the Town of Silistra is a receiving water of 3rd category, pursuant to Order No. RD-272/03.05.2001[1] of the Minister of Environment and Water. It is defined as heavily modified water body[2] with ecological potential "moderate", while its chemical state is bad, pursuant to Management of River Basin Plan of the Danube River region in this country and Letter No. 3804/08.01.2013 of the Danube Region Water Management Basin Directorate.

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[1] In the process of preparation of this Environmental Impact Assessment Report, Regulation) 7/1986 concerning indicators and norms of definition of the quality of flowing surface water was revoked by Regulation for evoke of Regulation No. 7, promulgated State Gazette, No. 22 of 05.03.2013

[2] Heavily modified water body is a surface water body – in this case a river, which has been substantially modified as a result of physical changes caused by human activity

At the moment the more important structures and installations built on Kozloduy Nuclear Power Plant (**Figure 1.1-3**) are:

- → Main building (reactor building and turbine hall) – the main buildings of units 1 and 2, as well as 3 and 4 are shared (all 8 turbine generators for units 1 to 4 are placed in a single machine hall);
- → Main building of units 5 and 6;
- → Special buildings 1 and 2 (SpB-1,-2) – they serve respectively units 1, 2, 3 and 4 of Electricity production -1; Special building 3 (SpB-3) – it serves units 5 and 6 of Electricity production-2
- → Chemical water treatment-1 – serves units 1 – 4;
- → Chemical water treatment -2 – serves units 5 – 6;
- → Central pump stations – 1 and 2 serve units 1 – 4, and Central Pump Station-3 and 4 serve units 5 and 6;
- → 2 diesel generator stations, which serve 1 – 4 units and 3 diesel generator stations, which serve units 5 and 6;
- → Open Distribution Arrangements composed of three parts: 110 kV, 220 kV, 400 kV;
- → Cold intake channel (CC-1);
- → Hot outlet channel (HC-1,-2);
- → Spray cooling ponds for units 1 – 6;
- → Spent fuel storage facility under water;
- → Dry spent fuel storage facility;
- → Oil and diesel facility in Electricity generation 1 and Oil and diesel facility in Electricity generation 2;
- → Fire fighting pump station -2;
- → Depot for non-radioactive domestic industrial waste;
- → Common purpose building -1 and Mechanical Repair Workshop in Electricity generation – 1, Common purpose building -2 in Electricity generation – 2 (unit 5 and 6);
- → Waste water treatment station – Electricity generation 2;
- → Sanitary and amenities building 1 and 2 in Electricity generation – 1;
- → Engineering and Laboratory building in Electricity generation 2;
- → Training and Technical Centre;
- → Information Centre;

→ Administration buildings: Kozloduy Nuclear Power Plant Management; Electricity generation 2 Management,; Investments Management, Engineering building of RandM Directorate

→ Warehouses (in the protected zone and out of it).

The site on which Kozloduy Nuclear Power Plant was built has an area of 4 471 000.712 square meters. Within this territory the following main zones have been separated:

1 Electricity generation -1, with 1÷4 energy units, special building 1 and 2, and auxiliary structures. Within the territory of this zone is located the spent fuel storage facility under water and the dry spent fuel storage facility. The operation of energy units 1 and 2 were terminated in 2002 and of energy units 3 and 4 – in 2006. At this moment units 1 – 4 have been declared as structures for radioactive waste management – property of Radioactive Waste State Enterprise.

2 Electricity generation 2, with energy units 5 and 6, special building 3 and auxiliary structures. A Radioactive waste processing facility, property of Radioactive Waste State Enterprise, is situated on this territory.

3 Territory of the incoming (cold) channel CC-1, the exit (hot) channels HC – 1 and HC – 2, as well as the installations of the Bank Pump Stations – all they supply technical water to the power plant.

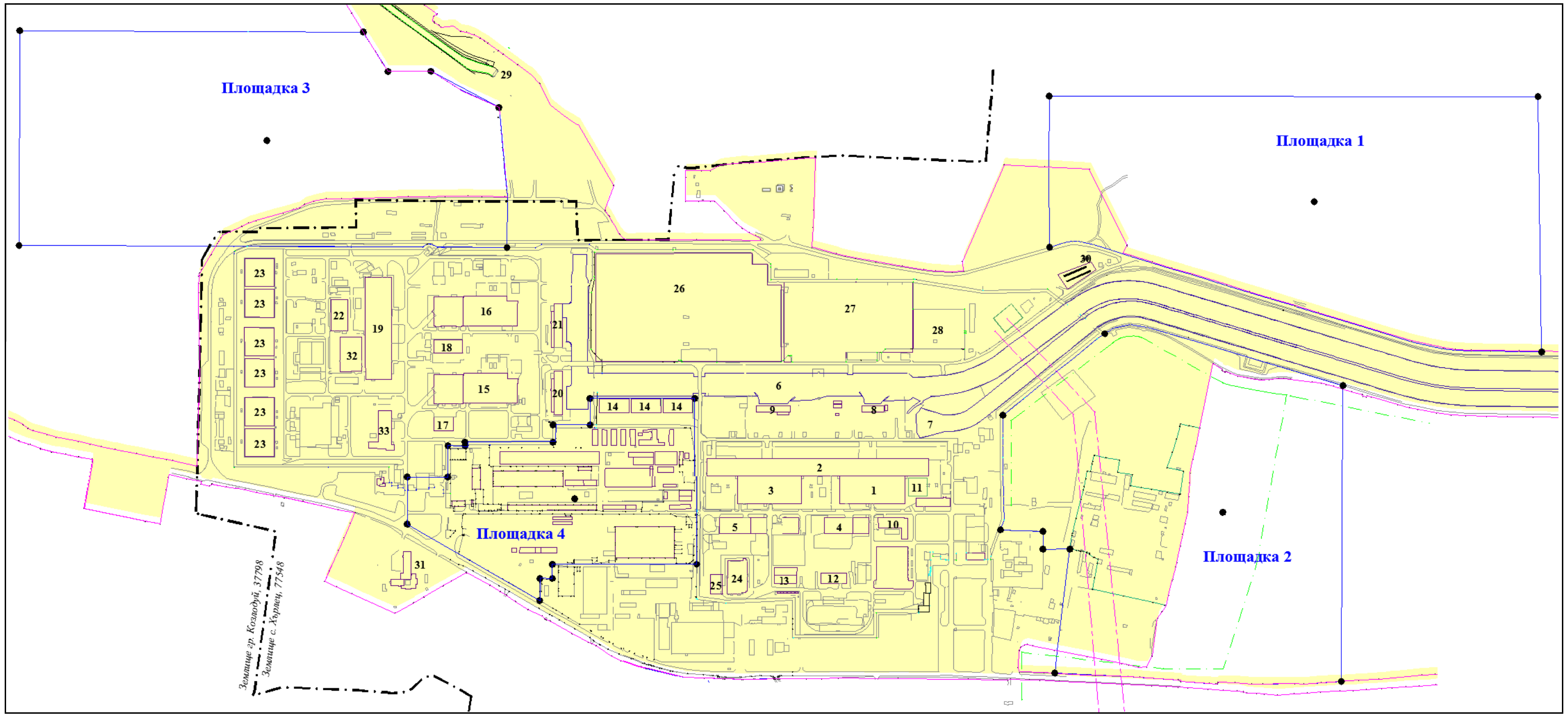

FIGURE 1.1-3: GENERAL PLAN OF THE KOZLODUY POWER PLANT AND DISPOSITION OF THE PROPOSED SITES OF THE NEW NUCLEAR UNITS

Legend:

1. Reactor section, unit 1 and 2
2. Machine hall unit 1 – 4
3 Reactor section, unit 3 and 4.
4. Special building 1.
5. Special building 2.
6. Cold channel 1.
7. Hot channel 1.
8. Circulation pump station 1.
9. Circulation pump station 2.
10. Chemical Workshop.
11. Workshop for size reduction and deactivation – project.
12. Diesel generator station 1.
13. Diesel generator station 2.
14. Spray ponds for units 3, 4.
15. Energy unit 5
16. Energy unit 6.
17. Diesel generator station unit 5
18. Diesel generator station unit 6.
19. Special building 3.
20. Circulation pumps station 3.
21. Circulation pumps station 4.
22. Warehouse for RAO.
23. Spray pond for units 5, 6.
24. Spent fuel storage facility.
25. Dry spent fuel storage facility.
26 Outdoor switchgear – 400 kV.
27. Outdoor switchgear – 220 kV.
28. Outdoor switchgear – 110 kV.
29. Hot channel 2.
30. Landfill for non-radioactive municipal and industrial wastes.
31. Base of the fire fighting protection unit.
32. A Radioactive waste processing facility of RAO State Enterprise.
33.Labour Medical Service.

1.1.1.3 SPENT NUCLEAR FUEL MANAGEMENT AT KOZLODUY NUCLEAR POWER PLANT

The spent nuclear fuel management is carried out through:

- ✓ pond for storing the bundles – serves to store within several years the bundles upon their taking out the active zone of the reactor aimed at reducing their activity, respectively their remaining energy generation before their transfer to the spent fuel storage facility;
- ✓ Spent fuel storage facility – it is designed for long-term storing under water of spent nuclear fuel. The design volume is filled with water, wherein the containers with the spent fuel bundles are placed. The water serves both for biological protection and for cooling the spent nuclear fuel;
- ✓ Dry spent fuel storage facility – the advantage of this decision is the elimination of transportation of the spent nuclear fuel out of the nuclear power plant site and the use of the existing nuclear power plant facilities without interference in the landscape. This decision is recommended also in the National Strategy for spent nuclear fuel and radioactive waste management until 2030, a time table having been developed to solve the problem of the high level radioactive waste at national level.

By storing the spent nuclear fuel the property over this material is retained and a possibility is ensured to use its energy resource in the future.

1.1.1.4 LONG-TERM MANAGEMENT OF RADIOACTIVE WASTE

The National Repository for Disposal of Radioactive Waste is aimed at burying used low and intermediate level short lived radioactive waste, which is generated during the operation of nuclear power plants, at decommissioning energy nuclear reactors and from other sources – medicine, scientific research, technical applications etc. According to a previously drawn timetable, which the Radioactive Wastes State Enterprise successfully observes, the first stage of the National Repository for Disposal of Radioactive Waste is scheduled to be completed by the end of 2015. Throughout the period of operation of the National Depot a strict entry control over the incoming radioactive waste, including radiation control and monitoring the area of the depot and the environment will be ensured.

It is planned that the depot will remain in operation, i.e. will be gradually filled in the next 60 years. In 2075 it is foreseen to shut it down and in the next 300 years to be subject of permanent control by the authorised authorities.

1.1.2 ON-SITE EMERGENCY PLANNING ZONES AT KOZLODUY NUCLEAR POWER PLANT

On the basis of the estimated analyses of all operational states of the existing units and of the radiological consequences, by Regulation on emergency planning and emergency preparedness in case of nuclear and radiological emergencies (Promulgated, State Gazette, No. 94 of 29.11.2011), the following zoned for emergency planning were determined, according to the Emergency Plan of Kozloduy Nuclear Power Plant EAD:

→ **On-site emergency planning zone at the site – protected zone No. 1**, the site of Kozloduy Nuclear Power Plant EAD.

→ **Precautionary protective action planning zone – zone No. 2,** having radius 2 km and geometrical centre between the ventilation pipes of 5th and 6th unit. The area of the zone is 12,566,000 square metres, of which 3,012,000 square meters, or 24% comprise the generation area of Kozloduy Nuclear Power Plant and the area for storage and processing radioactive waste of the Radioactive Waste State Enterprise. Its purpose is radiation prevention at emergencies.

→ **Urgent protective action planning zone**[3] **– zone No. 3** with **accepted radius of 30 km around** Kozloduy Nuclear Power Plant EAD and area of 284,874,000 square metres. Its role is to allow the necessary control for the purposes of the radiation protection:

- ✓ On the territory of the Republic of Bulgaria this zone comprises entirely the municipalities of Kozloduy, Valchedram, Hayredin, Mizia and partially the municipalities of Lom, Byala Slatina, Oryahovo, Boychinovtsi, Krivodol and Borovan. There are no big-scale Bulgarian industrial or military facilities inside the zone.
- ✓ On the territory of the Republic of Romania, 19[4] towns and villages of the districts of Dolzh and Olt are situated within the zone.

  (Kozloduy Nuclear Power Plant is obliged to carry out monitoring of the environment in case of emergency within a zone of 12 km)

The on-site emergency planning zones are divided into 16 sectors of 22.5° and are designated with the first 16 letters of the Latin alphabet from the north clockwise (A, B, C, D, E, F, G, H, J, K, L, M, N, P, R и S) – **Figure 1.1-4**. Depending on the emergency state, various measures of diverse character are carried out in the emergency zones to protect the staff and the population.

[3]The zone for immediate protection measures of 30 km is determined for the purposes of emergency planning. The same zone of 30 km for the purposes of radiation monitoring is called "Surveillance zone"

[4] Updated data for the territory of the Republic of Romania – letter of Kozloduy Nuclear Power Plant – New Capacities EAD No. 297/01.04.2013

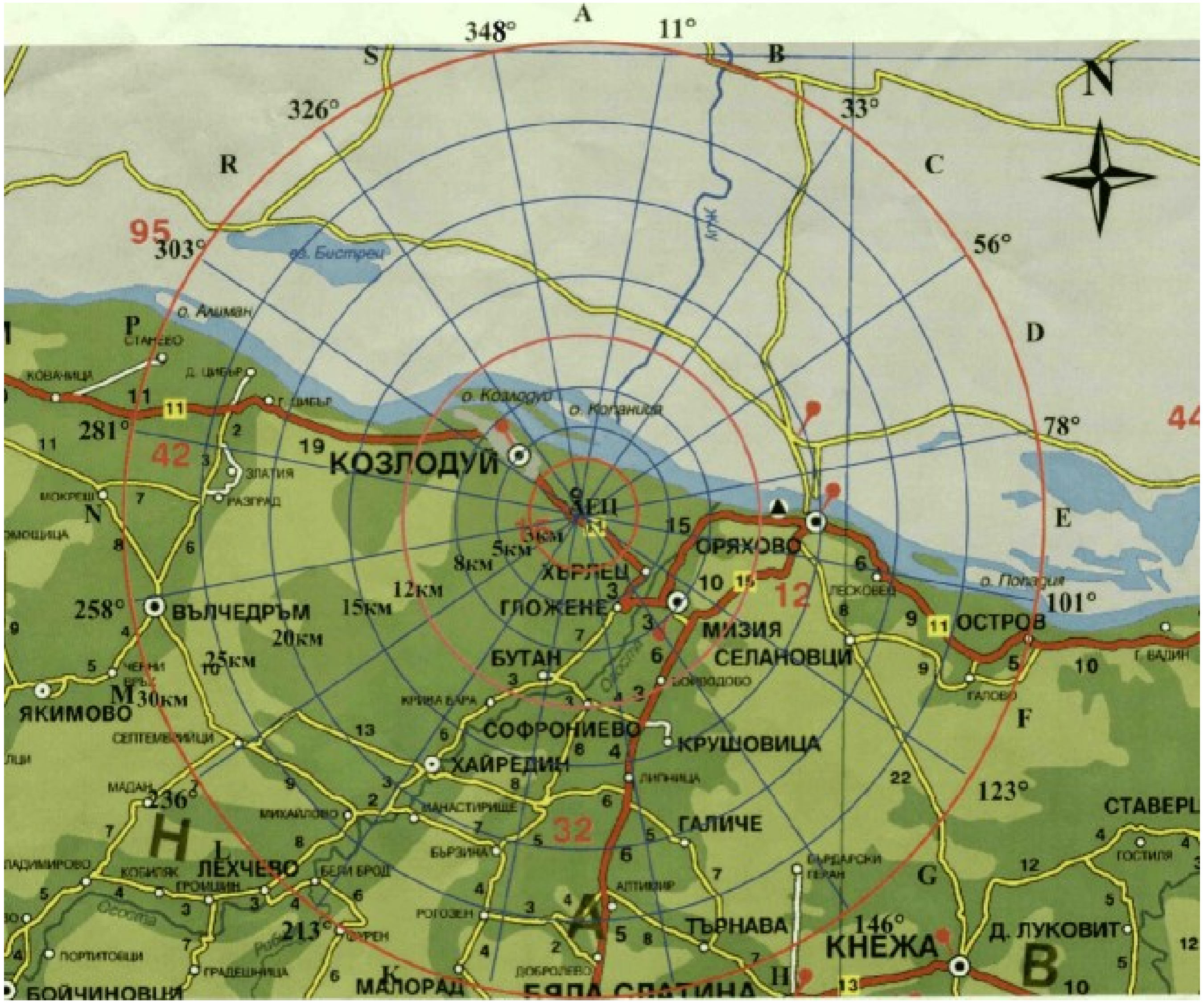

FIGURE 1.1-4: ON-SITE EMERGENCY PLANNING ZONES

1.1.3 Necessity of investment proposal

The reliable and successful operation of nuclear energy reactors of the pressurised water reactors type since 1974 up to now at Kozloduy Nuclear Power Plant showed that the Republic of Bulgaria has scientific and engineering and technical capacity to derive benefits of such highly technological production as the nuclear energy. The logic behind the investment proposal to build and commission new nuclear unit, is to put to successful use the whole potential of the Kozloduy NPP site, including the available infrastructure and the experienced and highly qualified staff.

1.1.3.1 Main objectives, principles and safety criteria

The investment proposal foresees building a new nuclear unit of the newest generation (Generation III or III+) with light water reactor with water under pressure of the type Pressurised Water Reactor, having installed electric power around 1 200 MW on one of the 4 potential sites and applying one of the three principal technical and component solutions for reactor installation of the newest generation.

The key advantage of the project of this generation of nuclear capacities in comparison with the projects of the second generation, which are operated worldwide at present, including the units 5 and 6 of Kozloduy Nuclear Power Plant with reactors of the WWER-1000/V320 type is that it would incorporate mainly passive safety systems, new design solutions for the construction and the protective shell and specific means of protection, including design solution of the concept of catching the melt of the active zone at over-design accidents, considerably increasing the safety of the nuclear energy unit.

In relation to safety, the project for construction of new nuclear unit at the Kozloduy Nuclear Power Plant site will be coordinated with the requirements of the Bulgarian legislation in the field of nuclear energy use, the requirements of International Atomic Energy Agency and the European requirements for safety described in the European Utility Requirements for LWR[5] Nuclear Power Plants.

1.1.3.2 Substantiation of the need of the investment proposal

The necessity to build new nuclear reactor at tge Kozloduy Nuclear Power Plant site is directly related to the ensuring of the energy balance of the Republic of Bulgaria on the one side and on the other – to ensure the necessary exportation.

As the planned building a new unit is designed to generate electric and low potential heat energy, then the assessment of the necessity of building the new nuclear unit consists in proving the contribution of the investment proposal to the benefits of society from the point of view of the energy balance in relation to the two mentioned types of energy, taking

[5] Using ordinary water unlike otyher type of reactors, which use the so-called heavy water – with molecule mass greater than the ordinary water

into consideration all impacts on the environment and the risk for human health, as well as the impacts from social and economic aspects.

The electric energy at its final consumption place is ecologically clean (no harmful substances are emitted at its utilisation) and has universal usage (i.e. it can be transformed into other types of energy). The functioning of all spheres of economy and the conditions for life of the population depend on the accessibility of electric energy. The eventual shortage, respectively the damages/shortcomings in the supply of electric energy embrace the entire society, therefore the increases social interest in relation to the safe supply of energy is quite justified.

According to the Prognostic energy balance of the country for the period 2020 – 2030, which takes into consideration the energy industry development at the existing energy policy (the so-called basic scenario, developed and periodically updated for Bulgaria at the request of the Transport and Energy General Directorate of the European Commission), the electric energy consumption in the country will grow respectively by 8% in 2020 and by 23% in 2030 as compared to the consumption levels accounted in 2005.

Alongside the forecast of the increase of energy consumption, the Bulgarian energy industry at present faces the necessity to overcome three basic challenges:

- → High energy insensitiveness of the Gross Domestic Product: Despite the positive tendency of improvement, the energy intensiveness of the national Gross Domestic Product is 89% higher than the average for the EU (taking into account the parity of the purchasing power).
- → High dependence on importation of energy resources: Bulgaria ensures 70% of its gross consumption of energy resources by importation. The dependence on the importation of natural gas, crude oil and nuclear fuel is practically total and there is traditionally one-sided orientation to the Russian Federation.
- → The necessity of ecology-based development: The world faces challenges connected with changes of climate, influenced by the increase of the greenhouse gas volume emissions. One of the main sources of greenhouse gas emissions is the consumption of energy resources, like the carbon intensity of the electric energy, defined as the ratio of the total emissions of the power plants to the total electric energy generation.
- → The latest ambitious aims of the European Union to reduce by 2020 the CO_2 emissions by 20% under the level of emissions in 1990 is based on considerable reduction of the emissions in the transport sector and the increase of the number and capacity of PV and wind plants. For instance the wind power production must grow by about 17 times in order to get even to the nuclear power production of electricity. It is difficult to prognosticate how this increase will be made possible, all the more that such calculation does not take into account the additional increase in demand of energy by 1.7% annually. For this reason irrespective of the stimuli to develop wind power generation, the

implementation of the EU plan to reduce the CO_2 emissions depends practically to a great extent on the energy generation by nuclear power plants.

The starting point of the European energy policy is in several priority directions:

→ Taking under command the negative changes in climate;

→ Reduction of the energy intensity of economy and increase of energy efficiency;

→ Restraining the external dependence of the European Union on imported energy resources and

→ Promotion of economic growth and employment thereby assuring secure and accessible energy for the consumers.

The sustainable energy development is made centre of the energy policy and its achievement is linked to the following long-term quantitative aims by 2020:

The materialisation of a new nuclear unit at the Kozloduy Nuclear Power Plant site entirely corresponds to the national priorities in the area of the energy system development of Bulgaria as part of the common European energy strategy. In practice the new nuclear unit in combination with the capacity for energy generation from renewable energy sources will ensure the nearing of the objectives of achieving emission-free energy cycle and an optimal mix of energy sources.

1.1.4 DESCRIPTION OF THE PHYSICAL CHARACTERISTICS OF THE INVESTMENT PROPOSAL AND THE NECESSARY AREAS

1.1.4.1 LOCATION OF THE NEW SITES AND THE EXISTING INFRASTRUCTURE

The site of Kozloduy Nuclear Power Plant is located on the right bank of the Danube River (at km 694). It is 3.7 km south of the navigation line of the river and the state border with the Republic of Romania. The strait-line distance to the capital Sofia is 120 km, while following the national road network the distance is about 200 km.

It is situated in the northern part of the first non-flooding terrace of the Danube River (altitude +35.0 m according to the Baltic altitude system) and has an area of 4,471,712 square metres.

To the north it borders with the Danube lowland. To the south of the site the slope of the water shed plateau is relatively high (100-110 m), to the west it is about 90 m and to the east it is lower and reaches an altitude of 30 m.

The nearest towns and villages to Kozloduy Nuclear Power Plant are the Town of Kozloduy – 2.6 km to the northwest, the Village of Hurlets – 3.5 to the southeast, the Village of Glozhene – 4.0 km to the southeast, the Town of Mizia – 6.0 km to the south, the Village of Butan – 8.4 km to the south and the Town of Oryahovo – 8.4 km to the east of the site.

The sites for the installation of the new nuclear capacities on the area of Kozloduy Nuclear Power Plant deemed suitable are shown on **Figure 1.1-5***.*

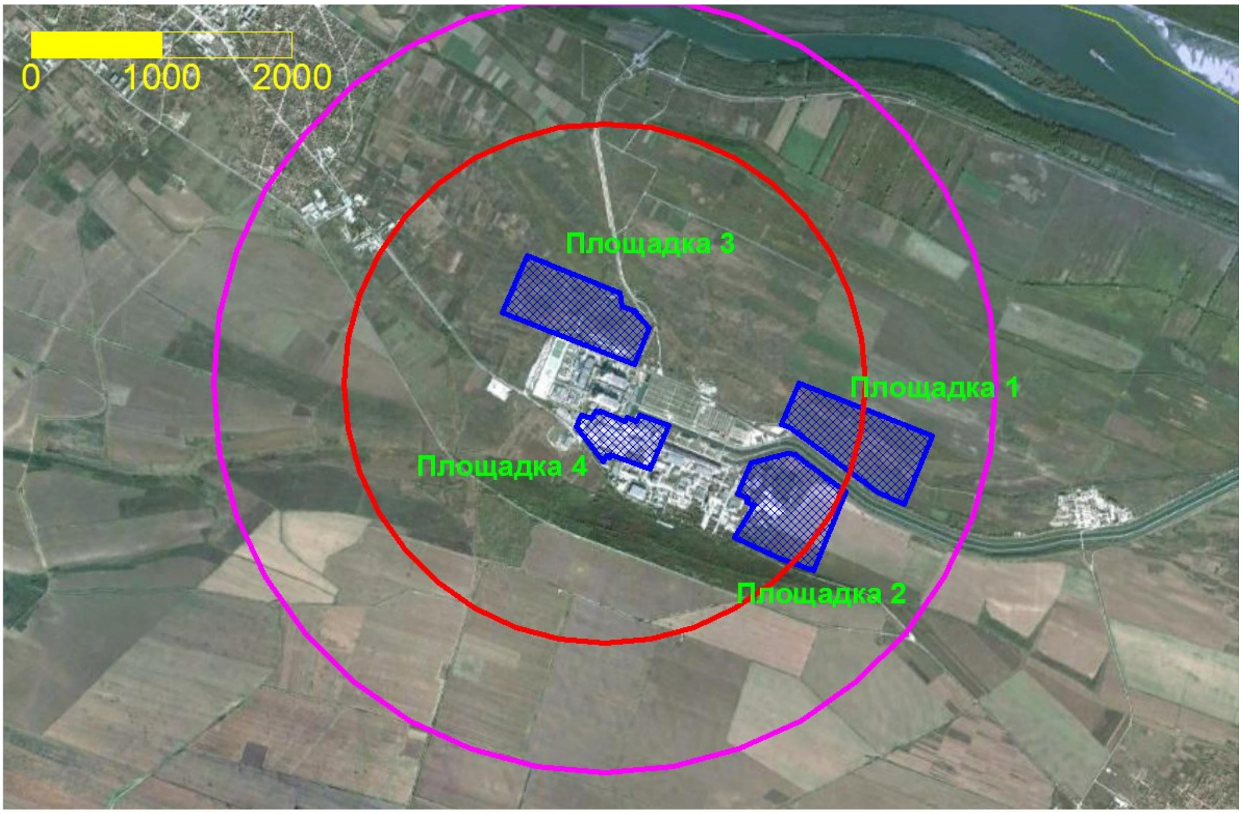

FIGURE 1.1-5: *DISPOSITION OF THE SITES OF THE INVESTMENT PROPOSAL*

(The red circle ( ) is a 2 000-metre precautionary action zone and the rose one ( ) is a 3000-metre zone around Kozloduy Nuclear Power Plant .)

Site 1 (provisional name) –The site is situated to the northeast of units 1 and 2 of Kozloduy Nuclear Power Plant, between the open distribution facilities and the Valyata area in the vicinity of the existing cold and hot channels – to the north of them. The area of the terrain is around 55 ha. The terrain is flat with small inclination from southwest to northeast.

Site 2 (provisional name) – The site is situated to the east of units 1 and 2 of Kozloduy Nuclear Power Plant in the direction to the Village of Hurlets, south of the existing cold and hot channels. The area of the terrain is about 55 ha. The terrain is hilly with considerable slope from the south to the north, more evident in the south-eastern part of the area. Within the boundaries of this site is a former agricultural ground.

Site 3 (provisional name) – The site is situated to the northwest of units 5 and 6 of Kozloduy Nuclear Power Plant in the vicinity of the ring road of the existing power plant. The area of the terrain is 53 ha. The terrain is flat with small slope from the south to the north.

Site 4 (provisional name) – The site is situated to the west of units 3 and 4 of Kozloduy Nuclear Power Plant and the spent fuel storage facility, south of the cold and hot channels.

The usable area is around 21 ha within the boundaries of the alienated terrains of Kozloduy Nuclear Power Plant. The terrain comprises the existing built service bases – Equipment Bureau, Auto repair base, Base of mounting works.

All main and auxiliary buildings and structures will be arranged within the boundaries of the proposed sites, the equipment necessary for the operation purifying structures and the Waste water treatment plant. The general plans with elaborated component disposition will depend on the functional designation of the buildings and the structures, separating the respective zones.

The site selected for the installation of the new nuclear unit will be fenced and safeguarded in accordance with the requirements of the Regulation for the provision of physical protection of nuclear facilities, nuclear material and radioactive substances (State Gazette No. 44 of 09.05.2008) and Zone of Preventive Protective Measures and Zone of Immediate Protective Measures will be established in compliance with the requirements of the Regulation on emergency planning and emergency preparedness in case of nuclear and radiological emergencies (promulgated, State Gazette No. 94 of 29.11.2011).

1.1.4.2 NECESSARY AREAS FOR THE IMPLEMENTATION OF INVESTMENT PROPOSAL (BUILDING WORKS AND OPERATION)

The necessary areas, according to the component solutions for the construction of the new nuclear units at the potential sites are determined by the following criteria:

- ✓ Dangers like internal and external floods and fires.
- ✓ Independence of components of different categories concerning safety will be maintained with the help of functional isolation and/or physical separation.
- ✓ ALARA – principle of achievement of the target doses by separation of the polluted systems or components from the unpolluted systems in different premises, taking them into account at the designing the space with the purpose of facilitating inspection and maintenance.
- ✓ Orientation of the turbine generators to avoid risks from flying objects to the nuclear island as a result of incidents and emergencies.
- ✓ Functional link between the main building, the auxiliary buildings and the circulating water flows.
- ✓ Minimum length of the pipelines and the cable routes.
- ✓ Connection with the overhead transmission lines powering the site.
- ✓ Minimum building of the site.
- ✓ Spatial organisation of the buildings from the point of view of construction and maintenance.
- ✓ Building constructions, which will contain equipment and systems, important for the safety:
  - Reactor section and secondary construction of the hermetic shell (for some of the reactors);
  - Special building;

- Spent fuel storage facility (this structure may be part of the reactor section with some types of reactor);
- The linked machines and electrical auxiliary buildings;
- Structure for reserve alternative electrical powering for safety;
- Emergency Response Center;
- Tanks or ponds for storing connected with safety.

The situation possibilities on the alternative sites for the layout of the main buildings and facilities are described in the following 3 points.

Site plan for layout of the main buildings and facilities of reactor AES-92

The preliminary estimated area for building a nuclear power plant with one unit AES-92 is about 35 ha.

Site plan for layout of the main buildings and facilities of reactor AR-1000

The estimated area for construction of one energy unit of a nuclear power plant AR-1000 plus the additional area, necessary for provisional buildings at the building works stage, therefore the total area will be 21 ha.

Site plan for layout of the main buildings and facilities of reactor AES-2006

The area, necessary to construct new nuclear unit with one AES-2006 reactor, including the additional area for construction of provisional buildings at the building works stage will be close to the size of a nuclear power plant with an AES-92 reactor – 35 ha.

1.1.4.3 NECESSARY AREAS DURING THE DECOMMISSIONING PROCEDURES

The shutdown procedure of nuclear installations is long and complex. This process is part of the technical design of the new nuclear unit, developed after selection of a given type of reactor, followed by licensing, construction and operation of the nuclear facility. Depending on the adopted strategy for decommissioning, the technical design contains development of additional areas with view to the requirement for construction of additional facilities connected with the operation of taking of nuclear materials out of use from a given reactor.

The process of shutting down a new nuclear unit is an activity, which needs an analysis of its own and assessment of the impact on the environment.

1.1.5 DESCRIPTION OF THE BASIC CHARACTERISTICS OF THE PRODUCTION PROCESS

The new nuclear unit proposed to be built at the site of Kozloduy Nuclear Power Plant will stand out as a highly technological energy facility for electric power generation with reactor of the III, III+ generation.

The parameters for the construction of an energy facility of this type assume availability of two main groups of sub-facilities and installations:

- Nuclear energy facilities and installations performing the principal technological process – generation of electric energy, some of them being source of radiation impact;
- Other production facilities and installations performing supporting/accompanying technological processes, important for ensuring operation of the principal nuclear energy process and/or appearing as source of different types of non-radiation impacts on the environment.

The technology, which will be used for the generation of electric energy from a nuclear source, will be a Pressurized (Light) Water Reactor (of the PWR – Pressurised Water Reactor type), where the moderator and coolant is light water.

The technological diagram, of the new nuclear unit is with two circuits – **Figure 1.1-6**. This solution is beneficial from the point of view of non-distribution of radioactive substances as there is no mixing of the water in the two loops. The whole equipment of the first loop is contained in a hermetic volume in which pressure is maintained lower than the atmospheric pressure with the help of pumping ventilation systems. Such solution prevents the possibility of uncontrolled polluted air getting into the rest of the plant premises and in the environment and will include:

- First loop – circulating radioactive environment, its purpose being to conduct the heat generated in the active zone and transfer it to the second loop.
- Second loop – it is non-radioactive and its purpose is to absorb the heat energy from the first loop and to transform it to kinetic energy to turn the steam turbine. This energy is transformed in the generator into electric energy, the process being highly effective. The electric energy is then fed into the electric energy system towards the consumers by means of outdoor switchgear.

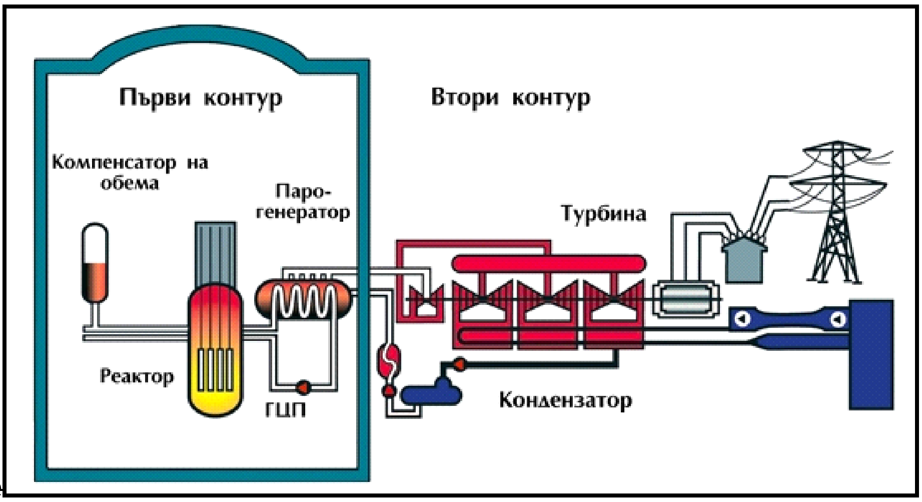

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FIGURE 1.1-6: TECHNOLOGICAL SCHEME OF PRESSURISED WATER REACTOR WITH TWO LOOPS

(to the left - First loop – Volume compensator – Steam generator – Reactor – Main circulation pump; to the right – Second loop – Turbine – Condensator)

The reactors of the WWER type (PWR) are used most widely in the world.

The new nuclear unit will have:

- Long operational period – at least 60 years;
- Possibility for operation at quick change of load within 80% – 100% of the nominal capacity without worsening the efficiency coefficient;
- Highly reliable systems allowing protection at all working regimes;
- Possibility to implement fundamental safety functions – radioactivity management, taking out the heat from the active zone; holding the radioactive substances within the fixed limits at any operational state and emergency conditions;
- Design utilising the principle of diversity and self-diagnostics;
- Design, incorporating technical means with the help of which human errors are eliminated or their consequences curbed;
- High resistance to internal and external impacts, including earthquakes, falling of flying objects, floods etc.;
- In case of fire – ensuring performance and long-term maintaining of the functions of safety and control of the energy power state, the fire-fighting measures ensuring in-depth protection by prevention of occurrence and spreading of fire, localisation of spreading of occurring fire and limitation of its consequences;
- Technical means and solutions for management of serious accidents and bringing their consequences to minimum, reduced probability for core melt;
- Greater discharge burning leading to reduction of the use of fuel and of the wastes;
- Burnable absorbers which lengthen the resource of the nuclear fuel.

The most substantial advantage of the project of the new nuclear unit against the second generation projects is that the design of the unit to be built **will include passive and specific means of** protection, including also a concept for catching the melt active zone, which considerably increases the safety of the nuclear unit.

Safety systems

- *Emergency core cooling system* [6] – the system of emergency cooling of the active zone protects it of heat damages. The active zone is situated in the central part of the nuclear reactor, it contains the nuclear fuel and therein the fission Chain reaction takes place. It acts as the main system at LOCA[7] accidents with loss of coolant in the first loop. At such accidents cooling boron-enriched water is fed into the reactor. A pond situated in the protected shell of the reactor and filled with sufficient volume of water, is used as tank for this purpose.
- *Residual heat removal system* – The system for taking out residual heat takes away the heat occurring in the shutdown reactor and additionally cools down the reactor at

[6] The burning zone of the reactor

[7] LOCA (Loss of Coolant Accident) – an accident whereat there is loss of coolant in the first loop.

normal operational conditions, at abnormal conditions and at designed emergency conditions, preserving the leak tightness of the first loop.

- *Pressure relief system* – The system of safe reduction of the pressure serves to ensure manageable reduction of the pressure in the first loop, necessary for the correct functioning of the emergency cooling system of the active zone and for its safeguarding from overheating.
- *Component cooling system* – closed cooling systems and stand as protection barrier against penetration of radioactivity into the technical water[8] system at abnormal regimes.
- *System for service water of important consumers* – this system ensures removal of residual heat from all important systems of the unit, which do not allow long lack of cooling.
- *SG Emergency Feedwater System* – to ensure feeding demineralised water to the steam generators in case of failure of the systems for normal operation. In this way it ensures removal of the heat from the first to the second loop at emergencies without loss of coolant in the first loop.

System of the safety shell

The system of the safety shell consists of internal hermetic and external safety shell. The hermetic shell consists of the construction itself and leak-tight units (passages, penetrations, air locks) and in its inner space the hermetic shell temperature and pressure control systems are located (eg. Passive heat removal, a spray system, a hydrogen ignition system, etc.).

The system of the safety shell is designed in such a way that during the operational state and in emergency conditions, related to emitting of radionuclides, including serious accidents, it contains these emissions to the environment. The construction of the systems of the containment (special external shell) are designed to protect from external events the reactor, the first loop and all related installations, important from the point of view of the nuclear and radiation safety. The system of the containment fulfils also the function of biological screen.

Control and management system

The control and management systems, together with the other systems of the power plant ensure generation of electric energy, keeping a high level of safety.

The information and control systems will be equipped with devices allowing the monitoring, measurement, registration and control of the operational parameters, which are important for the nuclear safety during normal operation and under emergency conditions.

[8] The water which circulates in the second loop and cools the first loop.

The signalisation and the management will be so designed and laid out that the servicing staff will have non-stop information on the operation of the nuclear facility and be able to interfere where necessary.

The management and information systems will have visual and sound signalisation, warning in case of emerging operational states and processes, which deviate from the limits of normal operation and may influence nuclear safety.

The management and information systems will record the values of the parameters, important for nuclear safety continuously, at certain intervals and depending on the needs.

Where emergency conditions occur the equipment will have devices, which will provide:

- Information on the instant state of the nuclear facility, on the basis of which safety measures will be taken;
- Basic information on the development of the accident and its recording;
- Information allowing forecasting and characterising the spread of radionuclides and radiation in the vicinity of the nuclear facility in a manner allowing timely undertaking of measures to protect the population.

According to the current requirements the new nuclear unit will be equipped also with devices to monitor the parameter at such extremely rare accidents connected with fuel melting.

Protective systems

The nuclear facility, part of which is the nuclear reactor, will be equipped with protective systems, which will be:

- Able to recognise emergency state and automatically switch into operation respective systems in order to guarantee that the design limits will not be exceeded;
- Foreseen for “manual” switching on the safety devices in case of need.

The safety and control systems will be separated in such a way that any damage of the control system will not influence the ability of the safety system to fulfil its functions of protection.

The protective systems will be designed with high functional reliability through creating reserve items and independence of the separate channels not allowing any elementary damage to cause loss of the protective functions of the system.

The link man – machine

A modern interface man – machine will be used to manage and operate the new facility. It will allow the operating staff of the electric power plant to react in time and adequately to all conditions of the nuclear facility and the systems of the electric power plant.

The operating staff will be assisted in their decisions by available information set in a suitable way to enable the staff to have at its disposal updated information on the status of the nuclear facility ensuring safe and effective management.

The information on the operation and the signalisation of occurring operational situations or abnormal conditions will be organised in a way to minimise the load on the operating staff.

The reactors of the WWER type (PWR) are the ones mostly used in the world. The process of designing, construction, putting into operation and shutting down of the new nuclear unit will be carried out in compliance with the statutory requirements, defined mainly in the Safe Use of Nuclear Energy Act and the normative provisions related to it.

1.1.6 TYPE AND QUANTITY OF USED RAW MATERIALS DURING THE OPERATION:

1.1.6.1 NON-RADIOACTIVE MATERIALS

The following substances and mixtures are expected to be used during the operation of the new nuclear unit:

→ ***Liquid fuels*** – they are used for the work of the diesel generators, providing reserve sources of electric energy for the energy units, for the need of the motor vehicles and for various workshops and units of Kozloduy Nuclear Power Plant EAD.

→ ***Fuels and greases*** – during the operation of the new nuclear unit it is expected to use oils and greases of various type and quantity – machine and compressor oils, turbine oils, motor oils, various greases.

→ ***Chemical substances and mixtures*** – in order to ensure the operation of the main technological process chemical reagents of different types will be supplied and used. They are certified for work in the nuclear industry. The delivery of the chemical substances and mixtures will be accompanied by safety instructions information, which is prerequisite for the ecological storage and use.

1.1.6.2 NUCLEAR FUEL (NF)

There exists various types of nuclear fuel; one of the most widely used is the type in which the uranium is present in the form of uranium dioxide (UO_2). This type of fuel is used in the reactors of the type PWER (Pressurised Water Energy Reactor). In all types of nuclear fuel the principal raw material is natural uranium excavated in various ways.

Taking account the fact that the fuel cycle is an important element of the operation of the new nuclear unit, it will be discussed at all stages from the point of view of its environmental impact assessment – supply of fresh nuclear fuel, transportation of fresh nuclear fuel, operation of the nuclear fuel, temporary storage of spent nuclear fuel and transportation of spent nuclear fuel.

1.1.6.3 Conditions for storage of fresh nuclear fuel

When designing the new nuclear unit, the fresh nuclear fuel management needs the following conditions to be foreseen and analysed:

- → ensuring possibility for incoming fuel control, technical servicing and carrying out periodic inspections and testing the components, important from the safety point of view;
- → ensuring control of the storage conditions;
- → reduction to the minimum the possibility of damage;
- → not permitting unauthorised access to the nuclear fuel;
- → prevention of falling of fuel bundles during transportation;
- → Prevention of falling of heavy objects on the nuclear fuel bundles.

1.1.6.4 Spent nuclear fuel

The spent nuclear fuel is an unavoidable technological product by generation of nuclear electric energy. It represents irradiated nuclear fuel.

The contemporary scientific research indicates that the spent nuclear fuel may be processed and successfully used as nuclear fuel for reactors on fast neutrons. This possibility will turn spent nuclear fuel into substantial energy resource. The use of spent nuclear fuel as a raw material instead of its processing as radioactive waste will bring about considerable financial economy for the country. This policy concerning spent nuclear fuel is pursued also by the other smaller states with nuclear energy generation like the Czech Republic, Hungary, Finland, Slovakia and others. An alternative possibility for spent nuclear fuel management is intermediate storage in the country with view to its future use as a resource.

The practices of management of spent nuclear fuel in the Republic of Bulgaria are connected with storage of the spent nuclear fuel at the site of Kozloduy Nuclear Power Plant in the ponds at the reactor for decay and in the spent fuel storage facility with subsequent transportation for technological storage and processing.

Each of the alternatives for nuclear unit under consideration foresees in the design Pond for Spent Nuclear Fuel where it will decay for 3 to 5 years, thereafter it will be possible to transport it out of the facility. The pond for spent bundles provides space for placing the fuel bundles during repair works at the unit and for storage of activated components under water.

1.1.7 Licenses issued to existing nuclear facilities on the territory of Kozloduy Nuclear Power Plant

Kozloduy Nuclear Power Plant has license to operate unit 5, unit 6, spent fuel storage facility, dry spent fuel storage facility. The decommissioned units 1 – 4 have been transferred over to Radioactive Waste State Enterprise as facilities for management of radioactive waste.

1.1.8 LICENSING OF THE NEW NUCLEAR UNIT IN BULGARIA

The activities related to the construction of the new nuclear unit – selection of the site, designing, construction, commissioning and operation, are subject to licensing regime in accordance with the requirements of the Safe Use of Nuclear Energy Act and the *Regulation for the procedure for issuing licenses and permits for safe use of nuclear energy.*

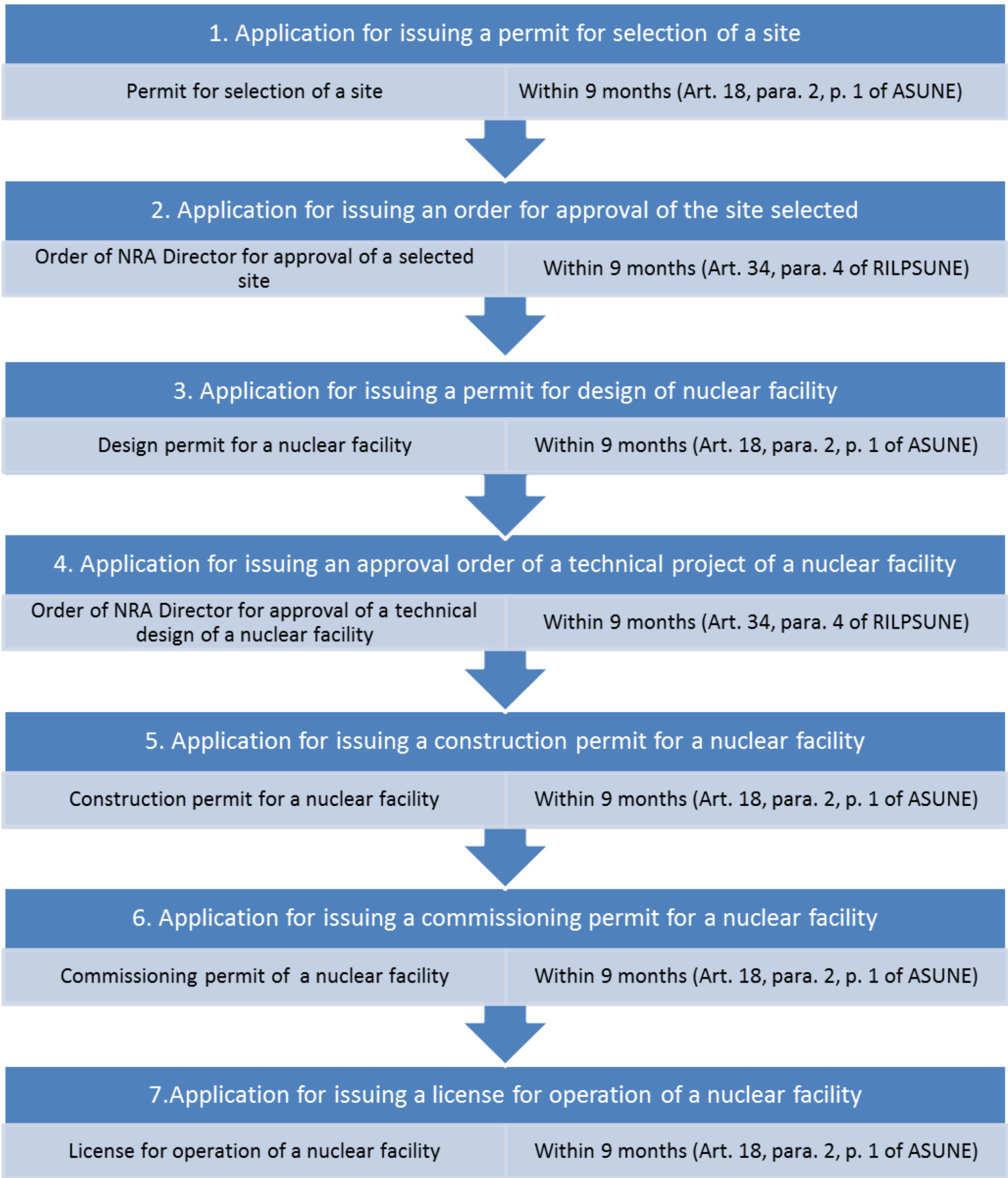

FIGURE 1.1-7: STEPS AND TERMS OF THE LEGISLATIVE PROCEDURES TO THE APPROVAL OF BUILDING A NEW NUCLEAR UNIT

The description of the licensing process, including the responsibilities of the various institutions to ensure the safety and the physical protection has been quoted as reply to a letter of the Romanian party – Ministry of Environment of Waters, reg. No. 3682 RP 18.10.2012.

Schematically the steps and terms of the statutory procedures up to the approval of building a new nuclear unit are shown on **Figure 1.1-7**.

1.1.9 PERMITS FOR OPERATION OF NEW NUCLEAR UNIT

In accordance with the national legislative documents related to environment, it is necessary that the operator of new nuclear unit possess all administrative acts, specified in the statutory documentation, which are based on regime of permission as required by the Protection of the Environment Act and the Territory Regulation Act.

2 LOCATION ALTERNATIVES (WITH OUTLINES AND COORDINATES OF THE CHARACTERISTIC POINTS IN THE APPROVED COORDINATE SYSTEM OF THE COUNTRY) STUDIED BY THE INVESTOR AND/OR TECHNOLOGIES ALTERNATIVES AND THE MOTIVES OF THE CHOICE MADE IN THE STUDY, TAKING INTO ACCOUNT THE IMPACT ON THE ENVIRONMENT, INCLUDING THE "ZERO ALTERNATIVE"

2.1 ALTERNATIVES BASED ON LOCATION

According to the Technical assignment, subject of assessment are four alternatives (**Figure 1.1-5)** based on location.

2.2 ALTERNATIVES FOR INFRASTRUCTURE ACCOMPANYING CONSTRUCTION WORKS AND OPERATION

Before the main construction works, it will be necessary to apply methods of improvement of the ground base of the proposed site so that its carrying capacity be in accordance with the load and the sagging to be within admissible limits.

In relation to the proposed site it will be necessary to organise temporary facilities related to the storage of bulk materials, readymade steel, concrete steel-concrete, metal and other construction elements, fuels and greases, temporary offices, temporary living premises to shelter the manpower from other parts of the country, temporary social and health amenities, drinking water network and network conducting waste water for purification, as well as structures for removal of rain water and a dewatering/drainage system for the groundwater. This organisation of the building site will be possible for the 1, 2 and 3 sites. Site 4 will require additional terrains.

The vertical planning of the proposed site will be coordinated with the working elevation of the existing site of the power plant, which is +35.00 m under the Baltic System of

Heights. This is determined by the fact that the facilities need to be linked to the existing cold channel and hot channel. For instance, at selection of site 1 or 3, in the construction works preparation stage it will be necessary to relocate or reconstruct the drainage channels drainage channels passing through them, while selecting Site 4 – demolition of the existing auxiliary buildings and their relocation to a new terrain. Where Site 3 is selected it will be necessary to relocate the high currency overhead transmission lines.

For all sites there is technical possibility to supply drinking water from the existing water network of the power plant.

All sites can technically be made accessible by motor vehicles via connection branches from the existing road network.

The liquid radioactive waste, which will be operation product of the energy unit of the first loop, will be processed in accordance with the requirements of the Safety Regulations for Management of Radioactive Waste.

The activities of management of radioactive waste will be carried out on the basis of administrative structures put in place with definitive status between the operator of the new nuclear unit and the Radioactive Waste State Enterprise by defined functions and tasks and clear allocation of the rights, liabilities and responsibilities.

2.3 ALTERNATIVES BASED ON THE BUILDING THE NEW NUCLEAR UNIT

In the field of nuclear energy the units of the IIIrd, respectively III+ generation represent the present level of the best technology. These are the newest designs of nuclear power plants, which compared to the older generations, exhibit better technological, economic and safety indicators.

The gradual development of the nuclear energy industry is shown on the next **Figure 2.3-1.**

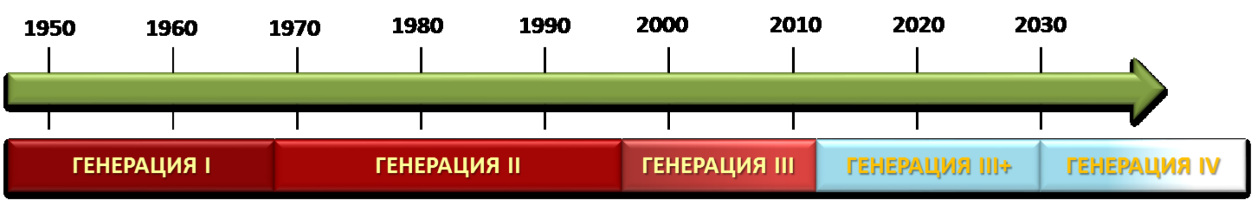

FIGURE 2.3-1: DEVELOPMENT OF THE NUCLEAR ENERGY INDUSTRY BASED ON THE REACTORS GENERATION

(from left to right – generation I – generation II – generation III – generation III+ - generation IV)

The electric power plants of the IIIrd generation use at this moment the best accessible technologies, based on the proven types of the IInd generation.

The generation III+ comes as a development immediately after the IIIrd generation. It concerns reactors with improved operation economics. Of the PWR reactors for instance units ERP belong to the III+ generation. They are being built at the Finnish Olkiluoto and the French Flamanville. Generation III+ are also the new Russian generator AES-2006, the Japanese EU-APWR or the reactors with the AP-1000 units of Westinghouse. The reactor (respectively the electric power plant), which is subject to this investment intention will belong to this generation.

According to the Technical assignment of the Investor, the realisation of the investment proposal is possible by two alternatives of construction of the nuclear unit with reactor of the latest generation, covering the contemporary requirements for safe operation:

- **A-1**: (Hybrid) maximum use of the equipment of the nuclear island, ordered for Belene Nuclear Power Plant and turbine island from another supplier.
- **A-2**: entirely new design

Both alternatives foresee use of energy reactors of the type Pressurised Water Reactor (PWR) of the newest generation (III or III+) with installed electrical power of about 1200 MW. Variations of different models for the two alternatives follow:

2.3.1 DESCRIPTION OF A-1

Belene Nuclear Power Plant (**Figure 2.3-2**)was designed with Pressurised Water Energy Reactor of the type WWER-1000/V466B with four circulation loops based on standard design for power plant AES-92. In the period from March 2004 to January 2006 the Coordination group of the EUR carried out detailed check for correspondence of the Design EAS-92 with the requirements of the European operating organisations. On 24.04.2007 the management of the EUR Club issued Certificate for correspondence of Design EAS-92 with the international requirements.

The main difference between this design and the former designs for a Nuclear Power Plant with WWER of the former generation are the following:

- Quick disruption of the chain reaction in the active zone through two entirely independent reactivity control systems.
- Removal of the heat by the residual energy generation and maintaining the reactor in a safe state by combination of active and passive systems, which do not need interference of operator and energy feeding from the outside.
- Double hermetic shell, foreseen for a wide spectre of inside or outside events: the inner containment with hermetic shell is constructed with reinforced concrete with steel insert and the outer shell is of concrete steel.

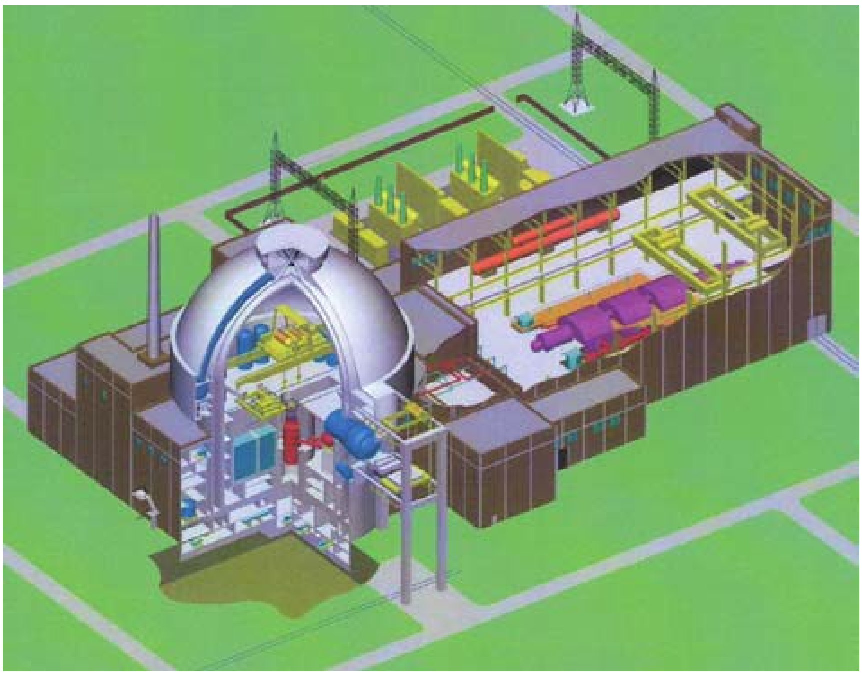

FIGURE 2.3-2: GENERAL LAYOUT OF AES-92 (V-466B – „BELENE")

Substantial improvements in leak-tightness provide maximum barrier to releases of radioactive products into the environment. It has been designed as a construction with double protective shell (called containment) where the inner containment is of reinforced concrete with hermetic metal shell and the outer containment is of reinforced steel concrete. The outer containment has been designed to withstand outer forces as for instance, impact of big passenger or military aircraft, outer explosion waves, hurricane winds, extreme temperatures and earthquakes.

2.3.2 DESCRIPTION OF A-2

As second alternative of the new nuclear unit it is considered to work out an entirely new design of a PWR, generation III or III+, with electrical capacity of around 1200 MW. Generation III and III+ improved reactors developed on the basis of the experience of the operation of the second generation reactors.

The design will be in accordance with the principal requirements of the International Atomic Energy Agency.

The models considered must cover the criteria for safety, defined in the Bulgarian normative documents, the documents of IAEA and the European Utility Requirements for LWR Nuclear Power Plants. In Bulgaria reactors of this type (WWER) are successfully operated since 1974.

- ✓ The highly qualified staff at the site of Kozloduy Nuclear Power Plant, who has great knowledge of this technology, will be used.

- ✓ The technology proposed is most widely used globally for generation of electric energy from nuclear source and approximately 80% of the reactors are precisely of this type.

At this moment more than 430 nuclear energy reactors are in operation worldwide with total installed capacity about 370GWe. Some tens of nuclear power plant units are in various phases of building –**Figure 2.3-3.**

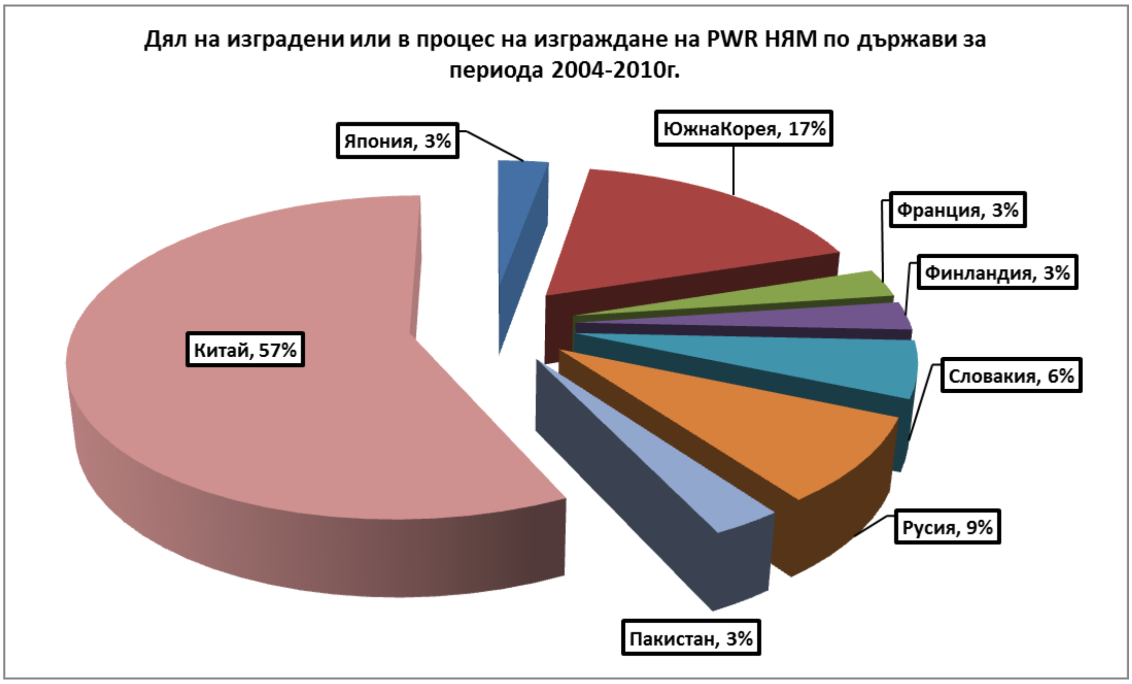

FIGURE 2.3-3: SHARE OF BUILT OR IN A PROCESS OF BUILDING OF PWR NEW NUCLEAR CAPACITIES BY STATE IN THE PERIOD 2004-2010

(COUNTERCLOCKWISE: CHINA, 57%, JAPAN, 3%, SOUTH KOREA, 17%, FRANCE, 3%, FINLAND, 3%, SLOVAKIA, 6%, RUSSIA, 9%, PAKISTAN, 3%)

Together with the project of Environmental Impact Assessment another project is underway – Technical and economic analysis to substantiate the construction of a new nuclear unit at the Kozloduy NPP site. In relation to Alternative **A –** 2 (entirely new design) the Technical assignment for the “Technical and Economic Analysis” has two requirements:

1. The installed single electrical power ought to be around 1200 MW.
2. Taking into account the fact that in recent years almost no new nuclear power plants have been built, the construction of a reactor of the III or III+ generation at this moment is considered an advantage.

Examining the requirements set in the Technical assignment for “Technical and Economic Analysis” and the models of reactors of generation III and III+ available on the market, it is evident that several models cover the mentioned requirements.

In the Environmental Impact Assessment Report on the Investment Proposal: "Building a New Nuclear Unit of the Latest Generation at the Kozloduy NPP Site" the following two models of reactors have been considered:

- AES-2006 ;
- AP-1000.

The model AES-2006 of Atomstroyexport is an evolutionary design of the project AES-91/92, which was developed also for Belene Nuclear Power Plant. The design AES-92 has passed evaluation for conformity with the requirements of EUR. At this moment the model AES-2006 is being built in Saint Petersburg, Novovoronezh, Kaliningrad.

The model Westinghouse AP-1000 has passed evaluation for conformity with the requirements of EUR and is licensed by NRC. At this moment it is being built in China (4 units to be launched into operation before 2015) and in the USA (combined license for construction and operation has been accorded by the NRC to 14 units).

These differing technical solutions appear in the investment intention as alternatives, which have undergone assessment from the point of view of impact on the environment. The requirements concerning environment and safety are similar for all types of reactors and their impact on environment have been assessed at their potential maximum values.

For the purpose of the Environmental Impact Assessment Report **the conservative** approach has been chosen and at assessment, always values have been evaluated, which appear to be less favourable, with view to the consequences on environment.

2.3.2.1 REACTOR AP-1000

AP-1000 of „Westinghouse" (**FIGURE 2.3-4)** is a generation III+ pressurized water reactor with slow neutrons and light water as moderator and coolant. AP-1000 has open fuel cycle with 18 months period of re-charging, with three cycles of the fuel. The designed operational period is 60 years.

The design has been licensed in the USA and China and at this moment Great Britain is the European state, which is licensing it. Currently China is building the first four units in Sanmen and Haiyang.

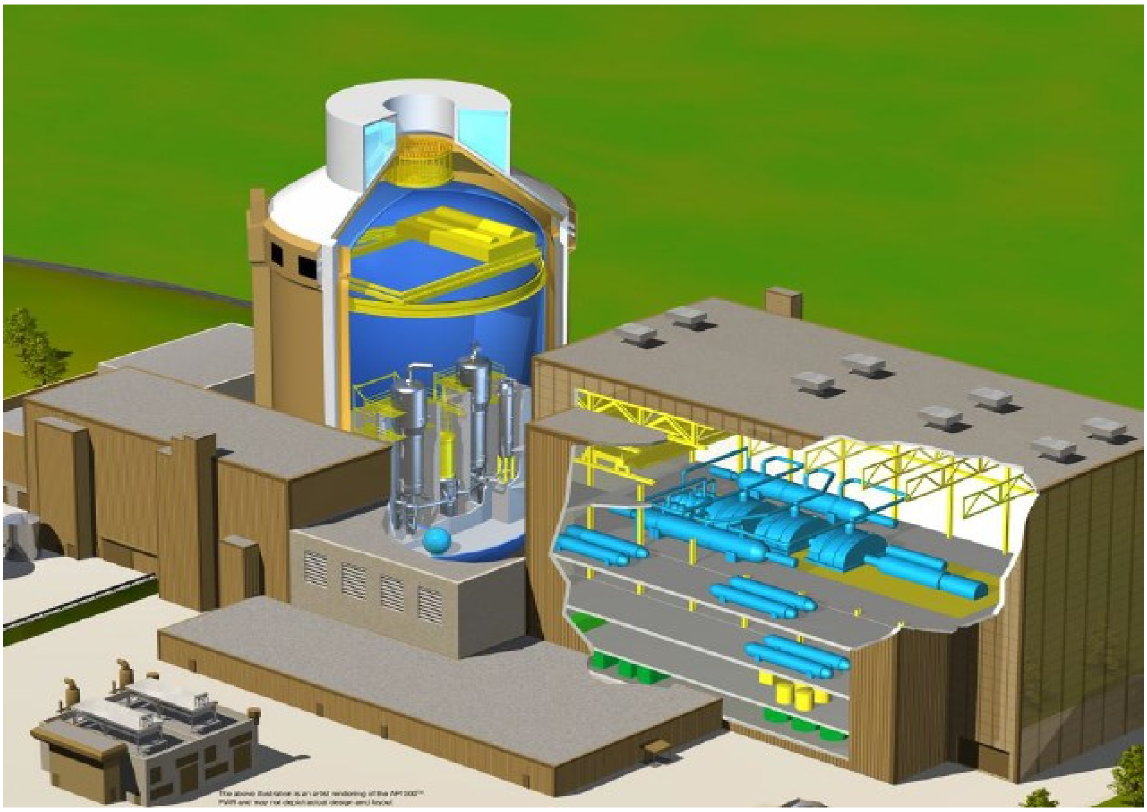

FIGURE 2.3-4: LAYOUT OF AP-1000

In comparison with a standard power plant of similar power output AP-1000 has 35% less pumps, 80% less pipes of high safety class and 50% less valves of ASME safety class. This makes the AP-100 power plant much more compact compared to the old designs. As it has less equipment and pipes, the greater part of the safety equipment is mounted in the hermetic construction. AP-100 has a relatively bigger pressure compensator, which allows easier adjustment to various regimes.

2.3.2.2 REACTOR AES-2006

AES-2006 is a pressurised water reactor under pressure with a power of 1200 MW. This is the newest design of the Russian company Atomstroyexport, owned by the Russian state company Rossatom. This design is based on the design and the experience of operation of WWER-1000 reactors and further development of the AES-92 design. The design of the AES-2006 is licensed in Russia.

At this moment the project AES-2006 is in a process of construction in Saint Petersburg – model V-491 and in Novorossiysk, albeit a different model – V-392M.

Despite the differences, both models cover the contemporary requirements for safety and the requirements of the Russian rules and standards. In the design phase it is foreseen that the two models will cover the recommendations of MAAE and EUR, so that both models obtain construction permit issued by Rosstechnadzor.

The safety functions of AES-2006 have been improved in comparison with the EAS-92 power plant. Both the active and the passive systems of the AES-2006 power plant are used to fulfil safety functions. In addition AES-2006 has systems for management of serious accidents. The nominal operational life of the power plant is 60 years. In the AES-2006 the constructive protection against impact of big aircraft is concentrated on the outer hermetic shell and the fresh fuel storage facility.

2.3.3 MATRIX FOR EVALUATION OF THE EXPECTED IMPACTS AS A RESULT OF EMISSIONS BY THE ALTERNATIVE TYPES OF REACTOR ON THE COMPONENTS AND THE FACTORS OF THE ENVIRONMENT.

The expected impacts by the operation of the new nuclear unit, as a result of emissions by the alternative types of reactor considered in this paragraph, on the different components and factors of the environment is shown on the next Table.

MATRIX FOR EVALUATION OF THE EXPECTED IMPACTS AS A RESULT OF EMISSIONS BY THE ALTERNATIVE TYPES OF REACTOR ON THE COMPONENTS AND THE FACTORS OF THE ENVIRONMENT

Component/Factor of the environment		AEC-92	AP-1000	AEC-2006
Atmospheric air	Non-radiation aspect		☐	
	Radiation aspect	☒	☒	*Analogous with AES-92*
Conventional waters		☒ *Based on data from *similar project Kudankulam Nuclear Power Plant, India; * Kozloduy Nuclear Power Plant – Unit 5 and 6*	☒	*Similar to AEC-92*
Lands and soils			☐	
Geology			☐	
Conventional waste			☐	
Radioactive waste		☒	☒	☒
Dangerous substances			☐	
Biodiversity			☐	
Landscape			☐	
Health and hygiene aspect and radiation risk for the population		☒	☒	*Similar to AEC-92*
Cultural heritage			☐	
Harmful physical factors			☐	

☒ – *Detailed assessment and modelling is being carried out*

☐ – *The analysis and forecast of other component/factors issued*

Similar to AES-92 – the similarity has been explained for each component/factor in paragraph 4 of the Environmental Impact Assessment Report

On the basis of the analyses made in the Table, a detailed assessment and modelling has been carried out in relation to the three proposed alternatives:

- ✓ Atmospheric air in radiation aspect;
- ✓ Groundwater in radiation aspect;
- ✓ Radioactive emissions;
- ✓ Health and hygienic aspects of the environment and the risk for the population

The analyses and the conclusions, which have been made in reference to the above components/factors in paragraph 4 of this *Environmental Impact Assessment Report,* are used to carry out prognosticated assessment of the impact also for

- ✓ Lands and soils;
- ✓ Earth interior;
- ✓ Landscape;
- ✓ Biodiversity;
- ✓ Non-radiation waste;
- ✓ Dangerous substances
- ✓ Harmful physical factors
- ✓ Immovable cultural heritage.

2.4 ZERO ALTERNATIVE

In view of the decision of the Government to reject Belene project and to build the new nuclear unit at the Kozloduy NPP site, using the equipment for the nuclear part produced for Belene Nuclear Power Plant and in accordance with the Decision of the Council of Ministers (Protocol No. 14 of 11.04.2012) for agreement in principle to undertake actions, necessary for the construction of new nuclear unit at Kozloduy Nuclear Power Plant, the Zero alternative is not realistic.

In this context theoretically the following two possibilities are available:

1. To look for another site in the country to build the necessary nuclear unit;
2. To put an end to any research and activities for construction of nuclear unit in the country.

The first possibility may be considered absolutely theoretically. Kozloduy Nuclear Power Plant is the only operating, licensed site, with the greater part of the accompanying infrastructure, necessary for the realisation of a new project, already built.

Practically any “Zero” alternative, or decision not to undertake any actions to materialise this investment intention at the Kozloduy NPP site, means abstention from construction of any new nuclear unit in the country in the foreseeable future. Such a decision is in contradiction to the objectives set in the National Energy Strategy of the country to launch new capacities and increase the share of electricity generated by nuclear power plants by 2020.

Of the two alternatives shown above, the second one is real and possible, however only if it is considered on its own merit without the energy needs of the country. From the point of view of the electrical energy sector, the rejection of the possibility to build a new nuclear unit means construction of another new non-nuclear electric power of 1000 – 2000 MW. Taking into account the energy resources of the country, the necessary new energy capacity most probably will need to be provided by a thermal power plant, which will be located at some other place. This will necessitate exploration for a new site and new planning, technical works, preparation of the site and construction according to the accelerated time-table with view to construction of a thermal electric power plant with capacity of 2000 MW.

3 DESCRIPTION AND ANALYSIS OF THE COMPONENTS AND FACTORS OF THE ENVIRONMENT AND OF THE MATERIAL AND CULTURAL HERITAGE, WHICH WILL BE GREATLY AFFECTED BY THE INVESTMENT PROPOSAL AND THEIR INTERACTION

3.1 CLIMATE AND ATMOSPHERIC AIR

3.1.1 CLIMATE

The region under consideration around Kozloduy Nuclear Power Plant is situated in the western part of two climatic regions according to the climatic regionalisation of Bulgaria – the Northern and Middle climatic region of the Danube hilly plain of the Moderate-continental climatic sub-region.

The climate in this region is characterised as pronounced continental because of the sharp contrast between the winter and the summer temperature conditions. The mean annual amplitude of the air temperature is between 24.5^{0}C and 26^{0}C – the biggest amplitude for the whole country. The continental character of the climate is confirmed by the regime of rains in the region. Their annual total is between 540 mm and 580 mm, the maximum being in July and the minimum in February. The summer rains however are grouped in some days and particularly in the second half of the summer there are droughts. In the summer and autumn there are on the average 4 – 5 rainless periods for more than 10 days and average duration f 16 – 20 days. In some years much more lengthy droughts are not rare.

In the parts of the region to the west of Ogosta River the influence of the Balkans is felt. It is exhibited in the yearly distribution of the rains, their seasonal amounts being almost equal without sharp extrema, which is result of the relative increase of the winter rains and decrease of the summer rains.

The dynamics of the air mass transport within the surface boundary layer is characterised by the wind rose. The indented character of the relief and the proximity of the Danube River are of considerable significance for the local climate, the Danube River being considered a big aeration channel. It leads to the significant heterogeneousness in the field of the meteorological elements and particularly such as the minimum temperatures and the surface wind, which are quite sensitive to the form and location of the terrain.

Up to 1997 the climatic characteristics of the region was based on data, defined by the statistics of the regular climatic measurements by Kozloduy Station, carried out in the period 1970 – 1982 and by the Lom Station. After 1997 real meteorological data are used, obtained by three meteorological stations, corresponding to class III, united in an automatic meteorological monitoring system. The first of them has been mounted on the off-site radiation monitoring area (representative for the region of monitoring) and the other two are located in the Blatoto area and in the Village of Hurlets.

The assessment of the local climate in the region has been made using mainly findings in reports assigned by the main office of Consortium "Meteorological Systems and Equipment" and official publications uploaded in Internet.

3.1.1.1 CLIMATIC PARAMETERS

3.1.1.1.1 Temperature of the air

The annual average temperature of the air in the region in question was around 13^{0}C in 2009, 2010 and 2011[9]. In the annual fluctuation of the average temperatures the maximum is reached in August (from 25.2°C to 26.2°C) and the minimum – in January (from 0.1°C to minus 1.9°C). The average temperature for the three years during the winter season is about 0.8°C, and for the summer season – 24.4°C. The average temperature in the autumn and the spring is 13°C.

3.1.1.1.2 Precipitation

The average annual precipitation in the period of 8 years is 481.9 mm, which is under the climatic norm (1961 – 1990)[10] of 545 mm for the precipitation in the region.

3.1.1.1.3 Relative humidity

During the winter months and the last two autumn months, the relative humidity is above 60%. The maximum of the relative humidity was observed in December 2011. In August the frequency of intrusion of fresh and humid Atlantic air is relatively low, therefore it is at this time that the lowest values of relative humidity are observed.

3.1.1.1.4 Wind

The dynamics of the air mass transport within the surface boundary layer is characterised by the wind rose – the velocity and the direction of the wind measured in 16 directions: the wind at a given place is one of the meteorological elements, which is heavily dependent on the local conditions and particularly on the form of the relief. The hilly relief leads to re-distribution and deformation of the air flow and as a result, both the velocity of the wind and the frequency of the dominant direction. A region like the one under consideration, is also greatly influenced by the vicinity of a big water basin such as the Danube River (aeration channel).

Figure 3.1-1 shows the wind rose for the gradation of the wind velocity in 2009, 2010 and 2011. The area of the colour fields for the different ranges of the wind velocity indicates the percentage of the share of the velocities in this range for all cases of wind during the year.

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[9] Report for the local meteorological condition in the region of Kozloduy Nuclear Power Plant, 2009, 2010 and 2011.

[10] The World Meteorological Organisation has defined climatic norm as the average value of a given climatic element in a fixed basis period of 30 yeears. The basis periods adopted for the time being are 1901-1930, 1931-1960, 1961-1990.

In 2009 the greatest is the south component at the low velocity of the wind from 2.9 m/s and in the range from 3 to 4.9 m/s – the greatest is the frequency of the north-eastern winds (**Figure 3.1-1**). The share of the winds in the range 1 – 7 m/s is in 97.8% of the cases.

In 2010 the greatest is the western component at wind velocities from 3 m/s to 4.9 m/s and from 5 m/s to 6.9 m/s. The share of the winds in the range of 1 m/s – 7 m/s is in 96.9% of the cases.

In 2011the greatest is the southern component at wind velocities from 1 m/s to 1.9 m/s. The share of the winds in the range of 1 m/s – 7 m/s is in 97.9% of the cases.

2009 **2010** **2011**

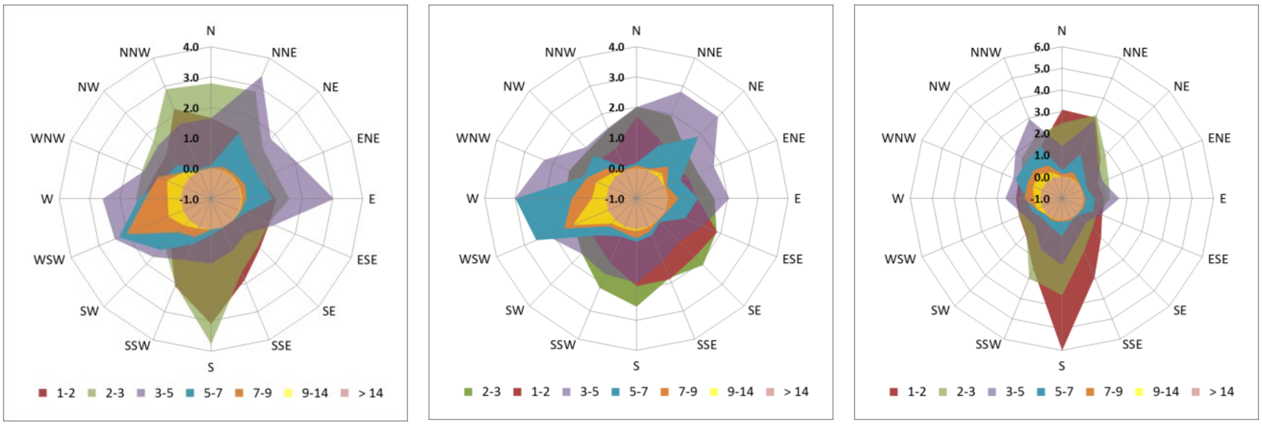


FIGURE 3.1-1*: WIND ROSE*

3.1.1.1.5 Annual characteristics of stability classes of the atmosphere as per Pasquill for the region of Kozloduy Nuclear Power Plant

In order to calculate the radiation exposure in the region of Kozloduy Nuclear Power Plant, information is necessary about the state of atmospheric turbulence, which determines the possibility of distribution of admixtures in the atmospheric air. For the basic part of the diffusion models, the stability class of atmosphere according to Pasquill is used most often. The stability classes are six: ***A – Extremely unstable conditions, B – Moderately unstable conditions***, ***C – Slightly unstable conditions***, ***D – Neutral conditions, E – Slightly stable conditions and F – Moderately stable conditions.***.

- ✓ In 2009 greatest was the share of slightly stable conditions (class **E**) – 54.15%,
- ✓ In 2010 greatest was the share of slightly unstable conditions (class **C**) – 28.6%,
- ✓ In 2011 greatest was the share of slightly stable conditions (class **E**) – 28.8%.

3.1.1.1.6 Cloudiness

The year round fluctuation of the cloudiness in the region is determined by the Annual Atmospheric circulation, the amount of humidity and the stratification of the air layers. From the middle of autumn to the end of winter the quality of low and general cloudiness increases because of the stability rise of the atmosphere and the falling of the height of the condensation level. The maximum of the general cloudiness is in December – 7.4 grades and the number of "dark" days (with cloudiness 8 – 10 grades) – 17 on the average. During the cold half year in the morning the cloudiness is at its greatest and the minimum cloudiness is during the evening hours. The annual minimum of the general cloudiness is in August.

3.1.1.1.7 Fogs

The data from the stations in Lom and Oryahovo concerning the number of misty days are very close, which may be taken as ground to assume that they are close to the data characterising the region and particularly the site of Kozloduy Nuclear Power Plant.

Concerning the duration of the fogs it ought to be noted that throughout the year in Lom they most often last less than 24 hours. In Oryahovo the percentage in January is somewhat different – 80% of the fogs last not more than 1 day, 14% last 1 – 2 days, 5% – 2 to 5 days and only 1% more than 3 days.

The indicated noticeable differences lead to the conclusion that there is no ground to acknowledge as characteristic for the region of Kozloduy Nuclear Power Plant the data on the fogs from the neighbouring stations. Therefore it is necessary to carry out monitoring on the regime of fogs at the site of the power plant.

3.1.1.1.8 Snow cover

The climatic characteristics of the snow cover in the region of Kozloduy Nuclear Power Plant may be judged by the data of the climatic stations of the National Institute of Meteorology and Hydrology at the Bulgarian Academy of Sciences, situated in the region.

3.1.1.2 METEOROLOGICAL PHENOMENA

3.1.1.2.1 Hail phenomenon

The greatest frequency of the hailstorms causing damages in the region under consideration occur in July (about 36%), followed by June (32%) and May (17) – "The Climate in Bulgaria", 1991. The frequency in April, September, and October is insignificant. The 24-hour distribution of the beginning of the hail precipitation indicated maximum in the interval 14:0 – 18:0 hours local time. Night hailstorms between 22:0 – 24:0 and 00:0 to 04:0 hours do occur too as a result of cold atmospheric fronts. As a whole one may say that the hailstorms from statistical point of view are quite a chance phenomenon because of their great space and time changes.

3.1.1.2.2 Icing of ground equipments and structures

The geographical position and the climatic peculiarities of the country create relatively good condition for icing and frost of ground objects or falling of wet snow in winter. The formation of ice on grounded objects – accumulation of wet snow and ice formation, characteristic for the non-mountainous parts of the country, are poorly researched in this country as elements of the climate. The most probable combination of temperature-wind-humidity during the process is: temperature between 0^0C and minus 2^0C to 4^0C, velocity of wind between 3 m/s and 5 m/s and relative humidity along the Danube River between 95% and 100%. In the period from November to March and mainly in the months of December and January, these meteorological conditions allow to make long-term climatic prognosis for the process of icing-up, taking into account the predominant direction of the icing wind.

3.1.1.2.3 Dust storms

There is no data for any dust and sand storms witnessed in the region of Kozloduy Nuclear Power Plant.

3.1.1.2.4 Snow storms

This phenomenon occurs as a result of moderate or strong wind (velocity over 5 m/s) and strong snowfall (it is called generally snow storm and it embraces the whole under-cloud layer) or where there is blowing away of freshly fallen "dry" snow (it embraces a layer of the ground air to a height of a few metres) – ground snow storm, or to a few tens of centimetres – "low snow storm"). This phenomenon causes difficulties for the road transport and other activities because it blows the snow into snow-drifts. In this country snow storms occur in the period December – February. They are most intensive in North-eastern Bulgaria and usually the snow is blown from the north of northeast.

3.1.1.2.5 Tornado

Two cases have been registered in the vicinity of the power plant in the period 2006 – 2009: at about 20 km south of the plant near the Village of Hayredin (case 5A) and the Village of Turnava – at about 35 km south-southeast and they occurred on one and the same day. These cases are the only ones in a period of over 100 years.

3.1.1.3 CONCLUSIONS

On the basis of the data and the analyses made in the Environmental Impact Assessment Report the following conclusions may be drawn on the processes and phenomena, which are of interest, concerning the site of Kozloduy Nuclear Power Plant in connection with the peculiarities of the site:

→ Because of the prevalence of low velocities of the wind (within the interval of 2 m/s to 5 m/s) the potential of the Wind field to carry pollutants to long distances is low, i.e. there is no immediate danger for trans-border pollution of the territories of Romania;

- → The rainfalls are below the climatic forms, therefore the potential for cleaning the pollutants (their wetting and bringing to the ground by rain) from the atmosphere is low;
- → The icing of ground structures in this part of the Danube River may occur at combination of the following meteorological parameters: air temperature between 0^0C and minus 2^0C to 4^0C, velocity of wind between 3 m/s and 5 m/s and relative humidity along the Danube River between 95% and 100%;
- → Hails, causing damages in Northwest Bulgaria, occur in the period 5 May – 31 July, however specifically at the site of Kozloduy Nuclear Power Plant from statistical point of view they are quite rare chance event, because of their great space and time changes;
- → The probability for snow storms is very small in comparison with the north-eastern part of the Danube plain;
- → The average probability for the country of formation of tornado is of the order 10^{-6} cases per year.
- → Mists occur on the average on 45 days, the maximum being 120 – 140 days. Their duration is up to 1 day in about 80% of the cases in the month of January.

3.1.2 THE QUALITY OF THE ATMOSPHERIC AIR

Emissions in the region of the investment proposal

The Region of Kozloduy embraces the municipalities of Kozloduy, Oryahovo and Mizia. There is no requirement to develop program for reduction of the pollution levels, as pursuant to Article 30 and Article 31 of Regulation No. 7 for assessment and management of the atmospheric air quality, the measured concentrations of harmful substances are lower not only than the admissible norm, but also than the higher and lower evaluation thresholds.

As a rule the quality of the ground layer of the atmospheric air in the region is determined by the work of Kozloduy Nuclear Power Plant, the industrial activities, the road transport and daily life sources.

On the territory of Kozloduy municipality the more significant sources of emission to air are: the Concrete Batching Plants with sieving equipment in the Village of Butan belonging to Patstroy engineering AD – City of Vratsa, the companies "Atomenergostroyprogres", "Zavodski stroezhi" and "Mechanisation and Transport"[11] these are sources of dust with local impact. The most substantial sources of carbon monoxide, hydrocarbons and nitrogen oxides are the transport motor vehicles. The roads in the municipalities are under intensive

[11] Used literature and impute data: Protocol for receiving and handing over, 26.02.2013

traffic. In the peak hours, though not for long, conditions arise leading to increase of emission by the vehicle transport.

Emissions from industrial fuel and production processes sorted by municipalities.

According to data from the National Statistical Institute, the regional, district and municipalities in the Republic of Bulgaria for 2006, 2007, 2008[12], in the Environmental Impact Assessment Report an analysis has been made of the emissions of industrial combustion and production processes for the Valchedram, Kozloduy, Mizia and Hayredin municipalities.

Kozloduy municipality has the most developed industrial output and the greatest share in the fuel emissions. They are not caused by the power plant because with nuclear power generation, there are no emissions of conventional pollutants. The emissions are related both to auxiliary production activities in the power plant and to the good business environment in the municipality, which encourages development of small production companies using burning processes and manufacturing products mainly for the power plant – asphalt facility, concrete production units etc. Statistically the fuel burning for heating is not included in the above quantities of emissions.

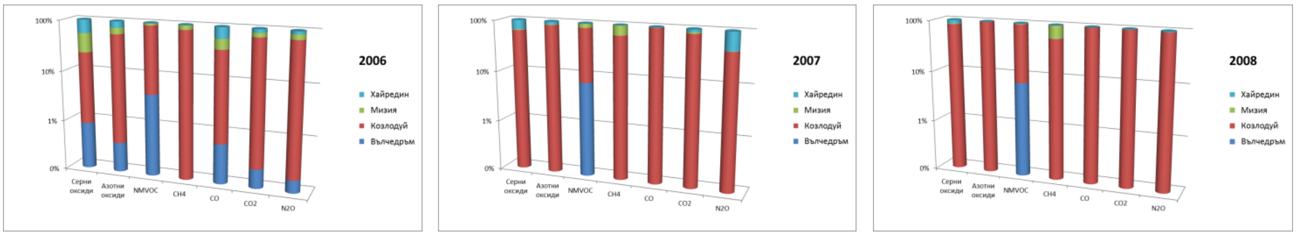


FIGURE 3.1-2: EMISSIONS FROM COMBUSTION AND PRODUCTION PROCESSES

Emissions related to the Danube River navigation

Along the River Danube, bordering with the Nuclear Power Plant, the navigation (both national and international) is source of emissions by the ships' engines. The emissions to air from the diesel compression-ignition engines along Inland Water Ways are regulated in MARPOL 73/78, Annex VI, where the limitations of the emissions for certain pollutants depend on the engine category (displacement).

The assessment of the emissions to air is based on information of the river traffic (number and type of passing ships) in the lower flow of the Danube River (the Bulgarian part of the river), published in EUROSTAT[13], where the total volume of goods (in tons) transported the year round along the inland water ways and the national, international or transit transportation is given in the format ton-km.

[12] The data of 2008 are used, since from 2009 the data for emissions in the different municipalities for power and industrial processes are confidential and are not accessible pursuant to Article 22 of the Statistics Act.

[13] http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database, upon registration.

The indices estimated for emissions of any given pollutant are under the usual values of the same indices for Varna Port, for instance.

Emission Sources in the air within 30 km zone around Kozloduy Nuclear Power Plant[14]

While complying with the emission norms, set down in the complex permits, the quantities of harmful substances, emitted in the atmospheric air by the above sources of emission, have no effect on the quality of the atmospheric air within the 30 km zone.

Emissions by vehicle traffic on roads second class II-11

The site of Kozloduy Nuclear Power Plant is linked with the national road network through a road of the second class, with two way traffic, asphalted and with good markings. This is road II-11, section Oryahovo – Mizia – Kozloduy – Lom, which passes south of Kozloduy Nuclear Power Plant and the site for the National Repository for Disposal of Radioactive Waste and continues along the non-flooding terrace of the Danube River. In this way the traffic of the inter-village road transport, including the transit goods traffic is taken away from Kozloduy Nuclear Power Plant site.

According to data for 2010 of the year round average 24-hour intensity of road traffic, taken at counting stations of the national road network by the Road Infrastructure Agency, for Road II-11 at the additional counting station 205 in the section Kozloduy – Lom and the additional counting station 496 in the section Mizia – Kozloduy – emissions of the regular traffic in the area around the power plant[15] have been evaluated for the 6 main categories of motor vehicles: light passenger vehicles, light cargo vehicles, medium cargo vehicles, heavy cargo vehicles, buses (intercity) and semi-trailers. The prognosis intensity for 2015 and 2020 has been made on the basis of traffic increase of the various types of motor vehicles of 10% to 18%.

Emission from the activities at the Kozloduy NPP site

Emissions from the Landfill for non-radioactive municipal and industrial wastes of Kozloduy Nuclear Power Plant

The Landfill for non-radioactive municipal and industrial wastes accepts non-radioactive waste from the protected zone of Kozloduy Nuclear Power Plant. The landfill is source of greenhouse gases – Methane (CH_4) and Carbon dioxide (CO_2) and smaller quantities of other volatile organic compounds.

Emissions from the diesel generators for emergency power supply of the safety systems

The generation of electric energy from any nuclear power plant practically goes without generation of greenhouse gas emissions. As part of the safety systems of the nuclear power units however, Kozloduy Nuclear Power Plant uses diesel generators and diesel pumps, the

[14] Regional Inspection on environment and waters – Vratsa, letter No. 198/25.02.2013 protocol for receiving and handing over, No. 15/26.02.2013 г.

[15] Annex 3 – Letter No. TsI-0158 of 04.02.2013

purpose of which being automatic switching on in case of emergency failure of the electric supply.

The diesel generators for emergency power supply of the safety systems at the Kozloduy NPP site are fuel-combustive installations with nominal power exceeding 50 MW, which puts them within the scope of Article 131v, par. 1 of the Environment Protection Act.

According to Article 10, par. 6 of the Regulation on the Way and Manner of Issue and Reconsideration of Permits for Greenhouse Gas Emissions and for Exercising Monitoring by the Operators of Installations and Operators of Aircrafts, Participating in the Scheme of Quota Trade for Greenhouse Gas Emissions (promulgated, State Gazette, No. 99 of 17.12.2010) Kozloduy Nuclear Power Plant has been issued Permit for greenhouse gas emissions – No. 143-H1/2012 with nominal heat capacity of the installation of 71.398 MW.

The diesel generators are dedicated for emergency electric powering of the safety systems of the Nuclear Power Plant, while the diesel pump aggregates ensure water for the fire-fighting systems in case of failure of the energy supply.

Emissions from the bus traffic to and from Kozloduy Nuclear Power Plant

The emissions in the Transport Scheme for transportation of workers[16] have been assessed according to EMEP/EEA CORINAIR'2009. The average speed of the buses is 50 km/h.

The emissions are released directly to the air by the exhaust pipes of the buses. The total quantity of greenhouse gases in tons equivalent to CO_2 is 55,415.4 tons per year. The quantity of diesel fuel related to emission factor, burned per year is 15,311.1 tons.

Emissions from the personal vehicles of the staff of Kozloduy Nuclear Power Plant

The yearly assessment of the emission levels from the vehicles of the staff has been made according to Tier 2 of the Air pollutant emission inventory guidebook EMEP/EEA CORINAIR'2009 for the main pollutants from light cargo transport vehicles (**1.A.3.b.ii**) for 1500 parking places[17] at average conservative value of traffic of the vehicle from/to the parking place of 1,000 metres.

The emissions are released directly into the atmospheric air by the exhaust pipes of the vehicles. The total quantity of the greenhouse gases in tons equivalent to CO_2 is 0.31 tons per year.

Measured concentrations

The National System for Environmental Monitoring, which exercises its activities of atmospheric air quality control on the entire territory of the country, has no permanent measuring station for the region of Kozloduy Municipality.

In 2011 according to an approved timetable for the work of the mobile automatic stations for making additional measurements in regions, which lack or have limited number of

[16] The data are for 2011, letter No. 118/31.01.2013, Kozloduy Nuclear Power Plant EAD.

[17] According to data by the Investor – letter No. 416 of 13.05.2013 by PPP No. 31 of 13.05.2013

permanent stations, measurements were made by mobile automatic stations for atmospheric air quality control in the period of 52 days in Kozloduy municipality. The measurements were made by the Regional laboratory – Pleven at the site of the regional fire-fighting and emergency safety service, town of Kozloduy. The wind roses during the period of measurement indicated that the predominant winds come from the south, which is a markedly local phenomenon, because in the region of Kozloduy municipality predominant are the zonal winds from the west to the east.

In some of the days of measurement the average day concentrations of fine particulate matter exceed the average 24- hour norm of 50 $\mu g/m^3$.

The comparison between the measured concentrations of sulphur and nitrogen dioxide indicated that the emissions of solid fuel combustion for domestic heating of the population during the winter increases the pollution with sulphur dioxide while the exhaust gases by the motor vehicle transport during the summer increases the pollution with nitrogen dioxide. The measured concentrations both of the sulphur and the nitrogen have values much under the limiting norms, which are respectively 350 $\mu g/m^3$ and 200 $\mu g/m^3$.

The other pollutants are in concentrations under the respective average daily and average hourly norm.

Therefore the quality of the atmospheric air within the 30 km zone remains unaffected.

3.1.3 ATMOSPHERIC ACTIVITY

Radio ecological monitoring of Kozloduy Nuclear Power Plant EAD

Aerosols – The radioactivity of the atmospheric air is being examined weekly at 11 control posts within 100 km of the zone under monitoring around the Nuclear Power Plant. The summarised data of the aerosol monitoring for the period 2009-2011 (Results of the radio ecological monitoring of Kozloduy Nuclear Power Plant, Annual report 2011) shows that the results are within the normal limits and the operation of Kozloduy Nuclear Power Plant , as potential source of pollution of the ground air radioactive substances **has not led to changes in the radiation gamma background** and to the atmospheric activity.

The measured concentration of ^{137}Cs in aerosols from all control posts within 100 km of the surveillance zone of Kozloduy Nuclear Power Plant in 2012 and in previous years are negligibly low – they have the values of background concentrations. Minimum activities have been measured only occasionally at some posts. No influence and tendencies have been registered in the aerosol activity by the operation of Kozloduy Nuclear Power Plant.

In 2012 no man-induced activity has been registered, different from the one of ^{137}Cs at any of the control posts within the region of Kozloduy Nuclear Power Plant.

The results of the monitoring carried out in 2012 and previous years show that the impact of Kozloduy Nuclear Power Plant on the aerosol activity of the air is negligibly low.

Practically this indicator has not been influenced by the operation of the power plant. The concentration of the man-induced radionuclides are with background levels.

The Radiation purity of the air entirely corresponds to the normative requirements.

***Atmospheric fallouts* –** The atmospheric fallouts are controlled monthly at 33 of the 36 control posts within 100 km of the zone under monitoring around Kozloduy Nuclear Power Plant. A slight seasonal dependence has been noted with maximum values during the spring-summer period, which is caused by the intensive rains and the self-cleaning of the atmosphere. It leads to reduction of the aerosol activity and correspondingly increases the fallouts activity.

In 2012 the controlled total beta activity of atmospheric fallouts varies within the interval 0.066 Bq/(m^2.d) ÷ 1.26 Bq/(m^2.d) at average value of 0.36 Bq/(m^2.d). The results are in correspondence with previous measurements for a number of years and present natural values characteristic for the region. The results for ^{90}Sr in atmospheric precipitations show steady tendency of reduction because of the self-cleaning of the atmosphere from the ^{90}Sr of Chernobil.

The results of the atmospheric precipitations in 2012 are utterly compliant with the ones in previous years and with the data for the region before the launching of Kozloduy Nuclear Power Plant.

Background gamma radiation – In 2012 a total of 1315 measurements have been made of the background gamma radiation at the control posts and the routes of the portable dosimetry devices and the stationary thermoluminescent dosimeters. Of them 1039 measurements have been made with portable dosimetry devices at a total of 77 control points of the 100 km zone.

A comparison with data from the Single national system of background gamma radiation monitoring at the Ministry of Environment and Waters is shown on **Figure 3.1-3**. The results are for the bigger cities of the country

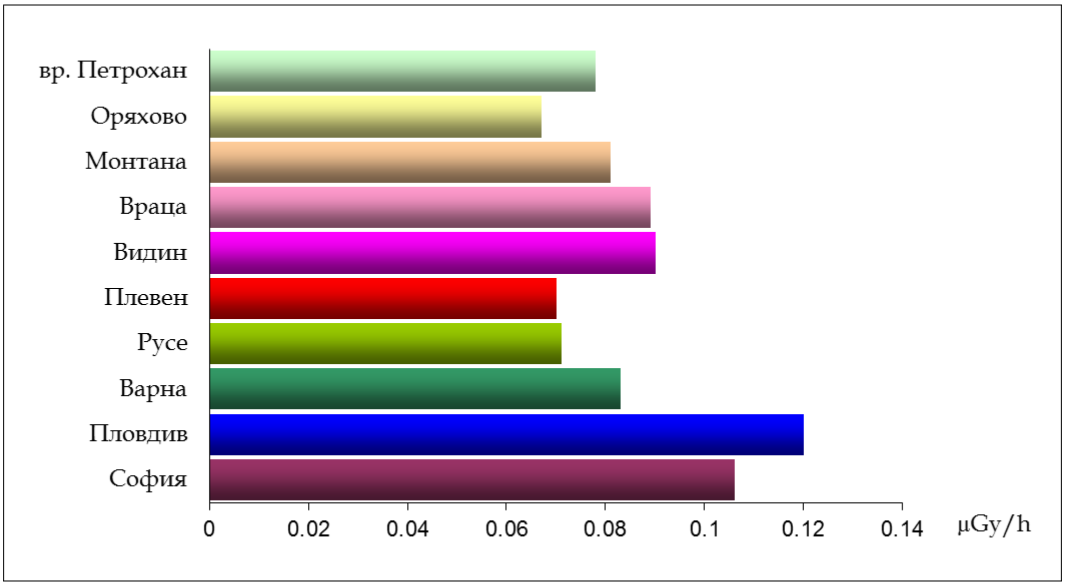


FIGURE 3.1-3: BACKGROUND GAMMA RADIATION IN THE GREATER CITIES IN THE COUNTRY, 2012, μGY/H

(from top to bottom – mountain peak Petrohan – Oryahovo – Montana – Vratsa – Vidin – Pleven – Ruse – Varna – Plovdiv – Sofia)

The summarised data and results for 2012 and their comparison with the ones for the period 2—7 – 2011 show that:

- Background gamma radiation in points at the fence of the Nuclear Power Plant and at the control posts and towns and villages within the 100 km zone is comparable and is in the range of the natural background radiation of 0.05 μSv/h ÷ 0.15 μSv/h.
- The radiation situation in the region is stable and unchanged by Kozloduy Nuclear Power Plant.

Radiation control on the territory of the Regional Inspection of the environment and waters – Vratsa 18.

The observation of the radiation parameters of the principal components of the environment is continuous and periodical and it is made with the purpose of ensuring up-to-date information for the public and local authorities and society. The radiation control on the territory under the jurisdiction of the Regional Inspection of the environment and waters – Vratsa is carried out by the Regional Laboratory – City of Vratsa at the Environment Executive Agency – Sofia.

In 2012 25 aerosol filters have been obtained by the permanent station in the City of Vratsa with the purpose of monitoring the presence of radionuclides in the atmospheric air (mBq/m^3).

No rise has been registered of specific activity of natural and man-induced radionuclides in the atmospheric air and the values measures do not differ from those in previous years.

In 2012 the state of the background gamma radiation continues to be monitored at the permanent posts for taking samples on the territory of the Vratsa District. The results of the monitoring in the 30 km zone stations: Hayredin and Oryahovo and in the 100 km zone: Vratsa show that the capacity of the equivalent dose is within the range of the characteristic background values for the respective posts and is within the range of 0.10 μSv/h до 0.20 μSv/h.

3.2 WATERS

3.2.1 SURFACE WATER

Several rivers flow through the region of the existing site of Kozloduy Nuclear Power Plant. They belong to the Ogosta River basin and the rivers west of it.

In the immediate vicinity of Kozloduy Nuclear Power Plant to the north flows the Danube River, which is of the greatest significance for the Nuclear Power Plant.

A system of drainage channels and structures has been built in the region of Kozloduy Nuclear Power Plant. These drainage channels protect the site of the power plant from flooding. The Main Drainage Channel is one of the recipients of four streams of waste water from the Nuclear Power Plant, including the whole territory of Electric generation – 1 by means of a mixed drainage system and taking part of the waste waters of Electric generation – 2.

The new sites proposed, provisionally called Site 1, 2, 3 and 4 are adjacent to the existing site of the Nuclear Power Plant.

For the existing site of Kozloduy Nuclear Power Plant, as well as for all proposed new alternative sites of the new nuclear unit, the Danube River plays the most important and substantial role.

The Danube River is used for circulation and technical water supply to all consumers at the site of Kozloduy Nuclear Power Plant. The river is an international transport water way. In 1992 a decision was taken and an International Commission for the Protection of the Danube River was set up. The Republic of Bulgaria has ratified the Convention on the Protection of the Danube River. In force is the first Danube River Basin Management Plan and a Management Plan of the Danube River Basin Management in the Republic of Bulgaria. In this plan the river has been categorised as a river named Danube RWB01, code BG1DU000R001 and type R6[18]. It has been defined as heavily modified water body/river wherein there is interference with its natural state – in this case dikes have been built along its banks, which protect from flooding. These dikes have changed the natural banks. Its state is moderately ecological, while from the chemical aspect it is bad. A program of measures has been developed and is implemented for reaching a good chemical status and good ecological potential within the next planned periods to 2021 and 2027. These

[18] Regulation H-4/State Gazette, No. 22 of 05.03.2013 concerning categorising surface water .

requirements are applicable in relation to the ecological requirements in the realisation of this investment proposal.

3.2.1.1 SUPPLY OF DRINKING AND HOUSEHOLD WATER

At the Kozloduy NPP site a very good water supply network has been developed for drinking and household water and for technical needs. The drinking water for the Nuclear Power Plant is provided from Raney Collector well – there are three of them situated on the terrace of the Danube River before the Town of Kozloduy, on the basis of a contract with the company "V&K" EOOD – Vratsa. For these Groundwater abstraction facilities Kozloduy Municipality has been issued a Water Abstraction Permit in accordance with the Water Act by the Danube Region Water Management Basin Directorate.

The balance of drinking water provided to consumers at the Kozloduy NPP site (quoted in the Environmental Impact Assessment Report) it is seen that there is a reserve of **70.90 l/s.**

For the shower-baths of Electric Generation – 1 there is a shaft well in the Valyata area. The operation of the facility is based on Water Abstraction Permit in accordance with the Water Act issued by the Danube Region Water Management Basin Directorate no. 11590203/30.05.2008.

The available reserve of 70.90 l/s is sufficient to provide drinking water and water for the households of the new nuclear unit and to cover the needs of drinking water during the construction works, the operation and the decommissioning of the new unit. There exists technical possibility to link the water supply network of the new unit with the existing water supply network of Kozloduy Nuclear Power Plant at suitable posts.

Number of staff of Kozloduy Nuclear Power Plant EAD

The total number of the staff of Kozloduy Nuclear Power Plant EAD – workers and employees, is 4105[19], the total number of the staff of a shift on duty on the territory of Kozloduy Nuclear Power Plant from 16:00 to 08:00 and on weekends and holidays is 600.

3.2.1.2 TECHNICAL WATER SUPPLY

The technical supply provides cooling water/circulation for the turbine's condensers and technical – for other facilities.

The conductivity of the cold channel is 180 m^3/s with proven maximum conductivity 200m^3/s[20], wherefore permits have been issued for water drawing by the Danube Region Water Management Basin Directorate

The water used in the energy units is returned to the Danube River by a "hot" channel HC-1. The conductivity of the hot channel is 180 m^3/s with proven maximum conductivity of

[19] Letter No. 55/29.01.2013 of Kozloduy Nuclear Power Plant.

[20] NITI Energoproject – 1991 – existing channels for technical water supply at Kozloduy Nuclear Power Plant.

200 m^3/s. The outgoing “hot” channel is laid down parallel to the “cold” channel CC-1 in the greater part of the route. The two channels have one common dike and form a double channel. Another channel HC-2 has been built with dimensions allowing 110 m^3/s for the needs of energy units 5 and 6.

In addition to these hydro-technical facilities, on the territory of the Nuclear Power Plant spray ponds have been built for cooling the water from the technical water systems of Electric generation – 1 and Electric generation – 2. The consumers of the technical water are combined into two groups – liable and not liable according to their relation to the nuclear safety.

From the viewpoint of providing technical water, taking into account the fact that the first four units are shutdown, there is 100 m^3/s free capacity available, while the conservative value adopted of the water necessary for the new unit is 60 m^3/s, according to letter of Kozloduy Nuclear Power Plant – New units EAD.

The requested water amounts of 60 Kozloduy Nuclear Power Plant for the new nuclear unit are considerably less that the quantities made free and therefore no exceeding use is made of the concrete source of water. In addition there are sufficient water quantities for drinking-household use and for industrial provision if the Investment proposal is realised.

There is an evident trend of steady decrease of the use of the Danube River for technical purposes and this is indicative of the lack of direct impact on the quantitative status of the river.

For all groundwater intake structures on the Danube River, for the groundwater intake and for the discharge of the waste waters permits have been issued by the Ministry of Environment/the Region Water Management Basin Directorate.

Where necessary, the permits issued in accordance with the Waters Act for intake and water use facility for discharge upon decision of the competent authority will be modified, if during the construction and operation of the Investment proposal it would not be possible to keep up all parameters and conditions set down. The Investment proposal will take into consideration the ban on new waste water discharge into irrigation and drainage systems and the ban on issue of permits for discharge into water bodies, as well as determination of individual emission limitations for point source of pollution.

3.2.1.3 SEWERAGE NETWORK

Kozloduy Nuclear Power Plant has sewerage of domestic, industrial and rain waters – mixed for Electric generation – 1 and split for Electric generation – 2. It embraces the whole territory of the power plant and takes in all types of waste waters.
The waste waters from the site (household-faecal, industrial and rain waters) form four streams, which discharge into the Main drainage channel and two streams, which discharge through TK-1 and TK-2 into the Danube River.

3.2.1.4 WASTE WATERS

Non-radiation aspect

Type of waste waters and streams

The non-radioactive waste waters at the site of Kozloduy Nuclear Power Plant are household-faecal, industrial and rain waters. The intake facility of these waste waters is the Main Drainage Channel of Kozloduy draining-irrigation system. Further on the waters of the Main Draining channel are fed into a Waste water treatment plant and are discharged into the Danube River. These streams of waste waters take also all waste waters from the territory of Electric generation – 1.

In addition to the four streams mentioned waste waters discharge in the Danube River through HC-1 and HC-2 – these waters are mainly cooling waters after the condensers and from the technical waters systems.

Quantities of the non-radiation waste waters

The quantities of the waste waters in 2007, 2008, 2009, 2010, 2011 and 2012 from the site of the Nuclear Power Plant are comparable to the permitted ones. Form the information provided it is seen that after 2009 the requested water quantities considerably exceeded the used ones and therefore **no excessive** use is made of the concrete source of water (surface and groundwater). There will be sufficient water quantities for drinking-household use and for industrial provision if the Investment proposal is realised.

Because of the fact that with the Investment proposal the energy units of Electric generation – 1 will not use cooling water and the quantity of the de-balanced and deoxidised waters is much less, it can be foreseen that as a whole the quantity of waste waters from the existing site of the power plant will be considerably reduced.

In the report of the environmental impact assessment the quantities of the waste waters from the Depot for non-radioactive domestic and industrial wastes are quoted according to the Annual reports for Kozloduy Nuclear Power Plant. The quantities of waste waters from the Depot for non-radioactive domestic and industrial wastes (on a year round basis) is negligibly small in comparison with the remaining waste waters from Electrical Generation – 2.

The waste waters from Kozloduy Nuclear Power Plant according to data by the Regional Inspection of the Environment and waters – Vratsa are 70.8% of the total quantity of waste waters of the Danube basin and 36.5% of the total mass for the whole country.

Existing Treatment facilities

At the Kozloduy NPP site a number of treatment plants have been built for processing the waste waters discharged by the various facilities:

- ✓ Treatment Plant at Electrical Generation – 2 – Treatment Complex of Kozloduy Nuclear Power Plant;

- ✓ Neutralisation pit for waste waters of the Chemical Water Treatment at Electrical Generation – 1
- ✓ Neutralisation pit for waste waters of Electrical Generation – 2
- ✓ Other local treatment facilities at Electrical Generation –1;
- ✓ Sludge and oil retainer for waste waters from the Main channel and Diesel generator's station of Electrical Generation – 2
- ✓ Old sludge and oil retainer at Electrical Generation – 2.

Domestic non-radiation monitoring of wastewaters by Kozloduy Nuclear Power Plant EAD

For the purposes of the Environmental Impact Assessment detailed results were provided on the quality of the surface water , collected by the monitoring of Kozloduy Nuclear Power Plant. Kozloduy Nuclear Power Plant EAD has organised and is carrying out regular and obligatory domestic non-radiation monitoring of the waste waters according to the terms in the Discharging Permit. Internal additional monitoring and control is also carried out at all discharging places at the Main Draining channel, TK-1 and TK-2, the Danube River and on the quality and quantity of the waste waters, taken into the sewerage network from external consumers on the territory of the power plant.

The characteristics of the non-radiation waste waters as summarised results have been analysed for 2007, 2008, 2009, 2010, 2011 and 2012.

There is no exceeding the individual emission limits for the streams has been registered.

Radiation aspect

Types and quantities of waste waters

In the process of operation of the Nuclear Power Plant operational radioactive liquid releases are produced by:

- The first loop of the nuclear reactor;
- The spent fuel storage facilities;
- Decontamination facilities;
- Equipment for regeneration of ion exchange filters;
- The washing facilities for special clothes and the sanitary filtering units;
- The Radiochemistry laboratories.

The radioactive waters produced under working conditions are three types – the so called floor drain, boron-containing water and waters from special washing units and sanitary filtering units.

The way of treatment and the quantity, calculated according to the volume of the intermediate stages is made in the Environmental Impact Assessment Report.

The percentage composition of the liquid components without tritium for 2012 can be found in the Environmental Impact Assessment Report, including the radioactivity of the debalanced waters for the period 2004-2012

Domestic monitoring of waste waters from radiation aspect

The radio-ecological monitoring includes the territory of the industrial site of the nuclear power plant, the 2 km zone for preventive protection measures, the 30 km surveillance zone and reference points within a radius of 100 km around the nuclear power plant.

The radio-ecological monitoring is subject to Annual programs and Annual reports of the activities are produced accordingly.

The approximate evaluation of the presence of radionuclides (natural and man-induced) in the waters is derived by the general beta activity.

The data show that the contents of tritium in the household waste waters in the whole **2007**, **2008**, **2009**, **2010** , **2011** and **2012** was lower than the **minimum detectable activity (such as may be measured by measuring devices), which is way under the drinking water norm.**

The specific activity of ^{90}Sr in all measured water samples was within the limits for the **values, characteristic for the natural water bodies.**

Conclusion:

In comparison with the results of the last 15 years, the specific activities of radio caesium in the waste waters discharged by the sewerage are among the lowest in the period 2007-2012.

This indicates an improvement of the radiation situation in the region as a result of the strict radiation control over the waters discharged by Kozloduy Nuclear Power Plant.

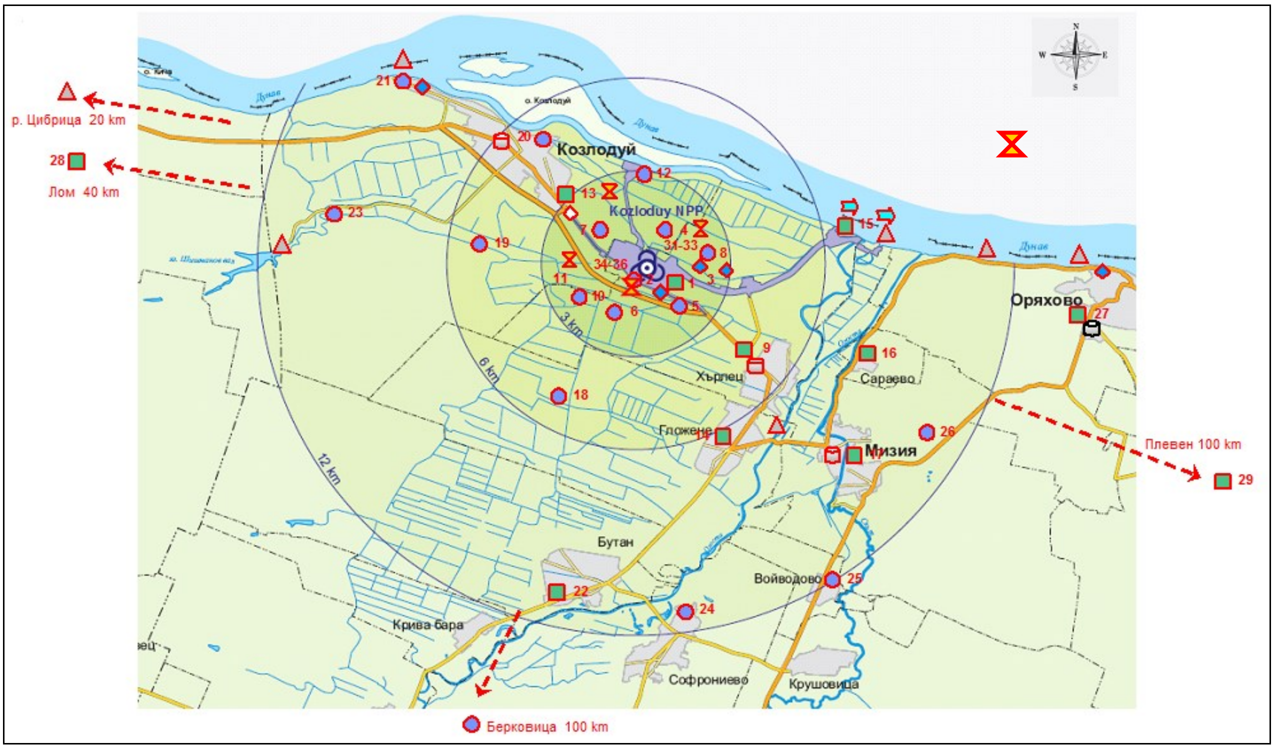
FIGURE 3.2-1: LOCATION OF THE POSTS OF RADIO-ECOLOGICAL CONTROL OVER THE SEWERAGE SYSTEM OF KOZLODUY NUCLEAR POWER PLANT

3.2.1.5 MONITORING OF THE NATURAL AND MAN-INDUCED RADIOACTIVITY OF THE SURFACE WATER IN THE REGION OF KOZLODUY NUCLEAR POWER PLANT, CARRIED OUT BY KOZLODUY NUCLEAR POWER PLANT EAD.

The domestic radiation monitoring of the environment is regulated by the Long-term program of Kozloduy Nuclear Power Plant for radiation monitoring of the environment. The program is based on the requirements of the statutory provisions in the region and the good international practice and operational experience of the Radio Ecological Monitoring Department. The program is coordinated with the Ministry of Environment and Waters, the Ministry of Health and the Nuclear Regulation Agency and is in compliance with the international recommendations in the field – Article 35 of the EURATOM Treaty and Recommendation 2000/473/EURATOM. The independent control is carried out on the basis of radiation monitoring programs by the Environment Executive Agency/Ministry of Environment and Waters and the National Centre of Radiobiology and Radiation Protection/Ministry of Health.

In order to localise and evaluate possible impact of Kozloduy Nuclear Power Plant on the environment and the population, 2 control zones around the power plants have been set up with different radius: Precautionary protective action planning zone (2 km) and Monitoring zone (30 km). In a 100 km zone, reference points have been set up. Object of monitoring is the very territory of the industrial site.

Within the 30 km zone a total of 36 control posts have been set up for the land ecosystem and 7 posts for the water ecosystem. These posts collect samples for laboratory analysis and measure the activity of man-induced radionuclides in the samples. Analysed are samples taken from the air, the soil, the plants, the waters and the bottom sediment; the background gamma radiation is also measured. In other than the mentioned posts measurement is made on samples of drinking water, milk, fish, agricultural products grown in the region – cereals and forage cultures. The distribution and the type of control posts are given on **Figure 3.2-2** in the Environmental Impact Assessment Report.



Legend:

- control post "**A**" type: aerosols, atmospheric fallouts, soil, plants, gamma background – 11
- control post "**B**" type: atmospheric fallouts, soil, plants, gamma background – 15
- control post "**C**" type: water, sediments, duckweeds, gamma-background – 7

Products of the food chain: – drinking water; – milk; fish; cereals

FIGURE 3.2-2: SCHEME OF LOCATION OF THE POSTS FOR RADIATION MONITORING AROUND KOZLODUY NUCLEAR POWER PLANT

The waters of the surface water bodies – natural and artificial in the region of the power plant are main object of the radio-ecological monitoring, being indicator for the ecological status in the region. Under study is the radioactivity of the waters of the Danube River along its flow and the inland rivers, water basins in the vicinity of the nuclear power plant – Ogosta River, Tsibritsa River and Kozloduy dam. As receiving water of the waste waters from the Nuclear Power Plant and border river between this country and the Republic of Romania, particular attention is devoted to the Danube River.

The practical experience shows that the results of the radio-ecological monitoring have values considerably lower than the values laid down in the statutory documents. For this reason more often is used the comparison of the current results with ones recorded in previous years of operation and before the commissioning of the nuclear power plant. This approach allows registering and analysing even the minimum trends to change in the radiation situation.

Detailed results for the quality of the waters of the Danube River were provided for the purpose of the Environmental Impact Assessment (the annual reports on the radio-ecological monitoring of Kozloduy Nuclear Power Plant).

Samples of the Danube River are taken at four control posts (1 before and 3 after the nuclear power plant location along the flow of the river) respectively: at the Radetski Port, draining channel at the Bank Pump Station, the Batatovets area (before the Town of Oryahovo) and at Oryahovo Port. Weekly samples of the waters are taken at three posts (Radetski Port, the Draining channel and Oryahovo), thereafter the samples taken in the respective month are analysed. Once yearly the waters of the inland water basins are analysed – Ogosta River, Tsibritsa River and the dam of Kozloduy and twice the year – the water of the Batatovets area. In all samples the general beta activity and the tritium are determined and concerning the waters of the Danube River – additionally Strontium 90 and Caesium 137. An assessment for the presence of radionuclides (natural and man-induced) in the waters is derived of the general beta activity.

Conclusions of the monitoring for the period 2007-2012:

- ✓ The operation of Kozloduy Nuclear Power Plant has not influenced the radio-ecological status of the waters of the Danube River and the other water basins in the region;
- ✓ The results are within the normal range, many times under the established norm.

The fulfilment of the program for radiation monitoring is checked and compared with the self-assessment criteria – fulfilment in the set volume at guaranteed reproduction and precision of the results. The precision of the results has been confirmed a number of times at national and prestigious international laboratories. Comparisons have been made at the World Health Organisation, the Federal Office for Radiation Protection – Germany (BfS), the International Atomic Energy Agency and the National Physical Laboratory – Great Britain. The results of the domestic radiation monitoring are confirmed annually with independent research of the Ministry of Environment and the National Centre of Radiology and Radiation Protection (Ministry of Health). The main conclusions are accessible to the wide public.

3.2.1.6 MONITORING OF THE SURFACE WATER IN THE REGION OF KOZLODUY NUCLEAR POWER PLANT CARRIED OUT BY THE MINISTRY OF ENVIRONMENT AND WATERS/ENVIRONMENT EXECUTIVE AGENCY – REGIONAL LABORATORY – VRATSA, MONTANA AND THE REGIONAL INSPECTION OF ENVIRONMENT AND WATERS

The river is an international transport water corridor. Following the assessment by the states around the river that there was a threat to the ecological state of its waters as a result of the increased impact by human activities along the banks and the transport traffic, as well as the need to ensure further preservation of many protected zones and habitats, which were under the influence of its waters, in 1992 a decision was taken to set up an International Commission for the Protection of the Danube River (CPDR).

According to the Bulgarian legislation – the Waters Act and the Framework Directive 2000/60/EC, the Danube River Basin Management Plan, as developed under the said legislation, defines our section of the river as category – river – with name DanubeRWB01, code BG1DU000R001 and Type 06, according to system B of the Framework Directive for the typology of the "river" in this country. This water body is of the type "heavily modified water body" with moderate ecological potential and bad chemical state. The aims and measures of the Danube River Basin Management Plan require these indicators to be corrected in the following years as planned until a better state and better potential are reached.

The information from the non-radiation monitoring carried out by the Environment Executive Agency – Regional laboratory – Vratsa, and the Regional Inspection of Environment and Waters has also been analysed. Data from the monitoring of the Ogosta River and Skut River are also provided.

The laboratory control of the Danube River has been made every two months at a post of the National System for Environmental Monitoring on the territory of the Regional Inspection of Environment and waters – Vratsa at the Town of Oryahovo. The indicators checked are within the range of the admissible concentrations and the waters of the river correspond to the category as per the design by all checked indicators.

In the course of the year control monitoring is made also of the Asparuhov Val dam, Barzina Dam and Tri Kladentsi Dam. No increase has been established of the checked indicators.

The information from the non-radiation monitoring of the surface water for drinking and household supplies within the 100 km zone of Kozloduy Nuclear Power Plant has also been examined in detail by the Regional Laboratory – Montana, which did not find any infringement of the normative requirements.

A steady tendency is apparent of improvement of the quality of the surface water in the region concerning the indicators Biochemical oxygen need$_5$ and dissolved oxygen.

Summarised information is provided in the Environmental Impact Assessment Report and analysis of the radiological control and surface water monitoring put in place in recent years by the Regional Laboratory – Vratsa and the Regional Inspection of Environment and Waters – Vratsa.

Data from the radiological monitoring carried out by the Environment Executive Agency – Regional Laboratory – Montana and the Regional Inspection of Environment and Waters – Montana have also been provided.

The analysis of the summarised information of the radiological monitoring by the Regional Inspection of Environment and Waters and of the data on the general beta activity of the waters of the Danube River (from the Village of Novo Selo to the Town of Silistra) compared to the waters from the "draining" channel of Kozloduy Nuclear Power Plant

shows values considerably below the maximum admissible, determined in the normative base on the quality of surface water (0.750 Bq/l). This conclusion refers to the other examined rivers in the region too.

The analysis of the data for general beta activity of the waters of the Danube River and the other main rivers, lakes and dams shows tendency concerning the radiological indicators, in comparison to previous years to keep their values, characteristic for the given monitoring post in the country. **This an indicator of lack of radioactive pollution of this component of the environment**

Summarised conclusions

On the basis of the domestic monitoring over the waste waters and the environment carried out by Kozloduy Nuclear Power Plant and the control monitoring carried out by the competent authorities – the Ministry of Environment and Waters, the Environment Executive Agency – Regional Laboratory – Vratsa, Danube Region Waters Management Basin Directorate and the Regional Inspection of Environment and Waters – Vratsa, **it may be summarised that the operation of the power plant does not endanger the state of the surface water in the region and most of all – the Danube River, inlet of all types of waste waters from the Nuclear Power Plant. The state of the Danube has not been influenced by the operation of the power plant.**

3.2.1.7 HYDROLOGY OF THE DANUBE RIVER

The Danube River has a definite importance for the operation and the safety of Kozloduy Nuclear Power Plant. The site of the power plant is situated on non-flooded terrace of the Danube River. The elevation of the site has been achieved by building-up the area in considerable dimension determined during the designing the power plant with reserve to non-floodability at the flow of 10,000-year high wave along the Danube River.

To protect from floods, at probability of 1% for a period of 100 years, the lowland is protected by a dike with average altitude of 30.5 m. The width of the river-bed of the Danube River varies between 800 – 1200 m. The maximum speed of the river flow is about 2.5 m/s (9 km/hr). Within the section of the river under consideration, the island of Kozloduy is situated (from km 701.5 to km 690; width to 1 km and length around 11 km), which divides the river into two branches.

The Danube River catches waters from a catchment basin of 584,400 km^2 before reaching the western borders of the Republic of Bulgaria and from additional 101,300 km^2 of the territories of Bulgaria and Romania in the section of the river shared by the two countries. The catchment basin of the river is situated in the European continental climatic zone; however the formation of the river flow is result of a multitude of interferences. In unapparent way this process contains information concerning physical processes, which develop both in the atmosphere and over the catchment basin. These processes develop under the influence of two main group of factors – natural and the human activities. The river is an important international transport water corridor.

In 1992 a decision was taken to set up International Commission for the Protection of the Danube River (CPDR). The Republic of Bulgaria has ratified the Convention for the Protection of the Danube River.

Water volumes

The analysis of the average flow for a number of years at Port Oryahovo, which has been used as analogue indicate that in the period 1941 – 1980 the Danube River has average volume of water Q_{av}=5 847 m^3/s.

The changes in the flow of the Danube River are considered greatest in the months of low water (August to January). The flow is steadiest (the size of the flowing water volumes) in the period of high water (February – July).

In the period 2002 – 2012 no clear trend to change may be detected.

Water levels

The determination of the water levels at various extreme states is of crucial importance for the safety of the power plant. Elevation +35.00 according to the Baltic altitude system has been accepted to be elevation 0.00 of the site of Kozloduy Nuclear Power Plant.

The determination of the water levels was based on the period 1941-1980[21] concerning maximum waters and 1937-1986 concerning minimum waters. The two water control posts were considered – Oryahovo and Kozloduy.

In connection with the designing Kozloduy Nuclear Power Plant a study was made to determine the hydrological and hydraulic characteristics of the Danube River[22]. According to the study the maximum water level at Kozloduy Nuclear Power Plant at the time of flow of a catastrophic wave, which would originate from the destruction of the Iron Gate Hydro-complex I and II would be 32.53 m. This maximum high wave would be registered 28 hours 20 minutes after the presumed destruction of Iron Gate Hydro-complex I and would last about 2 hours.

The maximum level at overlay of events with low probability has been defined at 32.93 m for the site of Kozloduy Nuclear Power Plant at the current state of the hydro-technical facilities on the Danube River. The scenario where this level would occurs would be sudden and consecutive rupture of Iron Gate Hydro-complexes I and II with overlay of the two waves and water volume of 10,000 m^3/s.

It follows from the above that all consequent analyses for the safety of the power plant would be estimated at **Maximum high wave = 32.93 m.**

Characteristics of the sediment flow

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[21] Study and determination of the location of preferred site for building new nuclear unit on the site of Kozloduy Nuclear Power Plant EAD and the adjacent territories. Review of the research undertaken, Ref No. REL-1000-ST-001-2, January 2013.

[22] Report related to Contract No. 511/14,12,2005. Task: "Evaluation of the hydro meteorological characteristics for designing the site of Belene Nuclear Power Plant.

In a number of studies analysis has been made of the data on the sediment flow. Particular attention has been paid to the representativeness of the data on the sediment flow – the multiyear characteristics of the sediment flow – floating and bottom sediments and their distribution during the flow cycle the year round. The changes of the sediment flow have been analysed as a result of various anthropogenic impacts along the Danube River – above the site of Kozloduy Nuclear Power Plant. It needs to be noted that until 1995 measurements have been made of the flow quantities each year on a regular basis. This makes it possible to determine the dependence between single sediment flow at the post where samples are taken and the average quantity for the entire cross section.

As a whole the sediment load of the Danube River presents no danger for the work of the bank pumping stations and the channels of Kozloduy Nuclear Power Plant

3.2.2 GROUNDWATER

The Kozloduy NPP site and respectively the four alternative sites for the construction of the new nuclear unit lie on parts of the following water bodies, according to the River basin management plan:

- ✓ **Groundwater body, defined by code BG1G0000Qpl005 – Porous groundwater in the Quaternary – Kozloduy low land.** This groundwater body (this is a separate level of the groundwater) covers the east-north-eastern part of the Kozloduy NPP site, including the non-flooding terrace on the Danube River.

- ✓ **Groundwater body defined by code BG1G0000Qpl023 –** Porous groundwater in the Quaternary – between the rivers of Lom and Iskar. The Kozloduy NPP site is entirely over this water body, which has an area of 2,890 km^2. This is the first aquifer from the surface (this is a sub-surface layer or layers with sufficient permeability to allow flow of groundwater.

- ✓ **Groundwater body defined by code BG1G00000N2034** – Porous groundwater in the Neogene – Lom-Pleven depression. The Kozloduy NPP site lies entirely over this water body, stretching under the Quaternary aquifer. It covers an area of 30.65 km^2.

3.2.2.1 CONCERNING DRINKING – HOUSEHOLD WATER SUPPLY

The waters of groundwater body BG1G0000Qpl005. The waters of the Quaternary – Kozloduy lowland are characterised by general beta activity and contents of natural uranium under the admissible values as per the requirements of Regulation No. 9/16.03.2001 on the quality of the water for drinking – household purposes, and the specific activity of the studied radionuclides is below the maximum admissible values, according to the Regulation on basic norms of radiation protection, 2012, amended State Gazette No. 76 of 05.10.2012.

According to information provided by the Danube Region Water Management Basin Directorate – Pleven No. ZDOI-380/11.02.2013, the territory of water body BG1G0000Qpl005 – porous groundwater in the Quaternary – Kozloduy lowland is being under the observance of one monitoring post ShK-P2 Water System Kozloduy. It is monitoring mainly the physical and chemical indicators and specific pollutants – a group of metals and metalloids and a group of organic substances.

The results of the analysis of the monitoring show that all monitored indicators are within norm, according to the standards for quality, stipulated in REGULATION No. 1 OF 10 OCTOBER 2007 ON THE EXAMINATION, USE AND PROTECTION OF GROUNDWATER, in force since 30.10.2007, promulgated, State Gazette No. 87 of 30 October 2007, amended State Gazette No. 2 of 8 January 2010, amend. State Gazette No. 15 of 21 February 2012.

The study for a number of years of the drinking water, carried out by Kozloduy Nuclear Power Plant within the program for monitoring the environment, indicate that the values of the general beta activity are considerably lower than the maximum admissible values, according to the requirements of Regulation No. 9/16.03.2001 on the quality of water for drinking-household purposes, while the contents of man-induced substances is several orders under the norms, according to the Regulation on basic norms of radiation protection, 2012.

The drinking-household water supply is provided by the drinking water pipe, feeding Kozloduy Nuclear Power Plant and the water comes from two underground sources (Raney Collector wells).

The estimations at average monthly consumption of drinking water by the consumers of Kozloduy Nuclear Power Plant indicate that the real volume of drinking water comes to about 35 – 40 l/s.s

3.2.2.2 CONCERNING THE TECHNICAL SUPPLY OF THE NUCLEAR POWER PLANT

The supply of groundwater is done in accordance with permits for water use No. 11530128/30.05.2008, No. 11590203/30.05.2008 and No. 11530128/30.05.2008. The supplying of groundwater is carried out as follows:

- ✓ Permit for water use No. 11530127/30.05.2008 by six shaft wells – ShPS 1-6 concerns a regulated water use for reserve (emergency) technical water supply to unit 5 and 6 spray ponds of Kozloduy Nuclear Power Plant
- ✓ Permit for water use No. 11530128/30.05.2008 from well of the Raney-5 type. It supplies technical water for technological needs (for lubricating the bears of the bank pumps) and for the fire-fighting system at the bank pumping stations 1, 2 and 3.
- ✓ Permit for water use No. 11590203/30.05.2008 from the Valyata shaft well. It ensures hygiene and household water supply of units 1 to 4 of Kozloduy Nuclear Power Plant.

The water volumes used by Kozloduy Nuclear Power Plant are considerably lower than the permitted, which is an indicator of availability of sufficient water volumes for industrial supply of the potential extension as per the investment proposal.

3.2.2.3 MONITORING OF GROUNDWATER

Kozloduy Nuclear Power Plant is carrying out its own non-radiation monitoring. On the territory of the industrial site a total of 181 monitoring wells (piezometers) have been drilled.

The monitoring of the waters is made with the purpose of coordinated review of the state of waters, including periodical measurement taking, monitoring and evaluation. The data from the mounting provide basis for the control of the production processes and measures to prevent/curb their negative impact over the waters.

3.2.2.3.1 Non-radiation monitoring

The non-radiation monitoring includes all measurements and laboratory analyses of basic ecological components of ground, surface and waste waters, which cover the requirements of the environment permits. This monitoring is divided into two parts – obligatory non-radiation monitoring and domestic company control.

The obligatory company-based non-radiation monitoring in Kozloduy Nuclear Power Plant EAD comprises all obligatory measurements and analyses, ensuing from normative requirements and from the terms of the permits issued to the company for water use and water use facilities and it includes:

- Measurement of the volume of used waters from the Danube River and the concentration of the pollutants in them;
- Measurement of the volume of waste waters and the concentration of the pollutants therein for which there are certain individual emission limitations in the permits issued to the company pursuant to the Waters Act;
- Measurement of the volumes of groundwater supplied:
- Monitoring of the water levels and the chemical state of the groundwater bodies, used to supply groundwater thereof.

The company-based control performs additional analysis of the waters; it is carried out by laboratories of Kozloduy Nuclear Power Plant and involves testing:

- The used waters of the Danube River;
- Waste waters;
- Waste waters of external organisations, discharging under contract into the sewerage system of Kozloduy Nuclear Power Plant EAD;
- Groundwater of the industrial site, including the territory on which the buildings of Decommissioning Special Company, Radioactive Waste Special Company of the Radioactive Waste State Enterprise

Monitoring is carried out also of the groundwater and waste waters of the Depot for Non-radioactive Household Industrial Waste

3.2.2.3.2 Radiation monitoring

The radiation monitoring of the environment is performed according to the "Program for radiation control of the environment during the operation of Kozloduy Nuclear Power Plant".

The Program is based on the requirements of the normative base in the region – Article 130 of the Regulation on ensuring the safety of nuclear power plants, promulgated, State Gazette No. 66 of 30.07.2004, Article 118 of Regulation for radiation protection during activities with sources of ionizing radiation, promulgated, State Gazette No. 74 of 24.08.2004, Article 14, par. 1, item 3 adopted by the Council of Ministers by Decree No. 200 of 04.08.2004, promulgated, State Gazette No. 74 of 24 August 2004, amend. State Gazette No. 76 of 5 October 2012, as well as on the good international practices and operational experience of the Radiation Monitoring Department staff. The Program was coordinated with the Ministry of Environment and Waters, the Ministry of Health and the Nuclear Regulation Agency and is in compliance with the international recommendation in this field, including Article 35 of the Treaty of EURATOM and Recommendation 200/473/Euratom. In order to endure independent control the control authorities the Environment Executive Agency/Ministry of Environment and Waters and the National Centre of Radiobiology and Radiation Protection implement programs for radiation monitoring.

In order to localise and evaluate eventual impact of Kozloduy Nuclear Power Plant on the environment and the population, 2 control zones around the power plants have been set up with different radius: Precautionary protective action planning zone (2 km) and Urgent protective action planning zone (30 km). The object of monitoring is the territory of the industrial site itself. For the reason of comparison, samples are taken and measurements are made in reference points as far as 100 km around the nuclear power plant, where no influence of the operation of the power plant is expected. Laboratory and automated control of the components of the environment is made..

For the purposed of the radiation control of the underwater at the site and in the area of the nuclear power plant a network of boreholes have been drilled.

In Implementation of the program for examination of the radioactivity of the underwater at the industrial site of Kozloduy Nuclear Power Plant samples are taken of 115 boreholes.

Water samples from the boreholes are analysed four times a year for general beta activity and contents of tritium.

3.2.2.3.3 Company-based monitoring of the groundwater supplied

The obligatory company-based monitoring of the supplied underwater is performed pursuant to the permits for water used (No. 11530127/30.05.2008, № 11530128/30.05.2008 and No. 11590203/30.05.2008) and involves measurement of the supplied volumes, monitoring the water levels and of the chemical state of the groundwater bodies, used for supply of water

The additional company-based control is performed by chemical laboratories of the Nuclear Power Plant, its purpose being to add to the obligatory control in the months when no mandatory analyses have been previewed, according to the permits for water use and the permits for water use facilities for discharging waste waters.

For purposes of internal control, part of the boreholes at the industrial site of Kozloduy Nuclear Power Plant have been equipped with piezometers, and periodical company-based test of non-radiation indicators are performed for the purposes of the radiation monitoring.

3.2.2.3.4 Company-based monitoring of the groundwater in the area of the depot

For the purposes of the company-based monitoring of the underwater in the area of the Landfill for non-radioactive municipal and industrial wastes of Kozloduy Nuclear Power Plant, monitoring has been set up in four monitoring posts.

All boreholes are tested twice yearly for lack of radioactive pollution.

3.2.2.3.5 Documentation and data processing of the monitoring of the groundwater

The measured volumes of surface water and groundwater and waste waters used by Kozloduy Nuclear Power Plant are recorded by the units responsible for the measurement in trimestral reference information, which is presented to Quality Management Office (UOS Department)

On the basis of the reference information concerning the measured volumes, UOS Department prepares the following documents:

- Trimestral Summarised reference information of the measured water levels and water volumes supplied from Valyata shaft well, Raney 5 Shaft well, Shaft well S 2-6;
- Annual report of the volumes of surface and discharged waste waters used.

The summarised trimester reference information is sent to the Danube Region Water Management Basin Directorate – City of Pleven before the 15th day of the month following the accounting three months.

The annual reports for the used and discharged volumes of water are registered and are sent to the Danube Region Water Management Basin Directorate – City of Pleven before 31st January of the following year.

Each year, before 31st March, an annual report is prepared of the results of the company-based non-radiation monitoring of the waters used during the operation of Kozloduy Nuclear Power Plant. The report is registered at the Central Archives and is sent to the Danube Region Water Management Basin Directorate – City of Pleven and the Regional Inspection of the Environment and Waters – Vratsa.

3.3 LANDS AND SOILS

3.3.1 LANDS

Basic characteristics of the sites are presented in **Table 3.3-1**.

TABLE 3.3-1: BASIC CHARACTERISTICS OF THE ALTERNATIVE SITES FOR DISPOSITION OF THE NEW NUCLEAR UNIT

Site	Total area decare	Land of	Municipality	Property of	Area decare
1	550	Hurlets	Kozloduy	Nuclear Power Plant Public organisations and private property	24.7 525.3
2	550	Hurlets	Kozloduy	Nuclear Power Plant GBS-ESM AD[23] Private lands	202.7 68.6 278.7
3	530	Hurlets	Kozloduy	Nuclear Power Plant Private agricultural lands	66.5 463.5
4	210	Hurlets Town of Kozloduy	Kozloduy	Nuclear Power Plant Enemona AD	161 49.0

Neither site is part of the forest fund. The available data on the distribution of the arable land into groups of crops within the 30 km surveillance zone indicate that the arable land is used mainly for cereal crops (52.109%), industrial crops (8.831%), vegetables (3.012%), vineyards (2.529 %).

The state of agriculture in the region of Kozloduy Nuclear Power Plant is defined on the basis of the information on the structure of the soil cover and the productivity of the lands, on the manner of consistent use of the agricultural lands.

According to the ecological evaluation of the Specialized detailed development plan, 12,566 decares belong to the precautionary protective action planning zone with radius of 2 km around Kozloduy Nuclear Power Plant, 3,012 decares of them being part of the industrial site of Kozloduy Nuclear Power Plant and the site for storage and processing of radioactive waste of the Radioactive Waste Specialised Company – Kozloduy, while the rest is arable land planted each year with various crops. The summarising conclusion, which may be drawn, is that plant-growing in the region is oriented towards production of grain, though the industrial crops and the orchards and vineyards are also of importance. Cattle-breeding is poorly developed, people raise cattle only for personal use. The territory of Kozloduy Nuclear Power Plant affected mainly agricultural lands with diverse usage – growing agricultural crops, part of them are swampy, building sites etc. Except the existing facilities and operating units of Kozloduy Nuclear Power Plant, there are some privatised buildings.

[23] ГБС-ЕСМ АД – Главболгарстрой–Енергостроймонтаж АД.

The total area of the land of the Town of Kozloduy in the vicinity of the sites, considered as alternative for the construction of the new nuclear unit, comprises 1,111.781 decares, of which the fields take up 426.848 decares, the private lands there of being 355.512 decares.

The area of the lands, which belong to the Village of Hurlets, adjacent to the sites, is considerably larger (more than 4 times the share of Kozloduy). The fields have a total area of 910.208 decares, the private lands being 338.131 decares. The total area of the lands of the Village of Hurlets in the area of the site is 4,877.916 decares, and the total land of the territories of the town and the village is 5,989.697 decares.

3.3.2 SOILS

From a non-radiation aspect

According to the soil-geographical zoning of Bulgaria[24.25], Kozloduy municipality is situated within the soil-geographic region of the Danube sub-zone of the chernozem soils, Middle province by the Danube and the agro-ecological region is also the region of the chernozems. The soils of Kozloduy municipality appear to be deep soils in the lowland regions – mainly calcareous chernozems and alluvial-delluvial-meadow soils.[26]

In relation to the land evaluation grouping (agronomic properties) the soils belong to the first (lands with 80 points and more) and second group (good lands with 61 – 80 assessment points)[27].

The ***chernozems*** have the widest distribution in the 30 km zone around Kozloduy Nuclear Power Plant. The most common of them are chernozems – carbonate sandy-clay, chernozems – typical sandy clay, eroded chernozems (calcareous and typical) and chernozems typical and heavy leached sandy clay.

The active soil acidity fluctuates in poor alkaline spectre 7.4 pH – 8.4 pH. The lower values are rarely met – I the region of Krushovitsa, (pH=6.0), Manastirishte (pH=5.5) and some other places.

At the first, second and third site the soils are alluvial meadow, while on **the fourth – carbonated chernozem – very anthropogenised,** with reduced profile and covered by buildings and impermeable asphalt covering. The alluvial meadow soils of the ***third*** site are very swampy.

From radiation aspect

A review has been made in the Environmental Impact Assessment Report of the results of the studies undertaken after 2000 of the contents of radionuclides in the soils on the

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[24] Koynov. V. Et al. 1974. Soil geographical regioning. Sofia.

[25] Ninov. N. (1982): Soil-geographical regions. pp. 399-400. Geography of Bulgaria. Publication BAS.

[26] Koynov. V.. Iv. Kabakchiev & K. Boneva. 1998. Soil Atlas of Bulgaria. Zemizdat. Sofia.

[27] Petrov. E.. I. Kabakchiev, Ya. Georgieva. P. Bozhinova. 1988. Methodology of work with the cadastre of the agricultural lands in Bulgaria.

territory of the Republic of Bulgaria and more specifically within 30 km and 100 km of Kozloduy Nuclear Power Plant. Results are presented of the radiation monitoring of the environment of Kozloduy Nuclear Power Plant carried out by units of the Ministry of Environment and waters, the Nikola Pushkarov Institute of Soil Science, Agrotechnology and Plant Protection, the assessment made in 1999 in the Environmental Impact Assessment of Kozloduy Nuclear Power Plant. The attention has been focused mostly on the contents of the two biologically most dangerous radionuclides – Strontium-90 and Caesium-137. A comparison has been made of the levels of these radionuclides in the soils of these regions from before the construction of Kozloduy Nuclear Power Plant up to 2012 and the established values of the contents of Sr-90 and Cs-137 and **no increase has been registered by the operation of the nuclear power plant.**

3.4 SUBSURFACE

The part of North-western Bulgaria, where the potential sites of the new nuclear unit are situated, is well researched in geological-tectonic, geomorphological and engineering geological aspect. In the second half of the previous century geological (including more than 50 deep drillings) and geophysical research have been carried out in search of oil and gas. In addition to the special studies, in 2012-2013, in connection with the construction of new nuclear unit, the Environmental Impact Assessment Report took into consideration the studies of Energoproject in the period 1967-1999 related to the designing of the energy units 1 – 6 and the studies in connection with the National Repository for Disposal of Radioactive Waste at the Radiana site. Data of Vodoproject, related to studies for draining Kozloduy lowland, have also been used.

In the Report on the Environmental Impact Assessment, any impacts have been considered from two aspects:

- ✓ Impacts of the new nuclear unit on the components of the geological environment at the different sites;
- ✓ Vice versa, what influence could the geological environment, and mostly the processes of the geological danger on the safe and long functioning of the new nuclear unit, which could affect harmfully the environment.

Geomorphological conditions

The geomorphological conditions, which appear to be an important component of the earth environment, have been studied both in the 30 km zone and in the adjoining zone of the new nuclear unit.

The potential Site 2 and 4 are situated in the first non-flooding Danube river terrace T_1, which has altitude of 35 – 38 m and Site 1 and 3 – on the flooding terrace T_0, which, at that location, has an altitude of 26-28 m.

An analysis has been made in the Environmental Impact Assessment Report of the development of the relief in the last 2.5 million years (i.e. in the Quaternary) for its future changes.

The geomorphological studies and analyses have led to the following conclusions:

- The surface of the 30-km zone of the site is flat with low altitude of 30 to 130 m on the Romanian territory and 30 – 160 m on the Bulgarian territory;
- On the right banks of the rivers Ogosta and Tsibritsa, far from the potential sites, one can see steeper slopes with conditions to develop landslides and erosion processes;
- The presence of wide flat spots (plateaus) on both banks of the Danube River is one of the geomorphological proofs that no significant faults have occurred in the last 2.5 million years (i.e. during the Quaternary);
- The sites are situated on terrains with good conditions for bringing and draining water for cooling the reactors;
- Taking into consideration the potentially unfavourable impact of the Danube River, the geomorphological condition at sites 2 and 4 are better than the ones at sites 1 and 3;
- In the next tens of thousands of years no changes are expected of the relief of the first non-flooding terrace T_1 where sites 2 and 4 are;
- In the next 1000 – 2000 years no substantial changes in the relief of the flooding terrace T_0 (sites 1 and 3) will occur. In this period the floods of the river and the Eolithic transport may cause slight changes in the altitude of the surface of parts of the terrace.

Geological structure of the sites' regions. Tectonics and neo-tectonics

The knowledge of the geological structure in depth has important significance for interpretation of the geodynamic and neo-tectonic development in the region around Kozloduy Nuclear Power Plant from viewpoint of the assessment of the long-term impact of the engineering facility on the environment.

In geological terms the region of Kozloduy Nuclear Power Plant belongs to the North-western part of the Moesian platform. It is built of foundation and covering with a total depth of 7 – 8 km, its structure being the same on the Bulgarian and on the Romanian territory. Layers in the Pliocene-quaternary cross-section have big depth and play the role of geological barrier against possible surface pollutions.

The geological-tectonic development of the region has passed a number of stages. The end of the intensive tectonic activity has come some 200 million years ago. The in-depth geological structure in the region of Kozloduy Nuclear Power Plant is shown in the geological profile (**Figure 3.4-1**). This favourable geological structure gives ground to foresee a long-term tectonic stability of the geological foundation in the region of the sites.

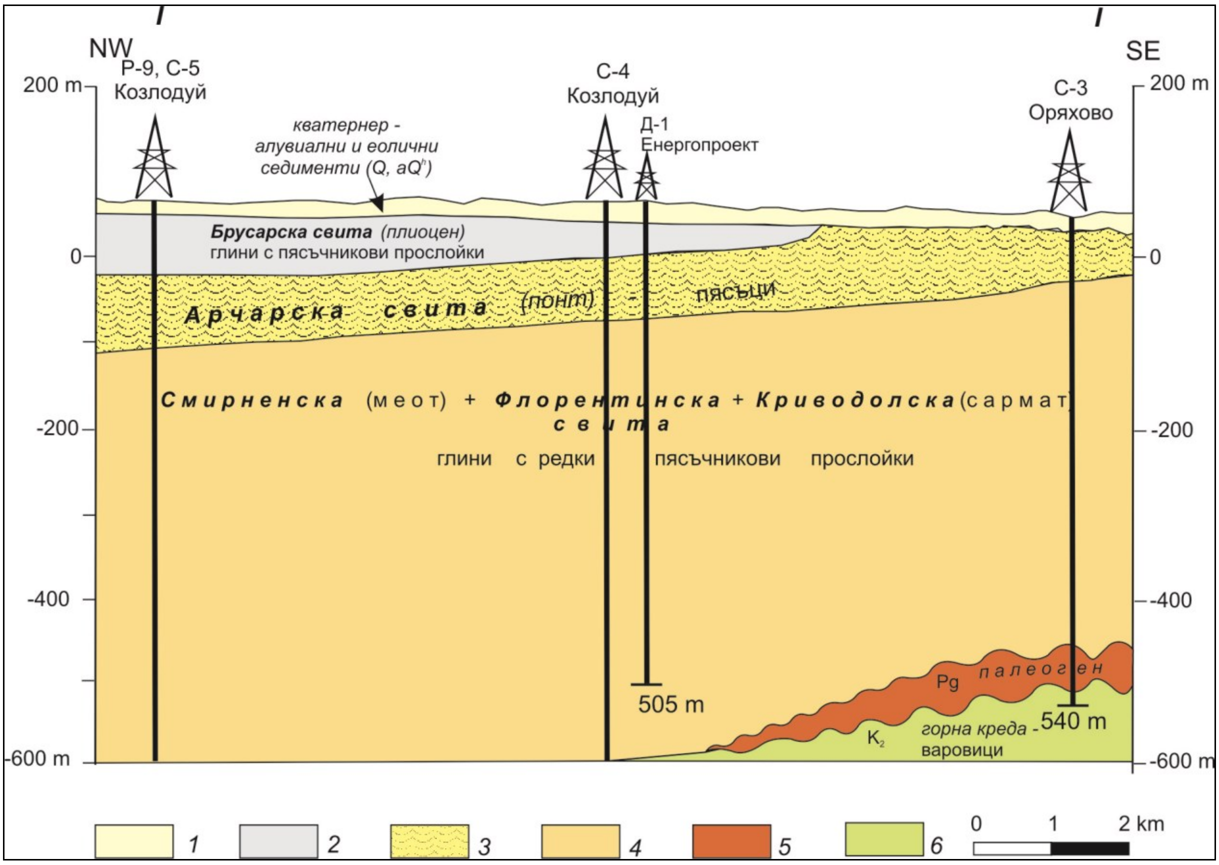

FIGURE 3.4-1: GEOLOGICAL PROFILE I – I IN A DEPTH TO 600 M THROUGH THE POTENTIAL GEOLOGICAL BLOCK "KOZLODUY"

Quaternary: 1 – alluvial and eolithic sediments – gravel-like, clay-sandy and loess materials; neogene: 2 – Brusartsi Formation – clays with sand seams (Pliocene); 3 – Archar Formation – water-filled sands with clay seams (pont); 4 – Smirnenska (meot) and Krivodol (sarmat) Formation – clays; Pliocene ; 5 – marls and sandstone, Upper Creda; 6 – sandstones.

There are no data in the 30 km zone around the new nuclear unit evidencing active tectonic structures. No breaks have been uncovered, which reach the earth surface

Engineering geologic conditions of the potential sites

In the Environmental Impact Assessment Report the potential sites are considered according to their situation and the engineering geological conditions. Sites 2 and 4 are situated on the first non-flooding terrace – T_1 of the Danube River, the surface of which is at elevation 35 – 38 m. In the geological profile of the terrace three types of deposits can be discerned: loess, alluvial and lake (Pliocene). The loess is deep 12 – 14 m. Underneath is the alluvium, made of sands in its upper part and of gravels in the lower part. The upper part of the alluvium is at a general elevation of 22-24 m. From an engineering geological point of view the greatest interest present the loess sediments as the foundations of the new nuclear unit will be laid in them. They are well researched by field and laboratory methods in connection with the construction of energy units 1 – 6 of Kozloduy Nuclear Power Plant.

No problems related to the basing have been encountered during the long years of operation of Kozloduy Nuclear Power Plant.

The sites 1 and 3 are situated in the flooding terrace T_0 of the Danube River, which has elevation 26-28 m. The terrace materials are water-saturated and unconsolidated and susceptible to liquefaction. In the Environmental Impact Assessment Report are presented the physical and mechanical parameters of the layers, constituting the earth foundation of the sites and the zone adjacent to them.

Hydrogeological conditions of the sites

The region of the new potential sites of Kozloduy Nuclear Power Plant is part of the Lom Artesian basin, with the characteristic distribution of the aquifers.

The levels of the shallow ground waters in the region of sites 1 and 3 (Terrace T_0) are near the surface of the terrain.

Concerning sites 2 and 4 (Terrace T_1) the ground waters are found at a depth of 3 m, which complies with the requirements for choice of site for construction of the Nuclear Power Plant. The shallow aquifers are recharged mainly by the slope of the Danube River adjacent to the terrace. The natural draining is effected by the Danube River and where its level is high, it feeds the aquifers.

At sites 2 and 4 the main hydrogeological zones are:

- Unsaturated (aerated) zone. Its depth is from 7 to 10 m;
- Water-saturated zone. It consists of a aquifer of two layers: upper and lower. Both parts of the aquifer are separated by a relatively impermeable layer.

The upper layer includes the lower part of the loess, which is clay and mainly sandy gravel – deposits on the terrace. In this layer is the shallowest aquifer. Its waters have direction southwest – northeast. A small part of the water is due to unfiltered rains. The main recharge comes from the adjacent slope. This is seen at Site 2. The level of groundwater fluctuates between 25.0 and 27.5 m.

The lower very permeable layer was formed in the sandy sediments of Brusartsi Formation and Archar Formation. Between the aquifers of the Brusartsi Formation and Archer Formation exists a layer of several meters of practically impermeable clays.

The results of the permanent hydrogeological and radiochemical monitoring of the ground waters in the region of Kozloduy Nuclear Power Plant show that the protective barriers put in place have not allowed penetration of pollutant to them.

Mineral resources

According to the specialised maps[28] pursuant to the Law on Mineral Resources, the following information is available about mineral resources in the 30 km zone of Kozloduy Nuclear Power Plant:

- Registered are 10 deposits, which are under account of the National balance of the reserves and resources of the mineral deposits. Mining in 5 of them has been granted as concession.
- The zone contains additional concession area, necessary to carry out activities for production of gas and wet-gas from the Koynare deposit, granted by Decision of the Council of Ministers No. 960/16.11.2012 to Direct Petroleum Bulgaria Ltd, City of Sofia.
- In relation to this territory valid are: permit to search and explore gas and wet-gas in an area – Block 1-12 Knezha held by Exploration and Extraction of Oil and Gas AD, City of Sofia and Permit for exploration and search of industrial materials in the Gladno Pole Area held by Industrial Minerals Ltd, City of Sofia.
- Etropolska Argilitna Formatsia gas and condensate deposit, registered as geological discovery under No. 0005/01.07.2010 held by Direct Petroleum Bulgaria Ltd, City of Sofia, which is under procedure to be announced as commercial discovery.
- There are no registered deposits of building materials as per the Law on Mineral Resources.

There are no registered deposits and active concessions related to mineral resources on the territory of the four alternative sites.

Construction materials (river aggregates and sand)

The aggregate and the sand are some of the building materials, which are used in the basic stages in the construction of the new nuclear unit – starting with the preparation of the site, the building of the underground and ground communications and ending with the main ground construction works of buildings and facilities at the chosen site. The construction qualities of the materials in accordance with the specificity of the facility and the corresponding construction works will be determined in the concrete technical design, connected with the realisation of the investment intention in the succeeding stages of designing. The supply to the building site of the necessary quantities of aggregate and sand will be carried out from regulated, as per the Waters Act, aggregates quarries in or out of the region. The statutory regulation is stipulated in the Waters Act. The regime of permits is managed by the Maintenance and Study of the Danube River Executive Agency – Ruse for supply of aggregate and sand from the Danube River, the Ministry of Environment and waters for supply from dams as per Annex I of the Waters Act and the management of the Danube Region Waters Basin Directorate – for aggregate from inland rivers.

[28] Letter №26-A-137/23.04.2013

Seismic danger in the area of the sites of Kozloduy Nuclear Power Plant

The site of Kozloduy Nuclear Power Plant is situated in the middle of a stable area in the south-western part of the Moesian platform, which is characterised by extremely low seismic activity. In the period of regional instrumental registration of earthquakes (1976 – 1997) on the whole territory of the local 30 km zone only 3 earthquakes occurred on the Bulgarian territory with magnitude M < 2.0 and one on the territory of Romania with magnitude M = 3.6. Upon installation of highly sensitive local seismic network it was found that not a single seismic event of the lowest possible magnitude has been registered. In relation to this region no historical earthquakes have been documented. The lack of documented seismic activity and the extremely weak sporadic seismic events characterise it as the “**seismically calmest**” area in a 320 km region

3.5 LANDSCAPE

On the territory of Site 1, 2 and 3 are differentiated agricultural and anthropogenic landscapes. At Site 3 appears also forest landscape. Site 4 is part of the anthropogenic landscape.

Within the boundaries of Kozloduy NPP are separated anthropogenic, aquatic and forest landscapes. These landscapes have low sustainability. Their existence depends on human activity.

In the 30-kilometer area around the territory of the NPP are found forest, pasture, agricultural, aquatic and anthropogenic landscapes. Aquatic and forest landscapes are characterized by high sustainability.

3.6 BIODIVERSITY, PROTECTED AREAS

General Characteristics of the Flora

According to the geo-botanical zoning of Bulgaria, the territory within range of 30 km around the Kozloduy NPP refers to the Eurasian steppe and forest-steppe region, province of Lower Danube, Danube County, Zlatiyski region. This area is largely treeless, occupied mainly by agricultural cereal plants and vines with small remnants of forests of Turkey Oak, Virgilian Oak and Pubescent Oak. At some places are formed secondary forest communities dominated by Oriental Hornbeam and Manna Ash. During the degradation of forests, bush communities were formed in many places. On the treeless areas are formed secondary grasslands dominated by Scented grass, Yellow bluestem, Bulbous bluegrass, etc. A number of steppe elements are also involved including Camphorine, Common broom, Jurinea albicaulis, etc. Cultures of hybrid poplar have developed in some sections. Communities of marsh grass vegetation dominated by reed have also formed.

Within a range of 30 km of the studied area are found plant species protected under BDA: Water Soldier, Centaury, Yellow pond lily and others. The assessment of the flora and vegetation indicates that during the construction and operation of the NNU there will be no significant negative impact on species protected under the Biological Diversity Act that are found in the within the IP-covered territory – the four alternative sites and those falling within the scope of impact of 30 km perimeter.

General Characteristics of the Fauna

According to the zoogeographic zoning of Bulgaria the area of 30 km around the Kozloduy NPP falls into the Danube zoogeographical region, in the flat and hilly belt and the foothill hilly belt of oak forests. Predominant are Euro-Siberian and European species with the participation of a significant number of Mediterranean species. Strong anthropogenisation of the land in the area has drastically affected the fauna and the formation of the today complex. The species composition of animal communities is significantly changed due to the considerable anthropogenic impact.

Among the factors that determine the species richness of the area is the presence of a large ecological corridor – the Danube River. During the various seasons, here are found 8 species of endangered birds: Dalmatian Pelican, Lesser White-fronted Goose, Red-breasted Goose, Ferruginous Duck, White-tailed Eagle, Red-footed Falcon, Corn Crake, European Roller.

Invertebrate Animals

In the area of Kozloduy (studied territory for NNU with radius of 30 km) are found terrestrial invertebrate animals – Dragonflies, Coleopteran, etc.

In water bodies within the 30 km zone of the NPP – the Danube River, downstream and the estuaries of the rivers Tsibritsa and Ogosta, Asparouhov Val DAm and others are established four types of protected aquatic invertebrate animals – Striped nerite, Thick shelled river mussel, Chinese pond mussel, Narrow-clawed crayfish.

Within the area of 30 km around the NPP are established or is expected penetration of invasive alien species of aquatic invertebrate animals with potentially negative impact on native species and ecosystems.

Ichthyofauna

In the Bulgarian-Romanian section of the Danube River are found 65 species of fish, while in the adjacent section of the Danube River, falling into the 30-kilometer area around KNPP have been identified 28 species of fish. In the surrounding waters are found Spined loach, European bitterling, Danube bleak, Chub, Gibel carp, Common nase, Stone loach, etc.

Within the area of 30 km around the NPP are established or is expected penetration of invasive alien species of fish with potentially negative impact on native species.

Herpetofauna

According to the published updated generalizations, it could be stated that in the 30-kilometer studied area are found 10 species of amphibians and 10 species of reptiles Nineteen of them are included in the annexes of the Biodiversity Act: Danube Crested Newt, Fire Bellied Toad, European Pond Turtle, Hermann's Tortoise, Blotched Snake, etc.

Mammals

For the Danube valley are typical 38 mammal species of which 4 species are included in the Red List of Bulgaria and 10 species are protected under the Biodiversity Act. Typical are the species with wide ecological plasticity, such as small rodents. A typical representative of the predators is Fox. In relatively high numbers are the species Brown hare, Wild boar, Jackal, Beech marten and European polecat.

Regarding the bat fauna, this is one of the least studied areas in Bulgaria. Bat species within the 30-kilometer studied area are mainly: Pipistrelle bat, Nathusius' pipistrelle, Serotine bat, Noctule bat, Leisler's Bat, etc. The main abundance of bats within the 30-kilometer studied area is concentrated in the valleys of the rivers Ogosta, Skat and Tsibritsa.

Avifauna

The species composition of breeding avifauna within a radius of 30 km around KNPP amounts to 147 species.

Breeding endangered species in the studied area are: Ferruginous Duck, Pygmy Cormorant, White-tailed Eagle, Red-footed Falcon, European Roller.

The territory in the area of observation is an important food for: White-tailed Sea-eagle, Mallard, Great Cormorant, Pygmy Cormorant, Black-crowned Night Heron, Little Egret, Long-legged Buzzard, Montagu's Harrier, etc.

The zone of observation falls in the eastern part of the Aristotle migration route, which is characterized by a relatively small migration flows from soaring birds.

After the assessment, it can be stated that during the construction, operation and decommissioning of the NNU, there will be no negative impact on fauna and on protected species under the Biological Diversity Act, as well as on those falling within the scope of impact of the 30 km perimeter and are found in the IP territory – the 4 alternative sites.

Protected Territories

Protected territories have a clearly defined area and specific scientific, social, aesthetic and cultural value. The 30-kilometer range of surveillance includes the following protected areas:

Maintained Reserve "Ibisha" with area 34.47 ha on the land of the village of Dolni Tsibar, Valchedram municipality, aiming to protect typical Danube island communities – flooded forests and marshes inhabited by endangered species of plants and animals.

Protected area "Kozloduy" with an area of 10 ha, on the land of the town of Kozloduy, for protection of characteristic landscape, former historical site.

Protected area "Kochumina" with an area of 2.5 ha, on the land of the village of Selanovtsi, aiming to protect the European White Water lily habitat.

Protected area "Gola bara" with an area of 2 ha, on the land of the village of Selanovtsi, aiming to protect the European White Water lily habitat.

Protected area "Kalugerski grad – Topolite" with an area of 0.2 ha, on the land of the village of Selanovtsi, aiming to protect Water Soldier).

Protected area "Koritata" with an area of 2 ha, on the land of the village of Sofronievo, Mizia municipality, aiming o protect the natural habitat of Balkan Peony and spectacular landscape.

Protected area "Daneva Mogila" with an area of 4.9 ha, on the land of the village of Sofronievo, Mizia municipality, aiming to protect the characteristic river landscape and a group of century-old trees.

Protected area "Tsibar Island" with an area of 101.48 ha, on the land of the villages of Upper and Lower Tsibar, Valchedram municipality, aiming to protect habitats for nesting, wintering and resting during migration of protected bird species (Common Tern, Little White-fronted Tern, Oystercatcher, Dalmatian Pelican, mixed heron colony, etc.).

3.7 WASTE

3.7.1 NON-RADIOACTIVE WASTE

On the territory of Kozloduy NPP are accumulated various types of non-radioactive waste in the premises and sites as a result of different activities and repair works. Non-radioactive waste is the waste whose radioactive contamination does not exceed the thresholds for release within the meaning of the existing regulations and internal documents, and which may leave the site of Kozloduy NPP (area for preventive and protective measures) in accordance with the radiation protection requirements.

Locations in the plant where waste is generated are related to production processes or the type of repair works. They are as follows:

Residential waste – Formed in all workplaces, administrative and industrial buildings, cafeterias, catering facilities, and when cleaning the plant site from branches, leaves, etc. They are gathered in a specially fitted vessels that are daily dumped in containers and periodically transported to a landfill.

The waste is transported and disposed at landfill – Landfill for non-radioactive and industrial waste of Kozloduy NPP after mandatory radiation control.

Construction waste – generated at repairs. Collected separately and transmitted to a specialized company in compliance with the Regulation on management of construction waste and use of recycled building materials[29]. Construction waste is generated depending on the volume of repair works.

Industrial waste – scrap metal waste that are not the result of direct power generation activities and are formed during routine repairs, waste and sludge from household

[29] Regulation on management of construction waste and use of recycled building materials, SG, No. 89/13.11.2012.

wastewater treatment plants, sludge from neutralization tanks from the production of demineralised water, worn-out tires, paper and cardboard packages, plastic packages, wood waste, etc. are delivered to specialized companies for recycling.

Hazardous waste – fluorescent and mercury lamps, batteries – are generated as hazardous waste in the emergency power lighting, control and other systems; *packaging of chemicals* – are brought in Kozloduy NPP in tanks; *waste from laboratory and industrial chemical substances and mixtures with expired shelf life, packaging of fuel and greases, oily rags, thread and wood chips, waste petroleum products* – are formed during treatment of oily wastewater in the local treatment facilities on the NPP territory – sludge and oil retainers.

Kozloduy NPP has authorization for collection, transportation, recovery and disposal of waste. The authorization is issued by the Regional Inspectorate Environment and Water (RIEW) – Vratsa, which exercises control over the implementation of the activities.

The system for collection and transportation of waste depends on the type, the quantities that are formed, and at the sub-sites. At this stage part of the waste is collected separately, and for the other part is designed efficient organization for such collection (waste greases and greases, small batteries for electronic devices (in special containers), sodium and other metal halide lamps, packaging of chemical substances and preparations, etc.).

Industrial waste generated by the plant's sub-sites (limiting is the quantity of dismantled equipment, steel structures and other scrap metal waste of ferrous and non-ferrous metals) is collected right next to the place of their generation and after radiation control is transported by plant's own transport to certain warehouses in and out of the site – in the area around the NPP port, Goods Handling Station-Vratsa, etc.

Radiation control

In the protected area of Kozloduy NPP is performed radiation control of sites of waste generation and collection – containers and temporary storage sites. All waste and vehicles leaving the protected area through the checkpoints are submitted to radiation control and reports are issued thereof. Radiation control is performed in accordance with statutory requirements and is based on internal corporate documents.

An **Action Plan (2011 – 2013)** is in place, which is regularly updated taking into account the level of significance of issues related to the effective management of waste from Kozloduy NPP.

3.7.2 RADIOACTIVE WASTE

The activities relating to radioactive waste (RAW) management at Kozloduy NPP include pre-processing, processing and storage of primary liquid and solid RAW. These activities are carried out at the plant site.

Operational RAW from Kozloduy NPP is stored at different sites in natural or processed form, which does not limit the options for its subsequent processing, release and / or disposal.

The adopted since 2005 approach to the management of radioactive waste from Kozloduy NPP is directed to delivering the current generated solid RAW and liquid concentrate to State Enterprise RAW for treatment gradual disposal of historically accumulated solid RAW.

Solid RAW is stored in special protective facilities located in the central halls of the reactors of units 1 ÷ 4 and in the specialized shell (SS – 3) at units 5 and 6.

Liquid RAW generated at Kozloduy NPP are mainly water soluble waste and relatively small volume of organic waste. Industrial radioactively contaminated wastewater is collected by means of special systems and is processed to yield distillates and concentrates.

The concentrate is stored in stainless steel tanks located in the specialized shells at the units of Kozloduy NPP. Storage facilities for liquid RAW are built together with the respective units. Organic liquid RAW (spent sorbents) is collected and stored in individual tanks in the specialized shells at the units of Kozloduy NPP. Currently is deployed technology for its processing at units 1÷4.

Sludge and sediments are relatively small quantities but belong to the so-called special waste. Currently is deployed technology for its processing at units 1÷4.

Kozloduy NPP annually generates small quantities of radioactively contaminated waste oils, which are treated and managed as non-radioactive liquid waste.

In 2005, at the site of Kozloduy NPP was completed the construction of a specialized unit for radioactive waste processing – SE RAW-Kozloduy, which is a part of State Enterprise RAW.

Reduction of the volume of solid compactable RAW is carried out by compression. Solid non-compactable waste is a relatively small part of the total quantity and is collected in 200-liter barrels without further processing. Reduction of the volume of liquid RAW is carried out by evaporation within the limits of the technological specifications.

Processing of solid and liquid RAW is performed by the method of cementing (conditioning). RAW that is processed for disposal is stored in reinforced concrete containers (RCC). Conditioned RAW from Kozloduy NPP is shipped to repository for temporary storage (prior to disposal). The repository is over-ground reinforced concrete facility, which provides the necessary engineering barriers between the stored RAW and the environment and staff.

This EIA Report describes in detail the processing, quantities and storage of solid and liquid RAW.

3.8 HAZARDOUS SUBSTANCES

The Protection from Harmful Effects of Chemical Substances, Preparations and Products Act and the regulations thereof are the basis for management of the activities related to hazardous substances.

According to the Protection from Harmful Effects of Chemical Substances, Preparations and Products Act, they are classified as hazardous if they fall into at least one of the properties of chemical substances, preparations and products that define them in the classification category 'hazardous'.

In Kozloduy NPP are used many types of materials, products, substances and mixtures that are classified as 'hazardous substances'. Their use is under strict control management of handling hazardous substances.

The substances used are classified according to the hazard categories in terms of risk to the health of workers and the environment and the instructions for handling hazardous substances are strictly complied with.

For the safe storage of harmful and hazardous substances and materials, in Kozloduy NPP have been developed Directions for Safe Storage of Harmful and Hazardous Chemicals and Materials.

All safety instructions for handling hazardous substances are regularly updated.

Types and quantities of non-radioactive materials and raw materials used at Kozloduy NPP EAD, classified as dangerous substances

- ***Liquid fuels*** **–** are used for the operation of diesel generators, which are reserve sources of electricity for power units; for the purposes of motor vehicles and the various workshops and units of Kozloduy NPP. Certain quantities of diesel fuel, gasoline, etc., are stored according to the statutory regulations.

- ***Fuels and greases*** **–** the operation of new nuclear unit is expected to use various types and quantities of oils and greases – engine and compressor oil, turbine oil, engine oil, various kinds of greases. They will be accompanied by the relevant certificates and other documents such as Material Safety Data Sheets indicating the correct method of storage, use and treatment.

- ***Chemical substances and mixtures*** **–** for the support of the basic process are delivered and used different types of chemical reagents, certified for use in the nuclear industry. They are accompanied by Material Safety Data Sheets, which is a prerequisite for environmentally safe storage and use.

The majority of the materials, reagents, etc., classified as 'hazardous substances' are stored mainly in warehouse, in packaging, containers and separate rooms and cells in accordance with instructions for their safe storage.

3.9 HARMFUL PHYSICAL FACTORS

3.9.1 NOISE

Sources of noise on the Kozloduy NPP territory are the basic and auxiliary equipment and the transport associated with the production activity. The majority of the facilities are located in confined spaces in the buildings existing at the plant site. They have solid structure, which significantly reduces the noise level of technological equipment that passes through them into the environment. Major sources of noise at the plant site located outdoors are: transformer sites of outdoor switchgear (400 kV, 220 kV, 110 kV), ventilation systems of specialized shells 1, 2 and 3, pumps for the moistening spray ponds and internal transport. The mode of operation of Kozloduy NPP is round-the-clock 24/7.

The noise pattern at the plant site is established through noise measurements in real conditions for the development of the EIA Report for Kozloduy NPP in 1999 and in 2010 by MoEW – EEA – Regional Laboratory – town of Pleven. The latter were performed along two measuring loops. Most values above 60 dBA were measured near outdoor noise sources – transformer platforms, pumps for moistening spray ponds, fans.

Production activity of Kozloduy NPP is not a source of noise in residential areas because there is a large distances between them.

NPP "Kozloduy", respectively the sites subject to EIA are connected to the national road network by road II-11 and II-15. The site is not connected to the national railway network. Noise characteristics of traffic flows on roads II-11 and II-15 were obtained by calculations based on data provided by the Road Infrastructure Agency (RIA) on the total profile counting of vehicles held in 2010. Traffic flows include also buses carrying workers to Kozloduy NPP. According to data provided by the Owner, 40 trips per day are made.

The limit values of noise level for different areas and development zones are regulated by Regulation № 6 on environmental noise indicators (MoH, MoEW, SG No. 58/2006). For residential areas, they are: day – 55 dBA, evening – 50 dBA, night – 45 dBA; for residential areas exposed to heavy traffic: day – 60 dBA, evening – 55 dBA, night – 50 dBA, and for industrial and storage areas – 70 dBA for day, evening and night.

Traffic flows on main roads in the area (II-11 and II-15) are a significant source of noise for the adjacent to the road route residential areas of the localities that are close to the site.

3.9.2 VIBRATIONS

The existing technological equipment by design is not a source of vibrations in the environment. Reduction of the spread of vibrations outside their source, for machinery and equipment, is achieved by the implementation of specific technical requirements for their installation: antivibration processing of their foundations through rubber pads, isolating spaces of vibration damping materials, removing the solid connections between the vibrating platforms and structural elements of the premises and others. There are no technological vibrations in the environment of Kozloduy NPP site. Technological vibrations are a factor only of the working environment. Vehicles supporting the operation of NPP also are not sources of vibration in the environment, since they run on the republican road network and are consistent with the category of traffic. In the implementation stages of the investment proposal technological vibrations are a factor only of the working environment.

3.9.3 NON-IONIZING RADIATION

The constructed to date facilities and equipment of Kozloduy NPP that are significant in terms of possible effects of non-ionizing radiation are outdoor switchgears consisting of three parts: 110 kV, 220 kV, 400 kV. Kozloduy NPP is connected to the electric power system (EPS) of the Republic of Bulgaria through three own outdoor switchgears at voltages of 400 kV, 220 kV and 110 kV with auto inductive coupling among them.

The main sources of electric and magnetic fields in the working environment are the outdoor switchgears of the transformers, bus systems, circuit breakers and power lines. Sources of Extremely low frequency (ELF) fields (mainly magnetic) can be turbine generators, rectifiers and low voltage power supply systems.

Sources of radio frequency (RF) and microwave (UHF – ultra-high frequency) electromagnetic radiation in Kozloduy NPP are found in:

- ✓ security systems;
- ✓ mobile communication systems;
- ✓ emergency warning systems.

Exceeding the maximum admissible values for electric field of industrial frequency can be expected only in the working environment.

The values of magnetic induction are much **below the admissible and cannot create any risk to the health of the workers.**

Outdoor switchgears are surrounded by technical barriers and therefore effects of electromagnetic field with industrial frequency on the population in the area of the outdoor switchgears is not discussed, regardless of the voltage applied.

3.9.4 THERMAL EFFECT OF THE DANUBE RIVER

Temperature of the Danube River

The temperature of the Danube in the Bulgarian section is of particular importance in assessing the impact of warmer exhaust circulating water from the operation of the plant. There is evidence of increased water temperature in European rivers by 1-3^{o}C, mainly due to climate change – increasing air temperature and anthropogenic impact, resulting mainly in infusion of warmed water, **which is of local nature**.

Heat exchange processes between the Danube and the environment (without regard to infusion of warm water from the NPP) depend on the following factors:

- ✓ Heat transmitted from solar radiation;

- ✓ Heat expended for evaporation and condensation;
- ✓ Heat resulting from turbulent flux exchange;
- ✓ Transfer of heat from the bottom of the river;
- ✓ Heat from liquid precipitation (rain) or consumption of such for melting of solid precipitation (snow, sleet, hail);
- ✓ Heat lost to draining or flowing water quantities;
- ✓ Heat received or expended for ice melting.

Throughout the period of operation of Kozloduy NPP studies have been performed on a regular basis to determine the impact of the plant on the temperature of the Danube River. During 1978-1995, there had been 12 expedition studies of research teams from the University of Architecture, Civil Engineering and Geodesy. For the purposes of the EIA Report of Kozloduy NPP in 1999, the team that prepared the document in collaboration with the management of Kozloduy NPP had organized research expedition along the Danube River.

In the EIA Report are analyzed and summarized the main results of the expedition research and the known publications on the issues of the thermal characteristics and the affected in this regard field of the Danube River.

Water temperature along the Bulgarian section of the Danube River decreases from Novo Selo to Silistra. Upon cooling the maximum temperature difference in the area is observed in March and reaches 0.5°C. Upon warming the maximum temperature difference between the two points reaches 1.3°C and is observed in August. A pattern is outlined with seasonal distribution in the summer months.

The change of temperature of the river as a result of the discharge of heated by Kozloduy NPP water is a specific form of impact. Limit for temperature rise of the open course is 3°C for the warmest and 5°C for the coldest month of the year.

For almost 30 years before commissioning of the NPP there was no difference between the average monthly temperatures at the two stations of Lom and Oryahovo. In 1983, when the 4 reactors (units 1 ÷ 4) were in operation, the average difference for the year was 1.84°C, while the year was dry. In 2006, the difference was only 0.84°C, but then the water quantity reached very high values. In the period 2008-2010, with two operating reactors, the average annual temperature difference between the two stations was 1.38°C. The differences are higher in winter than in summer, reaching 2.3°C, as well as in dryer years.

The conclusion is that the influence of heat exchange between the heated water coming from Kozloduy NPP into the Danube River section from kilometre 687 (discharge of the hot channel) to kilometre 678 (port Oryahovo) and the environment **is negligible and can be ignored**.

3.9.5 ICE REGIME IN THE DANUBE RIVER

Ice phenomena in the Danube River are related to many factors – climatic, hydrological and hydraulic, and therefore their formation and development should be considered for a section of the river with a considerable length, encompassing areas available to the NPP.

Freezing of the river and the formation of ice cover is normally accompanied by the formation of ice dams and raising the level of the river. In the area where influence of dams is spreading, the flow velocity decreases significantly, which further impedes the passage of ice and facilitates its accumulation and the freezing of the river.

Studies show that raising the water level and flooding of Kozloduy NPP due to dam up caused by **floating ice is very unlikely**.

3.10 HEALTH AND HYGIENIC ASPECTS OF THE ENVIRONMENT AND RISK TO HUMAN HEALTH

One of the guiding principles in the implementation of the IP is to ensure the health and safety of the workers on site and of the people living in the vicinity for the planned period of operation of new nuclear unit.

As potentially affected population of the Project implementation are considered mainly the residents of localities within the radius of 30 km around the Kozloduy NPP, which in Bulgarian territory are 65,994 people[30] and in Romanian territory- 75 150 people[31].

Health aspects of the condition of the affected population

Health status is determined by many factors of the environment and the working environment, social welfare, hereditary and demographic factors. Of particular importance are some specific criteria that can lead to more direct links between environmental pollutants and changes in health status, such as indicators for prevalence of cancer.

Kozloduy NPP is located in the municipality of Kozloduy, which consists of the town of Kozloduy and the villages Harlets, Glozhene, Bhutan and Kriva bara. The average population density according to data from National Statistical Institute from the census of 01.02.2011 for Kozloduy municipality is 74.4 people/ km^2. It is higher than the national average (66.35 people/km^2) and the average for the district of Vratsa (51.1 people/km^2), where Kozloduy Municipality is located. A significant part of the population of the town of Kozloduy is socially and economically connected to Kozloduy NPP.

Demographic development of Kozloduy Municipality is rather specific, yet typical of such settlements with large industrial facilities. On the one hand, the migration of part of the population (common in rural areas) to the big cities – in this case from the villages to the town of Kozloduy, and on the other hand, the increase in the total population as a result of influx from the interior of the country of construction workers and experts for the

[30] National Statistical Institute, census as of 01.02.2011

[31] A letter from the Rumanian Ministry of Environment and Forests, № 2830/RP/31-07-2012.

construction and operation of Kozloduy NPP, are factors determining the specific demographics[32].

In the 30 km are fall the whole municipalities: Kozloduy Valchedram Hayredin, Mizia and partially the municipalities of Lom, Byala Slatina, Oryahovo Boychinovtsi, Krivodol and Borovan, as well as a total of 19 villages in the counties of Dolj and Olt in Romania[33].

In the period 2005-2010, in all towns and villages on Bulgarian territory is observed progressive downward trend in the number of population, which is associated with negative natural growth. Only the town of Kozloduy has a positive mechanical growth, which has increased from 10498 of 14892 people. This is related to jobs and career opportunities for the operation and maintenance of Kozloduy NPP.

The distribution by gender indicates a higher proportion of women in the range of 0.8% to 1.4% above the average. Gender differences in the labour force have the following characteristics: the number of boys and girls under employable age is about the same. The proportion of men of employable age is higher than that of women in this age, but the differences are not statistically significant. The proportion of men over employable age has decreased significantly compared to that of women. This is associated with a trend for higher mortality among men compared to women over 60 years of age. Leading causes for mortality are mainly cardiovascular diseases.

For the Municipality of Kozloduy the number of persons under and over employable age has a relatively favourable distribution. Young people are more than 200 compared to adults over 60-65 years of age. Relative share of working-age population is larger. This is explained by employment opportunities in the Kozloduy NPP.

Relative share of unemployment in the municipality of Kozloduy in 2010 was 12%, while employment covers about 84% of the working population. Unemployment is lower than the average for Bulgaria (16.3%) and significantly lower than the unemployment rate for Vratsa (24%). The above data support the importance of the Kozloduy NPP for the socio-economic welfare of the population in the municipality of Kozloduy and the more favourable demographic indices in the distribution of population by employability.

Studies of the rate of morbidity of the population

Detailed study was made of the index "Registration of diseases in medical treatment facilities for outpatient care in Vratsa" for 2009-2011[34]. The survey was conducted for 19 classes of diseases.

It is noteworthy that in the Multiprofile Hospital for Active Treatment "St. Ivan Rilski" EOOD in the town of Kozloduy, the number of patients passed through the hospital is lower

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[32] Regional Health Inspectorate (RHI) – town of Vratsa, Annual Report, 2011.

[33] Up-to-date data for the territory of the Republic of Romania – Letter to Kozloduy NPP-NC EAD, 297/01.04.2013.

[34] Regional Health Inspectorate (RHI) – town of Vratsa, Annual Report, 2011.

compared to other hospitals in the area and the municipalities. It can be assumed that the residents of the town, the majority working in the Kozloduy NPP, are under regular medical supervision. This fact is clearly confirmed by the lower incidence of diseases of the respiratory system compared to any other part of the population in area involved in other economic activities.

Retrospective review of morbidity in Kozloduy Municipality shows that 18-20 years ago were observed higher levels of some diseases of the population of the municipality compared to the incidence in other municipalities in Vratsa District.

Specialized analyzes give reason to believe that the rates of cancer diseases for the district of Vratsa, which includes the Municipality of Kozloduy, are most likely due to the complicated socio-economic conditions in the area, with the decisive impact of irregular and poor nutrition of the population, including the population in the 100 km area around the NPP, which indicates that the operation of the power plant is not relevant to the rates of cancer diseases in the area.

Within the framework of the activity of Kozloduy NPP a study was carried out on 150 children from the area in order to identify possible local variation on the thyroid gland. Measurements were conducted in the localities of Kozloduy, Oryahovo, Mizia, Selanovtsi and Harlets. The content of ^{131}I was estimated.

The final analysis of the results shows that there is **no indication** of the presence of artificial radionuclides in the bodies of the studied children as well as of presence of ^{131}I in their thyroid glands. There is no difference in the spectral distributions and their numerical values from the individual measurements between clean area and the area of the NPP. According to the comparison of the spectra measured in both areas, it can be said that the internal dose uptake in tested children is due only of naturally occurring radionuclides (^{40}K), which will normally vary among individuals according to the area and the biological characteristics of the individuals[35].

With regard to ^{131}I, inflows of radionuclides in the thyroid gland were also not found.

Conclusion:

Kozloduy NPP did not cause pollution and consequently inflows of artificial radionuclides in the population that increase internal exposure.

The above conclusions regarding radiation exposure in the studied children, the majority of whom have parents that are NPP personnel, allow to conclude that the sanitary throughput regime works well.

Radioecological monitoring

[35] Independent expert assessment of the content of man-induced radionuclides in the bodies of 150 children living in the area NPP "Kozloduy ", Contractual task of NPP "Kozloduy " and NCRRP, 2003.

The natural gamma background for the Republic of Bulgaria has been measured continuously since the mid-1980s and is in the range from 0.06 to 0.60 µSv/h.

Since 1997 operates and the National Automated System for Continuous Monitoring of Gamma Radiation Background of the Republic of Bulgaria. It consists of a central control station, 9 regional stations, 26 local stations, one mobile station, crisis centre and emergency station. There is carried out sample selection for laboratory analysis for the presence of man-induced radionuclides in the main components of the environment – air, water, soil and vegetation. Special attention from health aspect is paid to the drinking water sources by RHI – Vratsa.

Radioecological monitoring in Kozloduy NPP is an integral part of ensuring the safety of nuclear power plant and radiation protection of the population and the environment in the area. The goal is to provide accurate and detailed evaluation of the radiation status of the environment and to detect possible effects from the operation of the nuclear power plant on the population and on the environment in the area within the established standards.

In accordance with the Regulation on Basic Norms of Radiation Protection -2012, the limit of the annual effective dose from the general external and/or internal irradiation of the population is set at 1 mSv/a. Based on this limit for the purposes of radiation control are derived secondary limits, such as limits for annual intake, limit average annual volume activity of a particular radionuclide in ambient air, drinking water, etc.

Determining the quantitative content of man-induced radionuclides in environmental sites shows that the results are usually lower than or comparable to the lower limit of detection with modern measurement techniques and equipment. This fact determines the necessity of the use of model-mathematical methods for evaluation of migration and quantitative content of radionuclides into the environment. For input data for modelling is used real data from the radiation control at the source – radioactive releases into air and water, real meteorological and hydrological data, statistical demographic data, data on consumption of foods produced in the area and data on the generated electric power from the NPP for the period of evaluation.

The results of the radioecological monitoring performed in 2012 and other radiation measurements from previous years provide a realistic evaluation of the negligible impact of Kozloduy NPP on the aerosol activity in the air. In practice, this parameter is not affected by the operation of the plant. Radiological air purity fully meets the statutory requirements and the radioactivity of atmospheric fallouts in the 30- and 100-km area is within normal background limits, unaffected by the operation of Kozloduy NPP .

The results of the plant's radiation monitoring are verified annually by independent research of MoEW and NCRRP (MoH)[36].

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[36] Reports of NCRRP - Sofia, 2009-2010.

The aggregation of data from long-term monitoring of the radiation background in the area of Kozloduy NPP shows that throughout the period of operation of Kozloduy NPP gamma radiation background in the areas of emergency planning is stable with relatively small deviations following the accident at the Chernobyl NPP compared to other areas of the country and the typical background values for individual regions are not exceeded.

3.11 RADIATION RISK TO THE POPULATION FROM RADIOACTIVE RELEASES DURING NORMAL OPERATION OF NPP

This report presents estimates of individual and collective doses to the population in 30-km area of gas-aerosol and liquid radioactive releases from Kozloduy NPP for the period 2010 ÷ 2012 (Annual Reports, Results of radiation monitoring of the environment of NPP "Kozloduy "in 2010, 2011 and 2012).

Resulting estimates for annual effective dose per capita of the population are compared with the limit value for population in the country of 1 mSv/a (BRPS-2012), with the limit for clearance from regulatory control – 10 μSv/a (BRPS -2012) and with the limit for irradiation from radioactive releases from NPP under all operating conditions – 0.25 mSv/a (Regulation on Ensuring the Safety of Nuclear Power Plants, 2004), and the background irradiation that is typical for this geographic area – 2.4 mSv/a. Statutory Statutory collective doses are compared with the average data for PWR reactors in the world (UNSCEAR Report-2000, 2008).

Under all operating conditions of Kozloduy NPP , the annual individual effective dose from internal and external exposure of the population caused by the impact of liquid and gaseous releases in the environment for all units and facilities that are and will be located at the Kozloduy NPP site should not be higher than 0.25 mSv (instructions NRA with letter № 47-00-171/12.02.2013).

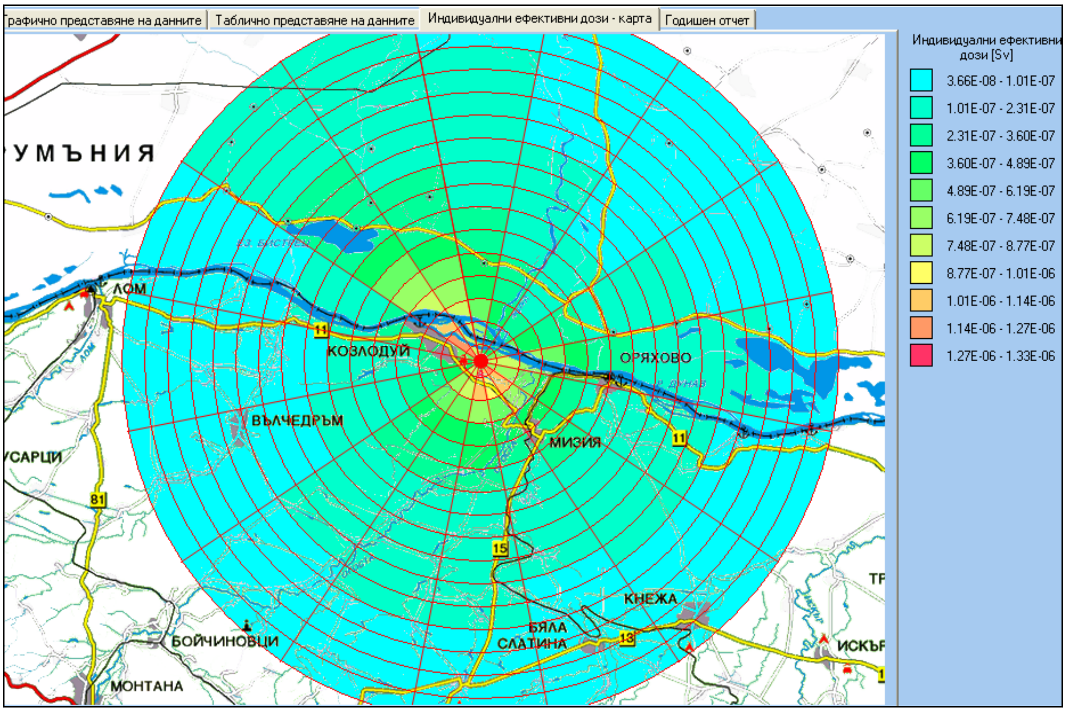

FIGURE 3.11-1. DISTRIBUTION OF INDIVIDUAL EFFECTIVE DOSE IN THE REGION OF KOZLODUY NPP IN 2012

Low values of radioactive releases with the discharge water from the Kozloduy NPP in 2012 and previous years determine the low levels of exposure in the region. The released in 2012 tritium activity of 24.1 TBq represent respectively 13% of the permissible level and 93% of the control level for the period. This parameter in the past decade is stable within 7 to 13% of the permissible level. Total activity (excluding tritium) of liquid releases is 411 MBq, which is only 0.28% of the control level of the limit approved by NRA for the period.

The maximum individual effective dose for the 30-km area is set at 6.37×10^{-7} Sv/a, and for a representative of the critical group of the population along the Danube River (town of Oriyahovo and the villages of Leskovets, Ostrov and Gorni Vadin) it is respectively 4.49×10^{-6} Sv/a. This irradiation is negligible and represents less than 0.5% of the annual limit of the effective dose of 1 mSv (BRPS-2012) and hundreds of times lower than the exposure from natural background radiation (2.33 mSv/a). Compared to the administrative quota for doses of liquid releases – 0.05 mSv/a, the maximum dose is 9%.

In 2010, the estimated maximum individual effective dose to population from total gaseous (including ^{14}C and ^{3}H) and liquid releases from the Kozloduy NPP in the environment is 1.4 μSv/a. This is only 0.06% of exposure from natural background radiation in the country (2.4 mSv), 0.14% of the rate for the population (1 mSv, BRPS-2012) and about 3% of the limit (0.25 mSv/a) for exposure to radioactive releases from NPP.

In 2011, the estimated maximum individual effective dose to the population from total gaseous (including ^{14}C and ^{3}H) and liquid releases from the Kozloduy NPP in the environment is 3.33 μSv/a. This is only 0.14% of exposure from natural background radiation in the country (2.33 mSv), 0.33% of the rate for the population (1 mSv, BRPS-2012) and about 1.3% of the limit (0.25 mSv/a) for exposure to radioactive releases from NPP.

In 2012, the estimated maximum individual effective dose to the population from total gaseous (including ^{14}C and ^{3}H) and liquid releases from the Kozloduy NPP in the environment is 1.97 μSv/a. This is only 0.08% of exposure from natural background radiation in the country (2.33 mSv/a), 0.2% of the rate for the population (1 mSv/a, BRPS-2012) and about 0.8% of the limit (0.25 mSv/a) for exposure to radioactive releases from NPP.

Annual collective dose for 2010 is estimated at 1.47×10^{-2} manSv/a. Statutory annual collective dose to the population of the 30-km area of gaseous and aerosol emissions amounted to 8.44×10^{-3} manSv/GW.a.

Annual collective dose for 2011 is estimated at 3.49×10^{-2} manSv/a. Statutory annual collective dose to the population of the 30-km area of gaseous and aerosol emissions amounted to 1.87×10^{-2} manSv/GW.a.

Annual collective dose for 2012 is estimated at 2.65×10^{-2} manSv/a. Statutory annual collective dose to the population of the 30-km area of gaseous and aerosol emissions amounted to 1.47×10^{-2} manSv/GW.a.

Estimations by components RNG (radioactive noble gases), LLA (long-lived aerosols) and ^{131}I (iodine-131) for Kozloduy NPP are fully comparable with the data for a large number of PWR reactors in the world (UNSCEAR–2000, 2008).

Low levels of radioactive releases from Kozloduy NPP determine values for radiation exposure with negligible radiation risk to the population in the area of the plant. Additional dose exposure of the population in the 30-km area per year on average is about 400 times lower than that received from natural background radiation (2330 μSv/a). In recent years, the maximum values of the individual effective dose to the population varies in the range of 1 ÷ 4 μSv/a, which is below the level for clearance from regulatory control – 10 μSv/a, BRPS-2012.

Performed mathematical model-estimates show that the additional dose exposure of the population in the 30-km area of operation of Kozloduy NPP is negligible.

The values of the maximum individual effective dose to the population within the 30-km area of Kozloduy NPP from total radioactive releases for the last three years are shown in Table 3.11-1:

TABLE 3.11-1: MAXIMUM DOSE EXPOSURE TO THE POPULATION IN THE 30 KM ZONE FROM GASEOUS AND AEROSOL AND LIQUID RELEASES, 2010-2012

Year	Maximum individual effective dose, [Sv/a]		
	Gas aerosols	Liquid	Total
2010	$8.02.10^{-7}$	$6.00.10^{-7}$	$1.40.10^{-6}$
2011	$2.72.10^{-6}$	$6.05.10^{-7}$	$3.33.10^{-6}$
2012	$1.33.10^{-6}$	$6.37.10^{-7}$	$1.97.10^{-6}$

The estimates for dose effect of the releases from Kozloduy NPP are fully comparable with the global practice, according to official data of the United Nations (UNSCEAR-2000, 2008). It should be noted that since then, the best international practice shows continuous improvement in the control of releases, respectively, reduction of emissions and their actual reporting, which result in lower dose estimates of the population in the regions of NPPs.

Low levels of releases from Kozloduy NPP determine negligibly low doses to the population in the area – hundreds of times less than the exposure from natural background radiation. Data for Kozloduy NPP is fully comparable with the releases from similar plants in the European Union, European Commission Radiation Protection 164, 2010.

According to statistical data of the National Statistical Institute from the Census of 01.02.2011, the number of people in the 30-km area around Kozloduy NPP on the territory of Bulgaria is 65 994 people, while on Romanian territory – is 75 150 people (Letter from the Romanian Ministry of Environment and Forests, № 2830/RP/31-07-2012).

For the considered population there is **no risk of development of deterministic effects on the population in the 30 km area of Kozloduy NPP** .

In recent years the values of the maximum individual effective dose to the population vary in the range 1 ÷ 4 μSv/a. Individual doses of gaseous and aerosol releases are within the limits of $7.18x10^{-9}$÷$2.72x10^{-6}$ Sv.

These doses are much lower than the threshold set under Art. 10, BRPS for limit of the annual effective dose to the population, which is 1 mSv.

On these grounds it can be stated that there is **no risk of development of deterministic effects on the population in the 30 km area of NPP**.

3.12 CULTURAL HERITAGE

In administrative-territorial aspect, KNPP and the envisaged new sites fall within the territory of the modern town of Kozloduy. The town has no museum structure in which there is any evidence of immovable cultural values (ICV) and archaeological artefacts. Territorially, the nearest specialized museum structure (Historical museum with archaeological collection) is in the town of Oryahovo. Monitoring, recording and study of sites of NCC is the prerogative of the Regional History Museum in Vratsa.

The Register of immovable cultural values (ICV) in the National Institute of Immovable Cultural Heritage (NIICH, formerly National Institute of Monuments of Culture) includes 2 historical sites (place of Kozloduyski Bryag and Mateev Geran) and 2 archaeological sites (ancient fortress Augustae in the place of Chetate and ancient fortress Regiana, in the place of Magura Piatra). In the automated information system "Archaeological Map of Bulgaria" (AIS-AMB)[37] there are registration cards for 18 sites within the municipality. Most of them are on the land of the village of Harlets, located east of the mouth of the Ogosta River, and are associated with the Roman camp and the city of Augustae[38]. Reported are also 4 sites located in the western end of the town's territory.

The data collected from archival sources, scientific literature and book-stock allow to conclude that the land of the present-day town of Kozloduy is relatively rich with sites of cultural heritage with a wide chronological range – from the Neolithic period (8-5 centuries BC), early and late Bronze Age (3200 – 1300/1200 BC.), Roman (I-IV century AD.), late antiquity (IV-VI century) and early medieval periods (VII-XI century). Data for such sites justifies the judgment that it is possible unknown sites to be affected in the course of new construction on land with surface unspoiled so far and with original topography.

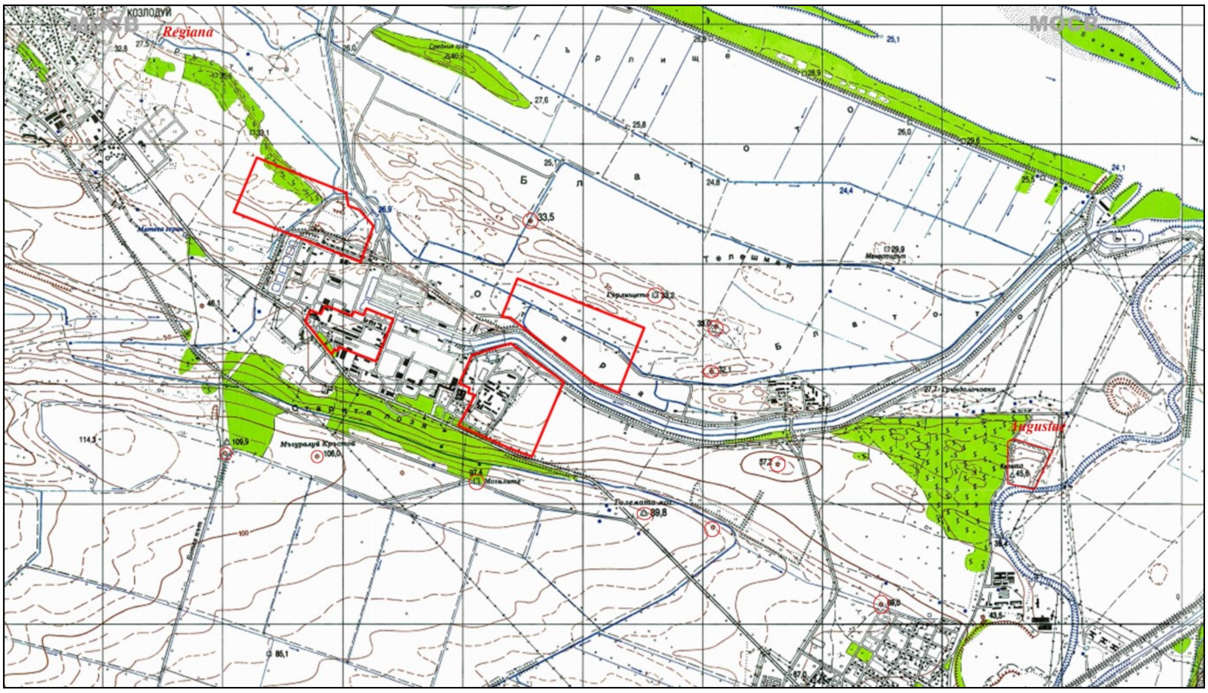

FIGURE 3.12-1: BURIAL MOUNDS SURROUNDING THE PROPOSED SITES FOR NNU OF KOZLODUY NPP

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[37] http://naim-bas.com/akb/

[38] Announced for ' national antiquity' already in 1927 (SG . 69/1927) and 'archaeological preserve with status of national importance' (Decision of the Bureau of the Council of Ministers № 14 of 25.06.1984).

4 DESCRIPTION, ANALYSIS AND EVALUATION OF POTENTIAL SIGNIFICANT IMPACTS ON POPULATION AND ENVIRONMENT IN RADIATION OR NON-RADIATION ASPECT AS A RESULT OF THE IMPLEMENTATION OF THE INVESTMENT PROPOSAL, USE OF NATURAL RESOURCES, EMISSIONS OF HARMFUL SUBSTANCES DURING NORMAL OPERATION AND EMERGENCY SITUATIONS, GENERATION OF WASTE AND CAUSING OF DISCOMFORT

4.1 CLIMATE AND ATMOSPHERIC AIR

4.1.1 POLLUTION SOURCES IN ATMOSPHERIC AIR

During construction

Quantities of gas emissions from construction mechanization and transportation activities for delivery of materials and waste disposal are determined based on the methodology **EMEP/EEA air pollutant emission inventory guidebook – 2009.**

Assessment of the quantities of dust emissions (total suspended particles (TSP) and fine particulate matter up to 10 microns (FPM_{10})) for various construction activities is performed based on the emission factors for open dust sources of U.S. Environmental Protection Agency (EPA) AP-42 – **Construction and Aggregate Processing and Fugitive Dust Open Sources**[39], where are given emission factors for the assessment of dust emissions from various construction tasks: preparation of the construction site (**Section 11.9.2** – scraping the surface humus layer, excavations, embankments, tamping and compacting the ground, reinforcement of the excavation or embankment) and dust from the necessary traffic in the construction site (**Section 13.2.2** – travelling unpaved roads).

Intensity of dust formation is highly dependent on weather conditions during the course of construction activities and on the season during which construction works will be performed, on the climatic and meteorological factors (wind, humidity, temperature, atmosphere stability), characteristics of earth particles and many others.

When the spray system is used to maintain adequate moisture within them, the levels of particulate emissions (controlled release) are reduced by 80%[40]

During operation

During operation, emissions are expected (as linear) from the exhaust of the equipment with internal combustion engines (ICE) of the transport service to NNU for delivery of

[39] http://www.epa.gov/ttn/chief/ap42/index.html
[40] http://www.epa.gov/ttn/chief/ap42/ch11/final/c11s00.pdf

materials and waste disposal. According to expert evaluation the intensity of this transport is expected to be half of the transport currently servicing units 5 and 6.

Fugitive dust emissions are not expected.

During decommissioning

Activities during decommissioning of the NNU are expected after more than 50 years. The very period of activities for decommissioning of the NNU will be a long one – more than 15-20 years, and therefore both in annual and spatial aspect, these emissions will have less significance than those generated during the construction of NNU.

Emission levels during decommissioning will depend both on technological dismantling of engineering structures and the driving force of technology that will be applied after more than half a century, so it is not serious to make quantitative estimates based on emission factors valid for this moment.

4.1.2 ASSESSMENT OF POTENTIAL IMPACTS ON CLIMATE AND AIR

4.1.2.1 CLIMATE

Implementation of the IP will have no impact on the regime and spatial distribution of climatic parameters in adjacent areas to the alternative sites.

Climate change is not expected to occur due to the power of non-radiation emissions during all three phases: construction, operation and decommissioning.

4.1.2.2 NON-RADIOACTIVE AIR POLLUTION

4.1.2.2.1 During construction

For the assessment of the dispersion of emissions from area sources during construction (for each of the 4 sites) is used the model of the U.S. Agency for Environmental Protection (EPA) ***ISC-AERMOD*** (Industrial Source Complex) with Windows interface developed by the Canadian software company Lakes Environmental.

Linear gas emissions will not affect air quality during construction.

4.1.2.2.2 During operation

During operation of the NNU pollution from diffuse particulate emissions is not expected. Gas emissions will be insignificant compared to the pollution from daily average intensity of traffic on the road II-11 of the national road network.

4.1.2.2.3 During decommissioning

Impact of all emissions during decommissioning would be similar to those established during construction, but as the impact will be at a larger time interval, their significance is expected to be negligible.

In terms of component atmospheric air, the 4 alternative sites where the NNU can be located have almost equal significance of impact – very low. None of the sites bears potential danger of anthropogenic air pollution by non-radioactive contaminants in the area of IP. Both the impact of emissions and concentrations of pollutants are well below the limits of admissible standards.

There is no transboundary impact for the atmospheric air component.

Based on the above rationale regarding the favourable climatic and meteorological characteristics of the area and the fact that the region has no major industrial polluters, it can be concluded that the impact of the IP on air quality will be negligible. It also means that through the air indirectly the impact on other components of the environment – soil, flora and fauna, and health and hygiene conditions, will also be negligible.

4.1.2.3 RADIOACTIVE AIR POLLUTION

Radioactive air pollution is due to radioactive releases (emissions) from a nuclear power plant. Airborne radionuclides can lead to irradiation in two principal ways: externally – by photons or electrons emitted as a result of radioactive decay, and internally – by their inhalation.

In terms of human health protection, these releases are evaluated based on radiation exposure of the human body as opposed to limit values for ambient concentrations for conventional pollutants.

Assessment of radiation exposure of the population in the 30-km area gas aerosol releases is made by means of modelling in item 4.11.

4.2 WATER

4.2.1 SURFACE WATER

The operative site of NPP is situated on the right bank (at the 694th km) of the Danube River. It is located in the northern part of the first non-flooding terrace of the Danube River and spreads on an area of 4471.712 acres. There are no natural water bodies – rivers – passing through the site.

In close proximity, to the north of the site flows the Danube River, which is of major importance for the NPP, signified by the name "Danube River RWB01" and by the code BG1DU000R001, in accordance with the River Basin Management Plans of the Danube region for basin water management in Bulgaria.

The sites in the area of Kozloduy NPP considered as suitable for installing NNU are shown on **Figure 4.2-1**. The area of the proposed sites, irrespective of the type of nuclear reactor, will accommodate all the major and auxiliary buildings and installations, the equipment needed for the operation, as well as all local treatment facilities and waste water treatment plants. The master plan that will be developed for the chosen site at the next design phase of the investment proposal will point out a precise situational solution of the project.

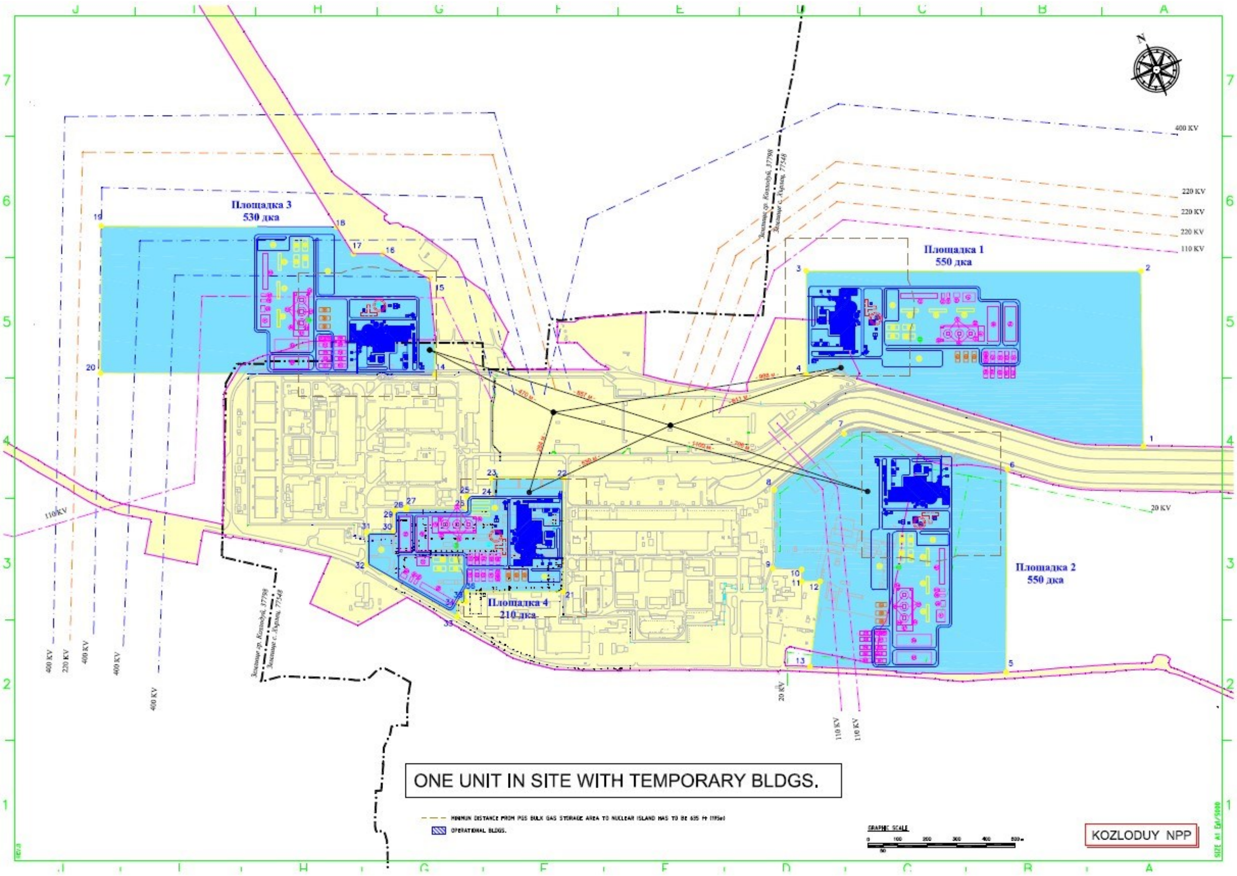

FIGURE 4.2-1: PRACTICABLE LOCATION OF ONE UNIT AT THE ALTERNATIVE SITES

For all sites there is a feasible technical option of providing drinking water supply using the existing water-main of the NPP and providing water for technical purposes – for cooling and for other purposes – using the existing hydro technical facilities.

All sites will be equipped with separate sewage systems for household and faecal waste water, for industrial and rain water.

4.2.1.1 DURING CONSTRUCTION

Site 1

There are no natural rivers flowing through this site. Drainage channels pass through the site, including the Main Drainage Channel receiving the waste water of Electricity

Generation-1 and part of the water of Electricity Generation-2 of the operative site of Kozloduy NPP and are part of the drainage system of Kozloduy lowland. To fully reclaim this site an overall reconstruction /dislocation/ of the Sewer Main Line will be required. The site is situated on the flooding terrace of the Danube River, grade level 25.0-26.0 m, with high groundwater overflowing the ground level.

This site has sufficient size area to set apart the necessary building and construction zone and adjacent infrastructure required for the construction works.

Drinking and household water supply

To provide the required drinking water supply of the site, a deviation of the existing water-main of the NPP will be constructed thus ensuring the water needed for internal fire control as well. The number of workers engaged in different construction phases might vary considerably. Based on the data submitted by the contracting authority, this number may vary depending on the type of units.

The water needed for drinking and household purposes will be provided by the existing water-supply network of the NPP by means of a deviation, which will fully satisfy the needs of drinking water during construction and operation. (As stated by Letter of Kozloduy NPP EAD No. Д”П”58/19.04.2013 the water-supply network has a reserve of 70.9 l/s).

Bottled water will be provided to the workers by the time the connection to the water-main is finalized.

Sewage system and household-faecal wastewater

Portable facilities will be used /chemical toilets / by the time the sewage system and the waste water treatment plant are finalized.

During construction household-faecal wastewater will result from about 2000 to 2500 people.

A waste water treatment plant will be built for the treatment of wastewater with adequate capacity to receive waters from the operation of NNU as well, and during construction it will undertake the treatment of any on-site household-faecal wastewater. The wastewater treatment unit will provide complete biological treatment of waste household and faecal water and adequate treatment of resulting sediments in compliance with relevant regulations. Provided the stipulated requirements during construction are strictly observed, significant impact on the Danube River water quality should not be expected.

Dewatering system/drainage system

The presence of high and close to the surface groundwater will necessitate the construction of a dewatering/drainage system on the site that should be in continuous operation both during construction and in the operational period.

Rain waste waters

During construction rain water will be generated during rainfall, snowmelt, cleaning work areas, etc. A separate sewage system will be built for rain water. Before discharging, waters will be collected in buffer arrester tanks and after adequate treatment and control they will be released to the receiving water, the Danube River, in compliance with the requirements prescribed in relevant regulations.

Technical water supply during construction

The construction of a nuclear unit is a process lasting several years and depending on a number of factors setting the time limit of the construction. It will be necessary to secure technical water supply of the site for this long period and large volume of construction and installation works. Kozloduy NPP has sufficient options to provide adequate connection to the prospective sites of Electricity Generation from any appropriate point of the technical water supply network of the operative site.

Connection of the new nuclear unit with Cold Channel-1 and Hot Channel-1

The connection of NNU with Cold *Channel*-1 and Hot Channel-1 on this particular site is technically feasible by means of a deviation from the cold Channel and a low-pressure and open channel for the hot water.

Advantages:

- ✓ For this particular site, a definite advantage is the close location of the "dual Channel" – at around 75 m on average, allowing quite shorter and easier connection, and accordingly lower investment and faster fulfilment;
- ✓ An advantage is the well-suited area for constructing the facility and the good prospects to organize the construction sector.

Disadvantages:

- ✓ The location of this site, which definitely demands reconstruction of the existing drainage channels;
- ✓ The connection to the Hot Channel-1 must pass under/above the Cold Channel-1;
- ✓ Heavy earthmoving and excavating works in order to reach the elevation of the main operative site;
- ✓ Very high groundwater overflowing to the surface.

Expected impact – temporary, short-term (for the construction period) with no cumulative effect, regional-sensitive, reversible once construction is finished.

Site 2

This site has sufficient size area to set apart the necessary building and construction zone and adjacent infrastructure required for the construction works.

The drinking and household water supply, the sewage system, the volume, the expected polluted load and the treatment of household and faecal wastewater are identical to those of **Site 1**.

Dewatering/drainage system

The groundwater in the area of this site is situated lower, at a greater depth. Notwithstanding this circumstance, a dewatering system will be necessary for the protection of NNU and for satisfying the requirements for safe operation of all buildings and facilities.

The operation of the system is the same as that of Site 1.

Rain waste waters

These waters will be led and treated in the same way as for Site 1.

Technical water supply during construction

The technical water supply will be provided by water sources for technical water supplying the operative site.

Connection of the new nuclear unit with Cold Channel-1 and Hot Channel-1

Here the connection of the technical water supply facilities for NNU will not be different in principle from that of Site 1, the difference lying in building an inverted siphon for the cold water coming from the Cold Channel-1 or using the Circulator Pump Station-1 and a bypass Channel line for the hot water coming from the Hot Channel-1.

Advantages:

- ✓ The location of the "dual Channel" in close proximity – at about 75 m, allowing quite shorter and easier connection, and accordingly lower investment and faster fulfilment. There is also an option of making a connection with the Cold Channel-1 through the Circulator Pump Station-1. Actually, the dual channel is actually the border with the site on the north.
- ✓ The lack of already built facilities that could be reconstructed;
- ✓ The well-suited area for the construction of the facility; the good prospects to adequately organize construction works and the possibility to use the existing buildings and structures for the purposes of the construction process;
- ✓ Landscaping – less earthmoving and excavating works.

Disadvantages:

- ✓ The connection with the Cold Channel-1 must pass under/above the Hot Channel-1;
- ✓ In case of connection through Circulator Pump Station-1 it will be much longer.

The expected impact is the same as for Site 1.

Site 3

The site is situated on the flooding terrace of the Danube River to the northwest of units 5 and 6 of Kozloduy NPP. The level of groundwater fluctuates depending on the water levels of the Danube River. It overflows to surface level or close to it.

Certain construction and building works will be necessary here related to reconstruction and/or dislocation of the existing open channel lines belonging to the irrigation and sewage system of Kozloduy lowlands and several high-voltage overhead transmission lines – the fan of ВЛ-400К [Overhead Transmission Line-400K].

Household and drinking water supply, the sewage system, as well as the volume and the expected contaminated load of the household-faecal wastewater are identical to those described for **Site 1**.

Dewatering/drainage system

The presence of high and close to the surface groundwater will necessitate the construction of a dewatering/drainage system on the site that should be in continuous operation both during construction and in the operational period.

The operation of the system is the same as that of Site 1.

Rain wastewater and technical water supply during construction will be managed in the same way as for **Site 1**.

Connection of the new nuclear unit with Cold Channel-1 and Hot Channel-1

Here the connection can be made without disturbing the operation of the other units provided there is an additional cold Channel – Cold Channel-2. After decommissioning units 1÷4, fresh technical water from the Danube River is available. This assured reserve does not demand building any additional facilities for technical water supply. The distance from the site to the Cold Channel-1 is about 235 m.

This site is located close to the Hot Channel-2 built for units 5 and 6. The investment proposal does not discuss the usage of this Channel.

Constructing a new channel from Site 3 to the open section of the Hot Channel-1 is proposed as an option.

Advantages:

- ✓ Demolition of existing buildings is not needed. Enough area.

Disadvantages:

- ✓ The location of the site, which demands reconstruction of the existing channel lines;
- ✓ Heavy earthmoving and excavating works in order to reach the elevation of the main operative site;
- ✓ Very high groundwater levels overflowing on the surface;

- Long connection to Cold Channel-1;
- Long connection to Hot Channel-1;
- Dislocation of the power transmission lines – the fan of the Overhead Transmission Line-400K.

The expected impact is the same as for Site 1.

Site 4

The site is situated on the first non-flooding terrace of the Danube River. The groundwater level is from 8.0 to 10 m from the surface. The site is located within the boundaries of the existing site of the NPP.

The drinking and household water supply, the sewage system, the treatment of household and faecal wastewater, rain waste water, and the technical water supply during construction will be identical to those of **Site 1**.

Dewatering/drainage system

The groundwater in the area of this site is located lower, at a greater depth. Notwithstanding this circumstance, a dewatering system will be needed.

The operation of the system is the same as that of **Site 1**.

Connection of the new nuclear unit with Cold Channel-1 and Hot Channel-1

As indicated in the Investment Proposal, the supply of technical water for the cooling system of NNU can be provided using the connection point for Units 3 and 4 /decommissioned/. The connection with the Hot Channel-1 should be made through its open section.

Advantages:

- The site is situated on the non-flooding terrace of the Danube River and lies within the boundaries of Kozloduy NPP;
- Short connection with the Cold Channel-1;
- Easy connection with the Hot Channel-1.

Disadvantages:

- The site has been urbanized; it accommodates many industrial buildings and facilities that have to be demolished and placed elsewhere;
- It is possible to detect underground communication infrastructure pertinent to the operation of the existing site.

The expected impact is the same as for Site 1.

General conclusions:

Impact characteristics – temporary, short-term (for the construction period) with no cumulative effect, regional-sensitive, reversible once construction is finished.

4.2.1.2 DURING OPERATION

The investment proposal for building a next generation new nuclear unit III, III+ on the proposed alternative sites considers 3 models of state-of-the-art reactors, as follows:

- AES-92 reactor;
- AP-1000 Reactor – Generation III+;
- AES-2006 Reactor – Generation III+.

AES-92 is an updated PWR-1000/V466B model, which is a pressurised water reactor with four circulation loops based on a standard VVER AES-92 plant design. The estimated number of staff needed for this reactor is 550 people.

The total number of staff needed for a site equipped with an **AP-1000** reactor is 502 people for one unit; shutting down and refuelling operations might need an additional number of 500 people for these particular periods.

The **AES-2006** reactor is a III+ generation evolution of VVER plant designs. The estimated number of staff needed for its operation is 600 people on-site and another 500 people for periods of planned repair and maintenance operations.

Each of the above-mentioned reactors can be accommodated on one of the four alternative sites discussed earlier. All sites indicate adequate technical opportunities for providing drinking water supply using the existing water-supply network of Kozloduy NPP and technical water supply – for cooling and for other purposes – through the existing hydrotechnical constructions of the NPP.

All sites will be equipped with separate sewage systems for household and faecal waste water, for industrial and for rain waste water.

SITE 1

4.2.1.2.1 Water supply

Drinking and household water supply

The water needed for drinking and household purposes will be provided by the existing water-supply network of the NPP by means of a deviation, which will fully satisfy the needs of drinking water.

The water needed for the different types of reactors is as follows:

– For AES-92 unit – Q average daily water use = 165 m^3/d

– For AP-1000 unit – Q average daily water use = 150.6 m^3/d

- For AES-2006 unit – Q average daily water use = 180 m^3/d

The deviation of the existing water-supply network of Kozloduy NPP , constructed in order to satisfy the needs for drinking and household water of the workers during the construction period, is absolutely sufficient to cover the needs for drinking water during operation. The pressure across the NPP water-main is 8 atm.

Provisionally pure water (non-drinking) for bathing, washing, toilets, etc.

Provisionally pure water for washing will be taken from the Pump Station "Valyata" having the relevant authorization for water abstraction/consumption issued by the Danube River Basin Directorate.

Technical water (non-drinking) for fire control purposes

Provisionally pure water for fire control purposes in NNU will be provided by the existing Kozloduy NPP site.

Water supply for technical purposes

Technical water supply provides cooling water /circulation – for the turbine's condensers; and technical – for Chemical Water Treatment and for other purposes /. Water from the Danube River is led to the NPP by means of the hydrotechnical facilities and constructions.

The capacity of the cold Channel line is 180 m^3/s with maximum provable capacity of 200 m^3/s[41]. Relevant permissions and authorizations have been issued by the Danube River Basin Directorate for using water from the Danube River and from mineral sources.

The water used by the power units goes back to the Danube River through an outfall "hot Channel duct called Hot Channel-1. The capacity of the hot Channel is 180 m^3/s with maximum provable capacity of 200 m^3/s and it depends on the grade level of the overflow drain after the low-pressure drains and on the water level of the Danube River. The outfall "hot" Channel runs parallel to the "cold" Cold Channel-1 along most of the pipeline route. The two Channel lines have a common dyke and form a dual Channel.

As far as the provision of technical water is concerned, taking into account that the first four power units of the operative NPP were decommissioned, free capacity is readily available so that part of the water on hand after decommissioning will be redirected for cooling the turbine's condensers and for the other systems of the investment proposal. Getting fresh water from the Danube River for the new nuclear unit **will not** result in violating the authorized quantity of fresh water as stipulated by the Permit for water exhaust issued by the Danube River Basin Directorate.

The estimates made indicate that the hydrotechnical facilities built up for bringing cold water from the Danube River and leading spent cooling water back into the river have

[41] Scientific Center "Energoproekt"-1991 – Existing technical water supply systems

sufficient capacity to guarantee the joint operation of NNU and the active power units 5 and 6.

Sewerage

The sewerage system of the site of the new investment proposal will be separate – for household faecal wastewater from the controlled zone and from the pure zone, for industrial and for rain wastewater. Sewerage will be built with materials providing high water tightness and preventing infiltration of contaminants into groundwater and subsoil.

Household faecal wastewater

Household faecal wastewater will be formed by everyday activities of the staff, by sanitary facilities and laundry equipment of the “pure” and the “controlled” zone.

Waste water treatment plants will carry out the purification of household wastewater, which were built during the construction of NNU and used to treat wastewater in that phase.

Bringing household wastewater to the treatment facilities will use two sewerage collectors depending on the location of the sub-sites and on the way they are formed – from the “pure” zone and from the “controlled” zone.

These waters will be led to a treatment facility consisting of two waste water treatment plants – one for the waters from the “pure zone” and one for those from the “controlled zone”.

Industrial wastewater

Industrial wastewaters are formed as acidic and alkaline wastewater in the production of demineralised and highly desalinated water from the Chemical Water Treatment and water contaminated with oils and petroleum products.

The maximum quantity of wastewater (acid and alkaline) varies for the different types of reactors. It is a periodic consumption and depends on the processing technology and on the quality of raw water.

Wastewater from the Chemical Water Treatment will be led to neutralizing pools. After processing these waters will be discharged.

The formation of industrial wastewater contaminated with petroleum products results from the drainage water coming from the engine room, the diesel generator station, the transformer sites and from the oil and petroleum plant.

Local treatment facilities will be built in the separate sub-sites for rough removal of petroleum products, and then water will be collected for additional purification in the waste water treatment plant followed by dosimetric control.

Discharge of all types of industrial wastewater will be carried out by means of a new Channel directly to the Danube River or by discharging into the Hot Channel 1.

Rain wastewater

A separate sewage system will be built for disposing of rain wastewater falling on the site.

Rain water will pass through buffer arrester tanks, two-sectional, amply dimensioned to take up the first contaminated rain water on the site, undergoing averaging of their physical and chemical composition, as well as a precipitation procedure to reduce the concentration of any non-dissolved substances and control the formation of sludge. Subsequent to the arrester tanks and following a mandatory radiation control, water will be disposed into the Danube River after carefully planned dosing.

Cooling water of the technical water system

Cooling water taken from the Danube River is sent back to the river using the Hot Channel 1. This water quantity, necessary for cooling one reactor, is brought back to the Danube River as spent cooling water. The total expected water volume that will be taken/returned from and to the river will be the same as the water volume that was taken and returned as spent wastewater during the operation of units 3÷6 by the time units 3 and 4 were decommissioned in the end of 2006. This water quantity falls within the limits of the authorized water exhaust from the Danube River with Permit №05628/14.03.2005 under the Water Law, issued by the competent authority. The estimated temperature above the raw water temperature will be up to T≤14.5°C.

4.2.1.2.2 Treatment facilities for non-radioactive wastewater

Treatment facilities for household wastewater

Two separate waste water treatment plants have been planned for household wastewater from the "pure" and "controlled" zone. The treatment technological scheme for household wastewater from the "pure" zone will include facilities for mechanical and biological treatment featuring continuous aeration and complete mineralization of the sludge.

This kind of treatment is expected to bring the parameters of the treated wastewater in compliance with the regulatory requirements for discharging wastewater into the Danube River, which will be laid down in the discharge authorization.

Building treatment facilities has been also planned for the treatment of household wastewater from the "controlled" zone. The technological scheme of the household waste water treatment plant from the "controlled" zone will include the same facilities for mechanical and biological treatment. The bio-pool[42] is planned as a low-load bio-pool with full mineralization of the sledge. Having passed through the waste water treatment plant, water will then undergo dosimetric radiation control before discharging into the recipient basin. In case wastewater does not meet the regulatory requirements after radiation control, it will be returned for second treatment.

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[42] A wastewater treatment facility as part of the technological scheme of a treatment plant where the biological treatment of wastewater is accomplished.

The treatment unit including the waste water treatment plants for household wastewater from the two zones will support a number of analyses of the treated and non-treated household wastewater from the two zones on a daily basis, namely: pH[43], temperature, permanganate oxidisability, chemical oxygen demand (COD) and quantity of dissolved oxygen in the bio-pool, etc.

It is possible to mix the two types of treated wastewater before discharging thus fulfilling only one discharge with continuous monitoring and radiologic control.

Treatment facilities for wastewater from Chemical Water Treatment

For the treatment/purification of wastewater from Chemical Water Treatment a neutralizing pool is to be built with the purpose of neutralizing aggressive water (acid and alkaline) released during the technological processes included in Chemical Water Treatment. The pool will have two chambers – working chamber and stand-by chamber. The neutralization of the incoming acid and alkaline waters will be executed without using any reagents, and wastewater stirring up will be done by compressed air.

Treatment facilities for wastewater contaminated with oils and petroleum products

Local treatment facilities for the elimination of petroleum products – sludge and oil retainers and sumps – will be built for the treatment of industrial wastewater from the diesel generator station, the transformer sites and from the oil and petroleum plant. The technological solution and design configuration of these facilities should follow state-of-the-art technology and meet the regulatory requirements with regard to the indicators stipulated for discharging into the receiving water.

Major flows of waste non-radioactive water

Wastewaters at Site 1 will form the following major flows:

- Household wastewater from sanitary facilities and laundry units of the "pure" zone and the "controlled" zone led to the waste water treatment plants through separate collectors;

- Acidic and alkaline wastewater from Chemical Water Treatment let to a neutralizing pool through a separate collector;

- Oil-containing wastewater collected in a holding tank and then led to a local treatment facility (sludge and oil retainer);

- Rain wastewater that are led through street effluents via the rain sewerage and across a buffer tank to be discharged into the receiving water.

Wastewater characteristics

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[43] Indicator for acidic or alkaline features of the medium.

The expected characteristics of wastewater and their impact on the environment can be estimated based on data about the long-term operation of Kozloduy NPP and of other nuclear power plants already operating or in the process of being constructed and employing the same type of reactors.

The contamination rates of wastewater resulting from NNU will be considered by analogy with the contamination levels of the existing power units of Kozloduy NPP . The characteristics of wastewater resulting from NNU disposed into the Danube River must comply with the contamination requirements laid down for the Danube River.

The Environmental Impact Assessment Report presents expected contamination levels and contaminating loads of cooling and industrial wastewater from NNU discharged into the Danube River. Contamination levels have been derived based on the data of the monitoring done by the Kozloduy NPP – waters discharged into the Hot Channel 1, annual average results for the year 2011 (accepted as analogue data for **NNU** waters with **AES-92 and AES-2006**, which will be discharged in the Hot Channel-1 in the present investment proposal).

Exceeded levels of the waters from the Hot Channel above the Individual Emission Limit Values are not expected.

Wastewater from NNU is not expected to have heavy metal content above the rates specified in the Individual Emission Limit Values.

The Environmental Impact Assessment Report presents expected contamination levels and contaminating loads of cooling and industrial wastewater from **NNU with AP 1000 reactor,** discharged in the Hot Channel-1.

The quantities of wastewater have been derived from the expected water volumes resulting from the operation of the AP-1000 reactor systems shown in the investment proposal. The contamination levels have been derived based on the data of the monitoring done by the Kozloduy NPP – waters discharged into the Hot Channel 1 (accepted as analogue data for NNU waters with AP-1000 reactor).

The expected contamination levels presented hereunder clearly show that the individual emission limit values for the Danube River – receiving water 3rd category – will not be exceeded[44].

The normal mode operation of the vastly improved technology of a pressurized water nuclear reactor AP-1000 will be supported by the following systems:

- ✓ Wastewater treatment and chemically desalted water system (DTS);
- ✓ Transmission and storage system of chemically desalted water (DWS);
- ✓ Stand-by oil system for diesel fuel.

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[44] Regulation №7/1986 , repealed SG, No. 22 of 05.03.2013

Regarding the quantities of discharged wastewater, they can be compared with the water volumes flowing in the receiving water – the Danube River (average and minimum water volume). Data on the quantities of the Danube River have been derived based on the data submitted by the Executive Agency for Exploration and Maintenance of the Danube River – Ruse. The water volumes refer to the town of Oryahovo.

The share of the water volumes resulting from the investment proposal released into the Danube River is as follows:

- For average water quantity – 1.4%
- For minimum water quantity – 3.6%. **The expected released water volume from NNU will not affect the debit of the river even for minimum water quantities.**

Based on the information submitted, the following major **characteristics** of conventional (non-radioactive) wastewater might be expected:

- ✓ Relatively constant wastewater debit in the absence of rainwater;
- ✓ Low organic contamination of wastewater, which is expected to comply with regulatory requirements and be relatively steady during the different hours of the day in view of the continuous operation mode of NNU;
- ✓ Heavy metal content above the Individual Emission Limit Values is not expected for the receiving water because the technological processes are not expected to yield the formation of water containing heavy metals;
- ✓ Regarding the functioning of oil yards, the proper operation of treatment facilities will assure that the released contamination will meet the regulatory requirements.

Radioactively contaminated industrial wastewater

Radioactively contaminated wastewater resulting from the operation of NNU will be identical to those falling off from the capacities operating at present.

In the process of operation of the power units operational radioactive liquid releases will be formed by:

- ✓ Leakages from the first contour of the nuclear reactors;
- ✓ The dedicated pools and repository for spent nuclear fuel;
- ✓ Chemical decontamination of facilities and equipment;
- ✓ Regeneration and washing of ion exchange filters;
- ✓ Protective clothing Laundry and hot shower;
- ✓ Radiochemistry laboratories, etc.

These waters will be processed (treated) consecutively in evaporating installations and filter facilities (special water purification systems) in the Special operation building of the new power unit. Purified waters, called "unbalanced", will be collected in intermediate tanks (reservoirs) and after radioactive control will be disposed in the Hot Channel-1 provided they meet the standards. Otherwise, they will be returned for second treatment.

Liquid waste control systems have been considered in detail in the Environmental Impact Assessment Report including also an analysis of liquid RAW. The assessment on the expected impact carried out through assessing the statutory collective effective annual exposure dose for the population due to the release is presented in item **4.11** of the report.

Expected impact

- ✓ Contamination of the receiving waters from conventional household and industrial wastewater resulting from the operation of NNU is not expected.
- ✓ Compliance with regulatory requirements, implementing separate state-of-the-art Sewerage preventing leakage and contamination of groundwater and avoiding the mixing of flows from the radioactive and from the non-radioactive zone, as well as compliance with all the requirements for proper operation of the treatment facilities, will assure conformity with the environmental standards in the operation of NNU.
- ✓ Wastewater discharge into the receiving waters during operation is not expected to cause any changes in the qualitative composition of the water in the Danube River.
- ✓ The implementation of treatment facilities for waste household faecal water and wastewater containing oil, and arrester tanks for rain wastewater, included in the investment proposal, is not expected to bring about any impact on the receiving water and the environment.
- ✓ The operation of local waste water treatment plants will target the emission limit values that will be prescribed by the Permit for wastewater discharge issued by the Danube River Basin Directorate.
- ✓ The monitoring process, now supported in the Nuclear Power Plant, will be further continued after the implementation of the investment proposal for the new nuclear unit and will be improved and expanded to effectively screen the performance of the new unit.
- ✓ The efficient control and management of treatment processes, and the continuous monitoring on the quality of water in radiation and non-radiation aspect, will guarantee that the emission limit values of discharged water into the receiving basin – the Danube River – will be reached and the quality of the aquatic ecosystem will be preserved.

The strategic and well-defined aims laid down in the River Basin Management Plans concerning the Danube River Basin, focused on efficient water management aiming to prevent the degradation of the aquatic ecosystem and achieve "good ecological status" of Danube River waters, will not be threatened as a result of introducing the new nuclear unit.

During operation wastewater will have local impact and no irreversible negative effects on the environment are expected.

- ✓ **Impact scope –** local.
- ✓ **Impact characteristics –** direct, positive, low level of impact, continuous, long-term, cumulative, and reversible.

SITE 2

This site is situated on the first non-flooding terrace of the Danube River.

The overall provision of potable water for the site, the supply of provisionally clean water (non-drinking) for bathing, washing, toilets, etc. and provisionally clean technical water (non-drinking) for fire control purposes will involve the same construction and assembly works as those planned for Site 1.

Water supply for technical purposes

The different types of reactors might need different quantities of cooling water. Technical water supply and the connection of NNU with the Cold Channel 1 and Hot Channel 1 are discussed in item 4.2.1.1 of this report.

Sewerage , household faecal wastewater (volumes, contamination and treatment), industrial wastewater and rain water are identical to those considered for Site 1.

Cooling water of the technical water system

The cooling water taken from the Danube River is sent back using the Hot Channel-1. For this site the discharge to the Hot Channel-1 is not complicated as this Channel line is actually the northern border of Site 2.

Treatment facilities for non-radioactive wastewater

Treatment facilities for household wastewater, wastewater from Chemical Water Treatment and for wastewater contaminated with oils and petroleum products are identical to those planned for **Site 1**.

Major flows of waste non-radioactive water

Wastewater at **Site 2** will form the same major flows as in the case of **Site 1**.

Wastewater characteristics

For the present there are no sufficient specific data to fully outline the wastewater characteristics, therefore, as in the case of **Site 1**, data by analogy will be used for this purpose.

The expected contamination levels and contaminating loads of cooling and industrial wastewater resulting from NNU operation equipped with AES-92 and AES-2006 and discharged into the Danube River will be same as for **Site 1**.

The expected contamination levels and contaminating loads of cooling and industrial wastewater resulting from NNU operation (with AP-1000 power unit) discharged into the Danube River through the Hot Channel-1 will be identical to those of **Site 1**.

Exceeded levels of the waters from the Hot Channel-1 above the Individual Emission Limit Values are not expected.

Radioactively contaminated industrial wastewater

Radioactively contaminated wastewater resulting from NNU operation will be analogous to the ones now dropping from the current operative units. These estimates are presented in the section about **Site 1**.

Based on the information submitted, the expected wastewater characteristics will be identical to those of **Site 1**.

Expected impact

During operation wastewater will have local impact on the ecological status in the region. Impacts are identical with those described for **Site 1**.

No irreversible negative impact on the environment is expected.

SITE 3

This alternative site, similar to Site 1 and Site 2, has enough capacity to accommodate NNU with reactors of the type AP-1000, AES-92 or AES-2006.

Household and potable water supply, the supply of provisionally clean water (non-drinking) for bathing, washing, toilets, etc., and the supply of provisionally clean technical water (non-drinking) for fire control purposes will be identical to the options outlined for **Site 1**.

Water supply for technical purposes

Technical water supply providing cooling water will be addressed in the same way as for **Site 1**.

The provision of technical water supply and the connection of NNU with the Cold Channel 1 and Hot Channel 1 are discussed in detail in item 4.2.1.1. of the present Executive Summary.

Sewerage

The sewerage system on the site of the new investment proposal, household faecal wastewater, contamination levels and contaminating loads for the different types of reactors and the treatment of household faecal wastewater will be identical to the solutions described for **Site 1**.

The technology and facilities for collecting and treating industrial wastewater, disposing of rain water and relevant treatment will be the same as for **Site 1**.

Cooling water of the technical water system

The cooling water taken from the Danube River is sent back using the Hot Channel-1.

The connection with the Hot Channel 1 will require the building of a new pipeline or Channel from Site 3 to the open part of the old hot Channel Hot Channel 1 as it is recommended to avoid any connection through the underground section of the hot Channel.

Treatment facilities for non-radioactive wastewater

Treatment facilities for household wastewater, wastewater from Chemical Water Treatment and for wastewater contaminated with oils and petroleum products are identical to those planned for **Site 1**.

The screening and analysis carried out on a daily basis in the treatment complex are discussed in the section about **Site 1**.

Major flows of waste non-radioactive water

Wastewater on **Site 3** will form the same major flows as in the case of **Site 1**.

Wastewater characteristics

The expected contamination levels and contaminating loads of cooling and industrial wastewater resulting from NNU operation with AES-92 and AES-2006 power units discharged into the Danube River will be identical to those of **Site 1**.

Exceeded levels of the waters from the Hot Channel above the Individual Emission Limit Values are not expected.

The expected contamination levels presented hereunder clearly show that **the individual emission limit values for the Danube River – receiving water 3rd category – will not be exceeded[45].**

The expected contamination levels and contaminating loads of cooling and industrial wastewater resulting from the operation of NNU (with AP-1000 reactor), discharged in the Hot Channel, are same as those for **Site 1**.

Exceeded levels of the waters from the Hot Channel above the Individual Emission Limit Values are not expected, for which there is a permit issued by the Danube River Basin Directorate.

Radioactively contaminated industrial wastewaters

[45] Regulation №7/1986, repealed SG, No. 22 of 05.03.2013

Radioactively contaminated wastewater resulting from NNU operation will be analogous to the ones now dropping from the current operative units. These estimates are presented in the section about **Site 1**.

Based on the information submitted, the expected wastewater characteristics will be identical to those for Site 1.

Expected impact

During operation no irreversible negative impact of wastewater on the environment is expected.

Impact is the same as for Site 1.

SITE 4

Household and potable water supply, the supply of provisionally clean water (non-drinking) for bathing, washing, toilets, etc., and the supply of provisionally clean technical water (non-drinking) for fire control purposes will be identical to the options outlined for **Site 1**.

Technical water supply

The type of water intake, the water inlet scheme form the Danube River and the return of spent water back to the river will be identical to the solutions suggested for **Site 1**.

The connection with the technical cooling water is discussed in detail in item 4.2.1.1.

Sewerage

The sewage system at the site of the new nuclear unit will be separate – for household faecal wastewater, for industrial and for rain wastewater, as with all the other sites.

Similar to the other sites, the treatment of household faecal wastewater, industrial wastewater and rain water will be identical to the solutions described for **Site 1.**

Cooling water of the technical water system

The cooling water taken from the Danube River is sent back using the Hot Channel-1.

As it is recommended to avoid any connection through the underground section of the hot Channel, the discharge of cooling water must be done in the open part of the Hot Channel-1 although the underground section of the hot Channel is in the northern corner of the site.

Treatment facilities for non-radioactive wastewaters

Treatment facilities for household wastewater, wastewater from Chemical Water Treatment and for wastewater contaminated with oils and petroleum products are identical to those planned for **Site 1**.

Major flows of waste non-radioactive waters

Wastewater at **Site 4** will form the same major flows as in the case of **Site 1**.

Wastewater characteristics

The expected contamination levels and contaminating loads of cooling and industrial wastewater resulting from NNU operation discharged into the Hot Channel will be identical to those of **Site 1**.

Exceeded levels of the waters from the Hot Channel above the Individual Emission Limit Values are not expected, for which there is a permit issued by the Danube River Basin Directorate for discharge into the Danube River.

Wastewater from NNU is not expected to have heavy metal content above the Individual Emission Limit Values, which are prescribed in the permit for discharge.

Radioactively contaminated industrial wastewater

Radioactively contaminated wastewater resulting from NNU operation will be analogous to the ones now dropping from the current operative units. These estimates are presented in the section about **Site 1**.

Based on the information submitted, the expected wastewater characteristics will be identical to those for **Site 1.**

Expected impact

During operation no irreversible negative impact of wastewater on the environment is expected.

Impact is the same as for **Site 1.**

Conclusions

Based on the analysis of the expected impact during the operation of NNU, the impact on surface water can be outlined as follows:

- **Impact scope** – local.
- **Impact type** – direct, positive, low level of impact. Negative impact could be expected in case of improper operation of the treatment facilities or accidental release.
- **Impact features** – continuous, long-term, cumulative, and irreversible.

On the grounds of the considered impacts of the NNU investment proposal, an imperative conclusion can be made that the impact of non-radioactive wastewater on the receiving basin – the Danube River – during the operation will be local, continuous, irreversible, but of negligible interest.

4.2.1.3 During decommissioning

The decommissioning phase of NNU is an operation that does not depend on the chosen site and on the type of reactor. Hence, here this issue will be discussed in principle as a process which is going to happen once the operational life of the power unit has expired, namely 60 years, unless there is a resolution to enable continuation of operation of the reactor.

In the process of preparing the decommissioning operations, generation of non-radioactive wastewater is expected (purified household faecal, industrial and rain water). The facilities providing the supply of potable water and water for technological purposes, as well as the facilities supporting the treatment of these waters, will continue to operate. During this period, the number of staff engaged in these operations is not expected to differ substantially from the routine staff in regular operations. The constructed treatment facilities will be sufficient and in a position to manage the formed wastewater flows.

Contamination of the Danube River with household faecal and industrial wastewater is not expected.

For NPP with latest generation reactors, disassembly will be much easier than the one for the pressurised water reactors PWR (WWER) operating to date on account of the smaller quantities of waste generated and released, which will reduce the quantity of demineralised water needed for decontamination. This condition is imposed as early as the design phase in the best interest of disassembly. For example, in the case of the AP-1000 reactor, back in the design phase a number of improvements have been made greatly contributing to safety and facilitating future disassembly.

It can be estimated that the contamination of wastewater will be considerable reduced compared to the operational period.

The existing non-radiation and radiation monitoring supported at Kozloduy NPP will be continued throughout the decommissioning of NNU.

4.2.1.4 HYDROLOGY OF THE DANUBE RIVER

To analyze the alternative solutions for the construction and operation of the new nuclear unit, from the point of view of the impact on the Danube River waters, hereby a brief description of the four sites proposed is made.

4.2.1.4.1 During construction

The choice of the site is of major importance for the completion of the required construction and assembly works. The key risk factor from the point of view of safety during construction is the likelihood of flooding the hollows of the excavations in the case of high water level flow along the Danube River. The hydrologic regime of the river is described and analyzed in detail in the Environmental Impact Assessment Report, but here only some of the key data will be re-emphasized bearing reference to the assessment of prospective significant impacts, such as water volumes and water levels in the river.

Water volumes

The average multi-annual runoff at Water Pump „Oryahovo" for the period 1941-1986 is Q_{av}=5 847 m^3/s. The variation of the Danube River runoff is defined as the biggest for low level water months (August through January). The river runoff is most steady for the high water period (February through July).

It is observed that there is a definite cyclical trend alternating a low water-level period – 2002 and 2003, with a period of relatively more moist years – at the mid-point of the period, followed by a low water-level period in 2011 and 2012.

The assessment of the water levels for different extreme situations is of primary importance for the safety of the power plant both during its construction and throughout its smooth operation. An absolute elevation of +35.00 by the Baltic Elevation System is accepted as ground zero for the site of the nuclear power plant.

Maximum water levels in the Danube River branch next to the site of Kozloduy NPP will be reached in the scenario of destruction of the hydroelectric power plants Iron Gates I and II. Accounting for the overflow and destruction of the dykes, and for the accumulation of part of the high tidal wave into the flooded plains, the maximum level will be 32.53 m. The scenario to witness such water level would be a sudden and consecutive collapse of the hydro-electric complexes Iron Gates I and II with overlap of the two tides and water quantity of 10 000 m^3/s.

Based on the water levels set for normal and natural conditions of the Danube River, the combination of the two events might also be assessed – the natural extreme water levels with low probability and collapse of the dam in the hydro-electric complex Iron Gates I and II. It must be noted that the combination of these two scenarios will lead to an event with very low probability of happening.

Conclusion

In the event of high waters with 0.01% probability of excess values combined with an overlap of catastrophic tides caused by destruction of the dam of the hydro-electric complex Iron Gates I and II, the level of high waters will not exceed the elevation of 33.42. This means that all four new sites proposed for the expansion of Kozloduy NPP , which are planned to be constructed at elevation 35.00, will not be affected by flood in the event of high waters. The existing protecting dykes, which are at crown elevation 32.00, will be overflown and this will lead to the flooding of the lowlands lying between them and the NPP site. **From the point of view of safety, sites 2 and 4 have a certain advantage. There the elevation is the highest and they are the outermost from the Danube dykes. They have a natural safeguard against flooding even in the event of catastrophically high water levels of the Danube River. Site 2 has an additional advantage with respect to building the connection with the existing cold and hot Channel lines.**

4.2.1.4.2 During operation

The description of the expected water quantities and water levels is also valid for the operation period. As regards the occurrence of catastrophically high water levels in the Danube, all four sites will not be exposed to any flooding. The analysis of the advantages and disadvantages of the sites in question clearly shows that the second site has least disadvantages, and at the same time, it brings in a lot of economic benefits.

To assess the impact of waters used from the Danube River for the cooling system, **Figure 4.2-2** shows the annual water volumes passing through the ranges of Water Pump Lom and Oryahovo for the period 2002-2012.

The **Environment Impact Assessment Report** presents a comparison between the authorized water volumes and the ones actually used. It can be seen that the volume of water used from the Danube River is 53.21% of the authorized quantity, which is obviously due to the reduced capacity of the power plant.

When Kozloduy NPP was fully powered with all the six reactors up and running until 2002, even in extremely low water conditions, the water use was very low – only 4.5 % of the river flow.

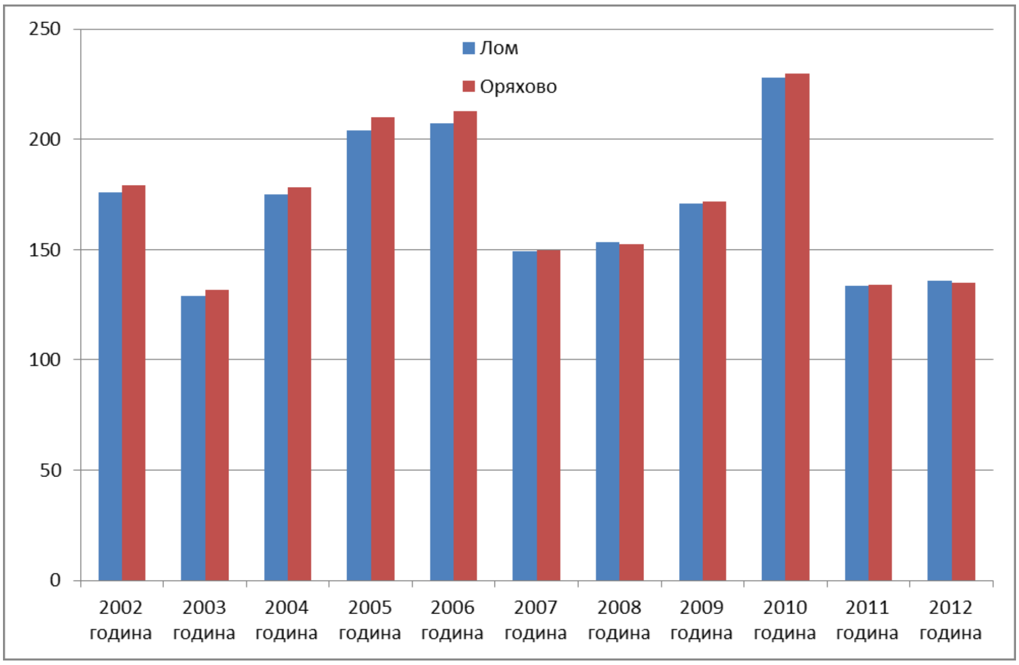

FIGURE 4.2-2: ANNUAL WATER VOLUMES ($M^3.10^9$) PASSING THROUGH THE RANGES OF WATER PUMP LOM AND ORYAHOVO FOR THE PERIOD 2002-2012

It can be concluded that the normal operation after launching the new unit, with a total average annual output of about 3000 MW, will require a water volume of about 3.5 % for the cooling system.

The irretrievable losses of water in Kozloduy NPP are estimated to 0.00092 % of the Danube runoff and to 0.044 % of the total water use of the power plant, and a sufficiently justified conclusion is made that **Kozloduy NPP has no influence on the Danube River runoff.**

Conclusion

A long-term, continuous, including cumulative and transboundary impact of the water drawn for cooling the existing and newly added power units of Kozloduy NPP on the Danube River runoff is not expected in any of the 4 site options.

4.2.1.5 GENERAL CONCLUSION UNDER ITEM T.4.2-SURFACE WATER

Impact on surface water is identical for all four sites and throughout all implementation phases of the investment proposal. The choice of the most suitable site will be motivated by the easiest and most accessible solution for connection with the Hot Channel-1, leading all wastewater to the receiving Danube River and allowing to accomplish only one discharge option with advanced state-of-the-art monitoring. Of major importance is reviewing the feasible options for connection with the Cold Channel-1 providing water from the Danube River to NNU, as well as considering the probability of having the site flooded by high waters. Another decisive factor is the lack of built and ready to be used hydrotechnical facilities at the site as well the level of groundwater.

Applying these criteria, the most suitable and well-fitted site in terms of the component "surface water", is Site 2. The connection with the Hot Channel is short and easy as it is situated on the northern border of Site 2. The connection with the existing Cold Channel will not be long either – about 75 m.

Based on the analysis and assessment made for the alternative site options and the different types of nuclear reactors that can be installed therein, Site 2 is positively identified as the most suitable in the following respects:

- → The analysis of non-radioactive waste household faecal, industrial and cooling waters, and of the raw water from the Danube River needed for NNU reveals certain differences in the three reactors under consideration with respect to the necessary quantities of raw water, **the smallest quantity needed being for AP-1000 reactor.**
- → There is also a difference in the daily quantities of wastewater and contaminating loads brought to the Danube River through the Hot Channel-1, **which is in favour of the AP-1000 reactor.**

Scope, characteristics and type of the impact – local, direct, negative, low impact level, temporary and restricted, provided the regulatory requirements and planned measures are strictly observed during construction, and direct, positive, with low to medium impact level and restricted if regulatory requirements and relevant measures are observed.

No transboundary impact is expected with regard to the component "Surface water ".

4.2.2 GROUNDWATER

Kozloduy NPP has submitted data on the estimated behaviour and the migration of radionuclides into the subsoil of the four alternative sites proposed for the construction of a new nuclear unit in Kozloduy NPP.

Assessments on the risk of contaminating the geological environment and groundwater during the operation of the NNU of Kozloduy NPP have been made based on the assumption that as a result of outflow of technological water and flooding of the concrete foundation of the reactor room, radionuclides of different type and different activity will be infiltrated into the subsurface space.

Based on detailed analysis on the characteristics and behaviour of the different isotopes, some „key" radionuclides of major significance have been chosen out of the whole range of radionuclides:

The chosen six „key" radionuclides have different rate of decay and different attenuation (retention) in the geological environment. The initial assumption is that the modelling of their behaviour will give an overall picture of the potential spread of the isotopes related to the operation of the reactors into the subsoil space and into groundwater.

The research and analysis done covers all components (parts) of the migration field, i.e. of the space where radionuclides are likely to migrate in operational conditions of the nuclear power unit. According to the conservative scenario, simulated in mathematical models, the migration field will include three major components:

- the engineering protective barriers at the foundation of the reactor room (concrete substructure and construction embankments);
- the unsaturated zone embracing the space from the edge of the concrete foundation to the level of groundwater, the so-called aeration zone (formally the engineering barriers are part of the unsaturated zone);
- the auriferous part of the massif (aquifers), i.e. the migration into groundwater.

The research results show that practically all radionuclides are retained within the framework of the unsaturated zone and in a very limited part of the aquifers zone. Only ^{3}H and to a certain extent ^{90}Sr migrate comparatively more intensively (but with very low activity rates) into groundwater, hence an estimate is made about their penetration and spread into the aquifers.

The potential media for the spread of radionuclides into subsurface space includes all low rank hydrogeological units formed in the geological intersection to a depth of 50-60 m. The considerations also cover the adjacent to the four sites territory to the nearest potential receiving basin of contaminants – the Danube River. There are two basic geological complexes within the spatial boundaries thus delineated:

- → quaternary complex, first non-flooding and flooding terrace of the Danube River (gravels and sands);
- → neogene complex represented by the sediments of the Brusartsi Formation (clays, sandy clays and sands).

The boundaries of the low rank hydrogeological units for the separate sites are illustrated on schematic intersections and block-diagrams employed in the developed mathematical models.

The geological environment has the property of sorbing (retaining) part of the radionuclide flow. In this regard, the low rank hydrogeological units (layers) represent **natural barriers** preventing the migration of radionuclides into the subsoil space.

The spatial parameters and geometry of engineering barriers are illustrated and analysed in the Environmental Impact Assessment Report on schematic intersections and block-diagrams employed in the developed mathematical models.

Modelling the migration of radionuclides through the engineering barriers and the aeration zone of the four sites

The specific natural features and assets of each of the four sites imply certain differences in the conditions for migration of radionuclides into subsoil and groundwater. Some of the more important ones are related to certain differences in the structure of the geologic foundation, the low rank hydrogeological units and engineering barriers present in the intersections, the thickness of the unsaturated zone (the aeration zone) under the concrete foundation (or its absence), etc. These specific aspects are reflected in the 2D mathematical models developed for each site.

The models have been developed by profiles passing through the central parts of the sites in South-North direction (**Figure 4.2-3**)

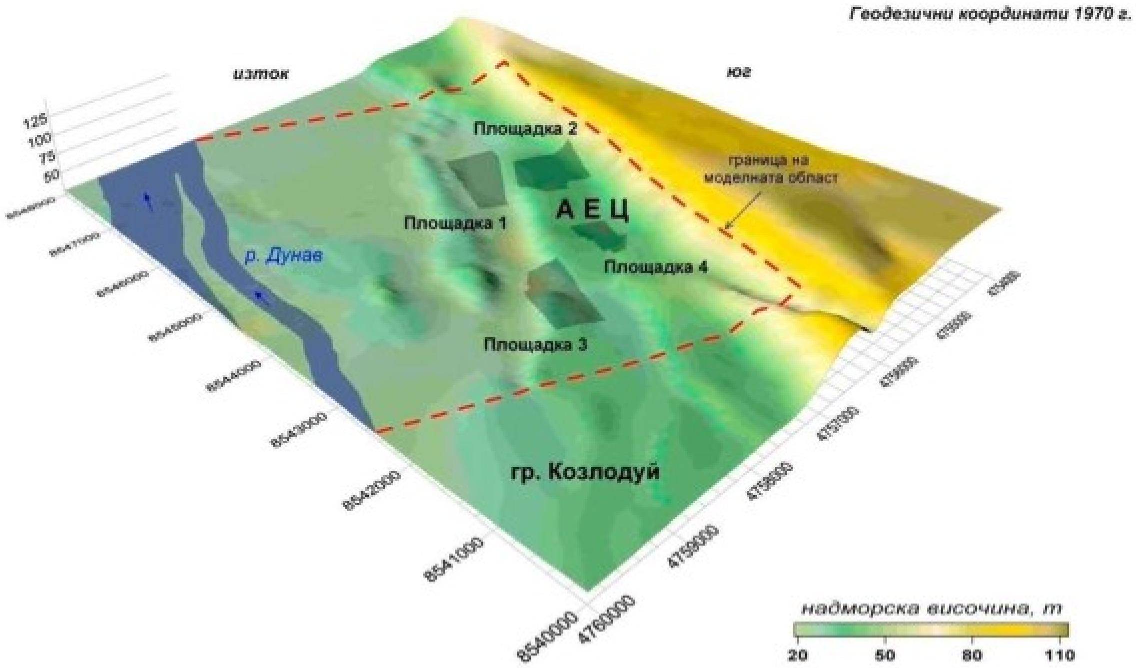

FIGURE 4.2-3: SCHEME ON THE LAYOUT OF THE PROFILES OF THE MATHEMATICAL 2D MODELS OF THE FUTURE REACTOR (POTENTIAL SOURCE OF CONTAMINATION)

Modelling the migration of radionuclides in the aquifers and drainage zones that are potentially threatened with contamination

The conjecture for a potential radionuclide migration into the groundwater in the area of the four sites is made by employing a three-dimensional (3D) mathematical simulation of the conditions for substance transmission. For this purpose, one basic filtration 3D model and four migration 3D models have been developed.

The basic filtration 3D model simulates the structure of the underground flow in the area of the four sites under consideration and their adjacent territory to the Danube River, which is a potential receiver of the radionuclides that have penetrated in the groundwater. The specific hydrogeological conditions and all external impacts have been taken into account. The modelled structure of the filtration field has been used as a basis for the development of the migration models.

The migration 3D models are computer simulations of the potential spread of the radionuclides penetrating from the corresponding site into the aquifers for a period of 10 000 years. They served to produce an estimate about the migration of **^{3}H** and **^{90}Sr,** as the solutions obtained by means of the two-dimensional models show that the remaining "key" isotopes are retained within the unsaturated zone or in a very limited part of the aqueous zone. In this respect, **^{3}H** and **^{90}Sr** are viewed as sufficiently indicative for the assessment of the contamination risk of aquifers and the nearest to NNU receiving water.

Key conclusions

The mathematical modelling of radionuclide migration from the four sites under consideration gives grounds to make the following key conclusions:

- → The estimates have been projected for a period of 10 000 years. This period is sufficiently long and actually goes far beyond the foreseeable future.
- → The migration of radionuclides into subsoil and groundwater and the differences in their spread pattern are determined mostly by the sorption capacity (retainment) of the corresponding radionuclide in the geologic environment and its decay rate through time. From this point of view, the chosen „key" radionuclides represent a quite diverse "bunch" of isotopes with quite dissimilar decay rates and largely different with regard to their sorption capacity. The varied combinations of these properties contribute to the wide representative quality of the research and investigation done.
- → The results are shown through the values of "relative activity rate" (the relation between the "current" and initial (input) activity of the given isotope), i.e. the decline of activity rates in time and space.
- → Among all isotopes the most "active" is tritium – ^{3}H, which is practically non-sorbable. Its spread depends only on the permeability of the medium (the filtration rate, respectively) and on its decay rate in the migration process.
- → The multiple and multi-variant investigations revealed a very important result, namely: out of all radionuclides (with the exception of tritium), the largest range of distribution and outreach is displayed by ^{90}Sr. The other radionuclides (throughout the forecast period of 10 000 years) have more narrow distribution. Consequently, the figures herein show specifically the spread of strontium in groundwater.
- → An important barrier for the spread of radionuclides is the substructure platform of the reactor and the aeration zone beneath it (the unsaturated zone between the bottom side of the slab and the groundwater level).
- → One very important finding of the studies and analysis is worth noting. The spreading of all radionuclides marks a peak "maximum" (different in time and place for the different radionuclides and sites), followed by a gradual "shrinking" of the contaminated zone. For all studied radionuclides (without tritium) however, even with the accepted very low values of relative activity, the outreach of contamination **never reaches the Danube River.**
- → This estimate implies certain reserves because the calculations have been done for low-level water in the Danube River. In high water periods the underground flow to the Danube is "blocked" (its direction is temporarily reverse), so that the

time it takes for the tritium to reach the river will be much longer than the one shown, and accordingly, the activity rate of the isotope will be still lower.

4.2.2.1 DURING CONSTRUCTION

Sites 1, 2 ,3 and 4

Expected impact

The expected impact on groundwater will be identical for all sites assessed as suitable to accommodate the NNU.

GROUNDWATER – (non-radioactive aspect)

Potential prospects of impact during construction – direct, negative, with high level of impact, restricted – if regulatory requirements and relevant planned measures are observed.

Impact characteristics – continuous, due to the eventual building up and maintenance of a dewatering system with expected cumulative effect on the level of groundwater.

GROUNDWATER – (radioactive aspect)

No substantial negative impact from the implementation of the investment proposal is expected due to the planned engineering barriers preventing the transmission of radionuclides into the environment and groundwater. Impact is not likely to occur during construction.

No transboundary impact is expected.

4.2.2.2 DURING OPERATION

Sites 1, 2, 3 and 4

GROUNDWATER – (non-radioactive aspect)

Impact scope on the territory of the selected site – direct, negative, middle level of impact, restricted – if regulatory requirements and relevant planned measures are observed. Impact features – temporary, short-term, reversible after the end of this phase.

GROUNDWATER – (radioactive aspect)

Impact scope on the territory of the selected site – direct, negative, middle level of impact, restricted – if regulatory requirements and relevant planned measures are observed. Impact characteristics – temporary, short-term, but having cumulative effect in case of regional sensitivity. Reversible after the end of this phase.

No transboundary impact is expected.

4.2.2.3 DURING DECOMMISSIONING

Sites 1, 2, 3 and 4

GROUNDWATER – (non-radioactive aspect)

Provided regulatory requirements are strictly observed, the selected option for decommissioning the nuclear unit will be optimal and safe and no negative impact on groundwater is expected. Impact scope on the territory of the selected site – direct, negative, low level of impact, restricted – if regulatory requirements and relevant planned measures are observed. Impact characteristics – temporary, short-term, reversible.

GROUNDWATER – (radioactive aspect)

Impact scope on the territory of the selected site – direct, negative, low level of impact, restricted – if regulatory requirements and relevant planned measures are observed. Impact characteristics – temporary, short-term, reversible.

No transboundary impact is expected.

4.2.2.4 Conclusion under t.4.2.2. – Groundwater

The impact on groundwater will be identical for all sites and throughout all implementation phases of the Investment Proposal.

The analysis and interpretation of the information available about the component "Groundwater" shows that Site No. 2 appears to be the most suitable one. It is situated on the first non-flooded terrace of the Danube River. The implementation of the considered Investment Proposal will require minor earthmoving and excavating work, which suggests less direct impact on the aquifer due to direct infiltration resulting from spillages and accidents during construction. The proximity of Site No. 2 to the Hot Channel, however, will require reliable measures focused on preventing any risks of overflows and/or undesirable filtration from the Channel to Site No. 2.

4.3 Land and Soil

4.3.1 Land

4.3.1.1 Impact during construction

Specific impact during the construction of NNU can be briefly described as follows:

- Territorial scope of impact: will be limited – only on the specific area of the site. Since the first three sites have approximately the same surface size, the territorial scope will be limited mainly to about 53-55 ha. Transportation of construction materials or removal of debris and earth will increase the dust on the roads and adjacent lands in the area. The territorial scope of impact on site 4 is smaller because its area is smaller.
- Degree of impact: the degree of impact on the land is low and mainly on the sites.
- Duration of impact: during the construction of the NNU – about 5-7 years.

→ Impact Frequency: continuous until completion of the NNU.

4.3.1.2 IMPACT DURING OPERATION AND DECOMMISSIONING

During operation, the negative impact on the land is insignificant – the land is anthropogenic.

4.3.1.3 IMPACT AFTER DECOMMISSIONING

After the final decommissioning of the site the land will be fully reclaimed and future land use will be designated – 'brown areas'.

4.3.2 SOIL

4.3.2.1 FROM NON-RADIATION ASPECT

4.3.2.1.1 Impact during construction

At **Site 1** the established power of the humus layer and necessary area of 55 ha involves depositing 210 000 m^3 of humus. For embankment of the terrain to ground zero level would be necessary 4 420 000 m^3 or the total earthworks for this site will amount to 4 630 000 m^3. Both land and soil of this site will be degraded and transformed landscape. After construction the land will lose the function of agricultural land and the land on the site will change its purpose. The undeveloped part of the terrain will be used only for landscape planning purposes.

At **Site 2** the power of the humus layer is similar to that of site 1, therefore the removal of the humus layer is determined to be 220 000 m^3. Excavation works are estimated at 343 000 m^3 of earth from the lower layers and the embankment works are about half of the former – 165 000 m^3. Both land and soil of this site will be degraded and transformed landscape. After construction the land will lose the function of agricultural land and the land on the site will change its purpose. The undeveloped part of the terrain will be used only for landscape planning purposes.

Site 3 has characteristics similar to those of the first site regarding earthworks: 210 000 m^3 humus layer and excavated earth amount to 3440000 м^3, and the need for embankment works is 3 650 000 m^3. Both land and soil of this site will be degraded and transformed landscape. After construction the land will lose the function of agricultural land and the land on the site will change its purpose. The undeveloped part of the terrain will be used only for landscape planning purposes.

Site 4 is an urban area. Soils are destroyed and sealed with concrete and asphalt.

During the construction soil will change its function not only on the construction sites but in the area in general due to direct earthworks – for construction of buildings, service roads, drains, etc. Impacts on soil are irreversible, direct and negative. These impacts are almost the same for any of the considered sites, except for site № 4, where the bulk of the soil is sealed under pavements or is destroyed in previous construction works. Earthworks will take place not on land but on building materials, foundations and geological foundation.

4.3.2.1.2 Impact during operation

During operation the negative impacts on land and soil are significantly less than those in the stage of construction. Much smaller areas of natural soil remain – green spaces and protected areas. The impact is temporary – upon compaction due to internal traffic, liquid spills, waste, etc. During operation the degree of impact on the soil for all sites is low.

4.3.2.1.3 Impact during decommissioning

Decommissioning and reclamation of the cleared areas will have almost the same impact on the environment as the construction stage. During that stage will take place uninstallation of the equipment, buildings will be demolished, earth masses will be brought in for filling the places of underground facilities, hazardous radioactive waste will be hauled out and the area will be disinfected. After completion of these activities will be developed green areas in accordance with elaborated and approved territorial zoning plan and landscape planning project. The territorial scope of impact will be limited – to the current zone of impact. Degree of impact: limited – to the area of the NNU; duration of impact: many years after decommissioning of the NNU.

4.3.2.2 FROM RADIATION ASPECT

4.3.2.2.1 Impact during construction

During construction there is no impact of radiation factors related to the investment proposal due to the absence of radioactive sources in this phase. The only possibility for using radioactive sources during this period is for metal control of welds of structures with radio-defectoscopy. In this case, the rules for operation and statutory instructions should be strictly followed.

During the construction of the new nuclear unit no impact on the soil is expected from radiation stand point. This applies for all four considered sites.

4.3.2.2.2 Impact during operation

The short comment on the NNU impact during normal operation is as follows:

- → Territorial scope of the impact: the impact of the operation of the production capacity mainly covers the area of the production site. The radiation impact however, extends mainly over the surrounding areas within a radius of 30 km.
- → Degree of Impact: The experience of the operation of NPP so far indicates that the impact is limited if the production requirements are followed in accordance with the relevant standards. In case of failure to comply with the production

discipline, there is a real danger of radioactive contamination not only of the site of the investment proposal, but also of the soil in the environment.

- Duration of impact: During the operation of nuclear unit.
- The impact will be permanent, but low, until the suspension of operation of the site, its closing and reclamation.
- The environmental impact will be of insignificant, cumulative nature, furthermore that part of the existing so far power units have already been closed down: if previous monitoring surveys report that the area is not strongly affected by the operation of the existing NPP facilities, the cumulative effect of the impact of the NNU substantially stronger than the impact up to now.

4.3.2.2.3 Impact during decommissioning

The difference in the decommissioning of NNU to that of any other industrial facility lies in the fact that at this stage the risk of radioactive contamination of land and soil is real both at the site and adjacent lands and soils. Decommissioning of the NNU shall be carried out in strict compliance with the requirements of the Regulation on Safety during Decommissioning of Nuclear Facilities (promulgated, SG, No. 73/ 20.08.2004), which ensures minimum impact on soil at the sites from radiation aspect. The degree of impact on the soil will be low to moderate if all the requirements for the safe management of radioactive waste are followed. Radiation control and radiological investigation of the soil before, during and after the decommissioning of the nuclear unit is mandatory.

This comment is valid for all the four considered sites.

The NNU is envisaged to operate for 60 years. The waste that will be generated over this period and the impact on the soil in the area of the investment proposal will depend on the arrangements made with the fuel supplier.

The brief forecast for the expected impact at this stage is as follows:

- Territorial scope of the impact: will be limited to hitherto area of impact.
- Degree of impact: limited – to the area of construction.
- Duration of impact: many years after decommissioning of the NNU.
- Frequency of impact: likely constant impact with a relatively low level.
- Cumulative impacts on the environment: cumulative impacts can be expected because to the long-term effect of human impacts and radioactive impact on the soil will be added new potential impacts through the air – from demolition, intensified transportation of construction waste, etc.

4.3.3 CONCLUSION:

Comparison of sites in terms of the least negative impact on the land and soil indicates the following:

At **Site 1** the earthworks will amount to 4 630 000 m^3.

At **Site 2** the power of the humus layer is similar to that of site 1, but excavation works are estimated at 343 000 m^3 of earth from the lower layers and the embankment works are about half of the former – 165 000 m^3.

Site 3 has characteristics similar to those of the first site regarding earthworks, but excavated earth amounts to 3 440 000 m^3 and the need for earth for embankments is 3 650 000 m^3. which shows a balance – roughly the excavated quantities will be filled back.

Site 4 is sealed so humus layer will not be removed at all. Excavation works are not foreseen and the embankment works are estimated at around 310 000 m^3. With regard to earthworks and the least impact on the soil, the location of this site is the most favourable. The difference in the use of land from the first, second and third site after the removal of the humus layer is that the first site will require back-fill of earth to level the terrain on which construction will be subsequently performed.

The third site has to be drained because both channels and drains pass through its area.

At Site 2 the balance of the landmasses is the most favourable also regarding the impact on the soil and from the soil on the other components and environmental factors; therefore this site seems to be **the most favourable**. Furthermore, the terrain is more stable and the least quantities of humus and other soils will have to be hauled to the landfills for temporary storage designated by the municipality of Kozloduy.

4.4 SUBSURFACE

4.4.1 IMPACT FORECAST OF SITE 2 AND SITE 4.

Site 2 and Site 4 have similar engineering-geological and hydrogeological features and therefore the anticipated impact on the geological environment is also similar.

4.4.1.1 IMPACT DURING CONSTRUCTION

At the construction stage, the environment of the sites will be subjected to the following impacts:

- ✓ Excavation of a substantial volume of soil from the sites as part of the excavation works for the foundations.
- ✓ Construction of insulation layers and berms using the excavated earth within the designated site.
- ✓ Vibrations as part of the ground base improvement, support and compaction works.

- ✓ Dust emissions at the adjacent areas resulted from the excavation works, along with noise emissions from the construction equipment.

Previous experience from the construction works for Kozloduy Nuclear Power Plant (Kozloduy NPP) demonstrated that those types of impact are manageable and do not damage the environment, operational safety of the existing facilities and public health.

4.4.1.2 IMPACT DURING NNU OPERATION

At the NNU operation stage within normal conditions, migration of radionuclides to the ground waters at Site 2 and Site 4 is very unlikely to occur. Such migration could occur in case of damage to the engineered safeguards of the nuclear facilities (reactor space, stores, radioactive waste facilities, radioactive waste treatment facilities, etc.), as well as the insulation layer, which is to be built in the ground base (soil-cement cushion). These sites benefit the natural insulating features of the clays of the Brusartsi Formation underneath the surface.

Shortly, the following favourable geological properties (geological safeguards) would prevent ground water pollution:

- ✓ Thick Pliocene clay in place under the alluvial sands and gravels of non-flooding river terrace (T_1), which would be a robust barrier against the migration of radionuclides to the aquifer underlying the clays in the Archar Formation.
- ✓ The construction of an impermeable to water soil-cement insulation on the entire footprint of the nuclear facilities would prevent ground water pollution in case of any potential spills of liquid.
- ✓ The conditioned low-activity and average-activity waste will be disposed in the designated cells of the adjacent national facility at the Radiana site, which will be built on the second non-flooding terrace of the Danube River, where the ground water level is below the T_1-level.

Therefore, the NNU is expected to have no negative impact on the geological environment, provided that the preliminary ground base preparation and insulation is in place and the plant operates within normal conditions.

4.4.1.3 IMPACT DURING DECOMMISSIONING

No such impact is expected to be in place after decommissioning of the NNU.

Impact forecast at Site 1 and Site 3

Site 1 and Site 3 have similar engineering-geological and hydrogeological features, as they are situated on the modern flooding terrace of the Danube River. In case NNU is built on these sites the construction project is very likely to involve ground base preparation works similar to those completed for Belene Nuclear Power Plant, and will include excavation of the weak ground down to the gravels, and construction of thick layer up to RL 34-35m. That would eliminate the risk of liquefying weak soils under seismic impact.

Site 1 and Site 3 have similar engineering-geological and hydrogeological features and therefore similar impact on the geological environment (earth interior) is anticipated.

4.4.1.4 IMPACT DURING CONSTRUCTION

The environmental impact of the sites at the construction stage will be as follows:

- ✓ Excavation of the weak liquefying soils down to the level of the gravels, i.e. to 4-7m depth. The excavated material will be stored at a soil disposal facility designated by Kozloduy Municipality. Excavation of a large volume of river gravel or any other suitable material for the construction of thick foundation embankment under the nuclear facilities. Any excavations below the RL of the ground waters will require the construction of a high-capacity dewatering system. That system will lower the water level at a very high distance and therefore impact on the adjacent wet areas would be very unlikely.
- ✓ Vibrations caused by the soil compaction works for foundations and berms.
- ✓ Dust emissions to the adjacent areas during excavation works and noise emissions from the construction machines.

Previous experience from the construction works for Belene Nuclear Power Plant (Belene NPP), which took place in similar conditions, demonstrate that these impacts are manageable and do not cause any lasting disturbance to the environment.

4.4.1.5 IMPACT DURING THE NNU OPERATION

- ✓ The sites are situated at the flooding terrace of the Danube River, whose ground waters have a hydraulic connection with the river. That increases the risk of radionuclide migration by the groundwater path compared against the case of Site 2 and Site 4. Furthermore the natural ground layers of Site 1 and Site 3 are of higher permeability, which involves higher risk of sharp rise of ground water levels.
- ✓ The risk of floods would be a serious risk to the NNU operation, in case the NNU built at Site 1 or Site 3.
- ✓ In a potential emergency situation caused by failure of the dam wall of Zhelezni Vrata (Iron Gate), the result will be a short rise of the groundwater level, which may impact the nuclear facilities.
- ✓ Data from the studies show that contrary to the other sites, the continuity of the clay layer under the alluvial gravels at Site 1 breaks in some sections of the site. In the east part, some of the gravels together with the sands of the Brusartsi Formation have a hydraulic connection with the sands of the Archar Formation.

- ✓ Previous experience shows that the facilities situated at the lowest terrace of the Danube, incur more earthquake damage in comparison with the higher terraces.

Therefore there is a higher risk of environmental impact at Site 1 and Site 3 vs. any potential impact at Site 2 and Site 4.

4.4.1.6 DECONDITIONING IMPACT

No such impact is anticipated after decommissioning of the NNU.

4.4.2 CONCLUSIONS ON THE SITE SELECTION BASED ON IMPACT ON THE EARTH ENVIRONMENT

Based on the analysis of any potential interaction between geological and seismological impact between the NNU and the environment, the conclusion is that the four potential sites have similar geological structure at depth and similar seismotectonic environment.

From an engineering-geological and hydrogeological point of view, Site 2 and Site 4 are preferable versus Site 1 and Site 3.

Their major advantages are as follows:

Site 2 and Site 4 involve no flood risk or risk of rising ground water level.

The ground base at Site 2 and Site 4 is more easily susceptible to improvements and will not require construction of thick foundation embankment of gravel or any other material.

They are situated on the same non-flooding river terrace of the Danube as the existing units of Kozloduy NPP, therefore the future NNU construction process could use the previous experience in the construction of reliable foundations and ground water protection against radioactive contamination.

At Site 2 and Site 4, there is much lower risk of radionuclide migration to the aquifer of the Archar Formation, vs. the potential risk at Site 1 and Site 3, since a relatively thick clay layer with substantial retention capacity is underlying the surface of Site 2 and Site 4;

Based on the engineering-geological and hydrogeological environment, Site 2 and Site 4 can be considered as sites, which are equally suitable for construction of the NNU.

4.4.3 SEISMIC RISK

The evaluation of the potential seismic risk and its impact on the environment **is independent** of the NNU construction, operation and decommissioning stage. The seismotectonic impact over the four sites based on the current seismic hazard calculation methods show equal results – there is no evidence of any active tectonic faults within the 30km zone, whereas the parameters of the seismic hazard (assessment of seismic impacts) of the four sites (less than 1.5km distance) within the current models of the respective regional seismic sources should not differ substantially from the current hazard assessment results of Kozloduy NPP site. Therefore, we could draw the conclusion that the implementation of the planned investment project is not expected to cause changes in the seismotectonic environment and would ensure the stability upon any seismic impact during the various stages of construction and operation of the new power plant units.

4.4.3.1 IMPACT DURING CONSTRUCTION

The environmental impact at the construction stage is associated with soil removal along with changes to other exogenic (surface) aspects of the geological environment (Section 4.4.1.1). Those aspects of the potential impact have been assessed. As part of the associated procedures, the particular sitting and layout of the new facilities will be planned and implemented with consideration to the existing structures and facilities and the power plant facility as one integrated site.

4.4.3.2 IMPACT DURING OPERATION

The operation stage of the NNU will use the operating principles of the existing power plant units, with some contemporary upgrades of those principles. Therefore, the structural components of the new nuclear facility will meet the operating needs and will provide stability against any seismic impact as required under the regulations, thus ensuring the continuity of the principles set for the design preparation, construction and operation of the existing sites of Kozloduy Nuclear Power Plant and using the seismic monitoring and proactive control over the vulnerability of the nuclear facilities.

4.4.3.3 IMPACT DURING DECOMMISSIONING

Same applies to the **decommissioning** stage of the new nuclear facilities, which has been successfully implemented at some of the existing power plant units.

Clearly, no substantial endogenetic (seismotectonic) parameters to the geological environment are expected any stage of the construction and operation of the new power plant facilities (including construction, operation, decommissioning). The anticipated impact is insubstantial.

4.4.4 NATURAL RESOURCES

4.4.4.1 MINERAL RESOURCES

No such impact is anticipated, as no geological discoveries have been registered at the proposed sites and no existing operations regulated by the Mineral Resources Act are in place at those sites.

4.4.4.2 CONSTRUCTION MATERIALS (RIVER GRAVEL AND SAND)

Inert construction materials, when produced from the dynamic reserves of water bodies – rivers in particular, have a substantial impact on the water body. That is the reason why that process is subject to permitting and restrictions as set in the Waters Act, art. 118h and restrictions by the River Basin Management Plans – the gravel production bans included in the Measures section. Any planned investment project associated with river gravels production must undergo the procedures regulated by the Environmental Protection Act fist and subsequently the procedures under the Waters Act.

The judgment of whether such production at a particular location may be accepted under the River Basin Management Plan is a responsibility of the respective Basin Directorate. The associated permit would strictly fix the annual production limit of a given location and the border points of the respective river section. The term of any permit may not exceed the validity term of the respective the River Basin Management Plan.

There is a list of locations and types of locations where no sand or gravel may be produced from river beds, and a regulated process of clearing riverbed depositions. The purpose of all those measures is to limit the impact on the aquatic ecosystem.

It should be noted that the NNU construction process is not expected to involve substantial volumes of such materials, which are required as a components of construction solutions and other specific construction activities.

According to information provided by the Ruse-based department of the Executive Agency for Exploration and Maintenance of the Danube River[46] (which, under the Waters Act, is the competent authority to issue permits for such production from the Danube), a total of 28 permits have been issued for particular sections of the river.

Given the stringent regulation, permitting and control by the competent authorities, the potential impact is assessed as direct, local (of the specific river section) and reversible.

4.5 LANDSCAPE

4.5.1 IMPACT DURING CONSTRUCTION

The impact of the construction works required for the new nuclear facilities, particularly the potential impact on the landscape components, will be assessed individually for each of the four sites.

4.5.1.1 SITE 1

The site's territory is part of an agricultural and anthropogenic landscape. The construction process under the investment project will gradually make the landscape anthropogenic from the initial agricultural landscape. The construction will impact the landscape components including the geological properties, soils and vegetation. As a result of the excavation works, the construction process will have a direct impact on the geological properties of the site. This impact is assessed as direct, negative, primary, irreversible, low to average degree, small in range as part of the particular construction site of the proposed investment project.

[46] Letter Ref. No VIII-2-204/18.02.2013

The impact on the soils and vegetation is assessed as direct, primary, negative, reversible, low-degree impact, small in range as part of the particular construction site of the proposed investment project.

As a result of the earth works, soils will be subjected to mechanical impact. The excavated humus will be stored at a temporary stockpile area at the selected site. The vegetation will be destroyed at the sections where construction will take place at the site. There will be visual changes to the landscape, both in terms of aesthetics and in terms of spatial perception.

No social and economic functions of the landscape will change as part of the construction stage of the investment project.

4.5.1.2 SITE 2

The construction stage of Site 2 will impact the landscape, including its geological properties, soils and vegetation. The impact on the geological properties will result from the excavation works. That impact is assessed as direct, negative, primary, irreversible, low to average degree, small in range as part of the individual construction site.

The impact on soils will be primarily mechanical. The excavated humus will be temporarily stored within the selected site. The site's vegetation will be destroyed. The social and economic functions of the landscape will change from natural environment to industrial environment. The visual perception of the landscape will also change, both in terms of aesthetics and in terms of spatial perception.

During the construction stage, the landscape will change, as it will cease to exist as agricultural and forest type of a landscape. The anthropogenic landscape will continue to exist as such and will expand in size, but its sustainability will depend entirely on the human activity.

4.5.1.3 SITE 3

The anticipated impact of the construction stage is negative, but small in range, particularly on the cross-section view of the landscape. The excavation works will directly impact the geological properties of the site. The impact is assessed as primary, irreversible, low to average degree, within the construction site area.

The excavated humus will be stored at the respective site and the impact on the soils is assessed as direct, negative, reversible, low-degree, small in range.

The vegetation, which is part of the agricultural landscape, will be removed. The impact is assessed as direct, negative, reversible, low-degree, and small in range. As a result, the current agricultural landscape will cease to exist and will become anthropogenic. The visual perception of the landscape will change, but its social and economic functions will remain unchanged.

4.5.1.4 SITE 4

The territory of the site is part of an anthropogenic landscape, which is part of the NPP[47]. As the setting-up of the construction site progresses, the existing buildings and facilities, which are part of the anthropogenic landscape, will be removed. As a result, there will be a direct impact on the geological properties and soils within the site. The impact on the geological properties is assessed as negative, primary, irreversible, low to average degree and small in range. The impact on the soils is assessed as insubstantial, as the existing development and capping prevails at the site. The humus will be temporarily removed and disposed within the respective site, and therefore the impact is assessed as direct, negative, reversible, low-degree and small in range, within the construction site.

The anthropogenic landscape of this site includes volunteer vegetation – stray trees and shrub in very small areas, which will be destroyed at the construction stage of the investment project. The social and economic functions of the landscape of Site 4 will remain unchanged.

The construction stage of the project at any of the four construction sites is not expected to cause chemical pollution of the landscape. The only source of pollution and potential impact could be the exhaust gases generated by the construction-related equipment, including CO, NO_x, CH_4, SO_2, and hydrocarbons. There will be a limited amount of emissions within the working hours, temporarily, by the completion of all construction woks at the site.

The construction stage of the investment project will involve no chemical pollution of the landscape.

The construction at any of the four proposed sites will have no impact on landscapes within Romania.

The preferred option at the implementation stage of the investment project is Site 4, as the construction at that site will not change the social and economic functions and purpose of the landscape. The impact on the soils will be the most insignificant. There will be no impact on arable land.

4.5.2 IMPACT DURING OPERATION.

The operation stage of the investment project and its impact on the landscape are assessed as identical of all 4 sites:

The lifetime of the operation is not associated with any impact on the landscape. No pollution is expected to impact the landscape.

Potential pollution could be expected as a result of incidents, which may cause soil and water pollution.

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[47] Nuclear Power Plant

The operation stage of the investment project will not involve impact on the landscape.

No impact is anticipated on the environment within the 30km area around Kozloduy NPP and the adjacent Romanian territories.

4.5.3 IMPACT DURING DECOMMISSIONING

No negative impact is anticipated on the structure of the landscape at any of the 4 sites in question. Rehabilitation of any disturbed land will have a positive effect on the landscape. Depending on the planned use of the respective site, the anthropogenic landscape may be replaced by a new one.

4.5.4 CONCLUSIONS

The construction stage will involve a direct, negative impact on the landscape components including the geological properties, soils and vegetation. The impact on the geological properties of all four sites is assessed as direct, negative, primary, irreversible, low to average degree, small in range, within the construction site of the proposed investment project. The impact on soils and vegetation is assessed as direct, primary, negative, reversible, low-degree and small in range, within the construction site of the proposed investment project.

In the course of the construction works, the landscape will gradually become anthropogenic from the initially agricultural landscape.

The construction stage within any of the four sites is not expected to involve any chemical pollution to the landscape. A potential source of pollution and impact could only be the exhaust gases from the internal combustion engines of the construction equipment, including CO, NO_x, CH_4, SO_2 and hydrocarbon emissions. A limited volume of such emissions is anticipated, within the working hours, temporarily, by the completion of the construction works at the sites. No chemical pollution of the landscape components is anticipated.

The **construction** stage at any of the proposed sites will not involve impact on landscapes on the adjacent Romanian territories.

The preferred site for the implementation stage of the proposed investment project is Site 4, as the construction works there will not change the social and economic functions and purpose of the landscape. The impact on soils will be most insubstantial. No arable land will be disturbed.

The **operation** stage of the investment project will involve no impact on the landscape components. Potential incidents may cause local pollution to water and soils.

No pollution is expected of the environment within the 30km area around Kozloduy Nuclear Power Plant at the operation stage and the adjacent Romanian territories.

The **decommissioning** stage is not expected to have any negative impact on the structure of the landscape. Any rehabilitation of the disturbed land will have a positive effect on the landscape. Depending on the planned use of the site area, a new landscape may replace the anthropogenic landscape.

4.6 BIODIVERSITY

4.6.1 IMPACT DURING CONSTRUCTION

4.6.1.1 DIRECT IMPACT:

As a result of the earthworks disturbance of the species by noise, vibrations and dust is possible.

Hydrobionts

Direct impact is expected of emerging or existing invasive (alien) aquatic species on native species of aquatic invertebrate animals and fish through predation, competition (for food resources, habitats), which will lead to their reduction, destruction or changes in the structure of their populations.

Herpetofauna

No direct impact on amphibians and reptiles is expected.

Mammals

No direct impact on mammals is expected.

Hiropterofauna

No direct impact on bats is expected as the activities outside the construction site do not affect their dwelling places.

Avifauna

No direct impact on avifauna is expected.

4.6.1.2 INDIRECT IMPACT:

Hydrobionts

It is expected that construction works will create favourable conditions for introduction and establishment of new invasive alien species (aquatic and terrestrial) – due to movement of equipment, people, transportation of goods, excavation, transportation and disposal of masses of soil, sand, water, aggregates, construction of creation of new surfaces on the terrain, etc.

Introduction of new, invasive alien species is expected via ships and waterways serving the construction of the NNU.

Herpetofauna

No indirect impact on amphibians and reptiles is expected.

Mammals

No indirect impact on mammals is expected.

Hiropterofauna

Possible indirect impact on forest bat species only in dwelling places near the selected site for the construction of NNU in terms of noise disturbance caused by the construction and transportation equipment, and light effects directly affecting the activity of insect species, which they hunt.

Avifauna

No indirect impact on avifauna is expected.

4.6.2 IMPACT DURING OPERATION

4.6.2.1 DIRECT IMPACT:

Hydrobionts

Mortality of hydrobionts is possible caused by intake of larvae or juvenile specimens in maintaining circulating, technical and household water supply.

Direct impact is expected of invasive, alien species on native species of plankton-eating and benthos-eating fish and invertebrate animals through predation, competition (for food resources, habitats), which will lead to their reduction or changes in the structure of their populations.

Direct impact is expected of invasive, alien species of invertebrate animals on native species through predation, competition (for food resources, habitats) and formation of fouling on them (from bio-sessile mussels), which will lead to their reduction or changes in the structure of their populations.

Herpetofauna

No direct impact on amphibians and reptiles is expected.

Mammals

No direct impact on mammals is expected.

Hiropterofauna

Expected low levels of background radiation during operation of the NNU and low noise levels close to the realized capacity shall not cause direct impact on bats.

Avifauna

No direct impact on avifauna is expected.

4.6.2.2 INDIRECT IMPACT

Hydrobionts

It is expected that constantly increased water temperature of Danube River below the discharge of the hot channel will adversely affect coldphilic invertebrate animals and fish and they will be replaced by thermophilic species, including invasive alien species.

It is expected that the envisaged operating activities (including navigation) will create favourable conditions for penetration of new alien species or strengthen the impact of existing ones – as a result of temporary or permanent changes in habitat quality (increased water temperature, flow velocity , water quality, nutritional base changes in the substrate, etc.).

It is expected that constantly increased water temperature of Danube River below the discharge of the hot channel will be favourable to the growth, development, reproduction and stabilization of populations of thermophilic, invasive alien species in the Danube River which will increase their impact.

Expected are changes in the physical and chemical parameters of the water, of the composition and structure of phytoplankton and zooplankton as a result of the filtering action of invasive alien species of mussels (*Dreissena, Corbicula*), which will lead to changes in the composition and structure of populations of aquatic invertebrate animals and fish.

Herpetofauna

No indirect impact on amphibians and reptiles is expected.

Mammals

Indirect impact on mammals is not expected, except for the Otter. The increased water temperature of Danube River below the discharge of the hot channel will have an indirect positive impact on the nutritional base (fish and shellfish) of this associated with water mammal.

Hiropterofauna

There are no factors that cause indirect impact on bats.

Avifauna

Indirect negative impact on avifauna is not expected. However, indirect positive impact is expected on wintering ichthyphagous birds (pelicans, cormorants, herons, etc.) as a result of increased numbers of fish populations in the outflow of the hot channel. At present these species form winter concentrations present in the outflow and below it.

4.6.3 IMPACT DURING DECOMMISSIONING

Impact in the 30 kilometre scope of monitoring will be similar to the impact during the construction of the NNU.

4.6.4 CONCLUSION

Permanent, indirect negative impact on hydrobionts is expected as a result of constantly increased water temperature of Danube River below the discharge of the hot channel, for example, more cryophilic invertebrate animals and fish may be supplanted by thermophilic species, including invasive alien species. It is possible to create favourable conditions for penetration of new alien species and to enhance the negative impact of existing ones. This will lead to permanent direct negative impact of invasive species on aquatic invertebrate animals and fish.

Indirect positive impact is also expected on mammals associated with water bodies (Otter), on wintering ichthyphagous birds (pelicans, cormorants, herons, etc.) resulting from increased numbers of fish populations in the outflow of the hot channel.

Neither direct nor indirect impact is expected on important for preserving species of plants and habitats within the 30 km range of influence.

For the development of this EIA Report and for assessment and forecast of the impact of the implementation of NNU, monitoring was performed on individual environmental factors to determine the current state of natural background radiation and radioactivity in the air in the region of the 30 km studied area around Kozloduy NPP before commencement of construction.

4.6.5 ESTIMATED NOISE VALUES

Values are calculated based on the distances from the NPP centre to the borders of PA (Chapter 4.9.1):

BG0002009 Zlatiyata	1.2 km and 1.9 km
BG0000533 Kozloduy islands	3.03 km
BG0000614 Ogosta River	6.09 km
BG0000336 Zlatiya	15.3 km

4.6.5.1 NOISE LEVELS DURING THE CONSTRUCTION (SITES 1,2,3,4)

The expected highest equivalent noise level reaching the border of the protected area (PA), which is nearest to the NPP – "Zlatiyata" (1.2 km) during operation of the construction equipment to the nearby from the side of the PA borders of Sites 2 and 4 is about 35 dBA, which decreases with the receding of the machines. At a greater distance deeper into area (1.9 km), the expected level of noise is 30 dBA. These levels are in the range of naturally-occurring low background noise (without pronounced sounds such as birds singing, the sound of the river, of strong wind, etc.). Construction activities carried out on the remoter Sites 1 and 2 will not be a source of noise for PA Zlatiyata because of the large distances and the shielding effect on noise propagation in this direction by the existing buildings at the NPP site. Construction activities will not be a source of noise for the other protected areas in the region due to the large distances to them (over 3 km) for all four alternative locations of the site of the new nuclear unit.

4.6.5.2 NOISE LEVEL DURING OPERATION

During the operation of the new nuclear unit the expected equivalent noise level reaching the border of the nearest site to the protected area (PA) – "Zlatiyata" is about 39 dBA in case the selected site is closer to the PA – (Site 3 or 4). At a greater distance and deeper into area (1.9 km), the expected level of noise is about 34 dBA. At the more distant sites (1 and 2) these levels will be about 4 dBA lower. Expected equivalent noise level reaching the border of PA " Kozloduy Islands" is about 29 dBA in case of choosing the closest to the protected area Site 3. For the other alternative sites the expected level of noise is lower. Noise levels of up to 35 dBA are in the range of naturally-occurring low background noise (without pronounced sounds such as birds singing, the sound of the river, of strong wind, etc.). It is expected that these indicated noise levels will not change the existing background noise in these areas by more than 1.5 dBA. The operation of Kozloduy NPP after the expansion will not be a source of noise for other protected areas in the region due to the large distances to them (over 4 km) for all four alternative locations of the site of the new nuclear unit.

4.6.5.3 NOISE LEVEL DURING DECOMMISSIONING

Noise levels in the 30-kilometer scope of monitoring will be similar to that during the construction of the NNU.

4.6.6 PROTECTED AREAS

The four alternative sites of the IP do not fall within the protected areas, which are located in the 30 kilometer scope of monitoring: **Managed Nature Reserve "Ibisha", Protected Site "Kozloduy", "Kochumina", "Gola bara", "Kalugerski grad-Topolite", "Koritata", "Daneva Mogila"and "Island Tsibar"**.

4.6.6.1 IMPACT DURING THE CONSTRUCTION

No direct or indirect impact on protected areas is expected.

4.6.6.2 IMPACT DURING OPERATION

No direct or indirect impact on protected areas is expected.

4.6.6.3 IMPACT DURING DECOMMISSIONING

No direct or indirect impact on protected areas is expected.

4.7 WASTE

4.7.1 NON-RADIOACTIVE WASTE

4.7.1.1 IMPACT DURING THE CONSTRUCTION

The assessment for the period of construction is made in accordance with the Waste Management Act (SG. 53/2012) and the secondary legislation thereto.

During the construction phase non-radioactive waste at Kozloduy NPP will be managed according to the "Program for Management of Construction Waste in Kozloduy NPP.

During construction is mainly generated residential and construction waste from the construction and installation of equipment within the construction borders and excavated earth masses. Residential waste will be generated from about 2000-2500 people – workers and employees – in the busiest period. The construction of NNU is envisaged to take 5 years. Non-hazardous industrial waste and hazardous waste will be generated as well.

Quantitative characteristics of the expected waste are indicative, as the investment proposal is at an early stage of the survey for site selection and options for selection of reactor types with certain capacities. The EIA Report describes the waste generated at the individual sites. The waste is of different quantities, since it depends on the location of the sites, topography, the size of the area that is not to be built-up, etc. Waste is classified in accordance with Regulation № 3 on Waste Classification (promulgated SG, No. 44/ 25.05.2004, amended and supplemented, No. 23/20.03.2012).

4.7.1.2 IMPACT DURING OPERATION

Assessment during the operation of the NNU is elaborated in accordance with the Waste Management Act (SG, No. 53/2012) and the bylaws thereto. Non-radioactive waste at Kozloduy NPP during the operation of the NNU will be managed in accordance with regulatory requirements. During the operation of new nuclear unit is expected generation of residential, construction, industrial and hazardous waste, as every year at the work premises and sites during various operating activities, repairs, reconstruction of buildings and premises, etc. are created conditions for generation of various types and quantities of non-radioactive waste. According to Art. 7of the WMA[48], persons whose activities generate waste and holders of waste shall either treat it independently or shall submit it for collection, transportation and disposal to entities that are authorized to carry out such activities in accordance with this Act.

4.7.1.3 IMPACT DURING DECOMMISSIONING

During decommissioning of various sites related to the operation of the NNU will be exercised strict control and effective management of the generated waste including non-

[48] Waste Management Act, SG, No. 53/12.07.2013.

radioactive waste. Reclamation of disturbed areas will be carried out periodically – by stages. Until the completion of decommissioning, the utilities serving the employees on the site (water supply, sewage, waste water treatment, etc.) will be retained. The characteristic of the expected waste generated at this stage is indicative and more specific information can be provided in subsequent design phases. This characteristic is presented in more detail in the EIA Report.

4.7.1.4 CONCLUSION

The specified methods for collection, transportation and disposal of waste generated by *the implementation of the investment proposal* are appropriate and environmentally friendly, and deterioration of the environmental situation in the region cannot be expected.

In compliance with the proposed measures for reduction to reasonable a minimum of the quantities of generated waste, under strict control and effective management, the summarized impact of the factor 'waste' during the construction of various sites of the IP, their commissioning, operation and decommissioning is expected to be as follows:

<u>Territorial scope of impact:</u> Within the boundaries of the respective site, within the area provided for temporary waste storage and disposal in accordance with the regulatory requirements and the developed Waste Management Programme.

<u>Mode and degree of impact:</u> In compliance with all the measures for effective management of non-radioactive waste, significant negative impact on the individual components of the environment is not expected.

<u>Duration of exposure</u>: Long term, over the entire period of construction, operation, decommissioning, including after its lifetime.

<u>Frequency of exposure</u>: Continuous, for the entire period of construction, operation, decommissioning, including after its lifetime.

Cumulative impact:

Increase in specific types of non-radioactive waste is expected:

during the construction period of 5 years **–** excess of earth masses is expected only on site 2 of about 180 thousand m^3 for the entire construction period. The majority of non-hazardous, non-radioactive waste will be utilized.

during operation – the different types of non-radioactive waste is expected to increase to the period of operation of the remaining reactors at the site.

during decommissioning cumulative effect is not expected.

Transboundary impact: Not expected.

4.7.2 RADIOACTIVE WASTE

The primary source of radionuclides is the nuclear reactor. Depending on the degree of tightness, and corrosion of the fuel elements in the respective reactor, the waste can be expected to vary in content of radioactive fission products and corrosion products of activation. The ratio between these radionuclides and their concentrations in RAW determines the waste category and ultimately the type and size of the facilities for processing, storage and disposal of conditioned RAW.

The new nuclear unit foresees the use of ionizing radiation sources for the purposes of metal control, calibration of dosimetric and radiometric equipment, for process measurement and control. After discarding them, they also will be treated as radioactive waste.

The adopted by IAEA "Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management" and the Regulation on the Safe Management of Radioactive Waste of NRA define the international criteria and national regulatory requirements in all aspects of activities associated with RAW. By virtue of the Regulation of NRA from 2004 are set three (3) categories of solid RAW depending on their activity – I^{st}, II^{nd} and III^{rd} category, called also low-, medium-and high-level radioactive waste. The liquid RAW are classified according to the characteristics of the solid radioactive waste, which is expected to be obtained after conditioning them.

In connection with the processing of radioactive waste and in accordance with Art. 5 of the Regulation on the Safe Management of Radioactive Waste, three categories of solid RAW are defined:

Category 1: Transient RAW that can be cleared from regulatory control after appropriate processing and/or temporary storage for a period not longer than five years,
Category 2: low and intermediate level waste containing radionuclides in concentrations, not requiring special measures for heat removal during its storage and disposal;
Category 3: high level waste with such a concentration of radionuclides that heat generation shall be considered during storage and disposal.

The systems for management of radioactive waste – liquid, gaseous and solid are discussed in detail in the EIA Report the three types of reactors AES-92, AES-2006 and AP-1000. Annual emission level is calculated at 50 tBq for one unit, of which 99.9% are inert gases and are 0.1% aerosols and iodine. Annual emissions of tritium are estimated at 3.9 TBq.

4.7.2.1 IMPACT ASSESSMENT OF RAW FROM THE OPERATION OF NEW NUCLEAR UNIT FOR SITE SELECTION

All four predetermined sites for construction of new nuclear unit are positioned so that the transport of RAW to existing facilities for radioactive waste treatment at the site do not intersect urban areas and roads of the national road network.

Conclusion: RAW generated by the operation of the NNU and the management thereof do not affect the choice of site.

4.7.2.2 IMPACT ASSESSMENT OF RAW FROM THE OPERATION OF NEW NUCLEAR UNIT FOR OPTION SELECTION

The technologies discussed as alternatives for the construction of the NNU are designed according to the requirements of EUR, which means that the generated RAW during the operation of the NNU are approximately the same for the three reactor technologies. At the Kozloduy NPP site the entire infrastructure for management of RAW has been built and is due for completion, including the RAW from decommissioning of the NNU, therefore the impact of RAW is expected to be limited to local site for all the three models of proposed reactors.

4.7.2.3 IMPACT OF RAW DURING DECOMMISSIONING FOR SITE SELECTION

Conclusion: regarding site selection, the conclusions made for RAW management during operation are valid also for the management of RAW during decommissioning, i.e. it is not relevant to the choice of site.

4.7.2.4 IMPACT OF RAW DURING DECOMMISSIONING FOR OPTION SELECTION

There is no sufficient data on the process of decommissioning of the alternative technologies for the NNU, but the specifics of the design of AP-1000 with the compact structure of the containment zone with less pipelines and valves shows that RAW during decommissioning will be less than those generated during decommissioning of AES-92 and AES-2006.

Conclusion: The preferred option, in terms of RAW generated **during decommissioning**, is AP-1000.

4.7.2.5 CONCLUSION

The forecast impact in the EIA Report reflects the expected changes in the quantitative and qualitative characteristics of RAW as a result of the IP implementation as an impact factor on the components of the environment, while subject to the assessment is the process of treating RAW generated by the NNU and their disposal. The assessment is justified on the basis of the capacity of the existing storage and treatment facilities. The results of the assessment are that all the three reactor installations included in Options A-1 and A-2 generate RAW that are comparable in volume and characteristics. (**Reactors meet the requirements set out in European Utility Requirements (EUR, Revision D) for LWR Nuclear Power Plants – Requirements of European organizations operating NPPs with light water reactors), i.e. RAW generated during operation of the reactor to be less than 50 t/y. At the Kozloduy NPP site are available the necessary technology and organizational structure for the management of these RAW. In the envisaged National Repository for Disposal of Low and Intermediate Level RAW near the**

Kozloduy NPP site are planned volumes for the disposal of RAW from the NNU. From the assessment made in the EIA Report follows that RAW generated by the NNU will not affect the choice of an option.

4.8 HAZARDOUS SUBSTANCES

4.8.1 IMPACT DURING THE CONSTRUCTION

The use of 'hazardous substances' is related to the construction, operation and decommissioning of individual sections of the sites of the IP.

Characteristics of hazardous substances used during construction

During the construction of sites of the investment proposal are used:

- ✓ diesel fuel, gasoline, hydraulic oil, etc. – used for the machines involved in the construction equipment and transport vehicles;
- ✓ paints and varnishes – industrial design;
- ✓ disinfectants for the residential waste.

The investment proposal does not provide for activities such as storage and handling of hazardous substances in quantities requiring a license under Article 104 of the Environmental Protection Act (Kozloduy NPP has a license, which will need updating with the addition of new quantities of hazardous substances). Warehouses for fuels storage and garages existing in the NPP will be used.

Potential impact of hazardous substances on humans and the environment during the construction

Use of hazardous substances during construction of the investment proposal is controlled. During construction primarily will be used fuel for the transportation and construction equipment, much smaller quantities of greases and also paints and varnish. Oil changes and refuelling of transport equipment will be performed outside the boundaries of the construction site – in the garages of Kozloduy NPP. If all instructions for labour safety, hygiene and fire safety (LSHFS) are adhered to, then negative impact on the labour environment is not expected.

Potential impact of hazardous substances on the environment

Impact – **direct, short-term, temporary, with insignificant degree**. In compliance with the operating instructions for handling hazardous substances and timely removal of any small accidental spills, the likelihood of impact will be minimized.

Transboundary impact is not expected.

4.8.2 IMPACT DURING OPERATION

During the operation of a new nuclear unit, the following substances and mixtures are expected to be used:

- ***Liquid fuels*** **–** are used for the operation of diesel generators, which are reserve sources of electricity for power units; for the purposes of motor vehicles and the various workshops and units of Kozloduy NPP. Certain quantities of diesel fuel, gasoline, etc. will be necessary. The quantitative characteristics are indicative and are given in details is the materials and raw materials used. The safe storage of hazardous substances will be ensured, for which Kozloduy NPP has experience in the implementation of good manufacturing practice for handling hazardous substances.
- ***Fuels and greases*** **–** the operation of new nuclear unit is expected to use various types and quantities of oil and greases – engine and compressor oil, turbine oil, engine oil, various kinds of greases. They will be accompanied by the relevant certificates and other documents such as Material Safety Data Sheets indicating the correct method of storage, use and treatment.
- ***Chemical substances and mixtures*** **–** for the support of the basic process are delivered and used different types of chemical reagents, certified for use in the nuclear industry. The main and more important hazardous substances and mixtures are: ammonia, sulphuric acid, hydrochloric acid, nitric acid, boric acid, sodium hydroxide, etc. Chemical substances and mixtures will be supplied accompanied by Material Safety Data Sheets, which is a prerequisite for environmentally safe storage and use.
- ***For the support of the primary side chemistry system (PCS)*** of the power units in Kozloduy NPP and for the other manufacturing and support activities are delivered and consumed large quantities of chemical reagents, some of which are: boric acid, nitric acid, sulphuric acid, hydrochloric acid, potassium hydroxide, sodium hydroxide – technical, ferric chloride, ammonia, hydrazine hydrate, hydrated lime, etc. There are opportunities for the separation of air and the capacity of the existing nitrogen-oxygen stations and the extent to which this meets the needs of the NNU. The supply of chemical substances and mixtures will continue the good practice and they will be accompanied by Material Safety Data Sheets, which is a prerequisite for their environmentally safe storage and use.

Substances that will be used during the operation of the IP sites are classified according to the hazard criteria in terms of health risk to workers and the environment.

Potential impact of hazardous substances on humans and the environment during operation

Use of hazardous substances during operation of the investment proposal will be strictly controlled in compliance with all instructions for labour safety, hygiene and fire safety (LSHFS).

It is necessary the supply of hazardous substances to be accompanied by a certificate and detailed instructions for storage and handling.

If the LSHFS instructions are strictly complied with for works involving hazardous substances (mandatory use of personal protective equipment and other measures) then risk to the health workers, local population and the environment is not expected.

Potential impact of hazardous substances on the environment: **direct, short-term, temporary, with relatively low degree** under strict control. If the operating instructions for working with hazardous substances are complied with and if any accidental spills are timely removed, then the likelihood of occurrence of impact is minimized.

Potential impact of hazardous substances on humans:

- health risk for individuals working with hazardous substances is not expected if instructions for labour safety, hygiene and fire safety (LSHFS) are observed and control over technological and labour discipline is exercised;
- health risk for the population in the region of the site is not expected due to the use of relatively limited quantities, the remoteness of the sites and the planned measures for use;
- for materials classified as hazardous substances are provided measures for storage and control at work in accordance with all regulatory requirements. Moreover, these materials are of high price and spills and leaks that have a negative impact on the environmental components – air, water, soil, flora, fauna, and cause health risks for the population living in the area – are almost excluded.

For the reduction of the risk, a significant role play the proven experience of NPP "Kozloduy", the use of well-maintained warehouses, facilities, machines and vehicles; i refill with high-quality fuels and regular change of greases, effective instructions, use of personal protective equipment and adequate clean clothing, provision of conditions for personal hygiene.

Further negative impact of hazardous substances on the residents of the inhabited areas in the region is not expected. They are located at a sufficient distance from the areas provided for the implementation of the sites of the investment proposal.

Potential negative impacts of the factor 'hazardous substances' during the operation of the sites of the IP are expected to occur mainly regarding the workforce and only in emergency situations and incidents, and will have territorial scope limited to the IP- related sites, with a significant degree – on NNU, moderate – at neighbouring sites, and frequency and duration of impact – depending on the period of onset, duration and time for elimination of the accident.

Transboundary[49] impact: Not expected.

[49] Impact that crosses the border of a country

4.8.3 IMPACT DURING DECOMMISSIONING

During decommissioning and reclamation of the sites potential impacts are similar to those during the construction phase.

Transboundary impact: Not expected.

4.9 HARMFUL PHYSICAL FACTORS

4.9.1 NOISE

4.9.1.1 IMPACT DURING THE CONSTRUCTION

The construction phase includes preparation of the site for the new nuclear unit and construction of individual sub-sites for the various types of works – earthworks, concrete, formwork, assembly, welding, transportation, etc., performed using standard construction methods and equipment – source noise in the environment. Construction works will be performed during the daytime period.

Construction equipment, except vehicles, will be located at the project site. Expected equivalent noise level emitted by operating machines and equipment is 85-90 dBA in the immediate vicinity.

Source of noise in the environment are also the heavy trucks serving the construction in site preparation, supply of building materials and technological equipment, and waste disposal. Equivalent level of its noise emission depends on the engine power of vehicles, the number of courses and their speed. According to data provided by Kozloduy NPP – Department "New facilities", the engineering preparation of the various alternative sites requires various amounts and types of works and respectively various duration: Site 1 – large volume of embankment works – about 158 days; Site 2 – a relatively small volume of earthworks and moving of two electricity lines – about 87 days; Site 3 – large volume embankment works and moving of one overhead transmission line – approximately 174 days; Site 4 – large volume of demolition of existing buildings and removal of debris, for which specific decisions are yet to be made. Preparatory work will be performed in two shifts, 14 hours per day. Expected equivalent levels of noise generated by freight trucks (rear-dump wagons 20 m^3) for transporting earth in preparation of individual sites at a distance 7.5 m from the axis of motion and an average speed of 40 km/h, are as follows: Site 1 – 74 dBA, Site 2 – 69 dBA, Site 3 – 73 dBA. Site for 4 – there is no specific information on the transportation activity, but it can be assumed that the level of traffic noise will be similar to that of sites 1 and 3. At a speed of 20 km/h, these noise levels will be lower by 3 dBA.

Construction works carried out at the project site will not be a source of noise for residential areas in the region (sites of standardized noise level) due to the large distances (over 2500 m). Near to the equipment operating at the construction site is expected exceeding of the standard noise level is 70 dBA for the production and storage areas.

Existing traffic flows on main roads in the area (II-11 and II-15) are a significant source of noise for residential areas located near to the sites. For residential areas adjacent to the road routes, the equivalent level of traffic noise during the daytime period is: in Kozloduy – about 60 dBA, in the villages of Harlets and Glozhene – about 68 dBA, in the town of Myzia, where traffic flows of both roads pass through a single route – about 70 dBA. It is expected that transport supporting the construction of the new nuclear unit will increase these levels of road noise as follows: for Kozloduy – by 5.5 dBA, for the villages of Harlets and Glozhene – by 1.5 dBA, for the town of Mizia – by 1.0 dBA, leading to a similar increase in excess of the existing hygiene standards for day period. Especially noteworthy is the noise impact of truck supporting the activities for preparation of the sites and passing through the nearby residential areas. For all four proposed alternative sites is expected an increase of the noise levels of existing traffic flows in urban areas, as follows: for Kozloduy – from 9.5 to 14.0 dBA, for the villages of Harlets and Glozhene – from 3.5 to 7.0 dBA, for the town of Mizia – from 2.5 to 5.5 dBA, whereby for the residential areas adjacent to the road route, the exceeding of hygiene standards for the daytime period are significant – between 9.5 and 15.5 dBA. The smallest exceeding of hygiene standards are estimated for preparation of Site 2.

The expected impact from passage of this traffic through the site of Kozloduy NPP is about the limit value of 70 dBA for Sites 1, 3 and 4 and below the limit value – for Site 2 at a speed of 20 km/h.

In conclusion, it can be inferred that the noise impact of the transport supporting preparatory works, exceeds to the smallest extent the hygiene standards has the shortest duration at Site 2.

Comparison of alternatives by location (Sites 1, 2, 3, 4)

Preparatory works for the individual alternative sites have different duration and intensity of supporting transport, which leads to a variable degree and duration of noise impact on areas with standardized noise level – the site of Kozloduy NPP and nearby residential areas in the region.

Impact (incl. above the standard) from construction equipment operating at the site and impact (around and under hygienic standard) of transport service will be registered on parts of the site of Kozloduy NPP located near to the alternative sites. It will have shorter duration in the event of selection of Site 2; the other sites are equivalent. The impact will affect the largest part of the NPP site in the event of selection of Site 4, which is located entirely within its boundaries, adjacent to the active production areas. The farthest from them is **Site 1**, while Sites 2 and 3 are equivalent.

There will be no noise impact from the construction equipment working at the sites on nearby residential areas because of the sufficiently large distances from the site for all four options of location (2500 m). Noise impact from the additional traffic on the residential areas it crosses will be the shortest and with the smallest excesses of hygiene standards in the event of selection of Site 2. The other three alternative sites (1, 3 and 4) are equivalent.

In conclusion – in terms of noise impact on areas with standardized noise level during the construction phase, Site 2 is the most favourable.

4.9.1.2 IMPACT DURING OPERATION

The investment proposal is an extension of the existing production of Kozloduy NPP by building a new nuclear unit, which will add new sites to the currently existing ones. New sources of noise in the environment will be the main technological equipment and ancillary facilities related to the operation of the new nuclear reactor: circulation pumps, steam generators, turbines, auxiliary equipment in the engine room, etc. The main equipment will be located indoors in solid buildings. At present, there is no information on the acoustic parameters of the new equipment and its location at each of the alternative sites.

In the absence of data on noise characteristics, according to Regulation № 6 on Environmental Noise Indicators, MoH, MoEW, 2006 (Appendix 3, item 4.6.) for the design of new sites, data from similar sites may be used. By analogy with the investment proposal under consideration is the extension of the existing nuclear power plant "Temelin" – Czech Republic with two WWER reactors with a minimum power of each unit of 1200 MW, for which EIA Report is prepared.

For assessment of the expected noise impact on the environment from the new nuclear unit for expansion of Kozloduy NPP at the least favorable scenario can be accepted a level of 116 dBA total sound power emitted in the environment, based on the level the total sound power of existing Power Generation -2 (units 5 and 6) – of about 119 dBA, considering the fact that the new unit consists of a single power unit. The nearest to Kozloduy NPP urban area is the town of Kozloduy, situated at 2500 m. The estimated expected level of noise reaching the town in unobstructed noise propagation over a planar surface is approximately 30 dBA, which is in the range of the low natural background noise. It can be assumed that the total sound power of the new electricity generation will be lower than the admissible, as the new equipment will be of a new generation (III, III +), with improved technical and environmental characteristics, including the acoustic characteristics, compared to existing one. In the simultaneous operation of Power Generation-2 and the new nuclear unit theoretically is expected a change of the existing background noise at the town of Kozloduy by no more than 1 dBA.

Based on the above data, it can be concluded that after the expansion with the new nuclear unit, the activities of Kozloduy NPP will not be a source of noise for the residential areas in the region.

During the operation, source of noise will be also the supporting automobile transport for delivery of production materials, maintenance equipment, transportation of nuclear fuel, radioactive and non-radioactive waste and workers. At this stage there is no information provided about the expected intensity of transport for different purposes. For the analogue site in NPP "Temelin" are envisaged to 55 trips per day for basic transport – delivery of production materials and maintenance equipment and about 10 trips per day – for transportation of workers. The intensity of the other types of transport is substantially smaller (several tens of trips per year).

For the considered extension of Kozloduy NPP can assumed four times less intensive transport to support the operation (the new nuclear unit has a single power unit), i.e. 15 trips a day. Expected equivalent level of noise generated by this traffic is about 56 dBA at a distance of 7.5 m from the axis of movement at a speed of 40 km/h. The effect on the existing levels of traffic noise when crossing residential areas located near to the site will be as follows: in Kozloduy – an increase by about 1.5 dBA, and for the rest – the villages of Harlets and Glozhene and the town of Mizia – practically no change (by about 0.3 dBA).

Comparison of alternatives by location (Sites 1, 2, 3, 4)

Expected is a change in the noise levels formed by the existing technological activity of Kozloduy NPP resulting from the operation of the new nuclear unit, which will occur on the overlapping parts of the existing NPP site and that of the new site: the site of PG- 2 and Site 3, the site of the PG-1 and Site 2, as well as around the common borders of Site 4 with PG-1 and PG-2. The change in the noise levels these areas will depend on the location of the noise sources at the site of the new unit. The expected maximum increase in the noise level as a result of aggregation is up to 3 dBA. Noise impact from technological activity carried out at the site of the new nuclear unit and of supporting transport will affect the largest part of the Kozloduy NPP site in the event of selection of Site 4, which is located entirely within its boundaries, adjacent to the active production areas of PG-1 and PG-2. The other options will affect small end portions of the NPP site. A significant change is not expected in the selection of Site 1, which is the farthest. Sites 2 and 3 may be regarded as equivalent.

There will be no noise impact from technological activity carried out at the site of the new nuclear unit on nearby residential areas because of the sufficiently large distances from the site for all four options of location (2500 m). The traffic supporting operation will use the same route for all four options; therefore they are equivalent with regard to noise impact on crossed residential areas.

In conclusion – in terms of noise impact on the Kozloduy NPP site the most unfavourable is Site 4, the most favourable is Site 1, and Sites 2 and 3 are equivalent. In terms of noise impact on populated areas in the region, the four options are equivalent.

Comparison of alternatives by technology

The investment proposal envisages nuclear unit with pressurised water reactor. At present there is no clarity on its model. In the EIA Report for the analogous IP – extension the nuclear power plant "Temelin" – Czech Republic – are considered four alternative models of reactors of the same type of technology, with some differences namely in the noise emissions of the equipment. The model study shows that after the expansion of the plant, the change in the noise level at a point located 2 500 m away from the site (equivalent to the distance between the town of Kozloduy and the NPP), is negligible – 0.7 dBA.

Based on this data it can be assumed that for the implementation of the new nuclear unit of Kozloduy NPP the alternative options for the model of the reactor are equivalent in terms of noise impact on nearby populated areas.

4.9.1.3 IMPACT DURING DECOMMISSIONING

The stage of decommissioning is connected with the construction of new and reconstruction of existent buildings, disassembly of equipment, activities for waste processing and transportation. A source of noise will be the equipment used for the various types of works. Besides the standard construction machinery and vehicles (excavator, bulldozer, head loader, truck crane, lorry) specific machines and equipment will be used to reduce the size of the dismantled equipment. The expected noise emissions in the environment and the impact on areas with standardized noise level in the area will be lower than those in the construction stage, since the period of decommissioning will be very long (years), very far in the future, and it is assumed that the equipment used will be of a new generation with improved noise characteristics.

In terms of noise impact in the stage decommissioning, the four alternative sites are equivalent.

Transboundary noise impact is not expected, given the long distance between the NPP site and the nearest populated areas on the territory of the Republic of Romania (over 10 km).

4.9.2 VIBRATIONS

4.9.2.1 IMPACTS DURING THE CONSTRUCTION PHASE

The building machines used for constructing the site are not a source of vibrations to the environment. Vibrations are a factor of the work environment when certain types of machines, facilities and vehicles are used. The heavy trucks serving the construction process can be a source of vibrations disseminating in the earth base only if the traffic routes are not appropriate to the category of the traffic and this must be taken into account when preparing the project transport plan.

4.9.2.2 IMPACTS DURING THE OPERATIONS PHASE

The project does not propose to use equipment that will generate vibrations to the environment. Vibrations are typical for large machine components at high revolution speeds. In the power generation industry these are mainly the turbines installed in the generator halls. In the case of machines and equipment, the dissemination of vibrations beyond their source is achieved by applying special requirements during their installation such as: anti-vibration treatment of their baseplates and fundaments by means of rubber pads, isolating spaces of vibration damping materials, elimination of the rigid connections between vibrating areas and structural elements of the premises, etc. Vibrations at industrial sites are factors of the work environment only.

The vehicles that will support the running of the new nuclear power unit are not expected to be a source of vibrations to the environment. They will use Class 2 roads of the National road network, which are designed to withstand that category of vehicle traffic and thus the vibrations from heavy trucks attenuate within short distances from the road.

For these reasons the vibrations caused by operational and transportation processes are not viewed as environment factors.

4.9.2.3 IMPACTS DURING DECOMMISSIONING

In terms of the Vibrations factor, this phase is similar to the construction phase.

4.9.3 NON-IONIZING RADIATION

According to the literature concerning Outdoor Switchgear Arrangements (OSGAs) rated 110, 220 and 400 kV, and also from our research across the country it becomes clear that unfavourable impacts from electric and magnetic fields are only expected on the personnel working at OSGAs and INSGAs (Indoor Switchgear Arrangements).

4.9.3.1 WORK ENVIRONMENT

Values above the norms can be detected on the walkways in and around Outdoor Switchgear Arrangements (OSGAs), in proximity to transformers, breakers and inlets/outlets of the loads[50]. Values above the norms can be expected mainly in OSGAs rated 220 and 400 kV, but only in the electric field component. The intensity of the electric field and the density of the magnetic flow (magnetic induction) in the work environment are not expected to exceed, in relative units, the values regulated in the national and European legislation.

4.9.3.2 POPULATED SETTLEMENTS

The estimation of the potential radiation impacts on the population from electric and magnetic fields of industrial frequencies is made on the basis of studies published in scientific journals.

The measured intensities of the electric fields depend on the voltage carried by power line. These intensities are highest above the conductors (buses) of the relevant phases of the power line and rapidly decrease as the distance increases.

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[50] M. Israel et al. – Theme 2.2. Assessment of impact of electromagnetic radiation on personnel working at electrical substations in Varna, Dobrich and Shumen District , NCHMEH, Sofia, 1998 r.

The intensity of the magnetic fields depends on the consumption of power during the measurements, therefore the values only reflect the power consumption at the time of measurement.

Around power lines there can also be values exceeding 5 kV/m, which has been accepted by international organisations (including ICNIRP) as a threshold reference value for populated settlements. Provided that the required servitude zones around high-voltage power lines are maintained, above-norm electric field intensities cannot be expected.

As concerns the magnetic fields, magnetic induction at levels of relevance to public health in populated settlements cannot be expected even if the electrical systems are operated at full load.

It can be summarised that the exposure (subjection, exposition) of personnel to EMFs of industrial frequency will be continuous, but at low levels provided that the national and EU standards are compiled and the designs are made in accordance with the regulatory requirements in our country and with the recommendations of the European Commission.

The population is not expected to be exposed to EMFs of industrial frequency originating from the NPP.

4.9.3.3 ASSESSMENT OF POTENTIAL IMPACTS

4.9.3.3.1 Impacts during the construction phase

Impacts from non-ionizing radiation are limited subject to compliance with the regulatory requirements and the envisaged measures, and are reversible after the construction phase. They relate to short-term radiation during welding works (low-frequency EMFs and UV radiation), and to electric and magnetic fields of industrial frequency 50 Hz coming from the power supply units of the building equipment.

The construction works carried out at the site of the new nuclear power unit will not be a source of non-ionizing radiation to the territories of populated settlements in the area since these impacts will be localized to the personnel working at the site.

4.9.3.3.2 Impacts during the operations phase

The impacts caused by the exposition of the personnel to electromagnetic fields of industrial and radio frequency are expected to be long-lasting, but of low to medium importance (above-norm intensities of electric and magnetic fields of industrial frequency are expected at certain workplaces in the OSGAa and INSGAs, although the initial exposure assessments demonstrate conformity with the threshold values) subject to compliance with the requirements of the national and European legislation.

Impacts on the population from EMFs of industrial frequency generated by the sources after the implementation of the investment project are not expected, provided that the national requirements for servitude areas around high-voltage power lines are complied with.

4.9.3.3.3 Impacts during the decommissioning phase

The impacts from harmful physical factors will be similar to the ones during the construction phase, but will be of very low importance.

The impacts of non-ionizing radiation during the decommissioning phase relate to the construction of new and reconstruction of existing buildings, dismantling of equipment and waste processing and transportation activities. These activities will not involve sources of non-ionizing radiation (NIR) except certain construction equipment having high electric power consumption.

At that time there will not be sources of non-ionizing radiation to the territories of populated settlements in the area, either.

The expected NIR impact on the various territories during the decommissioning phase can be defined in terms of: probability of occurrence – there is no such probability; territorial scope – there are no NIR sources either in the work environment or in the populated settlements; type – not discussed; level – very low; characteristics – temporary; no cumulative effect; reversal of the effect – not relevant because there is no such effect.

4.9.3.4 CONCLUSION

As far as the impact of non-ionizing radiation is concerned, it is not important which one of the 4 sites will be selected for implementation of the project. If the project is constructed at the so termed **Site 3** northwest of Units 5 and 6 of Kozloduy NPP, near the bypass road of the existing plant, there will be a need for certain specific measures in respect to OSGA 400 kV. From the perspective of engineering utilisation and connection to the power grid this scenario would require a great number of activities and complicated reconstructions of the long-distance overhead transmission lines – the fan of 400 kV overhead lines.

4.9.4 HEAT IMPACT ON DANUBE RIVER

Temperature profile of Danube river

The temperature profile of Danube river is highly relevant to the assessment of the impact of spent, warmed-up circulatory waters used for operating the plant.

The distribution of the temperature in the water across the river stream depends on the amount of water, the season and the hydraulic characteristics of the river section. The maximum values of the temperature variations measured widthwise the river reach 0.2 – 0.4 °C with the highest values occurring early in the morning. During the warm season the cross-section of the river is isothermal.

Depth-wise, the temperature of the water especially in the central part of the riverbed is equalized. Infrequent differences in the 0.2 – 0.4 °C range are observed in the midstream area. In the event of relatively rapid changes of the ambient air temperature, due to the resulting intensive turbulence-caused displacement and the inertia of thermal processes in open streams the temperature variations depth-wise the water remain in the 0.2 – 0.4 °C range.

The maximum water temperature in January is 6°C and the absolute maximum measured in August is 27.5 °C.

The maximum monthly amplitude of the temperature of the water is 14.9 °C and occurs in April.

Thermal pollution

The change of the river's temperature profile caused by the discharging of warmed-up waters from Kozloduy NPP is a specific form of pollution. The permissible threshold of temperature increase in the open stream is 3°C in the hottest and 5°C in the coldest month of the year.

When the plant is operated at 3760 MW (2002) and the corresponding amount of warmed-up water is up to 180 m^3/s, the length of the 3°C thermal impact zone will vary in the different months from 7.0 to 31 km at widths between 175 and 320 m. The size of the thermal impact zone is the largest typically in October. The thermal plume moves relatively quickly to the right-hand bank and at 7-7.5 km after the discharge point the difference between the temperature of the water and the thermal plume reaches 1.8°C (dissipation of about 80%). It can be concluded that the after the commissioning of Kozloduy NPP some extent of thermal burden is observed at Oryahovo (^{km}678) compared to Lom (^{km}743.3), which does not exceed the regulatory threshold of 3°C.

Seen from the above data, for nearly 30 years before the commissioning of Kozloduy NPP there had not been differences between the average monthly temperatures registered by the two stations at Lom and Oryahovo. In 1984, when the 4 units were in operation, the average difference in that year was 1.84°C, and it was a shallow-water year. The difference in 2006 was as little as 0.84°C, but the volume of water reached very high values in that year. During the period 2008-2010, when two units were operational, the average annual temperature difference between the two stations was 1.38°C. The differences in the winter months are higher than those in the summer months and reach 2.3°C, the differences are also higher in years characterized by relatively shallow waters.

4.9.4.1 IMPACTS DURING THE CONSTRUCTION PHASE

During the construction of a new nuclear unit, whatever site is selected, the temperature profile of Danube will not be affected in any way.

4.9.4.2 IMPACTS DURING THE OPERATIONS PHASE

According to the norms applicable in Bulgaria, thermal pollution of open streams must be assessed on the basis of minimum average monthly water volume (in a year with incidence

95%) and natural temperature of the open stream – average temperature in the hottest and coldest months of the year. The analysis of the results from previous studies demonstrates that at full capacity of the then operational six units, the expected discharge from Kozloduy NPP to Danube river via the existing discharge channel was about 180 m^3/s warmed-up water with temperature 10˚C higher than the natural temperature of the water in the river.

The water temperature in the discharge channel before discharging in the river follows the natural rise of the temperature of Danube water before the Onshore Pump Station (OPS) during the various time zones of the day, with temperature difference 7.5˚C – 8.5˚C at normal operational conditions.

When the plant is operated at up to 3200 MW and the corresponding amount of warmed-up water is up to 160 m^3/s, the length of the 3°C thermal impact zone will vary in the different months from 5.0 to 20 km at maximum width 250 m. The size of the thermal impact zone is the largest typically in October. It has been found that the thermal plume moves relatively quickly to the right-hand bank and at 7-7.5 km after the discharge point the difference between the temperature of the water and the thermal plume reaches 1.8°C (dissipation of about 80%). With temperature difference of 0.2°C the maximum width of the warm stream from the bank to the fairway reaches 195 m and the length is up to 20 m.

The above-cited results enable a conclusion that at water inflow rates of up to Q_T=160 m^3/s the impact of the heat exchange between the warmed-up waters from Kozloduy NPP to Danube river in the section between km 687 (discharge point of the hot channel) to km 678 (Port of Oryahovo) and the environment is insignificant and negligible. Even the connection of the new unit will not cause the warm plume to reach the maximum parameters cited above and measured in natural conditions when the power plant was operated at Q_T=180 m^3/s. After the commissioning of Kozloduy NPP some extent of thermal burden is observed at Oryahovo (^{km}678) compared to Lom (^{km}743.3), which does not exceed the regulatory threshold of 3°C.

Significant progress has been made during the recent years in the modelling of conservative and non-conservative pollutants in river streams. It is recommended that a detailed study is undertaken at the design stage in order to address finally this specific pollution burden.

4.9.4.3 IMPACTS DURING THE DECOMMISSIONING PHASE

After the new nuclear unit is decommissioned and the discharge of spent cooling water is discontinued, the thermal profile of the river stretch between OPS and VP Oryahovo is expected to recover promptly.

4.9.5 ICE IMPACTS

Ice dams (barriers of heaped ice blocks) occur mainly around groups of islands as there are favourable conditions for deceleration of the average stream speeds in these sections.

Typical ice dam sections where this phenomenon is frequent are those at kmR246, km140 and km81. All the three sections are beyond the Bulgarian stretch of Danube river.

The Bulgarian stretch of Danube river has seen only 5 ice dams in more than 70 years at flow rates between 4870 m^3/s and 11 910 m^3/s. The fact that the last one was in 1963 indicates that the construction of the Iron Gates Hydro Complex has significantly reduced the probability of freezing occurrences in the Bulgarian stretch of Danube river. Events such as catastrophic wave due to accident at Iron Gates I and II and ice dams are ones of low probability and should not occur concurrently, moreover ice damming is not possible in the existence of catastrophic tidal water flows above 20 000 m^3/s. Freezing can occur in low to medium waters (ca +25 m.), typically in winter. Assuming that even such an unlikely event occurs, its damming effect will be up to 2.5 m and from 25.00 m the average level will reach 27.00 m. Therefore, elevation of water levels and flooding of Kozloduy NPP due to the damming effect of ice drifts is an event of very low probability.

Earlier research demonstrates that the damming effect in the OPS area in shallow waters can reach 3.60 m and 1.50 m in high waters. The probability of damming due to ice dam at Oryahovo is 1 time in 10 years while the water standstills reached after damming correspond to standstills of repeatability 0.5, i.e. 1 time in 200 years. Thus far, the potential for formation of ice dams at higher water levels has not been investigated and the probability of such phenomena has not been assessed, either.

4.9.5.1 IMPACTS DURING THE CONSTRUCTION PHASE

Having regard to the above-stated facts, it can be expected with a high extent of probability that during the construction of the new nuclear unit there would not be a plausible danger of the construction site being flooded due to spillover from the fencing dykes. Even if extreme ice dams occur with sizes over and above anything registered to date, there is a risk, although a very limited one, for sites 1 and 3 (eventual spillover from fencing dykes during the construction process before conclusion of the construction works), while the expectations for sites 2 and 4 are that they would be fully protected from ice dams in the stretch at Kozloduy NPP.

Having regard to the foregoing considerations, we are of the opinion that, from the perspective of the security of the new site, the advantage is on the side of the proposed sites 2 and 4 as the ground level there is higher and they are at a maximum distance from the dykes at Danube river. They have natural flooding protection even in the case of ice dams causing catastrophic high waters in the Danube.

4.9.5.2 IMPACTS DURING THE OPERATIONS PHASE

The commissioning of a the new nuclear unit would not cause a significant change of the thermal and ice regime of the river stretch between the OPS and Oryahovo. As all the four proposed sites are at absolute altitude 35.00 the facility is unlikely to be flooded due to formation of ice dams in that stretch. If the water level of Danube river exceeds the crests of the fencing dykes, the floods would affect the lowlands near the river, which would protect the NPP site from flooding. The only problem that might occur is elevation of ground water levels (table) during the ice dam period. From this perspective sites 2 and 4 should be preferred to sites 1 and 3.

4.9.5.3 IMPACTS DURING THE DECOMMISSIONING PHASE

The conditions after the decommissioning of the new nuclear unit will be similar to those during the operations phase, which means that sites 2 and 4 should again be preferred to sites 1 and 3.

4.10 HEALTH AND SANITARY ASPECTS OF THE ENVIRONMENT AND RISK TO HUMAN HEALTH

4.10.1 IMPACT IN THE WORK ENVIRONMENT

The radiation impact of Kozloduy NPP is being assessed since the commissioning of the plant in 1974 in the framework of long-term programmes coordinated with the national supervisory authorities – the Nuclear Regulation Agency (NRA), the Ministry of Environment and Water (MoEW) and the Ministry of Health (MoH). The programmes define the control targets, the measurement frequencies, the controlled parameters and the analytical methods. The components of the environment are controlled by laboratory tests and automated equipment. A dedicated mobile laboratory is used for field measurements. The present scope of controls is consistent with the practices of EU Member-States that operate power plants.

A total of 36 control posts deployed over a zone of 100 km take samples for laboratory analysis of man-induced radioactivity in major environment components – air, soil and vegetation. The gamma radiation background is measured. 33 of these posts are in the 30-kilometers Surveillance zone (SZ) and the other 3 ones are accordingly in the towns Lom, Pleven and Berkovitsa. 7 other stations analyse natural waters and sediments: 4 at different locations in the stream of Danube river and in Ogosta river, Tsibritsa river and Kozloduy Dam. The radioactivity of foods typical of the region is monitored (milk from 3 farms, fish from the Danube and crops from the Radiation Protection Zone). 4 drinking water catchments are also monitored.

10 Berthold monitoring stations of the Automated Information System for External Radiation Control (AISERC) are deployed in the Precautionary protective action planning zone (PAZ) around the plant for continuous automated monitoring of the dose level and the contents of ^{131}I in the aboveground air. Three automated meteo stations and five waterborne stations for controlling the activity of unbalanced and waste waters also work in continuous mode as part of the system. The AISERC system of Kozloduy NPP is integrated with the national system of the MoEW with two-way information exchange facilities. The results of the plant's radiation monitoring are verified each year in the

framework of the radioecological survey programmes of the MoEW[51] and the National Centre of Radiobiology and Radiation Protection (MoH)[52].

Radioactive substances can be released in the environment during the operation of nuclear power plants. The routes for introduction of man-induced radionuclides in the environment are the releases of gases and aerosols in the aboveground air (gaseous and aerosol waste) and liquid radioactive releases (liquid waste).

The above-background irradiation to the population during normal operation of the NPP is typically caused by gaseous and aerosol releases of radionuclides in the ambient air. According to estimates of the UN Scientific Committee on the Effects of Atomic Radiation (UNSCEAR)[53], the concentrations of radioactive substances in the aboveground air account for about 96% of the total radiation dose to the population.

The evaluation of the above-background irradiation to the population depends on a number of factors, the most important of which are:

- Activity of the radioactive substances released in the atmosphere;
- Climatic and weather conditions in the plant's potential impact zone;
- Characteristics of the soil – prevailing types and categories of soil in the impact area;
- Demographic indicators;
- Consumption of locally produced main types of foods.

The summary of the results from the measurement of the gamma radiation background at the control posts and in the populated settlements in the surveillance zone around Kozloduy NPP in 2007 -2012 demonstrate that the strength of the gamma-radiation equivalent dose is within the boundaries of **the natural radiation background – from 0.05 to 0.15 μSv/h.**

The aggregate beta-activity measured in the waters of the open water streams in the region is within the normal rage: from < 0.018 to 0.084 Bq/l, which is from 3.6 % to 16.8 % of the norm 0.5 Bq/l [54]. The highest measured value for the waters of Danube is 0.084 Bq/l, measured at Oryahovo port [55] . The penetration of radioactive isotopes through the biological chain NPP – water – soil and biota – air – plants – animals – humans has a substantial contribution to the internal exposure of the population with long-life radionuclides. The largest contributor to the individual effective equivalent dose for the population in the area of Kozloduy NPP is the consumption of vegetable foods, fish and milk of local origin. In order to establish the transmission of radionuclides in the food chain during the period 2009 – 2011, the Regional Environment Protection Unit of Kozloduy NPP analysed milk samples from farms in the town of Kozloduy, the village of Hurlets and the

[51] Intra-institutional radiation monitoring, MoEW
[52] Programmes for radiological surveillance, NCRRP
[53] UN Scientific Committee on the Effects of Atomic Radiation (UNSCEAR)
[54] Наредба №Н-4/14.09.2012г.за характеризиране на повърхностните води.
[55] Regulation no. 9/2001 on the water quality for potable and domestic uses

town of Oryahovo. The measured values are proximal to those obtained during and before the operation of Kozloduy NPP and demonstrate the absence of impact from Kozloduy NPP on the ichtyofauna and the main foods consumed by the population.

The additional dose exposure to the population living in the 30-km zone from man-induced radionuclides released in the atmosphere by Kozloduy NPP at normal operational mode are below the values of the analytical method. The maximum value of the individual effective annual dose due to gaseous releases from the plant in the period 2010-2012 has been in the range of $8.02x10^{-76}$ – $2.72x10^{-6}$ Sv. This is less than the background exposure and is below 0.27 % of the 1 mSv norm as per the Regulation on basic norms of radiation protection (BNRP), 2012. The statutory collective effective annual dose to the population living in the 30-km zone due to gaseous and aerosol emissions varies from . $8.44x10^{-3}$ to $1.87x10^{-2}$ manSv/GW.a. In terms of Noble Radioactive Gases (NRG) and ^{131}I, the dose values are lower than the average ones in the countries with nuclear power plants. The doses received by the population from liquid and semi-liquid releases by the NPP are negligible and the highest estimated ones is $6.37x10^{-7}$ Sv.

Seen from these considerations, the above-background irradiation, although negligibly low in respect to the radiation risk and health status of the population in the 30-km zone, is mainly due to the presence of gases and aerosols in the aboveground air discharged by the NPP. The remaining sources of above-background radiation to the population, namely external irradiation from radionuclides depositions on ground surface and internal exposure from inhaled radionuclides and ones incorporated in the foods, have negligible contribution to the aggregate radiation.

The radiation situation in the 100-km zone does not differ from the other areas of the country.

4.10.1.1 IMPACTS DURING THE CONSTRUCTION PHASE

The main risk factors for the health of the workers engaged in construction activities for implementation of the proposed Investment Project (IP) are dust, toxic hazards, noise, general and local vibrations, unfavourable micro-climate and physical strain, radiation, generated in the environment as result of the arc welding and defect control of all welds using radiography method for defect not seen at visual control.

During welding works ionizing radiation emerges and created prerequisites for deteriorating the workers' health and required the use of protective screen around the welding area. The type of protection depends on the time period of exposure and the distance to the source. These activities shall be carried out in compliance to the documents for the welding specification, prepared in advance at the design stage, as well as with all valid rules and standards in the country.

The non-destructive control using radiation tools is carried out under a special mode of work with such tools by highly specialized workers, who are equipped with individual dosing devices and are under medical surveillance.

Possible risk factors for the population in the populated settlements nearest the NPP, such as the village Hurlets, relate to the polluted ambient air during the implementation of the proposed Investment Project and emergencies, including ones with radioactive components included in the technology of the new reactor, within the 30-km zone.

Among the chemical risk factors, the most important substances are those in the exhaust gases: polycyclic aromatic hydrocarbons (PAC), carbon and nitrogen oxides, sulphur dioxide, tars.

The adverse impacts during the construction phase are temporary and direct ones, and affect mainly the personnel directly involved in the construction and installation works at the NPP site.

Prevention or mitigation of health risks depends on compliance with occupational health and safety requirements. Kozloduy NPP personnel working at places proximal to the investment project site will incur temporary exposure to the above-stated non-favorable impacts.

A Health and Safety Plan will be developed in relation to the implementation of the proposed project and will form part of technical specification of the project. The Plan will be developed in accordance with *Regulation no. 2 on the minimum health and safety requirements during performance of construction and installation works*, which is harmonized Directive 92/57/EC [56].

Kozloduy NPP has well established infrastructure, good and secure power supply, fire fighting service, supply of drinking and domestic water, Sewerage system, draining systems for prevention of flooding during natural disasters, internal roads surfaced in asphalt or concrete. The plant has washrooms, toilets and bathrooms, canteen with warm food and fast food locations. Qualified medical aid can be provided within the NPP site. All this provides for the normal presence and safe working of the personnel that will be engaged in the construction and installation works described in Investment Project (IP) "Building a new nuclear unit of the latest generation at the Kozloduy NPP site".

During the construction phase no impacts from radiation factors related with the IP since there are no significant, constant and non-regulated radioactive sources, as well as due to the special mode of work for the non-destructive testing in compliance with the safety measures and all valid rules and standards in the country..

[56] Law on protection from adverse impacts of chemical substances, compound and products, 2000, last amended in State Gazette no. 63 of 13 August 2010.

4.10.1.2 IMPACTS DURING THE OPERATIONS AND DECOMMISSIONING PHASES

This section discusses the probable impact of radiation and non-radiation factors during the operation and decommissioning of the nuclear unit. Consideration is given to non-radiation and radiation impacts on the personnel, the population and the environment. The analysis deals only with the probable radiation impacts related with the operation and decommissioning of the reactor, together with the cumulative environmental impact from the operation of the NPP and the new nuclear unit.

In the non-radiation environment during operation

The main risk factors of non-radiation nature for the personnel engaged in the operation of the new nuclear unit are dangerous substances in the work environment, unfavourable physical factors of the work environment, physical and psycho-sensory strain of the personnel directly involved in welding activities, charging, sealing, transportation and arrangement in the Plant, and in the control for prevention accidents and work-related injuries.

The summarized results from the analysis of probable non-radiation impacts on health status of the NNU personnel are: negative, direct, combined and cumulatively related with risks of impact from physical, chemical, psycho-sensory, physiological and ergonomic factors of the work environment. **The level of impact of these factors is low.**

It is estimated that the non-radiation impact during the **decommissioning** of the new nuclear unit on the health of the personnel and other staff working at Kozloduy NPP will be comparable to the operations phase, but of even lower level due to the experience of the employees and the technical personnel.

The workers' exposure to impacts from non-radioactive substances is expected to be mostly direct, by atmospheric route, periodic in terms of duration and intensity, and affecting mainly the employees.

Direct exposure exists when the environmental pollutants reach the human organism, penetrate it and are metabolized in its biological media.

Following an assessment of the exposure routes, it should be said that the construction and installation works and the operation of the new unit are expected to produce mainly non-organised atmospheric emissions from:

- Exhaust gases from Internal Combustion Engines of the machines operated within the site and vehicles outside the site;
- Dust;
- Noise pollution from means of transport.

Part of the dangerous emissions are long-term ones, but of limited territorial scope and contingent on the measures that will be taken for their mitigation.

In radiation aspect

The radioactive exposure of humans in Bulgaria is regulated by the *Regulation on basic norms of radiation protection* (BNRP-2012).

The Regulation determines the radioactive protection requirements and the measures that must be taken for performing activities related with the usage of atomic energy and sources of ionizing radiation in accordance with the requirements of the *Act on the Safe Use of Nuclear Energy*[57]. Furthermore, the Regulation also controls the radiation exposure of the population from natural sources of radiation.

In addition to the radiation exposure determined in the Regulation there is one other major requirement: ensure that all radiation exposures will be justified and maintained at ALARA levels under the dose limit determined in the Regulation, taking into account the social and economic conditions.

The technical specification for design and construction of the new unit determines the requirements to the proposed facilities.

In accordance with the *Regulation on basic norms of radiation protection* (BNRP -2012), the CEO of Kozloduy NPP each determines administrative check levels of the doses at the site of the NPP [58].

The new nuclear unit project guarantees that the radiation exposure of the personnel will be in accordance with the ALARA principle and will be limited to BNRP-2012. It is expected that the experience gained in ensuring compliance with the procedures of Kozloduy NPP will be applied during normal and emergency operations and conditions, and will limit the likelihood of exposure in future.

It is expected that during the operations phase the dose exposure for the personnel will conform to the legal requirements.

The radiation resulting from the operation of the new nuclear unit is calculated as insignificant compared to other external sources – around 0.01% of the total exposure level.

4.10.2 IMPACT ON THE POPULATION

4.10.2.1 IN NON-RADIATION ASPECT

4.10.2.1.1 Impacts during the operations phase

The developed programmes and measures for prevention of health risks to the population in the 30-kilometers and 100-kilometers zone around Kozloduy NPP, and their efficiency, are proven by various national and international inspections.

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[57]Act on the Safe Use of Nuclear Energy, 2002.

[58] Regulation on basic norms of radiation protection (ONRZ -2012).

The risks for pollution of the living environment, the farming lands which are used mainly for growing fodder crops, of the drinking and domestic water from the water wells on the terrace of Danube river and of the riverbank, are all decreasing.

The necessary preventive and protective measures in and around the Plant have been developed. The main facilities are remote-controlled to ensure fast response if needed.

The European health indicators for the environmental impacts on the population are: quality of the ambient air, noise level, living environment including at home, traffic related accidents, quality of the drinking and domestic water, accidents with chemical substances, radiation. The collected information regarding the present situation of Kozloduy NPP and the non-radiation risk related with the proposed Investment Project enable the making of a conclusion that the operation of the NNU in the course of 60 years will not have a negative impact on the population in the 100-kilometers zone around the plant in Bulgaria and Romania.

Significant social impacts are not foreseen.

4.10.2.1.2 Impacts during the decommissioning phase

The negative impact related with the operation of heavy construction machines and transportation of large amounts of building waste will be limited to the determined by now ZPPM around the Kozloduy NPP.

The decommissioning of the new nuclear reactor is not expected to produce negative impacts on the population outside this zone.

4.10.2.2 IN RADIATION ASPECT

4.10.2.2.1 During the operations phase

The impact of radioactivity (natural and artificial) via ionizing radiation on living organisms is assessed on the basis of the received radiation.

The energy absorbed as a consequence of ionizing radiation divided by unit of mass of the substance in which the absorption occurs is the main parameter of radiation dosimetry. It is termed “dose” or “absorbed dose”. This parameter and its derivates are widely used in the area of radiation protection, radiobiology, nuclear medicine, nuclear technology, etc. The entire set of dosimetric values is directly related with the energy transmitted by ionizing radiation to the substance. The absorbed energy causes physical, chemical and biological processes leading to radiation induced processes. In this sense dosimetric values are a measure of the expected consequences from the exposure of living organisms.

Type of exposure

Sources of exposure are the natural radiation contained in the atmosphere and the artificial radiation released in the atmosphere, lithosphere and hydrosphere as a result of human activity – **Figure 4.10-1**. Sources of artificial (man-induced) radioactivity can be the industry (including power generation), medicine, scientific activities, the defence industry, etc. The exposure is the product of ionizing radiation and the penetration of radioactivity in living organisms and accordingly in the human body.

FIGURE 4.10-1: TYPES OF RADIATION SOURCES

Legend:
Left: Sources of radiation; right: sources of natural radiation
Clockwise from 1: Left: natural, medical, fallout, nuclear energy; right: earth origin internal exposure, earth origin external exposure, space origin external exposure, space origin internal exposure.

All natural media contain radioactivity. Thus for example one MT earth contains approximately 5 g Potassium-40 (^{40}K), 2.5 g Uranium-238 (^{238}U), 10 g Thorium-232 (^{232}Th). The human body also emits radiation.

TABLE 4.10-1: NATURAL RADIOACTIVITY OF SOME COMMON NATURAL MEDIA

Media	Radioactivity
Rainwater	0.5 Bq/l
Sea water	12 Bq/l (mainly Potassium-40)
Foodstuffs	Bq/kg
-potatoes	150 (Potassium-40)
-milk	50-80 (Potassium-40)
-fruits	40-90 (Potassium-40)
-wheat	140 (Potassium-40)
The human organism (80-90кг) contains approx.:	4500 Bq (Potassium-40) 370 Bq (Carbon-14)

The parameter "equivalent dose" has been introduced for more detailed characterization of the biological impact to take account of the various types of ionizing radiation. The equivalent dose is main parameter in the area of radiation protection as it reflects the amount of energy received by the organism and the distribution of this energy in the tissues of the organism.

Equivalent dose H[59] is the absorbed dose, average for an organ or tissue, multiplied by the relevant radiation weight factor. The unit of measurement is Sievert [Sv] - 1 Sv = 1 $J.kg^{-1}$.

Effective dose E[60] is the sum of the products of the equivalent doses in organs and/or tissues with the relevant tissue weight factor. The unit of measurement is Sievert [Sv] - 1 Sv = 1 $J.kg^{-1}$. In case of uniform radiation of the whole body the effective dose is equal to the equivalent dose.

Collective effective dose is the total effective dose for a specific group of population. The unit of measurement is man/Sievert [man.Sv].

Assessments of individual or collective doses to the population are a main factor in the determination of the radioecological impacts from the operation of any NPP. The term **statutory collective dose** has been introduced to achieve comparability of these parameters on international scale for all NPPs throughout the world. For this purpose the dose is divided by the amount of electric power generated during a certain period of time, typically one year. The unit of measure is **man.sievert/gigawatt.year [man.Sv/GW.a]**. The obtained values reflect the impact of the generated power on the dose exposure of the population. In certain cases it is not possible to directly measure and determine the doses obtained from a specific radioactive source. For example, during normal operation the releases of radioactive substances from a NPP are insignificant, hence it is not possible to determine directly the individual and collective doses of exposure of the population. In these cases, mathematical models are used to evaluate the migration and quantitative contents of radionuclides in the environment, and thence for calculation of the dose exposure of the population in the area. This is established practice, which uses internationally recognized methodologies and verified modelling software. Thus, Kozloduy NPP uses the CREAM methodology, which is accepted in the European Union. The estimated individual and collective effective doses are compared to the regulatory norms and the statutory effective doses are benchmarked to the worldwide practice – UNSCEAR. This methodology is also applied to prognosticate the results for this IP at the stated parameters of the new nuclear reactor.

The results demonstrate negligibly low levels of exposure of the population. For example, the additional dose exposure of the population in the area of Kozloduy NPP is less than 0.1% of exposure from the natural radiation background (country and world average – 2.33 mSv) and the annual limit of the effective dose 1 mSv, according to the *Basic norms of radiation protection* (BNRP-2012).

The limits for exposure of the population are:

[59] Regulation on basic norms for radiation protection, adopted with DCM No 229 dd 25.09.2012, Promulgated SG, issue 76 dd 5 October 2012

[60] Regulation on the basic norms for radiation protection, adopted with DCM No 229 dd 25.09.2012 ,Promulgated SG issue.76 dd 5 October 2012

Annual effective dose 1 mSv. Exposure above this limit is permissible in special circumstances and provided that the annual effective dose in the course of 5 consecutive years does not exceed 1 mSv.

The limits of the annual equivalent dose, in accordance with the thresholds of the effective doses in paragraphs 1 and 2 are:

- 15 mSv for eye lenses;
- 50 mSv for skin (this limit applies to average doses received by an area of 1 cm^2, irrespective of the area of the irradiated surface).

Based on the analyses and conclusions in the EIAR it can be stated that the level of potential impact of ionizing radiation on the population living near Kozloduy NPP, at normal operation, is very low.

4.10.2.2.2 During the decommissioning phase

The various activities related with the decommissioning of the Plant are not expected to produce a negative impact on the population outside the ZPPM of the existing by now nuclear facilities at the Kozloduy NPP site. The planned activities should exclude generation of radiation factors on soils and food ecochains.

The decommissioning of the Plant is not expected to produce impacts of non-radiation or radiation nature on tangible assets or lead to exhaustion of non-renewable sources.

The health risk to the population in the nearest residential zone (town of Kozloduy) is negligible.

4.10.3 Conclusion

The proposed Investment Project envisages a set of measures for mitigation, reduction or elimination of the risk to the environment and the health of the personnel and the population during the construction and operation of the new nuclear unit. The proposed measures will conform to the requirements of the health, labour and environment legislation on prevention, reduction of neutralization of the impact of the new nuclear unit, and will be compliant with the radiation protection requirements.

The expected impact during the construction phase is negative (within the construction site), direct, primary, temporary, short-term (only during daytime until the end of construction works), without cumulative effect and reversible.

During the operations phase, the non-radiation emissions from the new nuclear facilities are not expected to produce significant negative impact, provided that the necessary technological requirements are complied with and environmental monitoring is carried out on regular basis.

The potential impact zone is limited to the secure site of Kozloduy NPP. This zone is not accessible by the broad public. Transboundary impact is not expected.

The radiological impact during the operations phase on human health is very unlikely, indirect, secondary, temporary, short-term, of very low significance, without cumulative effect and reversible. Each probable negative impact of the NNU on the environment and the public health, including and taking into account the synergetic effect of the radiation background, is within the permissible limits according to the regulatory documents. The new nuclear unit is not expected to produce significant impact on the health of the population or cause negative deviations in the parameters that describe the prevalence of diseases or demographics.

The contribution of the new nuclear unit to the external radiation component of the radiation background in the vicinity of the town of Kozloduy is low. The cumulative impact on the environment will be negligible. Transboundary impact is not expected.

The expected impact during the decommissioning phase will be similar to the impact during the construction phase, namely negative (within the construction site), direct, primary, temporary, short-term (only during daytime until the end of the decommissioning activities), without cumulative effect and reversible. Transboundary impact is not expected.

4.11 RADIATION RISK TO THE POPULATION IN THE EVENT OF RADIOACTIVE RELEASES

4.11.1 CHARACTERISTICS OF THE ENVIRONMENTAL RISK DURING NORMAL OPERATIONS AND EXPECTED OPERATIONAL EVENTS

The evaluation of the risk to the population caused by radioactive releases during normal operation and expected operational events in the NNU includes:

- ✓ Evaluation of individual and collective doses to the population;
- ✓ Evaluation of the radiobiological effects and of the radiation risk.

The following routes of impact were considered in order to evaluate the internal and external exposure of the population in the NNU area from gaseous and aerosol releases:

- ✓ External irradiation from radioactive cloud;
- ✓ External irradiation from depositions on ground surface;
- ✓ Internal exposure by inhalation;
  - Internal exposure due to consumption of radioactively contaminated foodstuffs.

The following routes of impact were considered in order to evaluate the internal and external exposure of the population in the NNU area from liquid releases:

- ✓ Presence in/on the waters of Danube river – external exposure during swimming or boating;
- ✓ Contact with bank sediments at Danube river – external exposure to depositions on the bottom and during presence at beaches;
- ✓ Ingestion of products (fish) from Danube waters – internal exposure as a consequence of fish consumption;

- ✓ Presence on territories irrigated with water from Danube river – external exposure;
- ✓ Ingestion of vegetable products (fruits, vegetables, etc.) irrigated with water from Danube river – internal exposure;
- ✓ Ingestion of meat and milk from livestock watered with drinking water from Danube river – internal exposure;
- ✓ Ingestion of meat and milk from livestock fed with fodder irrigated with water from Danube river – internal exposure;
- ✓ Consumption of drinking water – internal exposure.

The scope of the radiation risk assessments is the following one:

(1) Risk for radiation induced cancer for the entire population and the persons in working age;

(2) Risk of hereditary diseases for the entire population and the persons in working age;

(3) Risks for and damage to certain tissues for the population as a whole;

(4) Risks of hereditary diseases for the first generation and for two generations;

(5) Risks of hereditary diseases for the reproductive part of the population evaluated for two generations with the first generation irradiated before the second one;

(6) Risks of hereditary diseases for the reproductive part of the population, evaluated for the first generation after the exposure.

4.11.1.1 DOSES FROM GASEOUS AND AEROSOL RELEASES

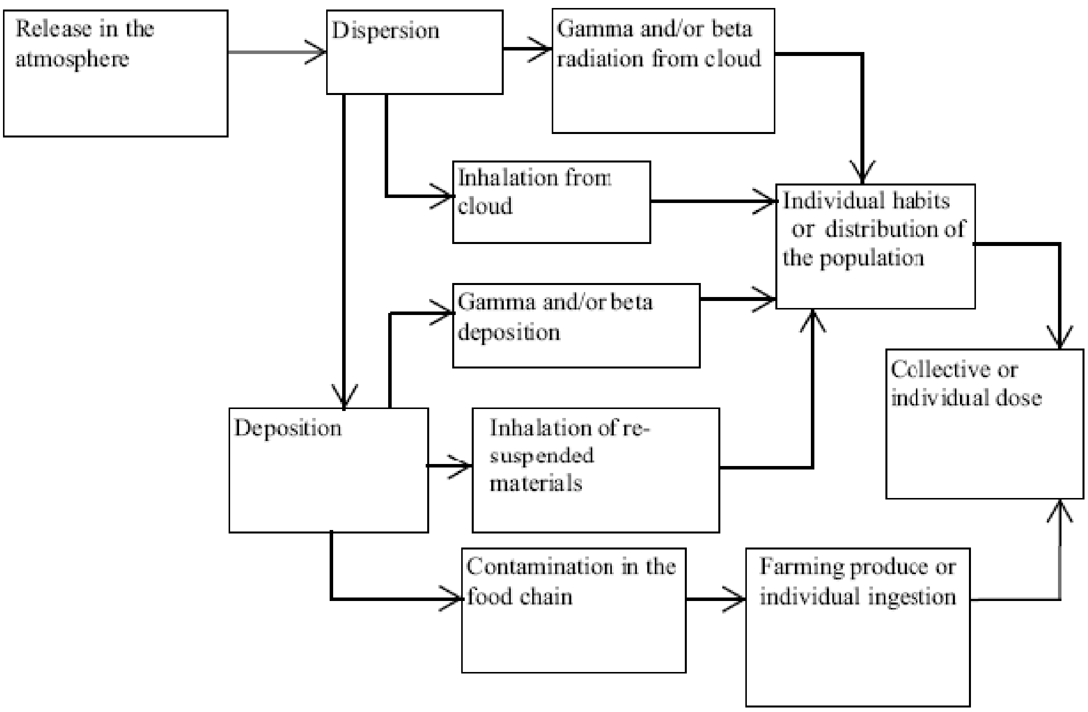


FIGURE 4.11-1: MAIN ROUTES OF RECEIVING INDIVIDUAL OR COLLECTIVE DOSES FROM GASEOUS AND AEROSOL RELEASES IN THE ATMOSPHERE

The modelling software used for evaluation of individual and collective effective doses to the population from radioactive releases in the environment are verified and validated.

Results

The evaluations made with mathematical modelling techniques demonstrate that the additional dose exposure to the population in the 30-kilometers zone from the operation of the NNU is negligibly low.

The estimated annual effective doses per capita have been compared with: the permissible norm for the population country wide 1 mSv/a (BNRP-2012); the limit for exemption from control 10 μSv/a (BNRP-2012); the limit for exposure to NPP at all operational conditions 0.05 mSv/a (NRA instruction letter no. 47-00-171/12.02.2013) and the background exposure typical of this area – 2.33 mSv/a. The statutory collective doses are benchmarked to averaged data for PWR reactors worldwide (UNSCEAR Report-2000, 2008).

The maximum individual effective annual dose in the 30 km zone from gaseous and aerosol releases, accordance to EUR, is estimated at 6.13×10^{-7} Sv/a with microclimate data. The maximum values are calculated in south-southeast direction at 2.5 km distance for age group 7-12 years.

The maximum individual effective annual dose in the 30 km zone for the design-based gaseous and aerosol releases of AR-1000 in the atmosphere are estimated at 5.99×10^{-7} Sv/a with microclimate data. The maximum values are calculated in south-southeast direction at 2.5 km distance for age group 1-2 years.

The maximum individual effective annual dose in the 30 km zone for the design-based gaseous and aerosol releases of ASE VVER-1000 in the atmosphere are estimated at 1.79×10^{-8} Sv/a with microclimate data. The maximum values are calculated in south-southeast direction at 2.5 km distance for age group 1-2 years.

Figure 4.11-2 presents the distribution of individual effective doses in the 30 km zone around Kozloduy NPP.

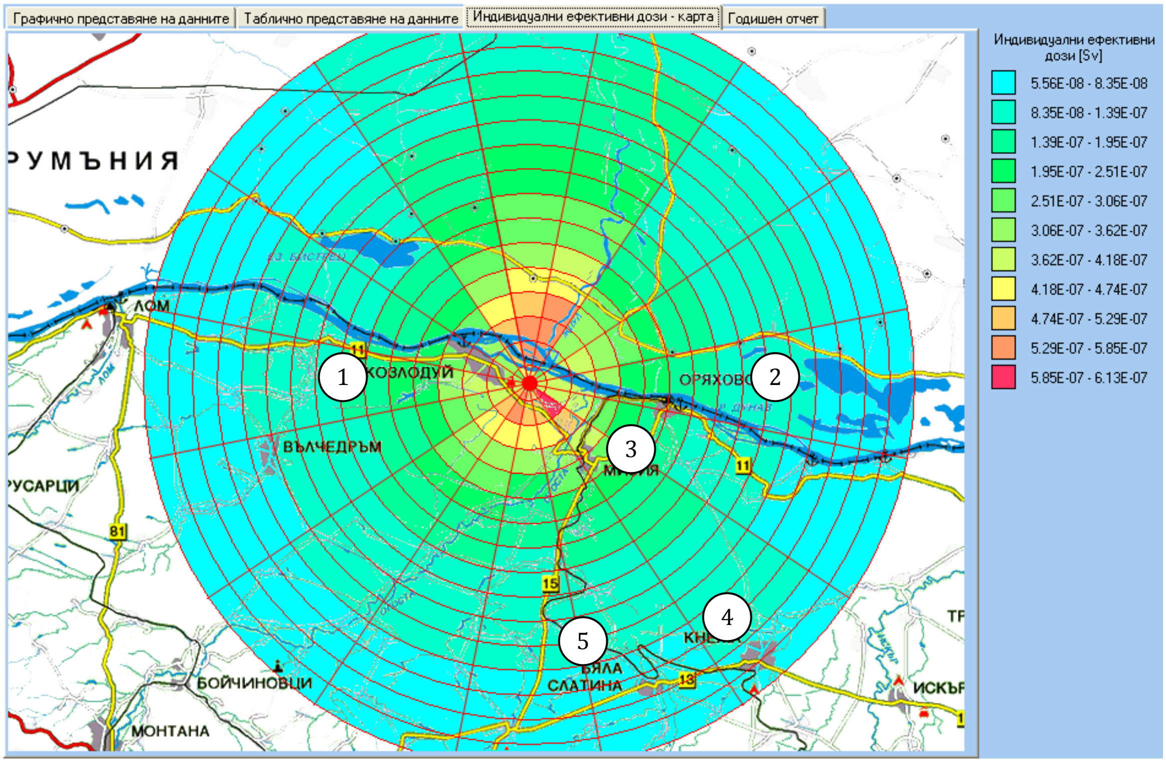


FIGURE 4.11-2: DISTRIBUTION OF THE INDIVIDUAL EFFECTIVE DOSE FOR ADULTS FOR ALL ROUTES OF EXPOSURE AND INTRODUCTION OF RADIOACTIVE EMISSIONS IN THE ATMOSPHERE IN ACCORDANCE WITH EUR, SV

Legend:
1 – Kozloduy, 2 – Oryahovo, 3 – Mizia, 4 – Knezha, 5 – Byala Slatina

The collective annual dose from radioactive emissions in the atmosphere is estimated, in accordance with EUR, at $2.49\text{x}10^{-2}$ manSv/a. The statutory collective annual dose to the population in the 30 km zone from gaseous and aerosol emissions amounts to $1.84\text{x}10^{-2}$ manSv/GW.a.

In respect to gaseous and aerosol emissions from AR 1000 in the atmosphere, the collective annual dose is estimated at $1.93\text{x}10^{-2}$ manSv/a. The statutory collective annual dose to the population in the 30 km zone from gaseous and aerosol emissions amounts to $1.79\text{x}10^{-2}$ manSv/GW.a.

In respect to gaseous and aerosol emissions from ASE VVER-1000 in the atmosphere, the collective annual dose is estimated at $1.59\text{x}10^{-4}$ manSv/a. The statutory collective annual dose to the population in the 30 km zone from gaseous and aerosol emissions amounts to $1.77.10^{-4}$ manSv/GW.a.

The NNU estimates are fully compatible with data for a large number of PWR reactors in various parts of the world (UNSCEAR–2000, 2008).

4.11.1.2 DOSES FROM LIQUID RELEASES

The liquid radioactive releases in Danube river proliferate as a result of the mainstream flows and sedimentation processes. The routes through which a radioactively contaminated water stream can affect humans are diverse, but can be assigned to two groups: external and internal exposure. The first relates to the individual's presence in the river (e.g. swimming, boating, etc.). The second one relates to human consumption of food and water and the introduction of radionuclides in the human organism via food chains containing products either directly taken from the water stream or produced with water from that stream (watering of livestock, irrigation).

All these routes are considered. Account is taken of the physical movement and dispersion of water masses, together with the radioactive decay of radionuclides. The resulting concentrations of radioactive substances in the water and the bottom depositions are used at inputs for calculation of the human intake by contact with the environment and ingestion, and the consequent individual and collective doses.

The modelling software used for evaluation of individual and collective effective doses to the population from radioactive releases in the environment are verified and validated.

Results

The maximum individual effective dose in the 30 km zone from liquid releases is estimated, in accordance with EUR, at $3.07x10^{-7}$ Sv/a, and for a representative of the critical group of the population along Danube river (town of Oryahovo, village of Leskovets, village of Ostrov and village of Gorni Vadin) it is estimated at $2.26x10^{-6}$ Sv/a.

The maximum individual effective dose in the 30 km zone for the design-based liquid releases from AR-1000 is estimated at $9.89x10^{-7}$ Sv/a, and for a representative of the critical group of the population along Danube river (town of Oryahovo, village of Leskovets, village of Ostrov and village of Gorni Vadin) it is estimated at $6.97x10^{-6}$ Sv/a.

This exposure is negligibly low and represents less than 0.7% of the annual limit of the effective dose – 1 mSv (BNRP-2012), and is hundreds of times lower than the exposure to the natural radiation background – 2.33 mSv/a. Regarding the limit of exposure to radioactive release from NNU under all operational modes (NRA guidelines given with letter No 47-00-171/12.02.2013), which is 0.05 mSv/a, the maximum estimated dose is only 2% of the quota.

The collective dose to the population in the 30 km zone from liquid radioactive releases is estimated, in accordance with EUR, at $2.45x10^{-3}$ man.Sv/a. The normalised collective dose per unit of generated electricity is $1.81x10^{-3}$ man.Sv/GW.a.

The collective dose to the population in the 30 km zone from design-based liquid releases of AR-1000 is estimated at $7.32x10^{-3}$ man.Sv/a. The normalised collective dose per unit of generated electricity is $5.42x10^{-3}$ man.Sv/GW.a.

The NNU estimates are entirely compatible with data for a large number of PWR reactors in various parts of the world (UNSCEAR–2000, 2008).

4.11.1.3 ASSESSMENT OF RADIOBIOLOGICAL EFFECTS AND RADIATION RISK FOR THE REFERENCE INDIVIDUAL

The usage of radioactive substances and ionizing radiation poses risk to human health. The risks and benefits to human health are the two sides of the application of radioactive substances and ionizing radiation. They are equally important and therefore have to be assessed concurrently. This concept makes sense, but its practical application is difficult because the risks and benefits should be quantified. For this purpose, the International Commission on Radiobiological Protection has developed a methodology for assessment of the risk from ionizing radiation.

The modelling software estimates:

Deterministic effects

These are effects such that even very low exposure levels can induce such energy in critical volumes of the cell, which would be enough to modify or destroy the cell. The death of one or few cells generally does not change the functioning of the tissue. However, changes in a single cell such as genetic modification or transformation can trigger a malignant process with serious consequences. The effects resulting from a single cell damage are termed "deterministic effects". There is certain probability of occurrence of deterministic events even at very low doses of radiation, therefore dose thresholds do not exist. Since there is no threshold, a dose level has been determined under which all damage is recoverable. As the dose increases the occurrence of such events increases too, but in the absence of other modifying factors the severity of the consequent effects is not expected to increase, and this distinguishes them from tissue reactions. The modelling software presents additional and summarised estimates of the limits of absorbed radiation at general full-body exposure of an adult individual, corresponding to 18% decease prevalence and mortality. Effects in various organs and tissues are presented depending on the time of emergence after the exposure.

Stochastic effects (Evaluation of cancer risk)

The radiation damage concept is used for quantification of the adverse genetic effects from the impact of ionizing radiation (INR) on various organs. It is determined starting from nominal risk factors, accounting for the severity of diseases as determined from mortality and years of lost life. The combined harm is the sum of the damage caused to each part of the body (tissues and/or organs).

New data regarding the risk of radiation-induced cancer and hereditary diseases have been used to model the risk and estimate the damage from the disease for the purpose of determining the nominal risk factors.

Based on these estimations, nominal risk factors accounting for cancer mortality are suggested and are equal to $5.5x10^{-2}$ Sv^{-1} for the population as a whole and $4.1x10^{-2}$ Sv^{-1} for the working population between 18 and 64 years of age. The nominal risk factors for hereditary effects, accounting for mortality, are $0.2x10^{-2}$ Sv^{-1} for the population as a whole and $0.1x10^{-2}$ Sv^{-1} for the working population.

The software provides detailed estimation of the damage: mortality, weight of non-lethal cases and relative loss of life for various cancer locations in the human body.

Risk of hereditary diseases

The term "genetic risk" refers to the probability of harmful genetic effects emerging in the offspring of a population exposed to exposure. These effects are manifested in increased background frequency of genetic diseases in the population per unit of exposure of low Linear Energy Transmission at chronic exposure to small doses.

The software provides the risk factors for the reproductive part of the population and the entire population estimated for two generations and risk factors only for the first generation after the exposure.

The modelling software used for evaluation of individual and collective effective doses to the population from radioactive releases in the environment are verified and validated.

Results

The obtained estimates of the dose impacts from NNU releases are entirely compatible with the worldwide practice according to official data (UNSCEAR-2000, 2008).

According to Census data of the National Statistical Institute, as at 01.02.2011 the population in the 30 km zone around Kozloduy NPP in the territory of Bulgaria was 65 994 persons and on the territory of Romania it was 75 150 persons. For this population, the following conclusions can be made concerning the radiobiological effects and radiation risk resulting from the operation of the NNU:

Deterministic effects

There is no risk for development of deterministic effects for the population in the 30 km zone around Kozloduy NPP.

The individual doses from gaseous and aerosol releases are in the range of $1.79x10^{-8}$ – $6.13x10^{-7}$ Sv.

These doses are much lower than the threshold determined in BNRP Art. 10 as a limit of the annual effective dose, which is 1 mSv for the population.

On this basis it can be maintained that there is no risk for development of deterministic effects for the population in the 30 km zone around Kozloduy NPP.

Stochastic effects

The risk of stochastic effects is negligibly low.

The probability of occurrence of radiation-induced cancer for the entire population is accordingly: $3.29x10^{-8}$ for AR-1000, $9.85x10^{-10}$ for AES VVER-1000/B466 and $3.37x10^{-8}$ for EUR release limits, and the probability of hereditary diseases is accordingly: $1.2x10^{-9}$ for AP-1000, $3.58x10^{-11}$ for AES VVER-1000/B466 and $1.23x10^{-9}$ for EUR release limits.

4.11.2 CONCLUSION

In terms of the Project's dose impact both technology alternatives conform to the regulatory requirements and the instructions of the NRA, namely that the annual individual effective dose per capita caused by the impacts of liquid and gaseous releases in the environment at all operational conditions must be limited to 0.05 mSv (letter no. 47-00-171/12.02.2013).

There is no risk to the population during the construction phase.

The radiation risk to the population during the operations phase is one of very low probability, temporary, short-term, without cumulative effect and reversible.

Radiation risk for the population during the decommissioning phase is not expected.

4.12 EXPECTED IMPACTS ON SITES OF IMMOVABLE CULTURAL AND HISTORICAL HERITAGE

The impact on immovable cultural heritage is expected to be direct.

4.12.1 IMPACTS DURING THE CONSTRUCTION PHASE

During the construction phase: Earthmoving works for massive structures, fixed underground and aboveground utilities, etc. are related to irreversible damage to the genuine landscape and the existing land surface. The construction of facilities on embankments suggests full-fledged damage of the landscape and surface that have taken millennia to form. The usage of lands as depots for earth, inert and other materials and for disposal of building and other waste also involves damage to the existing surface.

Archaeological artefacts and various types of remains from ancient anthropological activity are contained exactly in subsurface depositions in the soil. The archaeological structures created as a result of ancient inhabitancy and activity are very frequently of "negative" nature (buried under the level of the ancient terrain), i.e. they cannot be seen and identified by visual inspection of the surface, especially when the terrain is overgrown with vegetation or covered with artificial embankments made in present times.

If **Sites 1 and 2** are selected, cultural and historic assets unknown thus far may be discovered.

The selection of **Site 3** may lead to the discovery of archaeological sites and structures related with the usage of *Via Danubiana* in the Roman epoch and the Roman fortress in the locality Magura Piatra (Regiana). There can also be sites and structures of "negative" nature, which do not have observable traces on the present surface (from prehistoric or early medieval times).

4.12.2 IMPACTS DURING THE OPERATIONS PHASE

During the operations phase direct impacts are not expected, unless it becomes necessary to "acquire" new lands for operational purposes. Cumulative impact is not expected.

4.12.3 IMPACT DURING THE DECOMMISSIONING PHASE

During the decommissioning phase: Impacts are not expected, unless there are plans to use new areas with undamaged genuine surface.

The expected impact on sites of cultural heritage by activities related with construction of new assets (at any of the sites) is evaluated as **direct, positive (**the discovered artefacts will be in the public domain**) and highly important** for the preservation of the cultural and historic heritage.

5 CUMULATIVE IMPACT

The cumulative (combined) impact has been assessed by analyzing the dose burden on the population in the 30 km zone around Kozloduy NPP from gaseous, aerosol and liquid radioactive releases in the environment during normal operation and during expected operational events in all units and facilities/operations which exist or will exist at the Kozloduy NPP site (units 5 and 6 of the NPP, decommissioning of units 1 to 4, Spent Fuel Storage Facility, Dry Storage for Spent Nuclear Fuel and National Storage for Burial of Radioactive Waste, emissions from the Plasma Incineration Facility (PIF) and the NNU).

The assessment of the risk to the population posed by radioactive releases includes:

- ✓ Assessment of individual and collective doses for the population;
- ✓ Assessment of radiobiological effects and radioactive risk.

The following routes of impact were considered in order to evaluate the internal and external exposure of the population in the NNU area from gaseous and aerosol releases:

- ✓ External exposure to radioactive cloud;
- ✓ External exposure to depositions on the ground surface;
- ✓ Internal exposure by inhalation;
- ✓ Internal exposure due to consumption of radioactively contaminated foodstuffs.

The following routes of impact were considered in order to evaluate the internal and external exposure of the population in the NNU area from liquid releases:

- ✓ Presence in/on the waters of Danube river – external exposure during swimming or boating;

- ✓ Contact with bank sediments at Danube river – external exposure to depositions on the bottom and during presence at beaches;
- ✓ Ingestion of products (fish) from Danube waters – internal exposure as a consequence of fish consumption;
- ✓ Presence on territories irrigated with water from Danube river – external exposure;
- ✓ Ingestion of vegetable products (fruits, vegetables, etc.) irrigated with water from Danube river – internal exposure;
- ✓ Ingestion of meat and milk from livestock watered with drinking water from Danube river – internal exposure;
- ✓ Ingestion of meat and milk from livestock fed with fodder irrigated with water from Danube river – internal exposure;
- ✓ Consumption of drinking water – internal exposure.

The scope of the radiation risk assessments is the following one:

1. Risk for radiation induced cancer for the entire population and the persons in working age;
2. Risk of hereditary diseases for the entire population and the persons in working age;
3. Risks for and damage to certain tissues for the population as a whole;
4. Risks of hereditary diseases for the first generation and for two generations;
5. Risks of hereditary diseases for the reproductive part of the population evaluated for two generations with the first generation irradiated before the second one;
6. Risks of hereditary diseases for the reproductive part of the population, evaluated for the first generation after the exposure.

Assessment of radiobiological effects and radiation risk

According to Census data of the National Statistical Institute, as at 01.02.2011 the population in the 30 km zone around Kozloduy NPP in the territory of Bulgaria was 65 994 persons and on the territory of Romania it was 75 150 persons. For this population, the following conclusions can be made concerning the radiobiological effects and radiation risk resulting from the cumulative impact of the existing and new nuclear capacities:

- ✓ There is no risk for development of exposure induced diseases such as: radiation disease, impairment of eyesight, lasting female sterility, lasting male sterility, etc. These results are absolutely dependent on the dose, and the calculated doses are much lower than the threshold determined in BNRP Art. 10 as a limit of the annual effective dose, which is 1 mSv for the population.

On this basis it can be maintained that the estimated risk for development of radiation induced cancer for the population in the 30 km zone around Kozloduy NPP is negligible.

6 CHARACTERISTICS OF ENVIRONMENTAL RISKS FROM POTENTIAL ACCIDENTS AND INCIDENTS

In accordance with the *Basic Norms of Radiation Protection* (BNRP-2012) and the internationally adopted definitions of events at nuclear plants, an accident is every unplanned event (including operational error, failure of device or equipment or other incident), the consequences (or potential consequences) of which cannot be neglected from the perspective of protection and safety, and can lead to potential exposure.

6.1 CHARACTERISTICS OF THE EVENTS ACCORDING TO THE INTERNATIONAL CLASSIFICATION SCALE

The International Nuclear Event Scale (INES) was introduced in March 1990 by the International Atomic Energy Agency (IAEA) and the Nuclear Energy Agency of the Organisation for Economic Cooperation and Development (OECD/NEA).

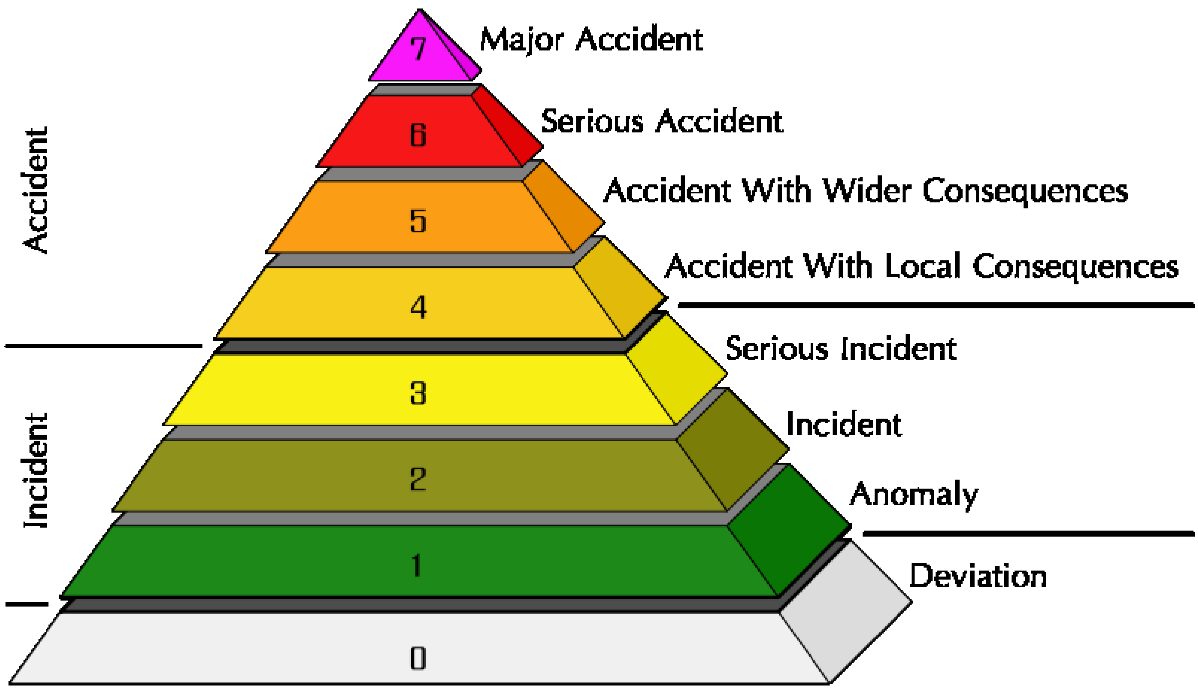


FIGURE 6.1-1: INES SCALE FOR EVALUATION OF NUCLEAR EVENTS

The scale (**Figure 6.1-1**) includes events building up to seven levels: the top levels (from 4 to 7) are termed “Accidents”, the low levels are “Incidents”. Events without any consequence to nuclear safety are assigned to level 0 (below scale) and are termed “Deviations”. Events which are not related with safety are designated as “Out of scale”).

By March 2011, there was one registered accident of level 7 (Chernobyl) and one accident of level 6 (the accident at Nuclear Complex Mayak). On 12 April 2011 the Japanese Nuclear and Industrial Safety Agency declared "provisionally" that the Fukushima accident is of level 7.

Not a single event higher than level 2 by the INES scale has been registered for the entire period of operation of the existing capacities (nearly 150 reactor-years) at the Kozloduy NPP site. The total number of registered and reported events is 52 events of level 1 and 2 events of level 2. Additional radiological impacts beyond the Kozloduy NPP site have not been identified for any of these events.

6.1.1 DESIGN-BASED ACCIDENT

Meteorological conditions of scenario 1 were selected for assessment of the impact of design-based accidents. Two different heights of release are chosen. The high release was modelled at 100 m and the aboveground release was modelled at 45 m.

6.1.2 MAJOR ACCIDENT

The two meteorological scenarios were used for modelling the effect of a major accident, long-term measures were modelled on the basis of scenario 1 with rainfalls that aggravate the short-range impact.

Urgent protective action can be expected in the event of major accident. The size of the potential evacuation zone is maximum 1 km. The size of the potential shelter zone is maximum 8 km.

The contribution of the estimated ingestion to the total dose is approximately 52% at the border of the emergency planning zone at 12-14 km and 71% at 45-50 km.

6.1.3 CONCLUSION

The radiological outcomes from the analysed accidents, as can be concluded from the conducted analyses, demonstrate that the environmental risks are acceptable.

The assessment of design accidents demonstrates that for any hypothetical design-based accident the level of exposure of the population would not require any urgent protective action even in the inhabitable zones that are most proximal to NNU – Kozloduy town.

The models of the radiological effects of major accidents did not exceed the threshold values which trigger urgent protective action beyond the boundaries of the existing emergency planning zones of Kozloduy NPP.

As concerns follow-up protective measures, lasting resettlement is not expected even in the nearest populated zone around NNU – Kozloduy town . In this case, one should not exclude regulation of the distribution and consumption of agricultural products within 30 kilometres from the source depending on the direction of the contamination.

In conclusion it should be summarised that, in accordance with the expectations, more than half of the entire exposure will be incurred by ingestion. Accordingly, it should be concluded that the imposition of short-term restrictions for consumption of locally grown/bred products would be extremely important for reducing the received dose.

The actual scope and place of follow-up protective measures will be contingent on the movement and development of the accident and the actual meteorological conditions, while the long-term measures will depend on the results of comprehensive monitoring of the affected territory.

The assessment of design-based accidents demonstrates that for any hypothetical design-based accident the levels of exposure of the population would not require any urgent protective action even in the inhabitable zones that are most proximal to NNU Kozloduy.

6.2 POSITION RELATIVE TO THE EXISTING EMERGENCY PLANNING ZONES

The concrete situation around Kozloduy NPP is such that the nearest populated zone is far from the 800 meters perimeter around the building of the future reactor and the distance can reach nearly 3 kilometer depending on which potential site will be preferred. Accordingly, the potentially most threatened area is not inhabited.

The analysis of the operational experience of Kozloduy NPP EAD demonstrates that the plant has developed strong administrative capacity, including capacity for accident and incident responses. Kozloduy NPP EAD has developed documents which regulate reporting procedures and responsibilities, analysis and assignment of operational events and control on the implementation of the corrective measures.

According to the emergency plan, the emergency zones are the following ones:

- ✓ On-site emergency planning zone – protected zone. This is Zone 1 at Kozloduy NPP EAD site.
  The inclusion of new nuclear unit may have an impact on Zone 1 as the on-site protected zone can be preserved or increased, or the zone can even be divided and a new on-site protected zone created depending on which construction site and technology is selected.
- ✓ Precautionary protective action planning zone (PAZ). This is Zone 2 with a radius of 2 km and centre between the pipelines of units 5 and 6.
  The protected zone will be defined in accordance with the following criteria:
  1. The annual individual effective dose to the population during normal operation of the nuclear unit or INR facility must not exceed the regulatory dose thresholds set in Art. 36(3) of the *Act on the Safe Use of Nuclear Energy*.
  2. The annual individual effective dose in the event of design-based accident must not exceed 5 mSv outside the boundaries of the radiation-protected zone.
- ✓ According to the EUR requirements the radius of the radiation protection area around the building, in which the reactors are located, is 800 m. In all three alternatives of the reactors the borders of this area meet EUR. According to the

requirements of the legislation of the Republic of Bulgaria this area correspond to ZPPM (zone for preventive protection measures)

6.3 ASSESSMENT OF THE PARAMETERS OF ANTHROPOGENIC IMPACTS ON THE SITE OF THE PLANT

6.3.1 AIRCRAFT IMPACT

Two main scenarios for Aircraft Impact events can be considered: accidental fall of airplane on the territory of the plant and malignant deliberate targeting of aircraft to a specific facility with the site of the plant.

The risk of airplane falling on the site depends on the intensity of air traffic (number of flights) in the space around the site and the frequency of aircraft accidents (number of accidents to number of flights). For the purpose of this study, statistical data has been compiled of civil flights in the 30 and 100 kilometre zones around Kozloduy NPP. The detailed assessment in the EIAR demonstrates that Airplane Fall hazard **cannot be generated** in these zones for the sites under consideration and **airplane fall impacts cannot be expected.**

6.3.2 LEAKAGE OF DANGEROUS LIQUIDS AND GASES

Leakage of dangerous (explosive, flammable, corrosive and toxic) liquids and gases in proximity to the site is another event which may lead to problems with the safety of the new nuclear unit.

The risk analysis demonstrates low probability of occurrence of emergency situations and accordingly impacts are not expected.

6.3.3 EXTERNAL FLOODING

The sources of eventual external flooding are the maximum natural high waters of Danube river, destruction of walls of the Iron Gates Hydro Complex, accident at Shishmanov Val Dam, slope waters from locality Marishkin Dol, waters from the affluent valley Marichin Dol and continuous torrential rain at the site of the plant.

The analyses made in the document EUROPEAN STRESS TESTS FOR NUCLEAR PLANTS, 2010, National report for Bulgaria confirm that the requirements of the *Regulation on ensuring the safety of nuclear power plants* are complied with. The maximum water level (MWL) and its duration is defined, the probability of ice damming of the river is explored and the potential combination of MWL with other adverse phenomena is assessed. The analysis of the results confirms that **the Kozloduy NPP site is non-flooded**. This conclusion equally applies to the proposed alternatives for NNU sites.

6.3.4 EXTREME WINDS AND TORNADO

The most frequent winds in the area of Kozloduy NPP are the west winds followed by east and northwest winds. At incidence P=1% (1 time in 100 years) the maximum wind speed in Kozloduy and Oryahovo is accordingly 37-42 m/s. The prevailing winds are western with frequency 34.9-35.5% and speeds 4.2-5.6 m/s.

The probability of a tornado sweeping over an area of 100 000 km^2 in one year is estimated at $5.05x10^{-6}$.

Therefore impacts are not expected because these impacts will be accounted for in the future designs of the NNU structures and facilities for nuclear and radiation safety.

6.3.5 FIRE RISK

Facilities at the Kozloduy NPP site

Significant amounts of flammable liquids are kept within the territory of the NPP, under certain conditions these can leak from their storage tanks, ignite and develop into complicated fires. Such fires may occur mainly in the Diesel and Oils Storage Yard, as significant amounts of diesel fuel and oils are stored there. The document **Analysis of the probability of occurrence of industrial accidents outside the buildings of the generation units in the territory of Kozloduy NPP EAD, 2007** establishes that, at the Kozloduy NPP site, **subject to compliance with the fire fighting rules regarding the availability of media for extinguishing fires caused by flammable materials and other dangerous substances, the impact will be localized to the site of the event, temporary, short-term and reversible.**

6.4 NON-RADIATION RISKS DURING THE CONSTRUCTION PHASE

The above-described risks are not applicable in the construction period. The usual risks associated with building or structural works can be addressed with the usual means for these types of activities.

6.5 NON-RADIATION RISKS DURING THE NNU OPERATIONS PHASE

The operation of the NNU, after the extension of the NPP, is not a risk factor to be considered in the context of the probability of occurrence of emergences that may have significant negative consequences for the environment and the population.

6.6 NON-RADIATION RISKS DURING THE NNU DECOMMISSIONING PHASE

The risks during the decommissioning period would not be greater than those during the preparation and implementation of the IP and in this case it should not be expected that there is a need for applying measures other than the usual ones.

7 DETAILS ON THE METHODOLOGIES USED FOR FORECASTING AND ASSESSMENT OF THE ENVIRONMENTAL IMPACT

Several generic methods typical of these types of assessments have been used in the production of the report on the environmental impacts of proposed Investment Project, namely:

- ✓ Desktop analysis of textual, graphic and visual information;
- ✓ Comprehensive multi-factor analysis of natural and anthropogenic components of the environment and their interaction;
- ✓ Comprehensive evaluation by panel of experts;
- ✓ Geographic information system.

7.1 METHODOLOGIES USED FOR FORECASTING AND ASSESSMENT OF IMPACTS

The specific methods on the basis of which the experts have developed their estimates for the environmental impacts of the IP are provided in the EIAR.

7.2 JUSTIFICATION OF THE SELECTED ALTERNATIVE

7.2.1 JUSTIFICATION OF THE SELECTED ALTERATIVE IN TERMS OF LOCATION

The 4 alternative sites proposed for construction of the NNU have been pre-selected by criteria, which exclude territories that are prohibited by regulatory acts and inconsistent with the environment protection legislation.

The assessments made in the EIAR of impact on the components and factors of the environment, as shown in the matrix for evaluation of potential impacts from the implementation of the proposed Investment Project (chapter 4, **Table 4.13-1**), were used as basis for developing an integrated approach for selecting one of the alternative sites, using a colour coding system. Green boxes mean that the IP is not expected to have impact on the corresponding component or factor of the environment, and white to dark pink boxes denote the level of the expected impact on a scale of 1 to 5.

Positive impact is expected only from the **Immovable cultural heritage** component, which is coloured in blue.

In selecting the site, priority is given to the one which has the lowest level of impact and ensures greatest extent of personnel, population and environment safety, as per **Table 7.2-1**.

It can be concluded from the table that **SITE 2 stands out as the most appropriate one and is proposed to host the NNU.**

TABLE 7.2-1: ASSESSMENT OF THE EXTENT OF IMPACT OF THE INDIVIDUAL SITES

No	PHASE	Ambient air	Surface water	Ground water	Lands and soils, non-radioactive	Soils, radioactive	Subsurface	Landscape	Non-radioactive waste	Solid and liquid RAW	Dangerous substances	Flora	Fauna	Noise	Non-ionizing radiation	Health and sanitary aspects. Personnel	Health and sanitary aspects. Population	Cultural heritage
Site 1	Construction				2							2	2			2		
	Operation		2							2						2		
	Decommissioning			2						2						2		
Site 2	Construction				2									2		2		
	Operation		2							2				2		2		
	Decommissioning			2						2						2		
Site 3	Construction				2							2	2	2		2		
	Operation		2							2				2		2		
	Decommissioning			2						2						2		
Site 4	Construction				2											2		
	Operation		2							2						2		
	Decommissioning			2						2						2		

7.2.2 ALTERNATIVE SOLUTIONS FOR SUPPORTING INFRASTRUCTURE DURING THE CONSTRUCTION AND OPERATIONS PHASE

The planning of the proposed IP construction site must take into account several very important parameters: the absolute elevation of the presently operational site of the plant, which is +35.00 meters as per the Baltic System, the connection of the site designated for the NNU with existing facilities which are important for its operation – link with the Cold channel (CC) and Hot channel (HC), engineering utilisation and connection to the power grid by Outdoor Switchgear Arrangement (OSGA), form of ownership of the land that has to be acquired, access by road vehicles that will be needed via branches from the existing roads, etc.

Table 7.2-2 presents the outcome of the developed evaluation approach. The columns represent the suitability criteria and lines **(1)**÷**(4)** present the ratings (from 1 to 5) of the suitability of the alternative sites in terms of supporting infrastructure.

TABLE 7.2-2: ANALYSIS OF SUITABILITY OF THE ALTERNATIVE SITES

Site	Connection to OSGA	Connection to old TK-1	Connection to SK-1	Floodability of the site	Demolition of existing infrastructure	Suitable for construction of NNU	Required land acquisition	Connection to existing access roads	INTEGRATED rating	% comparison	Line no.
Rank of the criterion	**4**	**5**	**5**	**5**	**2**	**2**	**3**	**3**			**(0)**
	Rate (1÷5 points)										
Site 1	2	3	5	1	3	4	3	4	25		**(1)**
Site 2	4	5	4	4	4	4	2	4	31		**(2)**
Site 3	1	1	1	1	2	4	1	4	15		**(3)**
Site 4	4	2	4	4	1	1	5	4	25		**(4)**
	Weighted rating (rate * rank)										
Site 1	8	15	25	5	6	8	9	12	88	25.4%	**(5)**
Site 2	16	25	20	20	8	8	6	12	**115**	**33.2%**	**(6)**
Site 3	4	5	5	5	4	8	3	12	46	13.3%	**(7)**
Site 4	16	10	20	20	2	2	15	12	97	28.0%	**(8)**

For greater precision, line **(0)** of the table assigns a rank to each criterion, which represents the weight of the criterion in the integrated rating.

Lines **(5)**÷**(8)** present the final suitability of the alternative sites expressed in per cent.

As seen from the table, the **most suitable** site for construction of the NNU in terms of connectivity with the existing facilities at Kozloduy NPP is **SITE 2** with suitability rating **33.2 %.**

7.2.3 ALTERNATIVES IN TERMS OF EQUIPMENT TO BE USED FOR THE NEW NUCLEAR UNIT

According to the Customer's Terms of Reference, there are two possible options for implementation of the IP and accordingly for building a new nuclear unit with a reactor of latest generation (generation III or III+), which is compliant with the contemporary requirements for safe operation:

- → **A-1**: (Hybrid) Maximum usage of the nuclear island equipment ordered for NPP Belene and turbine island from another supplier;
- **A-2**: Brand new project with two reactor models: AES-2006 and AR-1000, which must conform to the safety criteria laid down in the Bulgarian regulatory documents, the documents of the IAEA and the European Utility Requirements (EUR) for LWR Nuclear Power Plants.

Not all components and factors of the environment are subject to impact from the type of equipment, because all the 3 proposed options comply with the requirements of the European utility organisations for NPPs with light water reactors. The factors that can be expected to have quantifiable impact are provided in **Table 7.2-3**.

TABLE 7.2-3: ASSESSMENT OF EQUIPMENT OPTIONS

Reactor type	PHASE	Water requirement	Pollution burden	RAW management	Radioactive risk
		Non-radiation aspect		Radiation aspect	
AES-92	Operation				
	Decommissioning				
AP-1000	Operation				
	Decommissioning				
AES-2006	Operation				
	Decommissioning				

The non-radiation is assessed by two indicators: process water required (for the turbine's condensers and for the processes at the Plant for chemical treatment of water) and pollution burden (BOD5, non-dissolved substances, COD, other chemical substances), and the radiation aspect is evaluated in respect to the management of RAW and radiation risk on the basis of the modelled impact of gaseous-aerosol and liquid releases from each type of reactor.

Light green boxes mean that the reactor has the lowest value for the particular indicator (better than the rest) and dark green boxes denote higher assessed value of the corresponding indicator.

All the types of reactors comply with the requirements of the European utility organisations for NPPs with light water reactors, i.e. they do not exceed any norms and therefore, as concerns **protection of the environment (ecological aspect),** the three reactor models are acceptable for implementation of the IP.

7.3 CONCLUSION

The assessment of the criteria relating to the components and factors that have an impact on the environment and its protection, including biological diversity, identifies Site 2 as the priority choice for construction of the NNU.

As concerns the type of reactor, no specific model can be identified because all the three technical solutions are appropriate options for implementation of the proposed investment project.

8 DESCRIPTION OF THE MEASURES DESIGNED TO PREVENT, MITIGATE AND WHERE POSSIBLE ELIMINATE THE SIGNIFICANT HARMFUL ENVIRONMENTAL IMPACTS, IN RADIATION AND NON-RADIATION ASPECT, AND PLAN FOR IMPLEMENTATION OF THESE MEASURES

8.1 MEASURES AND PLAN FOR THEIR IMPLEMENTATION

The next table describes the measures designed to prevent, mitigate and where possible eliminate the significant harmful environmental impacts, in radiation and non-radiation aspect, and the plan for implementation of these measures.

D – design; **C** – construction and installation works; **O** – operation, **DC**- decommissioning

Table 8.1-1: Plan for implementation of the measures

No.	Measures	Period (phase) of implementation	Result
1. Ambient air			
1.1	Develop a Plan for organisation of the transport scheme	C, O and DC	Reduced harmful emissions of exhaust gases in the atmosphere and minimised harmful impacts on the ambient air in the area.
1.2	Maintain the construction and transport equipment/vehicles in good working order	C, O, and DC	Protection of air and the health of workers and population.
1.3	The equipment and vehicles to be used must satisfy the requirements of *Regulation no. 10/2004 on the measures for reduction of gaseous and dust pollutants from internal combustion engines installed on off-road and construction machines* (State Gazette 11/2004).	C, O and DC	Reduced harmful emissions of exhaust gases in the atmosphere and minimised harmful impacts on the ambient air in the area.
1.4	Do not overload vehicles with earth and gravel	C and DC During loading	Avoidance of spillage, crushing or grinding of these materials, because they become additional sources of unmanaged dust emissions.
1.5	Do not let the engines of machines and vehicles work at idle run.	C, O, DC	Reduced harmful emissions of harmful gases in the atmosphere. Protection of air and the health of workers and population.
1.6	Use a (mobile) sprinkling system to suppress dust emissions during the relevant operations (loading/unloading, excavation, piling, etc.).	C, DC	Reduced dust content in the ambient air. Protection of the health of personnel working in the area.
1.7	Sprinkle the storage yards for building materials in bulk form (mainly sand) and building waste during dry and windy weather.	C, DC Depending on the meteo situation	
1.8	1. Coordinate the transport scheme with local municipalities and mayoralties. 2. Restrict the passage of heavy traffic through populated settlements. If this is inevitable, ensure fast and unobstructed transit through the populated settlement at even speed (without stops and speed limits).	C and DC	Stable temperature mode of the engine, at which the emissions of pollutants are at very low levels.
1.9	Trucks carrying excavated earth,	C, DC	Avoidance of dust emissions.

No.	Measures	Period (phase) of implementation	Result
	building materials, building waste etc. must be covered with canvas.		
1.10	Use diesel fuel of low sulphur content.	C, O, DC	Less sulphur oxides in the atmosphere.
1.11	Clean up (rehabilitate) the storage yards for building materials in bulk immediately after the conclusion of construction works.	Immediately after the conclusion of C, DC	Protection of air. Waste management.
2. Surface and ground water			
2.1	Black and grey water must be discharged in chemical toilets until the construction of WWTP with capacity sufficient to take and process the locally generated black and grey water during the construction and operation of the NNU.	D, C	Protection of waters against pollution.
2.2	1. Maintain the electromechanical equipment of waste water treatment plants in good working order. 2. Develop and ensure compliance with operation manuals for all waste water treatment plants.	O, DC	Optimised management of the operation of the plant.
2.3	Prevent contamination of water during the construction, operation and decommissioning of the IP.	C, O, DC	Minimised impact of the project on water and biodiversity in the area.
2.4	The Sewerage system must be executed in materials of high resistance to permeation of water.	D, C	Protection of groundwater and subsurface from penetration of pollutants.
2.5	Design and execute the concrete structures in waterproof concrete.	D, ,C	Prevention of leaks. Protection of soil and groundwater against pollution.
2.6	Provide special yard/compound for parking the construction machines/vehicles such as to prevent pollution of surface and groundwater with petroleum products.	D, C	Protection of soils, groundwater and surface water against pollution with petroleum products.
2.7	Design and implement an appropriate technical solution for supply of drinking water from the existing water system of the plant and process water for cooling and other purposes from exiting	D, C	1. Minimised impact of the project on the quantity and quality of water in the area. 2. Avoidance of the risk of over-exploitation of groundwater.

No.	Measures	Period (phase) of implementation	Result
	waterworks.		
2.8	Construct separate wastewater systems grey/black water, industrial wastewater and rainwater with buffer reservoirs for retention of rainwater.	D, C	Prevention of pollution and surface water and soil.
2.9	Design and construct a dewatering system for the groundwater.	D, C	Protection of pits/excavations from harmful water impacts.
2.10	1. Design and construct a drainage system for discharging the water as part of the NNU monitoring system. 2. Drained waters should be discharged in Danube river only after they are captured in retention sump and after quality control.	D, C, ,O, DC	Protection from harmful water impacts.
2.11	Obtain new or amend existing Permits required by the Water Act.	D, C, O, DC	Compliance with all regulatory requirements for the protection of surface and groundwater.
2.12	Design and construct a NNU surface and groundwater monitoring system as part of the monitoring system of Kozloduy NPP, which will operate during the operation and decommissioning of the NNU.	D, C, O, DC	Efficient control of water status. Prevention of pollution.
3.Subsurface			
3.1	NNU designs must be based on up-to-date engineering-geological and hydrogeological surveys.	D	Appropriate designs not admitting major and uneven sinking of soil and protection of subsurface and groundwater.
3.2	Structural design must be made in accordance with the norms for seismic-resistant designs and construction of nuclear facilities based on the seismic characteristics of the area where the sites are located.	D	Structures will be able to withstand maximum possible design-based seismic event without compromising the structural integrity of the facilities or causing lasting loss of operability.
3.3	Construct cement-soil cushion (bed) under the fundaments of the NNU.	C	Increased the load-bearing capacity of the base, elimination of collapsibility of loess soils and establishment of barrier to in-depth penetration of radio-nuclides.
3.4	Ensure continuous monitoring of the groundwater table (GWT) and maintain it at natural level by eliminating the causes of water	C, O, DC	1. Prevention of GWT surge. 2. Preservation of the stability of the ground base and prevention of the shortening of the path by

No.	Measures	Period (phase) of implementation	Result
	surge.		which radionuclides can reach groundwater.
4. Land and soil			
4.1	**Non-radiation aspect**		
4.1.1	Humus must be stored apart from other earth.	C	Preservation of the soil layer.
4.1.1	Minimise the temporary and permanent acquisition of land stock.	D – Pre-study	Preservation of the land and forest fund.
4..1.3	Use part of the excavated earth for backfills, for repair of damage during construction works and for landscape rehabilitation.	D, C	Phased rehabilitation of damaged terrains.
4.1.4	Rehabilitate the territory affected by the construction works, erase the temporary sites and depots for excavated earth and recover the damaged soil and vegetation blanket.	D, C	Rehabilitation of the damaged soil blanket and landscape in the area.
4.1.5	Strengthen the damaged terrains with local plants/vegetation.	D, C	Preservation of plants/vegetation typical of the region.
4.1.6	Arrange for change of the land-use of the land affected by the project and plant greenery on vacant spaces.	D, C	Compliance with regulatory requirements.
4.1.7	Ensure maximum use of humus stocks with minimum damage of soils on adjacent terrains.	D, C	Preservation not only of the soils in the territory of the site, but also those of adjacent terrains.
4.1.8	Do not violate the boundaries of the site.	C, DC	
4.1.9	Do not pollute with building materials the soils outside the territory of the site.	C, DC	Preservation of soils
4.1.10	Do not dispose residential and other waste at places other than the ones designated for this purpose.	C, E, ИЕ	Preservation of soils
4.1.11	In selecting the new access/ service roads of the selected NNU site provide measures for free runoff and drainage of surface water.		Reduced risk of flooding and minimized degradation processes such as swamping/formation of marshes.
4.1.12	Rehabilitate the damaged terrains at the site and reuse humus collected before the construction works and stored at dedicated depot.	C, O. DC	Rehabilitation of the damaged soil blanket and landscape in the area.
4.1.13	Full rehabilitation of damaged terrains after the end of the	DC	Rehabilitation of the damaged soil blanket and landscape in the area.

No.	Measures	Period (phase) of implementation	Result
	operational life of the NNU.		
4.2	**Radiation aspect**		
4.2.1	Identify the initial radiological status of the soils.	D, before C	Prevention of population and protection of the environment.
4.2.2	Prepare and regularly update soil monitoring plan.	O, DC	Optimised protection of environment, soils and population.
4.2.3	To reduce the penetration of radioactive isotopes from soil to plants: introduce lime in the soil, introduce organic fertilizers, use mineral and micro-fertilizers.	O, DC	Prevention and ensuring production of safe foods for population and livestock. Minimised impact on environment, soils and water.
4.2.5	Select crops and varieties, which accumulate radioactive elements to a lesser extent.	O	Minimised impact on environment, soils and water.
4.2.6	Apply methods based on the usage of natural materials – natural zeolites or non-traditional chemical compounds.	O, DC	Prevention of radioactive impacts on soils and water.
4.2.7	Ensure that soils are monitored on monthly basis. Dispose low to medium radioactive, short-life soils, verified by measurements, in the Lime Yard.	DC	Safe storage and minimized impact on the environment.
4.2.8	Rehabilitate affected soils and recover damaged soil blanket with soils, the physicochemical properties of which imply lower transfer ratios.	C, DC	Rehabilitation of damages and contaminated soils in strict compliance with the regulatory requirements.
4.2.9	Strengthen the damaged terrains with local plants/vegetation.	D, C	Preservation of plants/vegetation typical of the region.
5. Landscape			
5.1	As part of the decommissioning stage, develop a plan for landscaping of the territory.	D	Preservation of landscape
5.2	Do not pollute adjacent landscapes with spills of fuels and oils from the equipment used at the construction site.	CMP, DC	Preservation of landscape
5.3	During and after the construction phase take measures to rehabilitate the damaged terrains and landscape them with suitable plants/vegetation.	D, CMP, O, DC	Preservation of landscape
5.4	Ensure biological and technical rehabilitation and apply the plan for landscaping of the territory.	3	Preservation of landscape
6. Biodiversity. Protected territories			
6.1	Carry out regular monitoring on the ecological status of the	C, O	Control on the quality of water and timely reporting to the MoEW and

No.	Measures	Period (phase) of implementation	Result
	Danube in the NPP area.		other supervisory bodies any unauthorised sources of pollution with organic and inert substances.
6.2	Carry out monitoring of any invasive alien species in the NPP port area during the construction of the NNU.	C	Invasive alien species will be identified immediately after their introduction and if necessary measures for their extermination will be proposed as well as preventive and control measures for reducing the cumulative effect with navigation.
6.3	Carry out regular monitoring of any invasive alien species in the NPP area of Danube river area during the operation of the NNU.	E	Invasive alien species will be identified immediately after their introduction and if necessary measures for their extermination will be proposed as well as prevention and control measures for reducing the risk of introduction of new invasive alien species and the impact on the ones that are already settled in the zone, and to reduce the cumulative effect with thermal burden of the water.
6.4	Ensure regular mechanical cleaning of the hot channels especially in the event of blossoming, foul, formation of mussel clusters, etc.	C, O	Destruction of newly introduced aquatic invasive species and control in order to reduce their impact on the ones that are already settled.
6.5	Ensure that the ships carrying fuel are cleaned before they enter the area of the hot channels – clean the foul, use anti-fouling coating for the bottoms and ensure that bilge waters are discharged in dedicated containers and never in Danube river or in the channels.	C, O	Prevention of the introduction and proliferation of new aquatic invasive species.
6.6	Cleanup of the site from vegetation and preparations for the construction works must begin before or after the nesting periods of the birds and the reproduction periods of the fauna (01.04.-15.06.)	C, DC	Minimised impact of the IP on birds nesting or reproducing in the area and other fauna species in the area.
6.7	Ensure that species typical of the area are used for the planned afforestation and rehabilitation works.	C, O, DC	Avoidance of adverse phenomena related with unnatural competition between local and non-local species, genetic contamination and erosion processes.
6.8	The biodiversity typical of the site should be restored after the new	C, DC	Preservation of local biodiversity.

No.	Measures	Period (phase) of implementation	Result
	changes to ensure that the damaged terrain is seamlessly integrated in the surrounding environment.		
6.9	Ensure strict compliance with the design documentation and prevent the piling of overburden and building waste outside sites and locations designated for this purpose and approved in advance.	C	Prevent unnecessary damage of vegetation blanket in plots adjacent to the ones used by the project.
6.10	Upon conclusion of the main construction works undertake greening measures, including local shrubs and trees.	Upon conclusion of the main construction works	Creation of favourable habitats for local fauna.
6.11.	Before the beginning of the construction works the site should be explored by a zoologist and any conservation-worthy species that may be found (amphibians, reptiles, etc.) should be captured and removed to suitable habitats in the area. Preferably, this operation should take place in the first half of May with prior notification of the Regional Inspectorate of Environment and Water.	C, O	Protection of conservation-worthy fauna species from destruction.
7. Waste			
7.1	Develop a Building Waste Management Plan.	C, DC	Compliance with regulatory requirements.
7.2.	Introduce Waste registration logs and produce Annual reports in accordance with Art. 44 of the *Waste Management Act*.	O	Compliance with regulatory requirements.
7.3	Ensure timely removal of generated waste.	O	Protection of soils and waters against pollution.
7.4	Upon conclusion of construction works dispose the building waste to a depot for building waste.	Upon conclusion of construction and installation works	Preservation of soils, management of waste.
7.5	Provide places for interim storage of residential waste until collected by specialised company.	D, CMP, O	Protection of the area and adjacent terrains against pollution, waste management.
7.6	Ensure maximum usage of excavated earth for landscaping of the IP site.	D, C, O	Protection of the area and adjacent terrains against pollution, waste management.
7.7	Ensure 100% usage of humus.	D, C, O	Protection of the area and adjacent terrains against pollution.
7.8	Conclude contracts with specialised companies for the	D, C, O	Waste management.

No.	Measures	Period (phase) of implementation	Result
	disposal and recycling of hazardous waste.		
7.9	Sprinkle the residential waste with lime or chlorinated lime for disinfection.	D, C, O	Prevention of health risks.
8. Hazardous substances			
8.1	Issue instructions for safe working and usage of personal protective equipment.	C, O, DC	Prevention of health risks for personnel working at the site.
8.2	Ensure compliance with all instructions for safe handling of hazardous substances. During the construction of the site and especially during the application of asphalt surfacing ensure strict compliance with the *Occupational Health & Safety and Fire Safety Rules* (OSHFS).	C, O	Prevention of health risks for personnel working at the site.
8.3	Ensure compliance with the requirements to the warehouses for chemical reagents. In order to mitigate the possible adverse impacts of hazardous substances, ensure compliance with the requirements for handling of materials in powder form that are supplied in paper or polymer bags, ensure appropriate storage of hazardous substances.	D, C, O, DC	Prevention of pollution of air in the work environment. Protection of the health of workers.
8.4	The materials and supplies delivered at the site must be accompanied with certificates of analysis, Safety Data Sheets, Safe Usage Manuals, including measures against spillage, dusting and hazards for the health of the personnel. Each original package must have a label with details of the health and environment risks and safety measures. Hazardous substances and products must be controlled by the MoH agencies.	C, O, DC	Prevention of health risks to the personnel working at the site. Protection of the health of workers.
9. Harmful physical factors – noise, vibrations, etc.			
9.1	Develop a Transport Plan for traffic of the freight vehicles used during the construction process and coordinate with Kozloduy municipality. The speed of trucks transiting residential areas should	D, C	Limitation of noise impacts in populated settlements.

No.	Measures	Period (phase) of implementation	Result
	be limited to 20 km/h.		
9.2	The building machines and equipment used for implementation of the IP must be compliant with the *Regulation on the essential requirements and conformity assessment of machines and facilities operated outdoors in respect to the noise emissions in the ambient air (SG no. 11/2004).*	C	Reduction of noise emissions in the environment, protection of the health of workers and population.
9.3	Provide silencers for the fans installed outside the production buildings if their noise emissions exceed the limits applicable to industrial and warehousing zones.	D, C	Compliance with the sanitary limits for noise emissions applicable to industrial and warehousing zones.
9.4	During the construction phase, workers must use personal noise protection devices for their personal protection against noise impacts.	C, DC	Protection of the health of workers and local population.
9.5	The machines used must be in good technical order and compliant with all contemporary technical requirements, specifications and binding norms in the EU.	C, DC	Protection of the health of workers and local population.
9.6	To avoid disturbing the ornithofauna with noise we recommend that noise generating machines be used only during daylight, until 5.00 pm. Noise impacts outside the area should be limited to 50 dBA.	C, DC	Protection of the health of workers and local population. Protection of the peaceful living of birds in the area.
9.7	The machines and equipment used for construction works must be ones of good technical specifications, including good acoustic performance. Provide appropriate silencers for the ventilation systems. Maintain the machines and the equipment in good working order.	C	Protection of the health of workers and local population. Protection of the peaceful living of birds in the area.
9.8	Ensure that the technical specifications and dimensions of the OSGA equipment are such as not to expose the workers to EMF stronger than the ones permissible for work	D, O	Protection of OSGA personnel against high voltage.

No.	Measures	Period (phase) of implementation	Result
	environments, by applying the national legislation for design of such facilities (*Regulation no. 14 on the technical norms and rules for design, construction and operation of sites and facilities for generation, transformation, transmission and distribution of electric power*, SG no. 53 of 2005).		
9.9	Ensure compliance with the national legislation for protection of personnel working in EMF environments: OHSA, Regulation no. 7 – SG no. 88 of 1999, *Regulation no. 3 on the working arrangements of Occupational Medicine Services,* SG no. 14 of 2008).	C, O, DC	Ensuring the health and safety of workers in accordance with the national legislation.
10. Health protection and risk management			
10.1	Ensure compliance with all *Occupational Health & Safety and Fire Safety Rules* (OSHFS) for the various types of workplaces.	D, C, O	Prevention of health risks.
10.2	All construction and maintenance works must be carried out in accordance with the minimum requirements for health and safety at work as applicable to the performance of construction and installation works.	C, DC	Mitigation of health risks to workers.
10.3	Ensure compliance with health prophylaxis requirements in respect to physiological regimes of work and rest and the physiological norms for lifting of weights laid down in the Regulations of the MoH.	C, O, DC	Mitigation of health risks to workers.
10.4	Ensure stringent use of the prescribed personal and collective protection equipment.	C, O, DC	Prevention of risks.
10.5	Mandatory briefings of the workers by competent specialists.	C, O, DC	Prevention of risks.
10.6	Ensure that prophylactic medical examinations area carried out at least once per year by the following specialised physicians: internist, otolaryngologist, cardiologist, neurologist and ophthalmologist (for welding works).	C, O, DC	Prophylaxis and diagnostics of workers.

No.	Measures	Period (phase) of implementation	Result
10.7	Prevent spillage of petroleum products. In the event of spillage take immediate measures for containment, removal and disposal at appropriate depots.	C, O	Prevention of risks.
10.8	Maintain the building machines in good order and operate them at optimal load to reduce the release of exhaust gases on one side and noise/vibration levels on the other side.	C, DC	Prevention of risks.
10.9	The work/rest regime must be designed such that the aggregate exposure per shift (contact with vibrations) does not exceed 90-120 min.	C, DC	Prevention of risks.
10.10	All professional activities must be carried out with usage of clothing appropriate for the season, personal protection equipment if harmful factors of the work environment are present (dust masks, ear plugs, gloves), and in accordance with a rational work/rest regime.	C, O, DC	Prevention of risks.
10.11	Maintain the first aid kits in good order.	C, O, DC	Timely provision of first medical aid to those affected by accidents/ injuries.
10.12	Update all programmes and procedures for radiation protection.	O, DC	Reduce the radiation impact on environment and personnel.
11. Cultural heritage			
11.1	If any findings are discovered during the construction works that appear to be monuments of culture, the work must be suspended and the finding reported to the municipality in the territory of which it was found, and investigated by non-destructive methods.	C	Preservation of cultural monuments.

9 MONITORING

Monitoring, as a mechanism, is directly linked to the management, development and decision making related to the activities of every economic entity. Environmental monitoring, as a part of the remaining management programs, is a proven tool within the modern concept of good planning and efficient operation of every production facility.

9.1 NON-RADIATION MONITORING

The Kozloduy NPP has successfully implemented and functioning: internal non-radiation monitoring, radio-ecological monitoring and supervisory institutional environmental monitoring. The purpose of the non-radiation monitoring is to ensure full compliance with regulatory requirements and the fulfilment of the terms and conditions envisaged in the permits issued by the MoEW, the BEEA, the BDWMDR and the Vratsa RIEW.

The "Kozloduy" NPP non-radiation monitoring on atmospheric air is not conducted by the "Kozloduy" NPP due to the lack of organized point sources, emitting conventional pollutants.

Non-radiation monitoring includes all measurements and laboratory analyses to the main ecological components of the subsurface, surface and waste waters that are envisaged in the terms and conditions of the environmental permits. It is divided into two parts – mandatory non-radiation monitoring and in-house control.

The mandatory own non-radiation monitoring at Kozloduy NPP EAD encompasses all mandatory measurements and analyses resulting from the regulatory requirements and the terms and conditions for the issuance of the company's permits for water abstraction and the water use bodies, and includes:

- ✓ Measuring the quantity of utilized water from the Danube River and the concentration of contaminants in it;
- ✓ Measuring the quantity of waste water and the concentration of contaminants in it, for which specific individual emission limits have been set in the permits issued to the Company under the Water Act;
- ✓ Measuring the quantity of extracted ground water;
- ✓ Monitoring water levels and the chemical status of the groundwater bodies used for water extraction.

The in-house control encompasses additional rapid water analyses; these are done at laboratories of the NPP and include the examination of:

- ✓ Utilized water from the Danube River;
- ✓ Waste water;
- ✓ Waste water from external organizations (EO) that is contractually discharged into the Sewerage network of Kozloduy NPP EAD;
- ✓ Ground water of the industrial site, incl. within the territory housing the buildings and facilities of the "SE" SD, "RAW" SD and "RAW" SE.

The in-house control is implemented via consistent internal inspections and controls. The institutional control on the non-radiation monitoring is conducted in the course of the year by the MoEW bodies, the Danube Region Basin Directorate and the Vratsa RIEW.

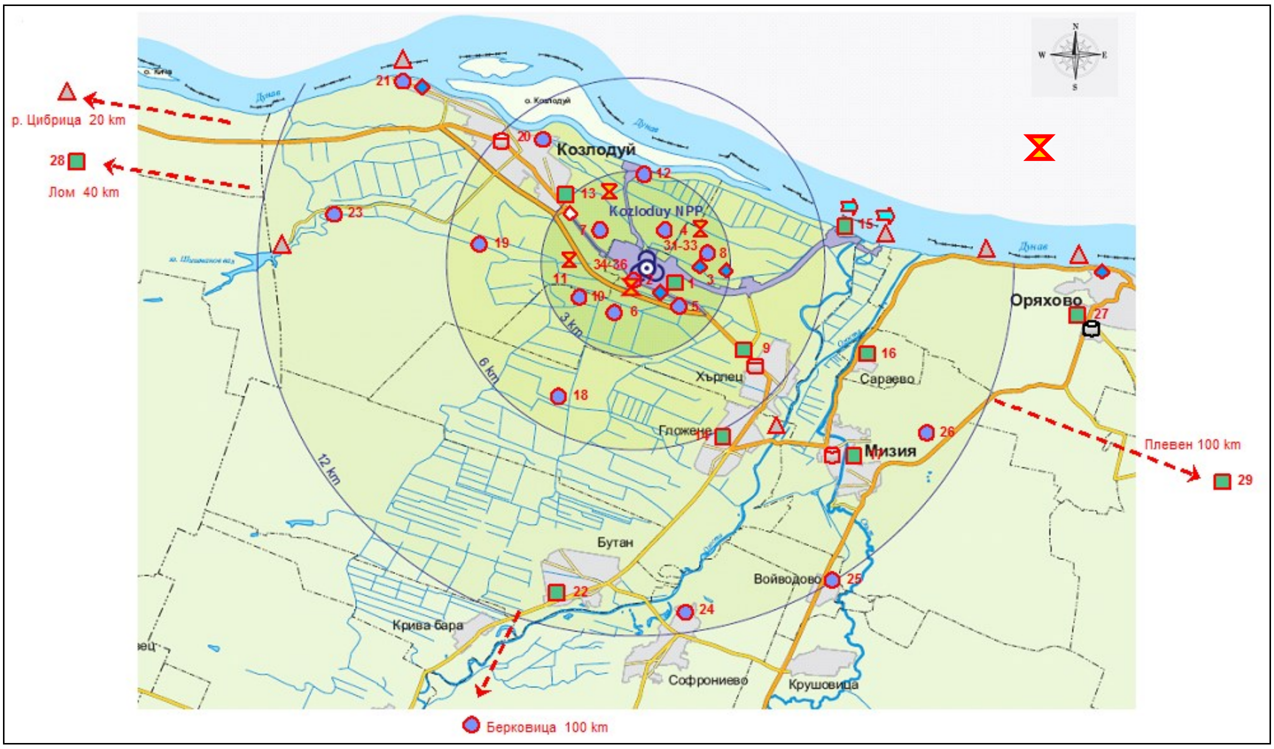
According to a MoEW-approved schedule for the operation of the Mobile Automated Stations (MAS) performing additional measurements in areas where there are no stationary measurement points or their number is limited, the Pleven Regional Laboratory takes measurements to control the quality of the atmospheric air within the Northern/Danubian Atmospheric Air Quality Assessment and Management District in Kozloduy municipality every few years, the last two being in 2008 and 20011.

9.2 RADIATION MONITORING

The radioecological monitoring conducted by Kozloduy NPP EAD encompasses all environmental components – air, waters, soils, vegetation, agricultural crops, typical foods produced in the region, etc.

The European requirements regarding the application of Art. 35 of the EURATOM Treaty regarding the continuous monitoring of the level of radioactivity in the air, water and soil, for the purpose of assessing the exposure dose for the population, are generally governed by the Recommendation of the European Commission 2000/473/Euratom, 08.06.2000. This recommendation is of fundamental importance for the standardization and unification of the practices utilized in the area of radioecological monitoring within the EU member-states. It defines the concepts and general requirements regarding the types of monitoring, monitoring networks and samples (dense and diluted), control periods, monitoring volume and sampling requirements and analyses on the primary controlled sites from the environment. It also defines the volume of the information accompanying the sample, its management and the submission of the monitoring data.

The institutional radiation environmental monitoring is governed by the long-term environmental radiation monitoring program of Kozloduy NPP EAD. The program is based on the regulatory requirements for the field, as well as the good international practices and the operational experience of the "RM" Division. The program is coordinated with the Ministry of Environment and Water (MoEW), the Ministry of Health (MoH) and the Bulgarian Nuclear Regulatory Agency (BNRA), and complies with the international recommendations in the field, Art. 35 of the EURATOM Treaty and Recommendation 2000/473/EURATOM. Independent control is ensured via the radiation monitoring programs of the control authorities: the EEX/MoEW and the NCPHA/MoH.



Legend:

– control outpost type "**A**": aerosols, atmospheric depositions, soil, gamma background (TLD) – 11 units
– control outpost type "**B**": atmospheric depositions, soil, vegetation, gamma background (TLD) – 15 units
– control outpost type "**C**": water, sediments, algae, gamma background – 7 units
food chain products: – drinking water; - milk; – fish; – grains.

FIGURE 9.2-1: OUTLINE OF THE RADIATION MONITORING OUTPOSTS AROUND THE "KOZLODUY" NPP

2 control zones with different radiuses have been established around the power plant in order to localize and assess the potential impact of the Kozloduy NPP on the environment and the population: a Precautionary Action Zone – PAZ /2 km/ and a Surveillance zone – SZ /30 km/. The subject of the monitoring is the territory of the actual industrial site. For comparison, samples and measurements are taken at benchmarking outposts up to 100 km around the NPP, where no impact is expected from the operation of the power plant. The environmental components are subjected to laboratory and automated control.

In the 30 km MZ there are a total of 36 control outposts for the terrestrial ecosystem and 7 outposts for the water ecosystem, performing sample collection for laboratory analysis, and measuring the activity of man-induced radionuclides in the samples.

Samples from the air, soil, vegetation, water and bottom sediments are analysed and gamma background measurements are taken. Outside the aforesaid outposts, additional samples are taken from drinking water, milk, fish, agricultural grain and fodder crops from the region. The placement and type of the control outposts is shown on **Figure 9.2-1**.

Apart from the radioecological monitoring, within the 100 km zone around the NPP radiation measurements are taken from the industrial site. The subject of control is the radiation gamma background, ground water, air, atmospheric deposits, vegetation and soil.

Four times a year water samples are taken from over 115 drilling wells and analysed for total beta-activity and tritium contents.

The radiation monitoring during the normal operation of the Kozloduy NPP is conducted using a conservative approach, in compliance with the following basic rules:

- ✓ measurements and/or sample collection should be done at potentially unfavourable points in terms of NPP impact;
- ✓ parallel measurements should simultaneously be made, or samples taken, from reference points where no impact from the power plant is expected;
- ✓ the analysed samples should cover the main ecological components, and elements of the radioactivity distribution chain leading to the human body;
- ✓ the samples from foods should be characteristic to the area around the power plant;
- ✓ the examined radionuclides should be typical for WWER-type nuclear reactors and should include the key radionuclides pursuant to the Recommendation of EU's Euratom 2004/2;
- ✓ at the same time reference radionuclides with a natural origin and contained in a relatively consistent quantity in the samples (for instance ^{7}Be for air, ^{40}K for soil and biota) should also be taken;
- ✓ the detectable minimum values should be low enough, so that they would allow determining the background activities from the global deposition of man-induced radionuclides and allow the registering, at a very early stage, of even the smallest changes to the radiation environment.

Experience has shown that the results from the radioecological monitoring tend to have values that are considerably lower than the limits envisaged in the regulations. That is why, usually the comparisons are made between current results and ones obtained in previous years of operation or before the commissioning of the NPP. This approach allows us to register and analyse even minimal trends in the radiation environment.

9.3 RECOMMENDATIONS ON NON-RADIATION AND RADIATION MONITORING AFTER THE CONSTRUCTION OF THE NNU

The Kozloduy NPP has successfully implemented and functioning: internal non-radiation monitoring, radioecological monitoring and supervisory institutional environmental monitoring. This established system serves as the basis for the development, expansion and improvement of the new Environmental Monitoring Program for the NNU in all aspects, including monitoring aimed at assessing the impact of the NNU on population's health within the PAZ and the MZ.

This program must operate in compliance to both the national legislation and European regulations, especially Art. 35 and Art. 36 of the EURATOM Treaty regarding the continuous monitoring of the level of radioactivity in the air, water and soil, for the purpose of assessing the exposure dose for the population, regulated by the Recommendation of the European Commission 2000/473/Euratom, 08.06.2000. This recommendation is of fundamental importance for the standardization and unification of the practices applied in the area of radioecological monitoring within the EU member-states. It defines the concepts and general requirements regarding the types of monitoring, monitoring networks and samples (dense and diluted), control periods, monitoring volume and sampling requirements and analyses on the primary controlled sites of the environmental. It also defines the volume of the information accompanying the sample, its management and the submission of the monitoring data.

The structure of the carefully reviewed and analysed existing monitoring system should be updated and optimized, and the following concepts should be included:

1. Determining the amount of pollution from the NPP and the NCC to the Danube River and making a more accurate assessment of the quality of river water at a certain monitoring point of the Danube River before the discharge point for the Kozloduy NPP and NNU waste water, as well as after the discharge point of Hot (Outlet) channel 1, where at least once a month measurements would be made on water quantities and the physical, chemical and biological elements characterizing the condition of the river water.
2. Taking geodesic measurements on the sinking of the foundations of buildings and the facilities within them. Based on the experience in measuring the sinking, accumulated during the operation of power units 5 and 6, it is recommended to improve the quality of measurements.
3. Developing a separate plan for in-house monitoring on the Local Waste Water Treatment Facilities (LWWTF) and the other local treatment facilities, which would include the waste generated during NNU operation.
4. Taking periodic measurements of the amount of sediment released, and determining its humidity and petrochemical contents, then delivering it to a licensed company for disposal. Keeping records of all received and available non-radioactive hazardous substances.
5. Transferring good practices on the establishment of an integrated RAW control system from the Kozloduy NPP to the New Unit, in the course of its construction.
6. Taking samples from the Danube River, from the discharge points of both hot channels, as well as a minimum of 2 additional stations situated below and above the Kozloduy NPP area, as a precaution against the introduction of new invasive species.
7. In the course of operation, noise monitoring should be conducted, in adherence to the Methodology for determining the total sound output emitted to the environment by an industrial enterprise and establishing the noise level at the point of impact, MoEW, 2012. Preparing a sound map for the area of the NPP and the NCC, representing the noise load from the operation of the capacities and determining critical monitoring points.

8. Conducting monthly monitoring on potential changes in the temperature regime of the river as a result of the discharge of water heated up by the Kozloduy NPP and the NNU – before and after the discharge point for the exhaust cooling water, measuring the water quantity and the temperature of the raw water and the exhaust water at the discharge point of Hot channel 1.
9. Conducting annual preventive examination of the personnel.

10 POSITIONS AND OPINIONS OF THE AFFECTED COMMUNITY, THE COMPETENT AUTHORITIES TAKING A DECISION ON THE EIA OR OFFICIALS AUTHORIZED BY THEM, AND OTHER SPECIALIZED ADMINISTRATIVE BODIES AND INTERESTED COUNTRIES IN A TRANSBOUNDARY CONTEXT, RESULTING FROM THE CONDUCTED CONSULTATIONS

In the course of EIAR development, the following positions and opinions were received:

1. WSS LTD, city of Vratsa, a letter with outgoing № 264 from 04.04.2013,
2. RAW SE, outgoing № П-06-00-533 from 05.04.2013,
3. MoEW, outgoing № 26-00-1035/09.04.2013,
4. Vratsa RHI, outgoing № КД-04-846/05.04.2013,
5. BEH, outgoing №01-0913/1 from 09.04.2013,
6. MEE, outgoing № 26-A-120/09.04.2013,
7. Vratsa RIEW, outgoing №B-825/10.04.2013,
8. Municipality of Kozloduy, reg. index 7300-28/1/11.04.2013,
9. Danube Region WMBD, based in Pleven, outgoing №3804/12.04.2013,
10. EEA, outgoing № 26-00-8/18.04.2013,
11. FSCP DG, per.№ПО-31414/18.04.2013,
12. MoI, reg. № I-10057, ex.1 from 23.04.2013,
13. NEC EAD, outgoing № 73-01-55/26.04.2013,
14. BNRA, outgoing № 47-00-58/13.05.2013,
15. NCRRP, outgoing № РД-02-08-17(12)/2013.05.20,
16. MAF, outgoing № 76-1457/22.04.2013,
17. MoH, outgoing № 26-00-621/30.05.2013,
18. Austrian Ministry of Agriculture, Forestry, Environment and Water Management, outgoing № 541402 from 26.06.2013,
19. Romanian Ministry of Environment and Climate Change, outgoing №3072/ RP/ 06.08.2013.

They have been taken into account for the development of the report.

11 TRANSBOUNDARY IMPACT

The ***Assessment Approach*** employed to establish the environmental impact of the Investment Proposal within the transboundary context incorporates:

- → Establishing the potential transboundary environmental impact within the territory of another state or states, resulting from the implementation of the investment proposal for the construction of a new nuclear power unit at the Kozloduy NPP site;
- → Devoting special attention to the aspects with potential transboundary impact and envisaging specific measures for their prevention and mitigation.

The present section is **aimed at presenting the environmental impact assessment within a transboundary context** in adherence to the procedure envisaged in the applicable Bulgarian legislation, and specifically in Art. 98, Par. 1 of the Environmental Protection Act and Art. 25 of the Regulation on the terms and conditions for performing EIA, as well as in accordance with the Convention on Environmental Impact Assessment in a Transboundary Context (the Espoo Convention). The convention was drawn up in 1991, at a moment when the European Communities had several years of experience with the application of Directive 85/337/EEC on Environmental Impact Assessment. The Convention envisages an expansion of the national EIA procedure with regard to the subject of assessment, the participating parties and the obligations of the competent authorities.

The Bulgarian national mechanisms for the implementation of the Espoo Convention have been defined in Art. 98 of the Environmental Protection Act (EPA) and in Chapter Eight (Art. 23-26) of the Regulation on the terms and conditions for performing EIA (OCPPEIA).

11.1 SUMMARY OF THE IMPACT OF EXISTING FACILITIES AT THE KOZLODUY NPP SITE

There are 6 nuclear power WWER-type units, constructed at the Kozloduy NPP site based on a Russian design. Units 1÷4 are of the model “BBEP-440”, and units 5 and 6 – “BBEP-1000”. The main features of the six units are presented in **Table 11.1-1**.

TABLE 11.1-1: MAIN FEATURES OF THE SIX UNITS

Unit		Reactor type – output in MW	Year of inclusion to the energy system	Fuel campaigns	Decommissioning
Unit 1		“BBEP -440”	1974	23	31.12.2002
Unit 2		“BBEP -440”	1975	24	31.12.2002
Unit 3		“BBEP -440”	1980	22	31.12.2006
Unit 4		“BBEP -440”	1982	21	31.12.2006
Unit 5	Lifespan 2017*	“BBEP -1000”	1987	18	not applicable
Unit 6	Lifespan 2021*	“BBEP -1000”	1991	17	not applicable

** in the event that the program to extend the service life of these units is not realized.*

During the operational years of the Kozloduy NPP, as outlined in **Section 9 – MONITORING** of the present Report, continuous control is being exercised on the impact of the operation of the nuclear power plant on the population and the environment. Measurements are taken on the potency of the equivalent dose. Furthermore, the exposure level of the population within the 30 km Surveillance zone to radioactive gaseous, aerosol and liquid emissions from the Kozloduy NPP[61] is also subject to ongoing assessment.

Data from the two periods – with six units in operation (1998-2002) and with two units in operation (2011 and 2012) – has been analysed and compared. The conclusions are as follows:

- ✓ The results from the measurements on the radiation gamma background, made at points from the fence of the NPP and at the control outposts and settlements within the 100 km zone, are completely comparable to the natural radiation background.
- ✓ The results from the aerosol monitoring conducted over the years provide a realistic assessment of the negligible impact of the Kozloduy NPP on the aerosol activity in the air. In practical terms, this indicator has not been impacted by the operation of the power plant. The established maximum values for ^{137}Cs are thousands of times lower than the regulatory limits.
- ✓ The radiation status of the drinking water sources in the region has not been impacted by the operation of the Kozloduy NPP and is fully compliant to the sanitary regulations. The established maximum values for ^{137}Cs and ^{90}Sr are thousands of times lower than the regulatory limits.
- ✓ No impact was established on the radioecological status of the soils in the environment due to the operation of the Kozloduy NPP. The values for ^{90}Sr contents are typical for Bulgarian soils.
- ✓ The radiation status of agricultural crops is of typical, natural levels. The established maximum values for ^{137}Cs and ^{90}Sr are thousands of times lower than the regulatory limits.
- ✓ The measured total activity in the milk is within typical, natural levels and is attributable to the completely natural isotope ^{40}K. There is no impact from the operation of the Kozloduy NPP on the radiation purity of the milk in the region. The established maximum values for ^{137}Cs и ^{90}Sr are hundreds of times lower than the regulatory limits.
- ✓ During these periods of operation, the maximum individual effective dose for the population due to liquid and gaseous emissions within the 30 km zone varies within the range 1 ÷ 4 μSv/a, which is no more than 0.4 % of the regulatory limit for the population (1 mSv) and is below the established limit for the release of control – 10 μSv/a, BRPN-2012.

[61] Results from the radiation environmental control for the period 1998-2002, 2011 and 2012 – ERC-008/009/010/011/012.

- ✓ Radiobiological effects and radiation risk data[62] shows that there is no risk of developing radiation-related diseases, and no risk of manifesting radiation-induced cancer for the whole population within the 30 km zone of the Kozloduy NPP.

The following conclusions and summaries can be drawn from the results of the **own non-radiation monitoring** conducted at the Kozloduy NPP during the period 2007–2012[63]:

- ✓ Water abstraction and the water use bodies for the discharge of waste water is done in compliance with the annual limits defined in the respective permits;
- ✓ Extracted groundwater complies with the quality standard envisaged in Appendix № 1 of Regulation № 1 from 2007 on the study, use and protection of groundwater;
- ✓ During the studied period, no exceeding of Individual Emission Limits (IEL) for the different indicators was observed for the waters from hot channel 1 and hot channel 2, and the quantity of the discharged waste water was smaller than the permitted quantity;
- ✓ With regard to surface water , at the Kozloduy NPP site only isolated and occasional cases were observed of exceeded norms for some indicators beyond the quality standard values, regulated by the Regulation on the study, use and protection of ground waters;
- ✓ During the studied period, the Landfill for non-radioactive municipal and industrial wastes was used predominantly for domestic and unusable industrial waste;
- ✓ As a result of the predominant quantity of residential waste and the higher compaction factor than the design-based capacity, the Landfill for non-radioactive municipal and industrial wastes is being filled at a slower rate than the one envisaged in the design, and for eleven years of operation only 85% from Stage I have been filled up;
- ✓ No tendency is observed for any change in the controlled indicators for the waste water from the Landfill for non-radioactive municipal and industrial wastes;
- ✓ In 2011 and 2012, as well as in previous years, in the great majority of cases the atmosphere had stable and neutral status – class DE. The highly instable conditions are a rare phenomenon for the area of the NPP and the Landfill for non-radioactive municipal and industrial wastes are observed mostly in the hot summer months when there is strong sunlight.

The analysis on the operational experience of the Kozloduy NPP shows that the power plant has accumulated a high administrative capacity, including such related to appropriate response to accidents and incidents.

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[62] Results from the radiation environmental control for 2011 - 12.RM.DOC.111.

[63] Annual reports on the results from the own non-radiation monitoring on the environment around the "Kozloduy" NPP - 2007, 2008, 2009, 2010 and 2012.

Here are the principles serving as the basis for the setting of final objectives related to reporting and analysing operational events and the feedback from the internal operational experience:

- protecting people's life and health and the environment has a primary importance above energy production and cannot be the subject of compromise;
- constantly improving the level, quality and culture of safety by introducing, analysing and developing a system of methods and measures for self-control, self-assessment and feedback from the operational experience;
- ensuring adherence to the requirements for nuclear safety, radiation protection, population and environmental protection, resulting from Bulgaria's ratification of international conventions and treaties.

The main requirements regulating the criteria and activities outlined in the documents arise from:

- the requirements envisaged by the Bulgarian legislation in the area of the safe use of nuclear energy;
- the requirements of the IAEA.

Kozloduy NPP EAD has developed a Procedure for the use and dissemination of operational experience. The purpose of the procedure is to regulate the order for:

- dissemination and use of the information from internal and external operational experience (OE)
- informing the nuclear community about any events occurring at Kozloduy NPP EAD via the World Association of Nuclear Operators (WANO).

For the whole period of operation of the existing capacities (about 150 reactor/years) no event above level 2 according to the INES scale[64] has been registered at the Kozloduy NPP site. The total number of events that were registered and reported is: 52 from level 1 and two from level 2. For all of these events no additional radiological impact outside the Kozloduy NPP site has been identified.

[64] The INES scale is a widely recognized international scale for nuclear events, which was adopted in 1990 by the IAEA in order to facilitate the communication of safety-related information in cases of nuclear incidents. The scale has 7 levels (degrees) of hazard and a zero level meaning absence of danger. The scale is a logarithmic and each level indicates an incident that is approximately 10 times more significant than the previous (lower) level.

11.2 SUMMARY OF THE IMPACT OF THE JOINT OPERATION OF EXISTING NUCLEAR CAPACITIES AND ONES PLANNED FOR COMMISSIONING AT THE KOZLODUY NPP SITE AND ITS VICINITY[65]

11.2.1 LOCATION OF THE ALTERNATIVE SITES FOR THE DEPLOYMENT OF A NNU

The Kozloduy NPP site is situated on the right bank (at the 694-th km) of the Danube River, 3.7 km to the south of the midstream of the river and the state border with the Republic of Romania. In a straight line, it is situated about 120 km to the north of the capital – the city of Sofia, and via the national road network the distance is about 200 km.

It is situated in the north part of the first non-flooding terrace of the Danube River (at elevation level +35.0m, based on the Baltic height system) and has an area of 4471.712 decares.

To the north it borders on the Danubian Plain. To the south of the site, the slope of the watershed plateau is relatively high (100-110 m), to the west – about 90 m, and to the east it is lower and reaches down to 30 m above sea level.

The closest settlements to the Kozloduy NPP are the following: the town of Kozloduy – 2.6 km to the northwest, the village of Harlets – 3.5 km to the southeast, the village of Glozhene – 4.0 km to the southeast, the town of Mizia – 6.0 km to the southeast, the village of Butan – 8.4 km to the south, and the town of Oryahovo – 8.4 km to the east of the site.

The site chosen for the deployment of the New Nuclear Unit will be enclosed and secured in compliance with the Regulation for the provision of physical protection of nuclear facilities, nuclear material and radioactive substances (SG, issue 44 of 9.05.2008) and a protected area, a PAZ and a UPAZ will be set up in adherence to the provisions of the Regulation on emergency planning and emergency preparedness in case of nuclear and radiological emergencies (Promulgated, SG, issue 94 from 29.11.2011).

The proximity of the alternative sites for the installation of the NNU to the Danube River, serving as the state border between the Republic of Bulgaria and the Republic of Romania, determines the possibility of expected indirect environmental impact on the territory of the neighbouring Romania, via the potential transfer of pollution resulting from the implementation of the investment proposal.

11.2.2 POSSIBLE CUMULATIVE IMPACT FROM THE JOINT OPERATION OF THE EXISTING NUCLEAR UNITS AND THE ONES ENVISAGED FOR CONSTRUCTION AT THE KOZLODUY NPP SITE AND ITS VICINITY

At present, the following nuclear facilities are in operation at the Kozloduy NPP site:

1. Industrial operation of units 5 and 6 with reactors “BBEP-1000” and total installed electrical power of 2000 MWe;

[65] A requirement of the MoEW, pursuant a letter with outgoing № OBOC-220/09.01.2013.

2. SNF storage facility under water (a Wet Spent Fuel Storage Facility) (WSFSP);
3. RAW management facilities, operated by the "RAW Kozloduy" Special Division;
4. Units 1÷4 as RAW management facilities, subject to decommissioning.

The following new nuclear facilities are envisaged for construction at the Kozloduy NPP site:

1. A new nuclear unit of the latest generation, meeting all modern safety requirements for III-rd generation nuclear reactors;
2. A Plasma Melting Facility for low and intermediate activity RAW (category 2a) with a high rate of volume reduction;
3. A repository for the dry storage of spent nuclear fuel (a Dry Spent Fuel Storage Facility) (DSFSF);

In addition to that, the Kozloduy NPP site houses the smaller "Radiana" site where the National RAW Storage Facility for the disposal of low and intermediate radioactivity RAW will be constructed.

Assessment of the potential impact of the nuclear facilities envisaged for commissioning:

1. After the construction of a new nuclear unit, pursuant to the provisions of the Bulgarian legislation, as well as those of the EUR, the impact from the operation of III-rd generation reactors under operational conditions and during design-based accidents is limited within the site of the nuclear facility (0.8 km), and in the event of severe accidents – within the 3 km zone [EUR Volume 2].
2. The construction of a Plasma Melting Facility for low and intermediate radioactivity RAW at the Kozloduy NPP uses a modern technology for the decontamination of the outgoing liquid and gaseous emissions, which does not result in any significant increase of the radiation risk beyond the site, and the impact on the critical group of the population is estimated as negligibly small and far below the regulatory requirements on dose limits. The contribution to the dose outside the building at ground level under the normal operation of the facility is 0.003 ± 0.002μSv/h; [ISAR PMF].
3. The construction of the National RAW Storage Facility for the disposal of low and intermediate radioactivity RAW will not lead to any significant increase of the radiation risk at the site, as indicated in the EIA Report[66]. During the operation of the facility and after its decommissioning – during the control period – no migration of radioactive substances is expected from the disposal facility.

[66] Environmental Impact Assessment Report on the investment proposal of the "RAW" State Enterprise for the construction of a national facility for the disposal of short-life low and average activity waste – the NRSF – 2011.

4. A repository for the dry storage of SNF at the Kozloduy NPP has been designed with a passive cooling system and based on the storage concept for "zero leakage" containers, which ensures high reliability and very low radiation risk.

Considering the fact that the decommissioning of units 1÷4 of the Kozloduy NPP and the removal of the nuclear fuel from the reactor pool of each one will lead to a significant reduction of the radiation risk at the site, as well as the fact that the expected low potential impact (limited within the 3 km zone) of the NNU envisaged for commissioning, we can project that no greater combined (cumulative) impact is expected on the components of the environment and the population than the one during the simultaneous operation of 6 nuclear power units from the second generation, as outlined above.

11.3 DESCRIPTION OF ENVIRONMENTAL COMPONENTS AND FACTORS RELEVANT TO THE TERRITORY OF THE REPUBLIC OF ROMANIA, WITHIN THE 30 KM ZONE

11.3.1 CLIMATIC PARAMETERS

Based on data provided by the office of the Ministry of Environment and Climate Change of the Republic of Romania, № 615/RP/15.03.2013, the meteorological parameters on the territory of the Republic of Romania have been analyzed and compared to those on the territory of the Republic of Bulgaria.

The comparison between the average annual temperatures, based on measurements from the Bechet station for 1961-2011, the Lom station for 1961-1998, and the data provided by the Assigning Authority and collected by the local stations of the "Kozloduy" NPP for the period 1997-2011 shows that the average annual temperatures for Lom and Bechet have an equal trend, with those in Lom being higher than those in Bechet by 0.5°C on average for the last climatic period (1961-1990).

The dynamics of air mass transport within the surface boundary layer is characterized by the wind rose – wind speed, measured in 16 directions. The wind at a given place is one of the meteorological elements that is highly dependent on local conditions, and especially on topography. For an area such as the one under review, the proximity of a large water basin is significant factor – in this case the Danube River (aeration channel).

The wind rose for the Becket station follows the zonal west-east transfer which is characteristic for our latitudes, with the predominant wind frequency being from the west (18.9%). The percentage of the so-called 'calm weather' – the number of cases with wind speed below 1 m/s – is 11.1% of the number of readings during this period, which corresponds to a low potential for contamination of the lower atmosphere, due to the proximity of the Danube River.

From the maps of the wind potential[67] of the averaged field of wind speeds for 2008, 2009, 2010 and 2011, it is evident that in the area around the Kozloduy NPP the predominant average wind speeds are not higher than 3.7 m/s, which means that the potential of the Wind field to transfer pollutants over long distances is low.

We can conclude that there are no climatic prerequisites for transboundary pollution.

11.3.2 SURFACE WATER

The existing site of the Kozloduy NPP is situated on the right bank (at the 694-th km) of the Danube River, in the north part of the first non-flooding terrace of the Danube River (at elevation level +35.0m, based on the Baltic height system). **No natural water bodies pass through it.**

The information sent by a letter from the MEF of Romania to the Assigning Authority and a letter by "Kozloduy NPP-NM" EAD, 297/01.04.2013, with data from the monitoring of the Danube River and the Jiu River, shows no impact on the waters on the territory of Romania from the activity of the existing Kozloduy NPP.

11.3.3 LAND AND SOILS

The data on the long-term use of the land within the 100 kilometer zone encompassing six counties (DOLJ, GORJ, MEHEDINTI, OLT, TELEORMAN and VALCEA) and covering **1 452 589.55** ha area has been divided as follows:

- Agricultural areas, amounting to **1 123 950.75** ha or 77.38% of the 100 km zone. The breakdown into autonomous areas is the following: integrated cultivation areas (2.9%), areas occupied by fruit trees and berry plantations (1.5%), unirrigated agricultural lands (74.6%), agricultural lands with natural vegetation (4.6%), vineyards (7.7%), pastures (8.3%) and rice fields (0.4%);
- Airports, discontinuous urban structure, dam walls, green urban areas, industrial and commercial units, quarries, road and railroad networks, recreation land – sports and recreation – 6.55%
- Beaches, dunes, sands, deciduous forests, mixed forests, natural pastures, etc. – 12.65%
- Water bodies and river beds – 1.8%;
- Internal marshland – 1.62%.

The DOLJ county occupies the largest total area (739 811.43 ha). The next largest county is OLT, with a total area of 408 528.94 ha, which is agricultural. The MEHEDINTI county has a total area of 148 753.96 ha. The remaining three counties have relatively similar areas –

[67] http://windtrends.meteosimtruewind.com/wind_anomaly_maps.php?zone=RBG

about 20 648.95 ha (GORJ), 36 474.79 ha (VALCEA) and about 98 371.48 ha (TELEORMAN).

The EIAR (item 3.3) presents detailed data on the radiological condition of the soils within the 30 km zone around the NPP on the territory of the Republic of Bulgaria. The established values for the contents of the two most biologically hazardous radionuclides, Sr-90 and Cs-137, **do not demonstrate any contribution from the operation of the nuclear power plant.**

The information on soils, provided by Romania, does not make any mention of contamination of their lands from the operation of the existing capacities of the "Kozloduy" NPP – neither within the 30-km, nor within the 100-km impact zone. Due to the specific meteorological conditions and the direction of the winds in the region, the potential for pollution of the soils on the territory of the Republic of Romania as a result of the operation of the NPP is smaller than the one for the region within the territory of the republic of Bulgaria. The conducted analysis on the radiological condition of the soils within the 30-km zone around the NPP within the Bulgarian territory suggests that during normal operation there would be no impact on land use and agriculture on the territory of the Republic of Romania.

11.3.4 SUBSURFACE

The outline of the deep geological structure in the part "Subsurface" (item 3.4.1.4) shows that the Moesian Platform in the area of the NNU is characterized by geological formations without any significant disturbances in the last 2.5 million years. The geological data for the deep structure, provided by Romania, shows that the stratigraphic structure of the Moesian Platform on both sides of the Danube River around the "Kozloduy" NPP is very similar.

In conclusion, the deep geological structure within the 30 km zone around the Kozloduy NPP is favourable, due to the presence of a number of natural barriers (clay formations) which would limit the migration of potential pollutants. This structure does not create opportunities for any significant transboundary impact before and during the construction and operation of the NNU.

11.3.5 SEISMIC RISK

An additional analysis has been conducted on the seismicity in the local and the regional zone of the "Kozloduy" NPP, based on the data on the seismic hazards, coming from Romanian sources [68].

2 catalogues, mostly of Romanian earthquakes, have been analyzed – one composed of historical and contemporary earthquakes within the subregional 160 km zone around the "Kozloduy" NPP, and the other one – containing historical and contemporary earthquakes

[68] Current data for the territory of the Republic of Romania – a letter of "Kozloduy NPP-NM" EAD, 297/01.04.2013

within the Vrancea seismic zone, situated in the north-eastern periphery of the regional 320 km zone around the "Kozloduy" NPP.

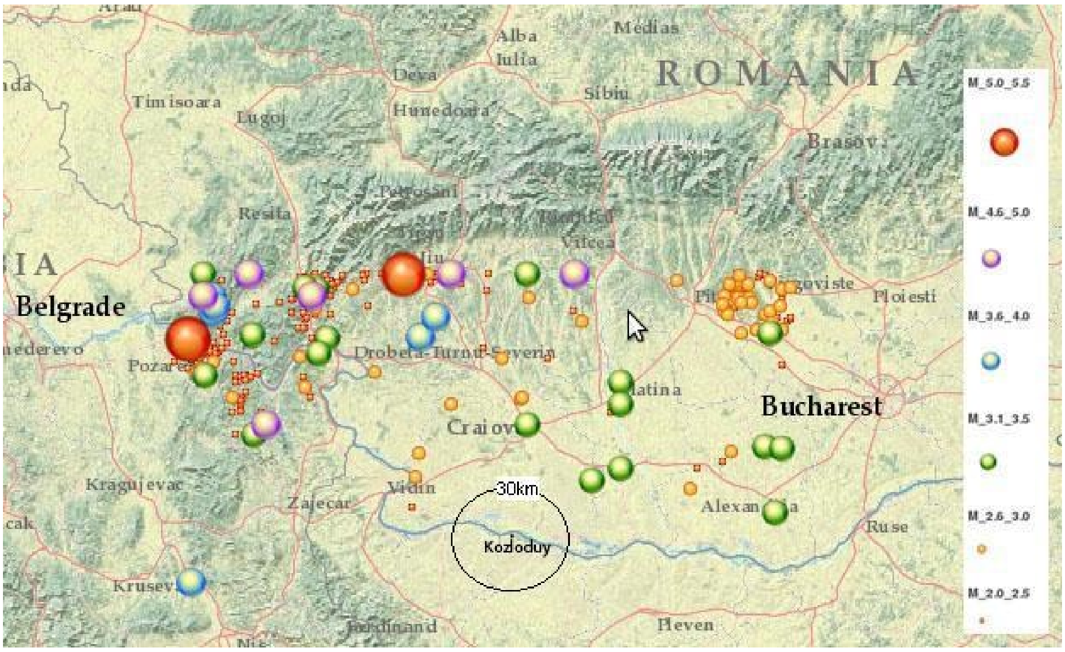

FIGURE 11.3-1: EPICENTRAL EARTHQUAKE DISTRIBUTION OF EARTHQUAKES WITHIN THE SUBREGIONAL 140 KM ZONE AROUND THE "KOZLODUY" NPP, BASED ON ROMANIAN DATA

The pattern of epicentral distribution on **Figure 11.3-1** shows that the Kozloduy NPP site is situated in the calmest part (in terms of seismic activity) of the Moesian Platform, and within the local 30 kilometre zone there have been absolutely no earthquakes. Up to the 50 km boundary there have been no Romanian earthquakes, and earthquakes with a magnitude of M > 5.0 have been registered as far as the periphery of the 160 kilometre zone, and that is toward the Serbian border.

11.3.6 BIODIVERSITY

11.3.6.1 INFORMATION USED

In order to characterize the quality of the environment on the territory of the Republic of Romania, as a subject of impact, and in order to assess the degree of impact on it from the operation of the NNU under the Kozloduy NPP, the following data has been analyzed in adherence to the examination procedure:

1. Information provided by the Republic of Romania regarding the European ecological network Natura 2000 and other protected territories in the Republic of Romania and along the Danube River within the 30 kilometre surveillance zone of the "Kozloduy" NPP, presented in the Standard Forms for Natura 2000, available in Romanian on the

website of the Ministry of Environment and Climate Change[69, 70]. Four Protected Areas fall within the 30 km monitoring scope of the Kozloduy NPP:

- ROSPA0010 Bistreț (Bistrets),
- ROSPA0023 Confluență Jiu-Dunăre (Merger of the Jiu River and the Danube River),
- ROSPA 0135 Nisipurile de la Dăbuleni (Sands of Dabuleni),
- ROSCI0045 Coridorul Jiului (Jiu River corridor).

2. Data on the winter waterfowl count for the last 5 years between km 660 and 730 of the Danube River and data on the spring and autumn migration.
3. Information on waterfowl count (for instance IUCN protection categories, IBA sites – the important locations for the birds, etc.[71, 72]).
4. Provided geographical data on nestling birds (within the 30 km surveillance zone of the "Kozloduy" NPP) and information obtained from the development of the project "Transboundary model for environmental protection and sustainable use of natural resources along the Danube River /United for the Danube/", completed in 2012 in partnership with the Romanian Ornithological Society, the Agency for the protection of Olt, Romania, the Bulgarian Bird Protection Association (BBPA) and Kozloduy Municipality of Bulgaria[73] – Fish stocks and target species from Appendix 2 of Council Directive 92/46 within the three zones under Natura[74] – Report on the ichthyofauna.
5. Red book of species (within the 30 km monitoring scope from the Kozloduy NPP) – Information on waterfowl (for instance IUCN protection categories, IBA sites – the important locations for the birds, etc.[75, 76]). The plans for the management of the Romanian protected areas from Natura 2000 within the 30 km surveillance zone, and the adjacent protected territories are in the development stage so there is no information about them.
6. Information on the Romanian flora and fauna within the 30 km surveillance zone of the "Kozloduy" NPP.

11.3.6.2 EXISTING CONDITION OF THE FLORA AND THE FAUNA

The characteristics of the "Flora and Fauna" component encompass a vast geographical region on the territory of the Republic of Romania, and it is assumed that it may potentially be impacted by the operation of the NNU. For the purposes of this assessment, in March of 2013 joint field observations were conducted on the typical habitats within the protected areas and their vicinities – large swamps and micro dams along the left bank in Romania within the surveillance zone (with a 30 km radius around the Kozloduy NPP). Over half of

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69 http://www.mmediu.ro/protectia_naturii/biodiversitate/2011-10-20_protectia_naturii_RO_SCI_SDF_2011.pdf

70 http://www.mmediu.ro/protectia_naturii/biodiversitate/2011-10-20_protectia_naturii_RO_SPA_SDF_2011.pdf

71 http://www.birdlife.org/datazone/sitefactsheet.php?id=24422

72 http://www.birdlife.org/datazone/country/romania

73 http://www.danubebiodiversity.info/publications/

74 http://www.ddni.ro/index.php?page_id=84&siteSection=1&sectionTitle=Home

75 http://www.birdlife.org/datazone/sitefactsheet.php?id=24422

76 http://www.birdlife.org/datazone/country/romania

this territory falls within the Bulgarian borders, and the remaining part – within Romania. There are totally or partially drained lakes and swamps converted into fishponds, Danube islands with flooded forests, estuaries, old spills, quarry lakes, etc. All of them determine a great variety of plants and animals within the specific region. There are distinct and sensitive zones with regard to biodiversity, presented on **Figure 11.3-2**:

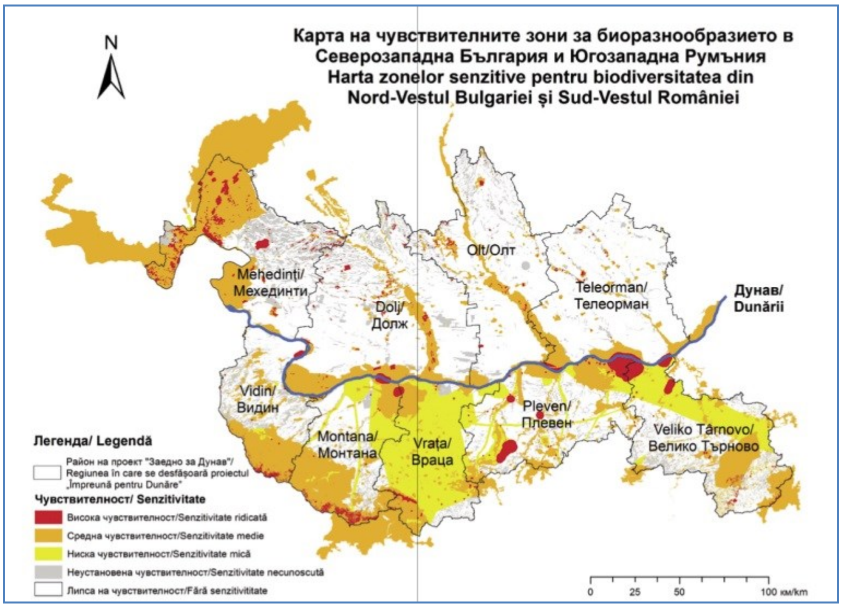

FIGURE 11.3-2: A MAP OF THE SENSITIVE AREAS IN TERMS OF BIODIVERSITY IN NORTHWEST BULGARIA AND SOUTHWEST ROMANIA[77]

As evident from the map, the specific region is characterized by average and high sensitivity.

The expansion of the anthropogenically transformed territories and of water pollution has a negative impact on the birds in the area.

In conclusion, we can state that:

1. The studied area is characterized by an extreme biodiversity of birds, which is confirmed by the fact that there are 7 protected areas under the Directive on Birds and by our observations accumulated in the course of the present assessment.
2. During this period (early March) and within the 30 km radius around the Kozloduy NPP, we identified occurances of two globally endangered species – the Dalmatian Pelican (*Pelecanus crispus*) and the White-Tailed Eagle (*Haliaeetus albicilla*).

11.3.6.2.1 Protected Area "Bistrets", ROSPA0010 Bistrets

This protected area is situated in the southwest part of Romania, on the left bank of the Danube River. It encompasses wetlands with a total area of 1915.6000 ha. The area houses important protected bird species: 36 species from appendix 1 of the Birds Directive and 79

[77] http://bspb.org/article_files/133234034543.pdf

other migrating species included in the appendices of the Convention on Migratory Species (Bonn Convention).

11.3.6.2.2 Protected Area ROSPA0023 "Merger of the Jiu River and the Danube River" (Confluența Jiu – Dunăre) under the Birds Directive 79/409/EEC.

This protected area is situated in the southwest part of Romania, on the left bank of the Danube River. It consists of the lower reaches of the Jiu River and its merger into the Danube River. Its total area is 19799.8000 ha. The area serves as a habitat to the following protected bird species: 36 species from appendix 1 of the Birds Directive and 79 other migrating species included in the appendices of the Convention on Migratory Species (Bonn Convention).

11.3.6.2.3 Protected Area ROSPA00135 "Sands of Dabuleni" under the Birds Directive 79/409/EEC

The protected area is situated in the east part of the merger between the Danube River and the Jiu Meadows: westward to the Sărata area, northward to the former "Potelu" tailing (currently being transformed into agricultural land) and the settlements Dabuleni and Ianca, to the east up to the Hotaru area, and to the south to the Danube River. Its total area is 11034.9 ha.

11.3.6.2.4 Protected Area ROSCI0045 "Jiu River corridor" (Coridorul Jiului) under Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora.

The protected area is situated along the Jiu River and its merger into the Danube River. Its total area is 71451.9000 ha. The area preserves habitats and plant and animal species from the continental biogeographic region, which are viewed as a priority to the European Community.

11.3.7 SUMMARY DATA ON RADIATION CONTROL IN ROMANIA WITHIN THE 30 KM SURVEILLANCE ZONE

The Romanian competent authorities have analyzed the data on the radiation background at the monitoring station on the Romanian bank that is closest to the Kozloduy NPP, coming up with an average value of about 0.095 μSv/h.

11.3.8 SUMMARY OF THE DEMOGRAPHIC AND HEALTH STATUS OF THE POPULATION WITHIN THE 30 AND 100 KM ZONES

The demographic potential within the 100 km zone, respectively the 30 km zone, around the Kozloduy NPP site is low. The average population density is 61.5 persons/km^2, which is considerably lower than the limiting condition of 100 persons/km^2 envisaged in the Bulgarian legislation and the IAEA guidelines for the deployment of NPPs. Within a 100 km radius there are 1289 settlements (546 in Bulgaria and 743 in Romania), and within a 30 km radius – 74 settlements (42 in Bulgaria and 32 in Romania). Most of the settlements are small villages (54.8% of all villages) and very small towns (57.4% of all towns). Within the

30 km zone, the largest settlements are the following: the town of Kozloduy (13 000 inhabitants), the town of Oryahovo (5 000 inhabitants), and on the territory of Romania – the town of Dabuleni (12 000 inhabitants) and the town of Bechet (3 400 inhabitants).

The dynamics of such a key demographic indicator as the total mortality is similar for both countries. For Romania in 2009 it was 1141.9‰, and in 2010 – 1142‰.

Studies conducted by Romanian specialists present a similarity in the level of total mortality in the country and that of the town of Becket within the 30 km zone from the Kozloduy NPP site. The trend of total mortality for the two countries is similar.

Incidence of malignant neoplasms, and in particular leukemia, for the same period is within the same range for both countries, and very similar.

In Romania in 2009 the incidence of malignant neoplasms was 224‰, and for 2010 – 177.1 ‰; and of the incidence of leukaemia for 2009 and 2010 was 17.1‰

Similar studies in the area of the town of Becket in Romania present a relatively higher incidence of these nosological units, including for recent years. Studies in both countries in similar settlements within the 30 and 100 km zones indicate the same trend for Bulgaria as well. Specialized analyses show that these trends are due to socio-economic factors.

The potential impact zone is limited to the secure area of the "Kozloduy" NPP. This zone is inaccessible to the general public. The potential impact zone does not go beyond the national borders of Bulgaria.

11.4 ASSESSMENT OF THE POTENTIAL TRANSBOUNDARY IMPACT ON THE ROMANIAN PART OF THE 30 KM SURVEILLANCE ZONE FROM THE IMPLEMENTATION OF A NNU

The activities on the present investment proposal fall entirely within the territory of the Republic of Bulgaria, but in close proximity to the Danube River and respectively to the territory of the Republic of Romania. In this regard and considering Chapter 8 of the Regulation on the terms and conditions for performing an environmental impact assessment, according to which Bulgaria is a Party of Origin, the Bulgarian Competent Authority (the MoEW) has notified the Romanian party for the present investment proposal and has sent information on the project in compliance with the provisions of the Espoo Convention.

In response to the presented information, the Romanian Ministry of Environment and Forests decided to participate in the EIA procedure in a transboundary context and sent its opinion and questions (forwarded by the MoEW to the Contractor by a letter with Outgoing № OBOC-220 from 09.01.2013). These opinions have been taken into account during the preparation of the EIA Report, including in the present section.

During the realization of the activities envisaged in the project – both during the construction stage and during the operation and decommissioning stages – no direct impact is expected on any environmental components and factors in the Republic of Romania.

The proximity of the alternative sites for the deployment of a NNU to the Danube River, which also serves as the state border between the Republic of Bulgaria and the Republic of Romania, determines the possibility for indirect environmental impact on the territory of the neighbouring Romania via the potential transfer of pollution as a result of the implementation of the investment proposal.

The possible pathways for a transboundary transfer of potential pollutants are via air currents – **gaseous and aerosol releases –** and **liquid releases** of unbalanced waters in the Danube River, as a result of the main water flow and precipitation processes.

11.4.1 NON-RADIOACTIVE ASPECT OF POTENTIAL TRANSBOUNDARY IMPACT

11.4.1.1 DUST EMISSIONS DURING CONSTRUCTION

The EIAR includes an assessment of the diffusion of emissions from area sources during construction (for each of the 4 sites) is based on the model of the American Environmental Protection Agency (EPA) ***ISC-AERMOD*** (Industrial Source Complex) with Windows interface, developed by the Canadian software company Lakes Environmental.

Based on the modelling, we can conclude that during the construction of the NNU no transboundary impact is expected as a result of gaseous and dust emissions on the Romanian part of the 30 km surveillance zone.

11.4.1.2 THERMAL POLLUTION

The change of the temperature regime of the river as a result of the discharge of water heated up by the Kozloduy NPP leads to a specific form on non-radioactive pollution. The permissible limit for the temperature rise of the open flow is 3°C for the warmest and 5°C for the coldest month of the year.

Based on the analysis, we can draw the conclusion that for inflowing water quantities after the commissioning of the new unit will not represent a thermal load to the water of the Danube River at Oryahovo (^{km}678) as compared to Lom (^{km}743.3), which does not exceed 3°C, which is the regulatory limit.

The commissioning of the new nuclear unit will not lead to any significant change to the thermal and icing status of the river in the section between the OPS and Oryahovo, as well as any cumulative and transboundary impact.

11.4.2 SUMMARY ASSESSMENT OF THE POSSIBLE RADIOACTIVE POLLUTION FROM THE IMPLEMENTATION OF THE NNU ON ATMOSPHERIC AIR – GASEOUS AND AEROSOL RELEASES IN THE ROMANIAN PART OF THE 30 KM SURVEILLANCE ZONE

Radioactive pollution of atmospheric air is caused by radioactive releases (emissions) from the nuclear power plant. Airborne radionuclides can lead to radiation via two principal pathways: externally – by the photons emitted as a result of radioactive decay, and internally – through their inhalation.

In terms of human health, these releases are evaluated by the radiation exposure of the human body in comparison to the threshold concentration levels of conventional pollutants in the atmospheric air.

The conducted model-based and mathematical assessments indicate that the additional radiation exposure of the population within the 30 km zone from the operation of the NNU is negligible and that no transboundary impact is expected.

11.4.3 SUMMARY ASSESSMENT OF THE POSSIBLE RADIOACTIVE POLLUTION OF SURFACE WATER FROM THE IMPLEMENTATION OF THE NNU – LIQUID RELEASES IN THE ROMANIAN PART OF THE 30 KM SURVEILLANCE ZONE

Liquid radioactive releases to the Danube River are dispersed as a result of the primary water flow and the process of precipitation. The main exposure pathways with regard to people are the following: external exposure from contact with the water environment and the accumulated precipitations at the river bottom, consumption of foods derived from the river, using the river water for drinking purposes, consumption of foods from crops and pastures irrigated with water from the river.

The summarized results from the assessments on the maximum individual effective dose within the 30 km zone and the critical group from the population living along the Danube River **regarding the NNU are completely comparable to the data for a large number of PWR reactors in the world (UNSCEAR–2000, 2008) and no transboundary effect is expected.**

11.4.4 SUMMARY ASSESSMENT OF THE POSSIBLE RADIOBIOLOGICAL EFFECTS AND RADIATION RISK FOR THE REFERENCE INDIVIDUAL WITHIN THE ROMANIAN PART OF THE 30 KM SURVEILLANCE ZONE

The assessment of the radiobiological effects and the radiation risk for a reference individual in the event of radioactive releases from the NNU shows that **there is no risk of the development of radiation-induced diseases for the population within the 30 km zone of the NPP on the territory of the Republic of Romania.**

11.4.5 SUMMARY OF THE POTENTIAL IMPACT OF THE IMPLEMENTATION OF THE NNU ON BIODIVERSITY IN THE ROMANIAN PART OF THE 30 KM SURVEILLANCE ZONE

11.4.5.1 FLORA

Both in the Bulgarian and in the Romanian part of the 30 km surveillance zone the implementation of the NNU no negative impact is expected on the flora and the natural habitats due to the absence of air, water and soil pollution by harmful emissions, as well as due to the absence of any radioactive and light pollution.

11.4.5.2 FAUNA

In the Romanian part of the 30-kilometer surveillance zone the implementation of the NNU is not expected to cause any significant negative impact on the fauna, due to the absence of air, water and soil pollution by harmful emissions, as well as due to the absence of any radioactive, noise and light pollution.

11.4.5.3 IMPACT OF THE IMPLEMENTATION OF THE NNU ON TARGET SPECIES IN THE PROTECTED AREAS FROM NATURA 2000 IN THE ROMANIAN PART OF THE 30 KM SURVEILLANCE ZONE

11.4.5.3.1 ROSPA0010 Bistreț (Bistrets)

No significant negative impact is expected from the implementation of the NNU on the target species within the protected area due to the absence of air, water and soil pollution by harmful emissions, as well as due to the absence of any radioactive, noise and light pollution.

The terrain of the IP is outside the borders of the protected area, and that is why no changes are expected to the structure, functioning, fragmentation and species composition.

Positive effects have been documented due to the thermal pollution of the Danube River from the "Kozloduy" NPP, on fish-eating birds, among which there are globally endangered species such as the Dalmatian Pelican (*Pelecanus crispus*).

11.4.5.3.2 ROSPA0023 Confluență Jiu-Dunăre (Merger of the Jiu River and the Danube River)

No significant negative impact is expected from the implementation of the NNU on the target species within the protected area due to the absence of air, water and soil pollution by harmful emissions, as well as due to the absence of any radioactive, noise and light pollution.

The terrain of the IP is outside the borders of the protected area, and that is why no changes are expected to the structure, functioning, fragmentation and species composition.

Positive effects have been documented due to the thermal pollution of the Danube River from the Kozloduy NPP, on fish-eating birds, among which there are globally endangered species such as the Dalmatian Pelican (*Pelecanus crispus*).

11.4.5.3.3 ROSPA 0135 Nisipurile de la Dăbuleni (Sands of Dabuleni)

No significant negative impact is expected from the implementation of the NNU on the target species within the protected area due to the absence of air, water and soil pollution by harmful emissions, as well as due to the absence of any radioactive, noise and light pollution.

The terrain of the IP is outside the borders of the protected area, and that is why no changes are expected to the structure, functioning, fragmentation and species composition.

11.4.5.3.4 ROSCI0045 Coridorul Jiului (Jiu River corridor)

No significant negative impact is expected from the implementation of the NNU on the target species of invertebrate animals, fish, amphibians, reptiles and mammals within the protected area due to the absence of air, water and soil pollution by harmful emissions, as well as due to the absence of any radioactive, noise and light pollution.

11.4.5.4 CUMULATIVE IMPACT IN COMBINATION WITH OTHER PROJECTS IMPLEMENTED AT THE PROPOSED SITE AND ITS VICINITY, WHICH MAY BE HARMFUL TO THE NATURAL CAPITAL OF THE TWO COUNTRIES

According to the information contained in letter №615/RP/15.03.2013 by the Ministry of Environment and Climatic Changes of the Republic of Romania, there are no investment plans for the Romanian side of the 30 kilometer surveillance zone.

Based on the above, we can draw the conclusion that no significant negative impact on the examined territory is expected from the implementation of the NNU, as well as cumulative effect on biodiversity and the target species within the four protected areas – ROSPA0010 Bistreț (Bistrets), ROSPA0023 Confluență Jiu-Dunăre și (Merger of the Jiu River and the Danube River), ROSPA 0135 Nisipurile de la Dăbuleni și (Sands of Dabuleni), ROSCI0045 Coridorul Jiului (Jiu River corridor).

No impact is expected from the implementation of the NNU within the 30 kilometer monitoring scope, as well as on the integrity of the four protected areas – ROSPA0010 Bistreț (Bistrets), ROSPA0023 Confluență Jiu-Dunăre și (Merger of the Jiu River and the Danube River), ROSPA 0135 Nisipurile de la Dăbuleni și (Sands of Dabuleni) and ROSCI0045 Coridorul Jiului (Jiu River corridor) – in terms of their structure, functions and conservation purposes. No transboundary impact is expected.

11.4.6 COMPARATIVE MEASUREMENT OF THE GAMMA RADIATION BACKGROUND WITHIN THE 30 KM ZONE

The radiation gamma background is an objective radiological indicator reflecting the dynamics of the radiological state of the environment in real time, especially with regard to atmospheric air, but this is also valid for the remaining components. For the purpose, the biodiversity team conducted measurements to determine the natural radiation background and air radioactivity within the 30 km surveillance zone around the Kozloduy NPP. They made instrumental measurements of the radiation gamma background at the four alternative sites for the implementation of the NNU and of selected locations within the protected areas under Natura 2000 – BG0002009 "Zlatiyata", BG0000533 "Kozloduy Islands ", BG0000614 "Ogosta River " BG0000336 "Zlatiya" in Bulgaria and ROSPA0023 "Jiu River – Danube River valley", ROSCl0045 "Jiu River corridor ", ROSPA00l0 "Bistrets River" and ROSPA 00135 "Sands of Dabuleni" in Romania using a mobile dosimeter "Radioscope" Massag Sensoric GmbH, Basel, Switzerland.

The obtained results on the potency of the equivalent dose of gamma radiation are within the range from 0.10 to 0.19 μSv/h, which are similar to the ones measured in recent years This implies that **this background will remain within the same range, during the construction and during the operation and decommissioning.**

No impact is expected from the implementation of the NNU within the 30 kilometer monitoring scope, as well as on the integrity of the four protected areas – ROSPA0010 Bistreț (Bistrets), ROSPA0023 Confluență Jiu-Dunăre și (Merger of the Jiu River and the Danube River), ROSPA 0135 Nisipurile de la Dăbuleni și (Sands of Dabuleni) and ROSCI0045 Coridorul Jiului (Jiu River corridor) – in terms of their structure, functions and conservation purposes. No transboundary impact is expected.

11.4.6.1 Measures to reduce the impact on the protected areas within the Romanian part of the 30 km surveillance zone around the "Kozloduy" NPP and the impact of residual effects after their implementation

Based on the assessments presented above, we can draw the conclusion that there is no need to prescribe measures to reduce the negative impact on biodiversity, and there is no need to prescribe measures to reduce the negative impact on the protected areas within the Romanian part of the 30 km monitoring zone around the "Kozloduy" NPP.

11.5 Compliance with the requirements of the MEF of the Republic of Romania

In compliance with the requirements contained in the letter presented to the Assigning Authority by the Romanian Ministry of Environment and Forests, with outgoing № 3672/RP/18.10.2012, the EIAR includes information regarding the results from all examinations, analyses and forecasts done as parts of the EIA which are related to identifying the locations within the territory of the Republic of Romania, as an Affected Party under the Espoo Convention, where a high risk of significant impact exists.

In this context – ***as a subject of the transboundary impact assessment*** – the EIA incorporated studies on the possible impact on the environment and on human health resulting from the implementation of the Investment Proposal inside a Surveillance zone (within a 30 km radius around the Kozloduy NPP site), encompassing a total of 19 settlements on the territory of Romania. The assessment process was conducted by a joint team including both Bulgarian and Romanian experts, in order to ensure the objectiveness of the process of collecting and analyzing the necessary data and drawing conclusions based on that.

11.6 Requirements of the Ministry of Agriculture, Forestry, Environment and Water Management (MAFEWM) of Austria

The MAFEWM sent a letter with incoming № 99-00-68/19.03.2013 to the MoEW by which Austria asked Bulgaria to provide information regarding the IP, pursuant to the Convention on EIA in a Transboundary Context (the Espoo Convention). Austria requested to receive the notification and documentation regarding the scope of the EIA that would enable it to determine whether there would be any significant negative impact on the environment on its territory.

After consultation on the Assignment for scope and content of EIAR the MAFEWM of Austria sent a letter with outgoing No. 541402 dd 26.06.2013 for the participation of Austria in the transboundary procedure of EIAR indicating specific requirements.

The system ESTE EU Kozloduy, adapted for 5 and 6 reactors of Kozloduy NPP, was used for the forecast of the radiation consequences of major accidents. The objective of the system is to provide simultaneous assessment of the emergency in both reactors. The ESTE EU Kozloduy system operates with a database of the release sources, estimated and prepared for emergency reactions in 5 and 6 units of Kozloduy NPP. The data base is adapted to the release sources of NNU.

With reference to Vienna (781 км straight line from the Kozloduy site) the forecast results are lower than **1.10^{-9} Sv/h**, which is many times smaller than the natural radiation background.

The results of EIAR are presented and based on the analyses carried out it may be concluded that **there is no radiation risk for the Republic of Austria.**

12 OPINIONS OF THE TEAM AND THE LEADER PREPARING THE ASSESSMENT

The EIA Report outlines and assesses the impact of the NNU on the environment and on people's health.

The EIA Report incorporates a detailed analysis, a forecast and an assessment on the impact on all environmental components and factors, as well as on the health and hygiene aspects during the construction, operation and decommissioning of the **Investment Proposal for "Building a new nuclear unit of the latest generation at the Kozloduy NPP site".**

The report was prepared in compliance with the requirements of the effective legislation. Specific measures have been proposed for the reduction, prevention or fullest possible elimination of identified impacts on the environment and on human health, and synergistic effects of the radiation background have been identified.

The main conclusions of the EIA Report are the following:

During NNU construction

- ✓ The existing NPP "Kozloduy" infrastructure contributes to the safety of the staff during construction;
- ✓ Wastewater generated during construction will not deteriorate the quality of water in the Danube River;

- Subsurface layers will not be affected substantially by the implementation of the investment proposal;
- No impact is expected on the land use, mineral diversity, cultural heritage and protected natural areas;
- Deterioration of the landscape structure is negligible;
- No impact is expected on the biological diversity and on the areas inhabited by protected, significant and sensitive flora and fauna species;
- Noise and vibrations are restricted only within the territory of the NNU construction site and have no impact on the environment;
- No impact due to radiation factors related to the investment proposal during construction is expected as there are no significant, constant and non-regulated radioactive sources at that phase. The tools for non-destructive testing used in compliance with the safety measures shall not be considered as factor for radiation pollution of the working environment during construction of the new nuclear unit;

During NNU operation

- The existing NPP Kozloduy infrastructure and the extensive experience and expertise in the operation of the power plant contribute to the safety both of the population and of the staff in the NNU operation;
- The potential radiation impact on the staff operating NNU is expected to be within the limits of the design requirements laid down in the Investment Proposal;
- In non-radiation aspect, the NNU operation throughout its 60-year lifetime will not have negative impact on the population within the 30 and 100-kilometer zone around the power plant;
- The health risk for the closest residential area for all the four alternatives sites proposed is insignificant;
- The gaseous and aerosol releases will not have any significant impact on the health status of the population within the 30-kilometer zone around NPP Kozloduy;
- Gas emissions from internal combustion engines of the special vehicles and trucks in the NNU area will be negligible;
- Accounting for the provided quantity of drinking water for NPP Kozloduy and the available reserve in the plant consumption that will be used by NNU, the impact on the total water consumption of NPP Kozloduy will be insignificant;
- Faecal, industrial and spent cooling wastewater will not affect the ecological status of the water in the Danube River;
- Non-radiation impact on the environmental components and factors is not expected;

- Radiation impacts are not expected to occur on waters, land and soil, geological environment, subsoil, land use, mineral diversity, biological diversity, ecology and cultural resources; areas inhabited by protected, significant and sensitive flora and fauna species; scenic countryside; historic and cultural sites, sites protected by virtue of international or national law, or on the health of staff and population;
- No negative impact is expected from radioactive waste (RAW) if observing the decommissioning plans of the nuclear facility and all applicable Bulgarian and international legislative requirements and practices;
- The NNU contribution to the background gamma radiation in the area of the town of Kozloduy due to external radiation exposure is negligible even in cumulation with the existing nuclear facilities of the NPP Kozloduy site. The cumulative impact on the environment in radiation aspect is qualified as insignificant; no cumulative impact in non-radiation aspect is expected;
- Transboundary impact is not expected.

During decommissioning:

- No negative impact is expected to ensue on the population beyond the 2-kilometer zone during NNU decommissioning;
- Non-radiation impact on the environmental components and factors is not expected;
- No radiation impacts are expected on waters, land and soil, geological environment, subsoil, land use, mineral diversity, biological diversity, ecology and cultural resources; areas inhabited by protected, significant and sensitive flora and fauna species; scenic countryside; historic and cultural sites, sites protected by virtue of international or national law, or on the health of staff and population;
- During decommissioning no cumulative impact due to non-radiation factors is expected;
- No negative impact is expected from RAW if observing the decommissioning plans of the nuclear facility and all applicable Bulgarian and international legislative requirements and practices;

During all three stages of the implementation of the IP: construction, operation and decommissioning, no transboundary impact has been identified for the Romanian territory within the 30 km zone around Kozloduy NPP.

The EIA Report includes a detailed analysis, forecast and assessment of the impact on all environmental components and factors and was prepared in compliance with the requirements of the effective legislation. Specific measures have been suggested to prevent, and where that is not possible, to reduce the identified and assessed impacts.

Based on the analyses made and the assessment on the impact on all environmental components and factors, including the preservation of biodiversity, from the implementation of the IP for *"Building a new nuclear unit of the latest generation at the*

Kozloduy NPP site", **the priority choice for the construction of a new nuclear unit (NNU) is Site 2.** *Regarding the decision for the type of reactor – no specific model can be identified, since the three technical solutions are viable options for the implementation of the investment plan.*

Given the measures suggested by the experts and outlined in detail in Chapter 8 of the EIA Report, ensuring compliance with the environmental quality standards and preventing the adverse effects on the health of the population and the workers, as well as the assessment made on the compatibility of the IP with the subject matter and purpose of the protected areas, we suggest that the esteemed Supreme Expert Ecological Council of the MoEW should approve the implementation of the investment proposal for **Building a new nuclear unit of the latest generation at Site 2, which is located within the land of Kozloduy NPP.**